IEEE

BHI2023

IEEE-EMBS INTERNATIONAL CONFERENCE ON BIOMEDICAL AND HEALTH INFORMATICS

October 15 - 18, 2023 | Pittsburgh, PA

IEEE BHI 2023 CONFERENCE PROGRAM

Please visit our website for more information!

bhi.embs.org/2023

SPONSORS AND ORGANIZERS

IEEE

IEEE EMBS

IEEE Engineering in Medicine & Biology Society

Table of Contents

Welcome Letter

Dear Participants,

We are delighted and honored to extend a warm welcome to you on behalf of the Organizing Committee for the IEEE International Conference on Biomedical and Health Informatics (BHI 2023). Taking place in Pittsburgh, Pennsylvania from October 15-18, the conference is proudly sponsored by the IEEE Engineering in Medicine and Biology Society (IEEE-EMBS). As EMBS's premier technical event focusing on informatics and computing in healthcare and life sciences, this year marks the 8th installment of the IEEE BHI series.

Our legacy is enriched by a lineage of successful previous meetings in locations ranging from Hong Kong (2012) and Valencia (2014), to Las Vegas (2016, 2018) and Orlando (2017), and to Chicago (2019), virtual conference (2021) and Ioannina (2022). Keeping our commitment to achieving competitive paper acceptance rates established since BHI 2018 and specially strengthened in BHI 2021 and BHI 2022, this year, we were thrilled to receive 292 four-page papers, of which only 69 were accepted, which yielded a highly competitive rate of 23.6%. In addition, 122 one-page abstracts were submitted, with 99 making the cut.

The program at BHI 2023 is designed to engage and enlighten. It features six workshops, three tutorials, and eleven special sessions. Our main agenda includes five keynote talks from distinguished researchers in the field of BHI, 36 oral presentations organized across six thematic sessions, 58 rapid-fire presentations, five technical and career panels, and three poster sessions including 138 poster presentations. To ensure that you get the most out of these offerings, the conference will follow a single-track format.

This year's theme is "Transforming Healthcare and Medicine with AI." Beyond a myriad of AI-focused oral and poster presentations, we have curated special content including tutorials, workshops, keynote talks, and a panel centered on advances in ChatGPT and Large Language Models to explore the opportunities and challenges of these technologies in the medical and healthcare sectors.

Furthering our commitment to educational development, BHI 2023 offers special initiatives for students and postdoctoral fellows. Thanks to a grant from the National Science Foundation (NSF), we have provided travel awards to selected students to present their work at the conference. We are also hosting a data competition, a career panel, and a "Meet the BHI Leaders" session sponsored by IEEE Future Directions, the National Institute of Health (NIH) and Google to provide further opportunities for networking and career development.

While the focus is heavily on technical innovation, we have not forgotten the social aspect of the conference. We invite you to join us for a Welcome Reception and a Gala Banquet, which serve as excellent platforms for scientific networking. Our additional offerings include:
Best Paper Awards, to be announced during the conference.
Data Competition Awards to top-performing teams
A funding agency panel highlighting grant opportunities from NSF and NIH.
Meet the JBHI Editor panel
BHI Technical Committee meetings.
Leadership and Outstanding Service Awards to honor colleagues who have made significant contributions to the BHI Technical Committee.
Preprint access for all accepted four-page papers.
Invitations for selected papers to submit to high-impact journals in the field: IEEE Journal of Biomedical and Health Informatics and Computerized Medical Imaging and Graphics.
Refreshment breaks and lunches to enhance your conference experience.

We would like to express our heartfelt gratitude to the steering, organizing, and technical committees for their tireless work, to our reviewers for their critical input, and to all volunteers for their support. We also appreciate the generous sponsorship from NSF, NIH, Google, and UPMC Hillman Cancer Center. Above all, we thank you, the authors and participants, for bringing your groundbreaking work to BHI 2023.

We eagerly look forward to a stimulating and unforgettable event with you all!

Yufei Huang
Georgia Tourassi
Bjoern Eskofier
BHI 2023 General Co-Chairs

Event Conduct and Safety Statement Language

IEEE believes that science, technology, and engineering are fundamental human activities, for which openness, international collaboration, and the free flow of talent and ideas are essential. Its meetings, conferences, and other events seek to enable engaging, thought-provoking conversations that support IEEE's core mission of advancing technology for humanity. Accordingly, IEEE is committed to providing a safe, productive, and welcoming environment to all participants, including staff and vendors, at IEEE-related events.

IEEE has no tolerance for discrimination, harassment, or bullying in any form at IEEE-related events. All participants have the right to pursue shared interests without harassment or discrimination in an environment that supports diversity and inclusion. Participants are expected to adhere to these principles and respect the rights of others.

IEEE seeks to provide a secure environment at its events. Participants should report any behavior inconsistent with the principles outlined here, to on-site staff, security or venue personnel, or to eventconduct@ieee.org.

BHI 2023 Committees

Conference Co-Chairs
Yufei Huang, Univ. of Pittsburgh Medical Center
Georgia Tourassi, Oak Ridge National Lab
Bjoern Eskofier, Friedrich Alexander University

Technical Program Co-Chairs
David Clifton, Oxford Univ.
Parisa Rashidi, Univ. of Florida
Jian Ma, Carnegie Mellon Univ.

Special Session/ Workshop Co-Chairs
Bobak Mortazavi, Texas A&M Univ.
Souparno Ghosh, Univ. of Nebraska–Lincoln

Finance Chair
Jie Liang, Univ. of Illinois Chicago

Industry Liaison Chair
Ahmed A. Metwally, Google

Special Panel Chair
Ranadip Pal, Texas Tech Univ.

Local Arrangement Chair
Arun Das, Univ. of Pittsburgh Medical Center

Publication Chair
Edward Sazonov, Univ. of Alabama

Educational Activity Co-Chairs
Yu-Chiao Chiu, Univ. of Pittsburgh Medical Center
Ahmad Pahlavan Tafti, Univ. of Pittsburgh

Data Competition Chair
Kathy Grise, IEEE Future Directions Senior Program Director

Data Competition Co-Chairs
Subhamoy Mandal, IIT Kharagpur
Bobak Mortazavi, Texas A&M Univ.
Tayo Obafemi-Ajayi, Missouri State Univ.
Ryan King, Texas A&M Univ.

Social Activity Chair
Robert Richer, Friedrich Alexander Univ.

Steering Committee
May D. Wang, Georgia Tech & Emory Univ.
Andrew F. Laine, Columbia Univ.
Stephen Wong, Methodist Hospital & Weill Cornell Medical College
Dimitrios I. Fotiadis, Univ. of Ioannina

IEEE Sponsors

Sponsors

Conference Venue

On Sunday, October 15, 2023, BHI 2023 will be hosted in the **WESLEY W. POSVAR HALL**.

The venue address is:

WESLEY W. POSVAR HALL
230 S Bouquet St,
Pittsburgh, PA 15213, United States

DISTANCES to WESLEY W. POSVAR HALL
Airport: 21.9 miles
Hampton Inn Pittsburgh: 1.0 miles
The Oaklander Hotel: 0.3 miles
Hotel Indigo: 0.9 miles

Between Monday, October 16, 2023 and Wednesday, October 18, 2023, BHI 2023 will be primarily hosted in **the Soldiers & Sailors Memorial Hall & Museum**– five interconnected exhibition and meeting spaces – with keynote talks presented in the Auditorium for over 2300 guest capacity.

The venue address is:

Soldiers & Sailors Memorial Hall & Museum
4141 Fifth Ave 3rd Floor,
Pittsburgh, PA 15213, United States

DISTANCES to Soldiers & Sailors Memorial Hall & Museum
Airport: 22.2 miles
Hampton Inn Pittsburgh: 1.2 miles
The Oaklander Hotel: 0.2 miles
Hotel Indigo: 1.4 miles

Program at a Glance

Eastern Time	Sunday, October 15, 2023 Tutorials, Workshops, and Special Sessions						
Room	**WESLEY W. POSVAR HALL 1500**	**WESLEY W. POSVAR HALL 1501**	**WESLEY W. POSVAR HALL 1502**	**WESLEY W. POSVAR HALL 5108**	**WESLEY W. POSVAR HALL 5200**	**WESLEY W. POSVAR HALL 5400**	**WESLEY W. POSVAR HALL 5404**
8:30-17:00	**Registration**						
9:00-10:30	**Tutorial 1** How to tame your ChatGPT: Complex Reasoning with LLMs using Few-shot prompting **Tutorial Organizer**: Aman Madaan **Affiliation**: Carnegie Melon University	**Special Session 1** Open-Source Initiatives in Digital Health: Challenges Faced and Lessons Learned **Special Session Organizers**: Md Mobashir Hasan Shandhi, Jessilyn Dunn **Affiliation**: Duke University	**Tutorial 2** From Few to None: Exploring Few-Shot, One-Shot, and Zero-Shot Deep Learning in Clinical Settings **Tutorial Organizers**: Ahmed P. Tafti, Yu-Chiao Chiu, Yanshan Wang, Yufei Huang, Dana Tudorascu **Affiliation**: University of Pittsburgh		**Workshop 2** Computational Medicine Leveraging High Performance Computing and Artificial Intelligence **Workshop Organizers**: Khan Iftekharuddin, Georgia Tourassi **Affiliations**: Old Dominion University, ORNL	**Workshop 3** Understanding Inner States of Humans using Measurements of "Invisibles". **Workshop Organizers**: Bjoern M. Eskofier, Martin Vossiek, Anne D. Koelewijn **Affiliations**: Friedrich-Alexander-Universität (FAU)	**Special Session 2** Intelligent healthcare system with medical data fusion. **Special Session Organizers**: Deepika Koundal, Yanhui Guo **Affiliations**: UPES Dehradun, University of Illinois
10:30-10:45	**Coffee break**						
10:45-12:15	**Tutorial 1** How to tame your ChatGPT: Complex Reasoning with LLMs using Few-shot prompting **Tutorial Organizer**: Aman Madaan **Affiliation**: Carnegie Melon University	**Special Session 3** Recent Advances in Cuffless Blood Pressure Measurement. **Special Session Organizers**: Ramakrishna Mukkamala, Sanjeev G. Shroff **Affiliation**: University of Pittsburgh	**Tutorial 2** From Few to None: Exploring Few-Shot, One-Shot, and Zero-Shot Deep Learning in Clinical Settings **Tutorial Organizers**: Ahmed P. Tafti, Yu-Chiao Chiu, Yanshan Wang, Yufei Huang, Dana Tudorascu **Affiliation**: University of Pittsburgh		**Workshop 2** Computational Medicine Leveraging High Performance Computing and Artificial Intelligence **Workshop Organizers**: Khan Iftekharuddin, Georgia Tourassi **Affiliations**: Old Dominion University, ORNL	**Workshop 3** Understanding Inner States of Humans using Measurements of "Invisibles". **Workshop Organizers**: Bjoern M. Eskofier, Martin Vossiek, Anne D. Koelewijn **Affiliations**: Friedrich-Alexander-Universität (FAU)	**Special Session 4** AI for Neurodiversity: Advancements and Opportunities. **Special Session Organizers**: Hugo Posada-Quintero, Youngsun Kong, Md Billal Hossain, Andrew Peitzsch, Jihye Moon, Sultan M. Manjur **Affiliation**: University of Connecticut

Program at a Glance

Eastern Time	Sunday, October 15, 2023 Tutorials, Workshops, and Special Sessions						
14:00-15:30	**Workshop 4** Unraveling Challenges in Time Series Analysis with Open Source Tools for Digital Health Applications **Workshop Organizers**: Md. Mobashir Hasan Sandhi, Hayoung Jeong, Ke Wang, Bill Chen, Bobak Jack Mortazavi, Jessilyn Dunn **Affiliations**: Duke University, Duke University, Duke University, Duke University, Texas A&M University, Duke University	**Tutorial 3** The Single-Cell Spatial Transcriptomics Analysis (ScSTA) Cookbook **Tutorial Organizer**: Arun Das **Affiliation**: University of Pittsburgh	**Workshop 5** The Opportunities and Challenges of ChatGPT in Brain-Machine Interface **Workshop Organizers**: Ker-Jiun Wang, Ramana Vinjamuri, Maryam Alimardani, Zhi-Hong Mao, Midori Sugaya **Affiliations**: University of Pittsburgh, UMBC, Tilberg University, University of Pittsburgh, Shibaura Institute of Technology	**Workshop 6** Transformative Pathways: Advancing Global Collaboration for Gender Equality and Inclusivity in Research and Innovation **Workshop Organizers**: Maria Fernanda Cabrera-Umpierrez, Yolanda Ursa **Affiliation**: Life Supporting Technologies, INMARK	**Special Session 5** Enabling Closed-Loop Technologies for Mental Health: Biobehavioral Sensor Informatics and Just-in-Time Interventions. **Special Session Organizers**: Asim H. Gazi, Jin-Oh Hahn, Omer T. Inan **Affiliations**: Gerogia Institute of Technology, University of Maryland, Georgia Institute of Technology	**Special Session 6** Trustworthy and responsible data analytics for mental health. **Special Session Organizers**: Theodora Chaspari; Brandon Booth; Tiantian Feng; Emily Mower Provost; Adela C. Timmons; Shrikanth Narayanan **Affiliations**:	**Data Competition Co-Chairs:** Kathy Grise, Subhamoy Mandal, Bobak Mortazavi, Tayo Obafemi-Ajayi, Ryan King
15:30-15:45	**Coffee break**						
15:45-17:15	**Workshop 4** Unraveling Challenges in Time Series Analysis with Open Source Tools for Digital Health Applications **Workshop Organizers**: Md. Mobashir Hasan Sandhi, Hayoung Jeong, Ke Wang, Bill Chen, Bobak Jack Mortazavi, Jessilyn Dunn **Affiliations**: Duke University, Duke University, Duke University, Duke University, Texas A&M University, Duke University	**Tutorial 3** The Single-Cell Spatial Transcriptomics Analysis (ScSTA) Cookbook **Tutorial Organizer**: Arun Das **Affiliation**: University of Pittsburgh	**Workshop 5** The Opportunities and Challenges of ChatGPT in Brain-Machine Interface **Workshop Organizers**: Ker-Jiun Wang, Ramana Vinjamuri, Maryam Alimardani, Zhi-Hong Mao, Midori Sugaya **Affiliations**: University of Pittsburgh, UMBC, Tilberg University, University of Pittsburgh, Shibaura Institute of Technology	**Workshop 6** Transformative Pathways: Advancing Global Collaboration for Gender Equality and Inclusivity in Research and Innovation **Workshop Organizers**: Maria Fernanda Cabrera-Umpierrez, Yolanda Ursa **Affiliation**: Life Supporting Technologies, INMARK	**Special Session 7** Machine learning-enabled solutions to improve diagnostic and prognostic accuracy in patients with severe brain injury: challenges and perspectives. **Special Session Organizers**: Andrea Mannini, Anna Estraneo **Affiliations**: IRCCS Foundazione Don Carlo Gnocchi Onlus, Italy	**Special Session 8** Recent Advances in Statistical Methodologies with applications in Health and Medical Informatics **Special Session Organizer**: Souparno Ghosh **Affiliation**: University of Nebraska–Lincoln	**Data Competition Co-Chairs:** Kathy Grise, Subhamoy Mandal, Bobak Mortazavi, Tayo Obafemi-Ajayi, Ryan King

Program at a Glance

Eastern Time	**Monday, October 16, 2023**	
8:30-17:00	Registration	
8:15-8:30	Opening ceremony	
8:30-9:15	**Keynote**: Bin He - "AI for Mapping and Interfacing with the Brain" Chair: Yufei Huang	
9:15-9:30	Coffee break	
9:30-11:15	Oral session 1 AI for Mental and Population Health **Chair**: Bobak Jack Mortazavi	
11:30-12:30	**Panel**: ChatGPT for Medicine: Exploring the Journey from the Past to the Present, and Beyond **Panelists**: Carolyn Rose, CMU Shyam Visweswaran, Pitt DBMI Shandong Wu, Pitt Radiology Yonghui Wu, University of Florida **Moderator**: Yanshan Wang (Room: Auditorium)	
12:45-13:45	Rapid fire 1 & box lunch **Chair**: MD Mobashir Hasan Shandhi	
14:00-15:45	Oral session 2 Disease Detection and Diagnosis **Chair**: Souparno Ghosh	
15:45-16:00	Coffee break	
16:00-17:00	**Panel**: Meet the funding agencies **Panelists**: NSF: Mitra Basu (https://www.nsf.gov/staff/staff_bio.jsp?lan=mbasu&org=NSF&from_org=) NIH: Juli Klemm (https://cssi.cancer.gov/about-us/leadership/juli-klemm-phd) **Moderator**: Ranadip Pal (Room: Auditorium)	
17:15-19:00	Poster session 1	Special session 9 Artificial Intelligence (AI) in Critical Care **Special Session Organizers**: Parisa Rashidi, Azra Bihorac **Affiliation**: University of Florida
19:15-21:00	Reception	
19:30-20:30	**Panel**: Meet the BHI leaders (Room: Ballroom)	

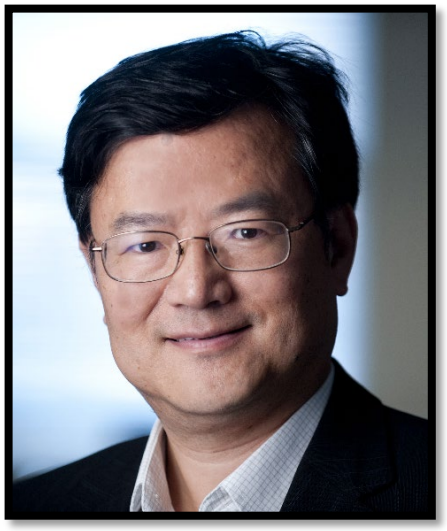
Program at a Glance

Eastern Time	**Tuesday, October 17, 2023**	
8:30-17:00	Registration	
8:30-9:15	**Keynote**: Yonghui Wu - "Large Language Models in Medicine and Healthcare"	
9:15-9:30	Coffee break	
9:30-11:15	Oral session 3 Informatics and Health Systems **Chair**: Ahmed Metwally	
11:30-12:15	**Keynote**: Tulay Adali - "Matrix and Tensor Factorizations for Neuroimaging Data Analysis and Fusion" **Chair:** Jie Liang	
12:25-12:55	Meet the JBHI Editor - Dimitrios I. Fotiadis **Moderator**: May D. Wang	
13:00-13:55	Rapid fire 2 & box lunch **Chair**: Akane Sano	
14:00-15:45	Oral session 4 Medical Imaging and Sensor Data **Chair**: Edward Sazonov	
15:45-16:00	Coffee break	
16:00-17:00	**Panel**: Career Panel **Panelists**: Dr. Ahmed Metwally, Google Dr. Sreeram Balasubramanian, Novasenta Dr. Ryan Weil, Frederick National Lab Dr. May D. Wang, Georgia Tech Kathy Geise, IEEE Future Directions **Moderator**: Georgia Tourassi (Room: Auditorium)	
17:15-19:00	Poster session 2	Special session 10 Multimodal Learning in Healthcare: From Wearable Sensing to Clinical AI Decision-Making. **Special Session Organizers**: Lei Lu, Tingting Zhu **Affiliation**: University of Oxford
19:00-21:00	Banquet (Room: Ballroom)	

Program at a Glance

Eastern Time	**Wednesday, October 18, 2023**	
8:30-17:00	Registration	
8:30-9:15	**Keynote**: Rick L. Stevens – "AI for Science, Energy, and Security: DOE Laboratories &Vision for Advanced AI Systems" **Chair:** Georgia Tourassi	
9:15-9:30	Coffee break	
9:30-11:15	Oral session 5 Medical Imaging and Sensor Data **Chair**: Yu-Chiao Chiu	
11:30-12:15	**Keynote**: Tansu Celikel - "Innovation through Imitation: Designing Artificial Networks with Lessons from Neural Networks" **Chair:** Bjoern Eskofier	
12:30-13:15	Rapid fire 3 & box lunch **Chair**: Arun Das	
13:30-14:00	Data Competition **Co-Chairs**: Kathy Grise, Subhamoy Mandal, Bobak Mortazavi, Tayo Obafemi-Ajayi, Ryan King, Robert Richer	
14:15-15:45	Oral session 6 Medical Imaging and Sensor Data **Chair**: Lei Lu	
15:45-16:00	Coffee break	
16:00-17:45	Poster session 3	Special Session 11 State-of-the-Art in Predictive Analytics for Inpatient Care **Special Session Organizers:** Joo Heung Yoon, Michael R. Pinsky **Affiliations:** University of Pittsburgh
17:45-18:00	Award and closing ceremony (Room: Auditorium)	

Keynote Speakers



Date: Monday, October 16, 2023
Time: 8:30 – 9:15
Location: Auditorium

AI For Mapping and Interfacing with the Brain

Speaker: Prof. Bin He
Abstract: Brain activity is distributed over the 3-dimensional volume and evolves in time. Mapping spatio-temporal distribution of brain activation with high spatial resolution and high temporal resolution is of great importance for understanding the brain and aiding in the clinical diagnosis and management of brain disorders. Electrophysiological source imaging from noninvasively recorded electroencephalogram (EEG) has played a significant role in advancing our ability to image brain function and dysfunction. We will discuss how AI/ML can greatly facilitate addressing technical challenges in electrophysiological source imaging, and applications to mapping cortical sensory processing, perception and epileptogenic networks using high density EEG. We will also discuss principles and state of the art of brain-computer interface using noninvasive EEG, from which human intention is decoded using novel ML/AI algorithms. We show that human is able to control the flight of a drone and a robotic arm for reach, grasp and continuously move in 3D space, using "thoughts" alone decoded from noninvasive EEG. Our results also show that experience with mindful meditation can improve human's capability for mind control, suggesting the importance of human-machine intelligence.

CV: Bin He is a Trustee Professor of Biomedical Engineering, Professor by courtesy of Electrical and Computer Engineering, Professor of Neuroscience Institute, and director of NIH Neural Interfacing Training Program at Carnegie Mellon University. He's major research interests include brain-computer interface, electrophysiological neuroimaging, and neuromodulation. He's pioneering and sustained contributions helped transform electroencephalography (EEG) from a 1-dimensional sensing technology into a modern 3-dimensional functional neuroimaging modality for source localization and imaging of spatio-temporal brain activity and functional connectivity. He has made significant original contributions to noninvasive brain-computer interface. His team was the first to enable a human to fly a drone as well as the first to control a robotic arm to reach and grasp an object, and continuously move in 3-dimensional space, using "thoughts" alone decoded from noninvasive EEG. He has published ~300 peer-reviewed journal articles, and given over 180 plenary, keynote, and invited talks at a number of national and international conferences and institutions. He is a Fellow of the International Academy of Medical and Biological Engineering (IAMBE), the National Academy of Inventors (NAI), IEEE, the American Institute of Medical and Biological Engineering (AIMBE), and the Biomedical Engineering Society (BMES). His research has been recognized by major awards including the IEEE Biomedical Engineering Award, IEEE EMBS William J. Morlock Award, and the IEEE EMBS Academic Achievement Award. He is the Editor-in-Chief of the IEEE Reviews in Biomedical Engineering and was the former Editor-in-Chief of the IEEE Transactions on Biomedical Engineering. Dr. He served as a Past President of IEEE Engineering in Medicine and Biology Society and is the immediate Past Chair of International Academy of Medical and Biological Engineering.

Date: Tuesday, October 17, 2023
Time: 8:30 – 9:15
Location: Auditorium

Large Language Models in Medicine and Healthcare

Speaker: Prof. Yonghui Wu

Abstract: Brain activity is distributed over the 3-dimensional volume and evolves in time. Mapping spatio-temporal distribution of brain activation with high spatial resolution and high temporal resolution is of great importance for understanding the brain and aiding in the clinical diagnosis and management of brain disorders. Electrophysiological source imaging from noninvasively recorded electroencephalogram (EEG) has played a significant role in advancing our ability to image brain function and dysfunction. We will discuss how AI/ML can greatly facilitate addressing technical challenges in electrophysiological source imaging, and applications to mapping cortical sensory processing, perception and epileptogenic networks using high density EEG. We will also discuss principles and state of the art of brain-computer interface using noninvasive EEG, from which human intention is decoded using novel ML/AI algorithms. We show that human is able to control the flight of a drone and a robotic arm for reach, grasp and continuously move in 3D space, using "thoughts" alone decoded from noninvasive EEG. Our results also show that experience with mindful meditation can improve human's capability for mind control, suggesting the importance of human-machine intelligence.

CV: Dr. Wu is an Associate Professor with Tenure in the Department of Health Outcomes and Biomedical Informatics at the University of Florida (UF) College of Medicine. He also serves as the Director of Natural Language Processing (NLP) at UF Clinical and Translational Science Institute (CTSI) and OneFlorida+ Clinical Research Consortium. Dr. Wu's primary research interests include clinical NLP, machine learning, and Electronic Health Record (EHR) based drug repurposing. He has worked on various challenging clinical NLP topics including large language models, prompt-based learning, text generation, patient information extraction, NLP-powered computable phenotyping, disease predictive modeling, and many other artificial intelligence (AI) applications in the medical domain. His work was supported by funding from the National Institutes of Health (NIH), Patient-Centered Outcomes Research Institute (PCORI), and Centers for Disease Control and Prevention (CDC).

Date: Tuesday, October 17, 2023
Time: 11:30 – 12:15
Location: Auditorium

Matrix and Tensor Factorizations for Neuroimaging Data Analysis and Fusion

Speaker: Tülay Adali

Abstract: In many fields today, such as neuroscience, remote sensing, computational social science, and physical sciences, multiple sets of data are readily available. Matrix and tensor factorizations enable joint analysis, i.e., fusion of these multiple datasets such that they can fully interact and inform each other while also minimizing the assumptions placed on their inherent relationships. A key advantage of these methods is the direct interpretability of their results. This talk presents an overview of models based on independent component analysis, and its generalization to multiple datasets, independent vector analysis, and explains how these methods effectively leverage the information within and across the datasets. Examples using multi-subject neuroimaging data are given to demonstrate the effectiveness of the methods in applications such as subgroup identification for precision medicine.

CV: Tülay ADALI is a Distinguished University Professor at the University of Maryland Baltimore County (UMBC), Baltimore, MD. She received the Ph.D. degree in Electrical Engineering from North Carolina State University, Raleigh, NC, USA, in 1992 and joined the faculty at UMBC the same year. Over the years, she has served the IEEE and the IEEE Signal Processing Society (SPS) in numerous capacities. She is currently the Chair of the IEEE Brain Technical Community, and served as the Signal Processing Society (SPS) Vice President for Technical Directions 2019−2022. She has been part of the organizing committees of many conferences and workshops including the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Technical Chair (2017), Special Sessions Chair (2018 and 2024), Publicity Chair (2000 and 2005), and Publications (2008). She was the General/Technical Chair for the IEEE Machine Learning for Signal Processing (MLSP) and Neural Networks for Signal Processing (NNSP) Workshops 2001−2009, and 2014, and she is General Chair for 2023 MLSP. She served multiple terms in three technical committees of the SPS (NNSP/MLSP, Bio Imaging and Signal Processing, Signal Processing Theory and Methods) and chaired the NNSP/MLSP Technical Committee, 2003–2005 and 2011–2013. She served or is currently serving on the editorial board of multiple journals, including the IEEE Transactions on Signal Processing, Proceedings of the IEEE, and the IEEE Journal of Selected Topics in Signal Processing. Prof. Adali is a Fellow of the IEEE, AIMBE, and AAIA, a Fulbright Scholar, and an IEEE SPS Distinguished Lecturer. She is the recipient of the SPS Meritorious Service Award, Humboldt Research Award, IEEE SPS Best Paper Award, the SPIE Unsupervised Learning and ICA Pioneer Award, the University System of Maryland Regents' Award for Research, and the NSF CAREER Award.

Date: Wednesday October 18, 2023
Time: 11:30 – 12:15
Location: Auditorium

Innovation through Imitation: Designing Artificial Networks with Lessons from Neural Networks

Speaker: Tansu Celikel
Abstract: Biological networks exhibit remarkable complexity and organization, enabling them to perform a wide range of computations efficiently. The study of biological networks can provide valuable insights into the principles of information processing, robustness, and adaptability, which can be leveraged to develop better artificial networks.

This keynote lecture will discuss the intersection of biological networks research and artificial intelligence, and present examples of how the study of biological networks has informed the design of new artificial network architectures and algorithms. I will also discuss the challenges and opportunities for developing artificial networks that can match the performance of biological systems.

Take-home message: The study of biological networks organization can provide valuable insights and principles that can help in the development of better artificial networks. By understanding the connectivity, node types, direction of information flow, and structural and functional organizational principles of biological networks, researchers can design artificial networks that mimic the computational efficiency and functional scalability of biological systems.

CV: Tansu Celikel received his Ph.D. in Systems Neuroscience from La Scuola Internazionale Superiore di Studi Avanzati (SISSA, Italy) in 2001. After postdoctoral research at the University of California, San Diego (USA) and the Max-Planck Institute for Medical Research (Heidelberg-Germany), he started his first laboratory at the University of Southern California (Los Angeles-USA) in 2008. In 2012, Dr. Celikel was promoted to full professor and moved to Radboud University, the top-ranked university in the Netherlands. At Radboud, he established the Department of Neurophysiology, a binational (Dutch/German) Graduate School of Bionics, formed the Neurotechnology and Neural Computation research cluster at the Donders Institute for Brain, Cognition, and Behavior and became a member of the board of directors at Donders in 2016. Dr. Celikel served as the Speaker of the Institute between 2016-2019 before being appointed as its Scientific Director in 2019. In 2021, Dr. Celikel joined Georgia Institute of Technology as the next chair of its School of Psychology.

Dr. Celikel's research is focused on reverse engineering the brain circuits and neural computations that are responsible for sensorimotor control, and forward engineering brain-inspired in silico circuits that perform active sensing, adaptive computations, and maples navigation. His research is regularly published in top scientific journals including Science, Science Robotics, PNAS, Nature Neuroscience among others. He is a Sloan Fellow (USA), Alexander von Humboldt Fellow (Germany), a Whitehall Investigator (USA), and a recipient of the young investigator award from the Italian Ministry of University, Scientific Research, and Technology. He also received the "Cube Award" and "Team Science Award" from Radboud University for his exemplary work to promote DEI and for founding the NeurotechEU to promote team research and education across Europe, respectively.

Date: Wednesday October 18, 2023
Time: 8:30 – 9:15
Location: Auditorium

AI for Science, Energy, and Security: DOE Laboratories' Vision for Advanced AI Systems

Speaker: Rick. L Stephens

Abstract: In the summers of 2019 and 2022, the DOE Laboratories convened a series of influential townhall meetings, drawing attention to the potential and challenges of harnessing AI for groundbreaking scientific research, spanning from biology to high-energy physics. This presentation will distill the key insights from these workshops, spotlighting the six roles AI ispoised to play, and provide examples. We'll discuss how the DOE's investments in Exascale computing platforms like Aurora, Frontier, and El Capitan, coupled with DOE's network of national experimental user facilities and a robust data infrastructure, are setting the stage for pioneering AI systems. Building on this foundation, we envision a major initiative in AI research and development, with the goal to accelerate discoveries in the fundamental sciences, advance innovations in energy technology, and improve our approaches to national security.

CV: Rick Stevens is a Professor of Computer Science at the University of Chicago as well as the Associate Laboratory Director of the Computing, Environment and Life Sciences (CELS) Directorate and Argonne Distinguished Fellow at Argonne National Laboratory. In these, and in numerous other roles, he is responsible for ongoing research in the computational and computer sciences from high-performance computing architecture to the development of tools and methods for bioinformatics, cancer, infectious disease, and other challenges in science and engineering. Recently, he has focused on developing AI methods for a variety of scientific and biomedical problems, and also has significant responsibility in delivering on the U.S. national initiative for Exascale computing and the Argonne AI for Science initiative.

Currently, Stevens is the PI of the Bacterial / Viral Bioinformatics Resource Center (BV-BRC) which is developing comparative analysis tools for infectious disease research and serves a large user community; the Exascale Deep Learning and Simulation Enabled Precision Medicine for Cancer project through the Exascale Computing Project (ECP) which focuses on building a scalable deep neural network application called the CANcer Distributed Learning Environment (CANDLE) and recently earned a 2023 R&D100 Award; the Innovative Methodologies and New Data for Predictive Oncology Model Evaluation (IMPROVE) project which is building a comprehensive framework and exascale workflow to compare deep learning models that are aimed at solving critical problems; and the Exploration of the Potential for Artificial Intelligence and Machine Learning to Advance Low-Dose Radiation Biology Research (RadBio-AI) project to investigate the opportunity of understanding the impact of low doses of radiation on biological systems, including humans.

Stevens is a Fellow of the American Association for the Advancement of Science and a Fellow of the Association of Computer Machinery (ACM).

Panels

ChatGPT for Medicine: Exploring the Journey from the Past to the Present, and Beyond Panel

Moderator: Yanshan Wang, University of Pittsburgh
Date: Monday, October 16, 2023
Time: 11:30 – 12:30
Location: Auditorium

Panelists:

Carolyn Rose, CMU
Shyam Visweswaran, Pitt DBMI
Shandong Wu, Pitt Radiology
Yonghui Wu, University of Florida

Meet the Funding Agencies Panel

Moderator: Ranadip Pal, Texas A&M University
Date: Monday, October 16, 2023
Time: 16:00 – 17:00
Location: Auditorium

Panelists:

Mitra Basu, National Science Foundation
Juli Klemm, National Institutes of Health

Meet the BHI Leaders Panel

Moderators: Yu-Chiao Chiu, Ahmed A. Metwally, Ahmad P. Tafti, Yufei Huang
Date: Monday, October 16, 2023
Time: 19:30 – 20:30
Location: Ballroom

Panelists:

Tülay Adali, University of Maryland, Baltimore County
Mitra Basu, National Science Foundation
Bjoern Eskofier, Friedrich-Alexander-Universität Erlangen-Nürnberg
Andrew F. Laine, Columbia University
Georgia Tourassi, Oak Ridge National Laboratory
Stephen T. Wong, Houston Methodist Hospital & Weill Cornell Medicine
Yonghui Wu, University of Florida
Kathy L. Grise, IEEE Future Directions
Jie Liang, University of Illinois Chicago
May D. Wang, Georgia Tech & Emory University

Dine and network with world-class leaders in Biomedical and Health Informatics. Don’t miss your chance to win raffle prizes for this event!

Career Panel

Moderator: Georgia Tourassi
Date: Tuesday, October 17, 2023
Time: 16:00 – 17:00
Location: Auditorium

Panelists:

Dr. Ahmed Metwally, Google
Dr. Sreeram Balasubramanian, Novasenta
Dr. Ryan Weil, Frederick National Lab
Dr. May D. Wang, Georgia Tech
Kathy L. Grise, IEEE Future Directions

IEEE BHI 2023 Workshops

All workshops will be held on Sunday, October 15, 2023.

Title: Understanding Inner States of Humans using Measurements of "Invisibles"
Organizers: Bjoern M. Eskofier, Martin Vossiek, Anne D. Koelewijn
Affiliations: FAU Friedrich-Alexander-Universität (FAU)
Location: Wesley W. Posvar Hall 5400
Time: 9:00-10:30; 10:45-12:15
Short Description: Every movement of the body of a living being is the result of mechanisms of action taking place inside of the body and interactions between them. The body's motor functions are initiated and regulated by neuronal processes and, more complex movements, controlled by sensitive body perception and cognition. Depending on the physical constitution, state of health or stress, and movements, parameters of the (interaction) mechanisms change. The symposium will focus on new ideas, sensors, and technologies such as radar, radio, laser, and camera sensors (called "Invisibles") to improve the diagnosis process and the daily lives of patients and physicians. It will bring together technical experts in biomedical signal processing and physicians specializing in patient care. The symposium will provide a forum for academia, clinicians, industry, health insurance, and governing bodies to exchange ideas and promote collaboration.

Title: The Opportunities and Challenges of ChatGPT in Brain-Machine Interface
Organizers: Ker-Jiun Wang, Ramana Vinjamuri, Maryam Alimardani, Zhi-Hong Mao, Midori Sugaya
Affiliations: University of Pittsburg, UMBC, Tilberg University, University of Pittsburg, Shibaura Institute of Technology
Location: Wesley W. Posvar Hall 1502
Time: 14:00-15:30; 15:45-17:15
Short Description: The emergence of brain-machine interface (BMI) technology has revolutionized the way we interact with machines and computers, enabling direct communication between the human brain and external devices. With recent advancements in artificial intelligence, ChatGPT, a language model developed by OpenAI, has become a powerful tool for natural language processing and generation. This workshop explores the challenges and opportunities associated with integrating ChatGPT into BMI systems. One of the main challenges lies in developing a seamless and efficient connection between ChatGPT and the BMI, allowing for real-time bidirectional communication. This requires overcoming the limitations of current BMI technology, such as low signal resolution, signal latency, and the need for invasive neural implants. Additionally, ChatGPT needs to be adapted to process and generate text in a way that aligns with the user's intentions, while also respecting ethical and privacy considerations.

However, the integration of ChatGPT in BMI systems presents significant opportunities. Firstly, it can enhance the communication capabilities of BMIs by enabling users to generate and receive text-based information through their thoughts. This can greatly improve the speed and efficiency of human-machine interaction. Moreover, ChatGPT's ability to understand and generate natural language can facilitate more intuitive and user-friendly interfaces for BMIs, enabling individuals with limited mobility to operate devices and communicate with others more effectively. Furthermore, ChatGPT can act as a mediator between users and external systems, providing a bridge for individuals with disabilities to access and control various technologies. It can assist in tasks such as composing emails, browsing the internet, or controlling smart home devices, opening up new possibilities for individuals with motor impairments. Additionally, the continuous interaction with users through ChatGPT can enable personalized and adaptive BMI systems, improving user satisfaction and system performance.

While integrating ChatGPT into BMI systems poses technical and ethical challenges, it also offers immense potential for advancing human-machine interaction. By addressing these challenges and leveraging the opportunities, the synergy between ChatGPT and BMIs can pave the way for more natural, efficient, and inclusive communication between humans and machines, empowering individuals with disabilities and enhancing overall quality of life.

IEEE BHI 2023 Workshops (continued)

Title: Unraveling Challenges in Time Series Analysis with Open Source Tools for Digital Health Applications
Organizers: Md. Mobashir Hasan Sandhi, Hayoung Jeong, Ke Wang, Bill Chen, Bobak Jack Mortazavi, Jessilyn Dunn
Affiliations: Duke University, Duke University, Duke University, Duke University, Texas A&M University, Duke University
Location: Wesley W. Posvar Hall 1500
Time: 14:00-15:30; 15:45-17:15
Short Description: Time series analysis is becoming increasingly important in digital health and healthcare predictive analytics because it allows us to analyze data collected over time from medical devices and wearables. By analyzing time series data, clinicians can better understand the trajectory of a patient's condition, monitor disease progression, and provide longitudinal care and management. However, challenges still exist in identifying proper preprocessing and feature engineering methods, incorporating multimodal signals, imputing missing values, and cleaning noisy data while retaining meaningful information about one's physiological and behavioral changes. From processing the multimodal wearable sensor data to the development of machine learning models, we will introduce open-source initiatives and resources that can be readily used by researchers in digital health. In addition, we will emphasize the importance of open science and invite researchers to contribute their work to open source initiatives to enhance the reproducibility and accessibility of their research. In this workshop we will introduce digital health, digital biomarkers, and time-series physiological signals and data collected through various wearable sensors. We will discuss the current trends (in academia and industry) & challenges in preprocessing and performing data analytics/predictive modeling using multi-modal, time-series biomedical signal/data. We will further introduce a open source initiative, i.e., the Digital Biomarker Discovery Pipeline (DBDP) that host pre-built modular methods to process time-series data and demonstrate how currently available open source tools can be utilized by researchers, clinicians, and bioinformaticians. Finally, we will summarize the lessons learned in the workshop and share how the community can contribute to these efforts.

Title: Computational Medicine Leveraging High Performance Computing and Artificial Intelligence
Organizers: Khan Iftekharuddin, Georgia Tourassi
Affiliations: Old Dominion University, ORNL
Location: Wesley W. Posvar Hall 5200
Time: 9:00-10:30; 10:45-12:15
Short Description: The convergence of personalized digital health technologies, high performance computing, and artificial intelligence have ushered a new era in health informatics and healthcare delivery. Computational medicine holds immense promise for personalized disease management, from diagnosis, to treatment, to prognosis. This session aims to highlight successful examples of multi-scale, multi-modal disease modeling and applications from the bench to the bedside, to fully realize the potential of computational modeling and personalized data in clinical practice. The workshop will include 5 invited speakers covering a broad spectrum of computational medicine applications highlighting the importance of high-performance computing and AI. The session will conclude with a panel discussion.

We will send announcements to relevant computational, machine learning, and biomedical mailing lists. As soon as our proposal is accepted, we will create a webpage and call for participation immediately. We will continue to send the call for participation to relevant mailing lists. We will also advertise the workshop in all appropriate presentations that we give, and we will ask our speakers to do the same.

IEEE BHI 2023 Workshops (continued)

All workshops will be held on Sunday, October 15, 2023.

Title: Transformative Pathways: Advancing Global Collaboration for Gender Equality and Inclusivity in Research and Innovation
Organizers: Maria Fernanda Cabrera-Umpierrez, Yolanda Ursa
Affiliations: Life Supporting Technologies, INMARK
Location: Wesley W. Posvar Hall 5108
Time: 14:00-15:30; 15:45-17:15
Short Description: The workshop aims to promote a collective comprehension of the fundamental principles and values that should drive international cooperation in science, technology, and innovation (STI), specifically focusing on fostering gender equality and inclusivity in research. Despite advancements in policy adoption at both international and national levels, the implementation of gender equality policies continues to pose challenges at the institutional level. Moreover, it is crucial to broaden the scope of gender equality policies to encompass inclusivity and intersectionality, considering other dimensions of diversity and potential grounds for discrimination, such as ethnicity, disability, or sexual orientation.

By exchanging best practices and embracing a multilateral perspective, participants will have the opportunity to share policies, initiatives, and activities, thereby cultivating a trusted environment for collaborative research and innovation with specific attention to gender equality and inclusion. The workshop aims to create a platform for open discussions, enabling the exchange of ideas and experiences among diverse stakeholders. Through interactive sessions, participants will explore effective strategies to address the existing gaps and barriers in achieving gender equality in R&I.

The workshop will be divided into two engaging parts, fostering collaboration and enabling participants to contribute their insights and ideas towards driving change in research and innovation.

IEEE BHI 2023 Tutorials

All tutorials will be held on Sunday, October 15, 2023.

Title: From Few to None: Exploring Few-Shot, One-Shot, and Zero-Shot Deep Learning in Clinical Settings
Organizers: Ahmed P. Tafti, Yu-Chiao Chiu, Yanshan Wang, Yufei Huang, Dana Tudorascu
Affiliations: University of Pittsburgh
Location: Wesley W. Posvar Hall 1502
Time: 9:00-10:30, 10:45-12:15
Short Description: Deep learning algorithms have made significant advances in a wide range of clinical applications, including medical imaging informatics, clinical natural language processing, and health data sciences. However, traditional deep learning methods often require large columns of manually annotated and gold-standard data, which can be expensive and very time-consuming in clinical settings. In recent years, there has been growing interest in developing deep learning methods that can learn from a few samples or even no samples at all, known as few-shot and zero-shot learning, respectively. The current tutorial at IEEE BHI 2023 aims to mainly provide a professional forum to share state-of-the-art in few-shot, one-shot, and zero-shot learning in two different settings: (1) Medical Imaging Informatics and Transcriptomics, and (2) Clinical Natural Language Processing. In this tutorial, which is also equipped with a hackathon, we will be exploring the latest advances in few-shot deep learning. We will start with an overview of the basic concepts and techniques involved in these areas, and we will then dive into specific applications of few-shot, one-shot, and zero-shot learning in medical imaging, image embeddings of molecular (RNA-Seq) data, and clinical natural language processing. Participants will have the opportunity to work on hands-on coding exercises and challenges, using popular deep learning frameworks such as PyTorch. They will learn how to build, train, validate, and test few-shot models, and how to evaluate their performance on different datasets. By the end of the tutorial, participants will have a solid understanding of the state-of-the-art in few-shot deep learning and will achieve practical experience in implementing and validating these techniques.

Title: How to tame your ChatGPT: Complex Reasoning with LLMs using Few-shot prompting
Organizers: Aman Madaan
Affiliations: Carnegie Melon University
Location: Wesley W. Posvar Hall 1500
Time: 9:00-10:30, 10:45-12:15
Short Description: Few-shot prompting, a technique where a model is presented with a few examples (or 'shots') of a task, and then 'prompted' with a similar task, has been transformative in the field of natural language processing. It has enabled us to leverage the power of Large Language Models (LLMs) such as ChatGPT and PaLM2 to effectively respond to a wide array of tasks without requiring extensive task-specific training. However, employing few-shot prompting for complex reasoning tasks introduces unique challenges. The performance of these models can be highly sensitive to the prompt's specifics, and they may display peculiar failure modes.

This tutorial aims to present techniques that can help navigate these challenges. We will start with an overview of LLMs and the principles of few-shot prompting. Following that, we will explore various strategies that have been developed to enhance the robustness and performance of few-shot prompting. We will discuss 'prompt-design' techniques, like chain-of-thought prompting and least-to-most prompting, that guide an LM to include reasoning steps in its output. We'll also introduce dynamic prompting techniques that adapt the prompt for each specific input, like selecting the best fitting training examples for the prompt and modifying the prompt based on feedback from similar tasks.

Towards the end, we will delve into the use of code-generation for generating structured outputs (like graphs and plans) from LLMs. The tutorial will be interspersed with hands-on exercises that offer a practical understanding of these techniques. These exercises will include tasks using biomedical and health informatics data. The tutorial is designed to be broadly accessible, and only some familiarity with Python is necessary.

IEEE BHI 2023 Tutorials Continued

All tutorials will be held on Sunday, October 15, 2023.

Title: The Single-Cell Spatial Transcriptomics Analysis (ScSTA) Cookbook
Organizers: Arun Das
Affiliations: University of Pittsburgh
Location: Wesley W. Posvar Hall 1501
Time: 14:00-15:30, 15:45-17:15
Short Description: This tutorial aims to provide attendees with comprehensive knowledge and hands-on experience in the data analysis of sub-cellular resolution single-cell spatial transcriptomics (ScST) technologies such as Nanostring CosMx and 10X Genomics Xenium. ScST is a cutting-edge technology that profiles single-cell transcriptomics with spatial information of cells/transcripts in intact tissues. While it enables researchers to understand gene expression patterns in the context of tissue structure and disease pathology, it poses unique challenges in data analysis. This tutorial will cover each step of the analysis workflow and showcase typical use cases. It intends to accelerate the adoption of spatial single-cell transcriptomics analysis and foster breakthroughs in our understanding of complex biological systems.

Objectives:
Introduce participants to the principles and significance of ScST.
Familiarize attendees with the components of the Single-Cell Spatial Transcriptomics Analysis (ScSTA) pipeline, including image registration, cell segmentation, cell type identification, spatial gene expression analysis, spatial correlation analysis, and more. Provide practical experience in using relevant computational tools and software for ScST. Illustrate the application of ScST in disease pathology research, biomarker discovery, and patient outcome prediction.

Proposed Agenda:
Module 1: Introduction to Single-Cell Spatial Transcriptomics technology
Overview of single-cell spatial transcriptomics and its limitations.
Importance of incorporating spatial information for deeper insights.
Introduction to the ScSTA pipeline and its key components.

Module 2: Image Registration and Cell Segmentation
Familiarizing the popular libraries for image registration and cell segmentation.
Importance of maintaining good image registration and cell segmentation in whole-slide-image (WSI) tissues.

Module 3: Data Preprocessing, Quality Control, and Cell Typing
Cleaning and normalization of the segmented single-cell spatial data.
Addressing technical variability and batch effects.
Quality control measures for reliable downstream analysis.
Using a scRNA-seq reference genomic profiles to carry out cell type transfer to spatial single-cell transcriptomics datasets.
Using marker-based cell typing for ScST datasets.

Module 4: Spatial Mapping, Neighborhood Analysis, and Visualization
Extracting spatial features such as cell density, average gene expression, and neighborhood cell type composition.
Identifying spatial hotspots using spatial correlation methods.
Developing visualization techniques for spatial mapping of the extracted spatial features.

Module 5: Hands-on Practical
Guided tutorial using real-world single cell spatial transcriptomics dataset.
Step-by-step walkthrough of the ScST analysis pipeline.
Interactive assistance and troubleshooting.

Module 6: Future Directions and Challenges
Emerging trends in single-cell spatial omics technologies.
Ongoing challenges and opportunities in the field.
Collaboration possibilities and resources for continued learning.

Sunday, October 15, 2023

8:30 – 17:00
Registration

9:00 – 10:30
Tutorial: How to tame your ChatGPT: Complex Reasoning with LLMs using Few-shot prompting
Room: Wesley W. Posvar Hall 1500

9:00 – 10:30
Special Session: Open-Source Initiatives in Digital Health: Challenges Faced and Lessons Learned
Room: Wesley W. Posvar Hall 1501

Organizers: Md Mobashir Hasan Shandhi; Jessilyn Dunn, **Affiliations**: Duke University

Titles & Speakers:

A. Building the Digital Biomarker Discovery Project (DBDP): Challenges and Lessons Learned: Md Mobashir Hasan Shandhi (Duke University)

B. **OpenSim: An Open-Source Software Ecosystem for Movement Data:** Carmichael Ong (Stanford University)

C. Development of HRnV-Calc for heart rate variability analysis: Nan Liu (Duke-NUS Medical School, National University of Singapore)

D. The Path to a Modular and Standards-based Digital Health Ecosystem: Paul Schmiedmayer (Stanford University)

9:00 – 10:30
Tutorial: From Few to None: Exploring Few-Shot, One-Shot, and Zero-Shot Deep Learning in Clinical Settings
Room: Wesley W. Posvar Hall 1502

9:00 – 10:30
Workshop: Computational Medicine Leveraging High Performance Computing and Artificial Intelligence
Room: Wesley W. Posvar Hall 5200

9:00 – 10:30
Workshop: Understanding Inner States of Humans using Measurements of "Invisibles"
Room: Wesley W. Posvar Hall 5400

9:00 – 10:30
Special Session: Intelligent healthcare system with medical data fusion
Room: Wesley W. Posvar Hall 5404

Organizers: Deepika Koundal (UPES Dehradun, India), Yanhui Guo (University of Illinois, Springfield)

10:30 – 10:45
Coffee Break

10:45 – 12:15
Tutorial: How to tame your ChatGPT: Complex Reasoning with LLMs using Few-shot prompting
Room: Wesley W. Posvar Hall 1500

10:45 – 12:15
Special Session: Recent Advances in Cuffless Blood Pressure Measurement
Room: Wesley W. Posvar Hall 1501

Organizers: Ramakrishna Mukkamala; Sanjeev G Shroff, **Affiliations**: University of Pittsburgh

Titles & Speakers:

A. Smartphone-Based Blood Pressure Monitoring: Ramakrishna Mukkamala (U. Pittsburgh)

B. Development of a One Dollar Blood Pressure Monitor: Edward Wang, (University of California at San Diego)

C. Development of a Wearable Cardiovascular Sensor for Clinical Use: Jurgen Fortin (CNSystems Medizintechnik GmbH)

D. Non-Invasive, Continuous Blood Pressure from First Principles to Clinical Measurement: Aditya Rajagopal (California Institute of Technology)

E. Hypertension Detection in Pregnancy Using One-Dimensional Doppler Ultrasound: Exploring Fetal-Maternal Blood Flow: Gari Clifford (Emory University)

10:45 – 12:15
Tutorial: From Few to None: Exploring Few-Shot, One-Shot, and Zero-Shot Deep Learning in Clinical Settings
Room: Wesley W. Posvar Hall 1502

10:45 – 12:15
Workshop: Computational Medicine Leveraging High Performance Computing and Artificial Intelligence
Room: Wesley W. Posvar Hall 5200

10:45 – 12:15
Workshop: Understanding Inner States of Humans using Measurements of "Invisibles"
Room: Wesley W. Posvar Hall 5400

10:45 – 12:15
Special Session: AI for Neurodiversity: Advancements and Opportunities
Room: Wesley W. Posvar Hall 5404

Organizers: Hugo Posada-Quintero; Youngsun Kong; Md Billal Hossain; Andrew Peitzsch; Jihye Moon; Sultan M Manjur, **Affiliations**: University of Connecticut)

12:15 – 14:00
Lunch on Your Own

14:00 – 15:30
Workshop: Unraveling Challenges in Time Series Analysis with Open Source Tools for Digital Health Applications
Room: Wesley W. Posvar Hall 1500

14:00 – 15:30
Tutorial: The Single-Cell Spatial Transcriptomics Analysis (ScSTA) Cookbook
Room: Wesley W. Posvar Hall 1501

14:00 – 15:30
Workshop: The Opportunities and Challenges of ChatGPT in Brain-Machine Interface
Room: Wesley W. Posvar Hall 1502

14:00 – 15:30
Workshop: Transformative Pathways: Advancing Global Collaboration for Gender Equality and Inclusivity in Research and Innovation
Room: Wesley W. Posvar Hall 5108

14:00 – 15:30
Special Session: Enabling Closed-Loop Technologies for Mental Health: Biobehavioral Sensor Informatics and Just-in-Time Interventions
Room: Wesley W. Posvar Hall 5200

Organizers: Asim H Gazi (Georgia Institute of Technology); Jin-Oh Hahn (University of Maryland); Omer T Inan (Georgia Institute of Technology)

Titles & Speakers:

A. Continuous Mental Stress Tracking Based on Multi-Modal Physiological Sensing and Collective Inference: Yuanyuan Zhou and Jin-Oh Hahn (University of Maryland)

B. Multimodal Sensor-Based Machine Learning for Mental Health: Akane Sano (Rice University)

C. Designing Digital Health Technologies for Discovering Multi-Modal Digital Phenotypes of Mental Health Disorders in Young Children: Ryan McGinnis (University of Vermont)

D. Sensor-Triggered Just-in-Time Stress Assessments: Santosh Kumar (University of Memphis)

E. Characterizing the Stress-Reducing Effects of Non-Invasive Vagus Nerve Stimulation: Asim H. Gazi (Georgia Institute of Technology)

F. MINDWATCH: A Closed-Loop Neural Wearable for Mental Well-Being: Saman Khazaei (New York University)

14:00 – 15:30
Special Session: Trustworthy and responsible data analytics for mental health
Room: Wesley W. Posvar Hall 5400

Organizers: Theodora Chaspari (Texas A&M University); Brandon Booth (University of Colorado Boulder); Tiantian Feng (University of Southern California); Emily Mower Provost (University of Michigan Ann Arbor); Adela C. Timmons (University of Texas, Austin); Shrikanth Narayanan (University of Southern California).

Titles & Speakers:

A. "Emerging Behavioral Privacy Risks in Daily Usage of Wearables": Santosh Kumar (University of Memphis)

B. "Multimodal AI: Understanding Human Social Behaviors": Louis Philippe Morency (Carnegie Melon University)

C. Sarah Fox (Carnegie Melon University)

14:00 – 15:30
Data Competition
Room: Wesley W. Posvar Hall 5404

15:30 – 15:45
Coffee Break

15:45 – 17:15
Workshop: Unraveling Challenges in Time Series Analysis with Open Source Tools for Digital Health Applications
Room: Wesley W. Posvar Hall 1500

15:45 – 17:15
Tutorial: The Single-Cell Spatial Transcriptomics Analysis (ScSTA) Cookbook
Room: Wesley W. Posvar Hall 1501

15:45 – 17:15
Workshop: The Opportunities and Challenges of ChatGPT in Brain-Machine Interface
Room: Wesley W. Posvar Hall 1502

15:45 – 17:15
Workshop: Transformative Pathways: Advancing Global Collaboration for Gender Equality and Inclusivity in Research and Innovation
Room: Wesley W. Posvar Hall 5108

15:45 – 17:15
Special Session: Machine learning-enabled solutions to improve diagnostic and prognostic accuracy in patients with severe brain injury: challenges and perspectives
Room: Wesley W. Posvar Hall 5200

Organizers: Andrea Mannini; Anna Estraneo, **Affiliations**: IRCCS Fondazione Don Carlo Gnocchi Onlus, Italy

Titles & Speakers:

A. "Prognostic accuracy in ML models of CRS scale, its subscales, and its derived metrics": Silvia Campagnini (IRCCS Fondazione Don Gnocchi, Italy on behalf of Prof Llorens (U.P. Valencia, Spain))

B. "Improved cortical lesion segmentation using SynthSR": Jian Li (Massachusetts General Hospital and Harvard Medical School, USA)

C. "EEG and connectivity measures in brain injury": Michael Lassi (Scuola Sant'Anna, Italy)

D. "Graph theory applications to EEG analysis in pDoC patients": Piergiuseppe Liuzzi (IRCCS Fondazione Don Gnocchi, Italy on behalf of Prof. Andrea Frosini, PhD (Univ. of Florence, Italy))

E. "ML methods in the pediatric population with a disorder of consciousness": Erika Molteni (Kings College, UK)

F. "Machine Learning after Multiple Imputation Techniques: an Application to the Prediction of Post-Stroke Ambulation Recovery": Silvia Campagnini (IRCCS Fondazione Don Gnocchi, Italy)

15:45 – 17:15
Special Session: . ***Recent Advances in Statistical Methodologies with applications in Health and Medical Informatics***
Room: Wesley W. Posvar Hall 5400

Organizer: Souparno Ghosh, Affiliation: University of Nebraska -Lincoln

Titles & Speakers:

A. Controlling FDR in selecting group-level simultaneous signals from multiple data sources with application to the National Covid Collaborative Cohort data : Cheng Zheng (University of Nebraska Medical Center)

B. Correction of prevalence estimators for sampling bias with testing errors: Daniel A. Diaz (U. Miami)

C. K-Modes Clustering for Identification of Alpha-1 Antitrypsin Deficiency Patients within Electronic Healthcare Records Database: Sarah Aurit (Optima)

D. Beamsteering Analysis of Physical Activities Using an FMCW Radar: Changzhi Li/ Victor Gabriel Rizzi Varela (Texas Tech U.)

15:45 – 17:15
Data Competition
Room: Wesley W. Posvar Hall 5404

Monday, October 16, 2023

8:30 – 17:00
Registration

8:15 – 8:30
Opening Ceremony

8:30 – 9:15
Opening Keynote: Bin He
AI for Mapping and Interfacing with the Brain
Chair: Yufei Huang (University of Pittsburg Medical Center, USA)

9:15 – 9:30
Coffee Break

9:30 – 11:50
Oral Session #1
AI for Mental and Population Health
Session Chair: Bobak Jack Mortazavi

9:30
Accurate Identification of Human Emotional States from Images Using Deep Learning
Emmy Yang (USA); Jake Y Chen (University of Alabama at Birmingham, USA)

Facial expression recognition is a crucial aspect of human communication, especially for building social relationships. However, machine-based recognition remains a challenging task. Our research proposes an automatic emotion identification system that utilizes emotional state heatmaps (ES-MAPs) and neural network classification algorithms. Using MediaPipe Face Mesh, our system extracts facial landmark coordinates and calculates the distance between all landmarks. A neutral baseline is subtracted from the landmark distances and saved as a heatmap to train a designed CNN model. Our proposed system, ESH-Net, achieved significantly higher test accuracies on several datasets compared to other SOTA models. In addition, ES-MAPs produced better clustering than the original facial images, indicating significant improvement in the separability and consistency of representation of emotional states. This study demonstrates the potential for emotional state heatmaps and deep learning models to significantly improve the accuracy and efficiency of emotion identification, which can greatly assist in assessing patient's emotional state in medical diagnosis and practice.

9:45
Exploring the Capabilities of a Language Model-Only Approach for Depression Detection in Text Data
Misha Sadeghi and Bernhard Egger (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Reza Agahi (Syenah GMBH, Germany); Robert Richer, Klara Capito, Lydia Helene Rupp and Lena Schindler-Gmelch (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Matthias Berking (Friedrich-Alexander-Universität Erlangen Nürnberg, Germany); Bjoern M Eskofier (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

Depression is a prevalent and debilitating mental health condition that requires accurate and efficient detection for timely and effective treatment. In this study, we utilized the E-DAIC (Extended Distress Analysis Interview Corpus-Wizard-of-Oz) dataset, an extended version of the DAIC-WOZ dataset, which consists of semi-clinical interviews conducted by an animated virtual interviewer called Ellie, controlled by a human interviewer in another room. With 275 participants, the E-DAIC dataset represents a valuable resource for investigating depression detection methods. Our aim is to predict PHQ-8 scores through text analysis. Leveraging state-of-the-art speech processing, LLM-based text summarization, and a specialized depression detection module, we demonstrate the transformative potential of language data analysis in enhancing depression screening. By overcoming the limitations of manual feature extraction methods, our automated techniques provide a more efficient and effective means of evaluating depression. In our evaluation, we achieve robust accuracy on the development set of the E-DAIC dataset, with a Mean Absolute Error (MAE) of 3.65 in estimating PHQ-8 scores from recorded interviews. This remarkable performance highlights the efficacy of our approach in automatically predicting depression severity. Our research contributes to the growing evidence supporting the use of LLMs in mental health assessment, showcasing the role of innovative technologies in advancing patient care for depression.

10:00

VoStress - Voice-based Detection of Acute Psychosocial Stress

Marie Oesten, Robert Richer and Luca Abel (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Nicolas Rohleder (Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany); Bjoern M Eskofier (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

Current stress assessment methods include self- reports and biomarkers which are evaluated in often complex, laboratory procedures. Due to that investigating new indicators for acute stress is crucial for the development of automatic stress detection systems. A promising extension might be provided by investigating speech, which has been shown to be affected by negative emotions and threatening situations. For that reason, we extracted verbal acoustics from audio data collected during a study where N=21 participants underwent the Trier Social Stress Test (TSST), the gold standard for laboratory stress in- duction, and a stress-free control condition (friendly-TSST) while concurrently collecting cortisol via saliva samples to assess the biological response to stress. Our results show that acute stress leads to significant ($p < 0.05$) alterations of acoustic features. A stepwise backward multiple linear regression model explained 58.8 % of the variance of the maximum cortisol increase. In addition to that, we performed classification experiments that distinguished stress from non-stress situations with an accuracy of 80.0 ± 12.7 %. While further research is needed to validate our approach, we are convinced that the information extracted from speech can be a valuable indicator for automatic stress detection systems and can even predict the biological response to stress situations.

10:15

Prediction of Stress Coping Capabilities from Nightly Heart Rate Patterns using Machine Learning

Linda Vorberg, Siri Pflueger, Robert Richer and Katharina M Jaeger (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Arne Küderle and Nicolas Rohleder (Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany); Bjoern M Eskofier (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

Stress is related to short- and long-term alterations in stress systems, including the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS). While it is well established that stress experienced during the day can affect sleep quality, less is known about how it affects stress systems during the night. We assume that stress coping strategies can have an impact on how stress carries over into the night and that individuals with bad coping mechanisms show elevated activation of stress systems during sleep. For that reason, we recorded the heart rate (HR) and heart rate variability (HRV) of 21 healthy participants on two consecutive nights during sleep and the first hour after awakening, Additionally, we extracted cortisol and alpha-amylase from saliva samples collected in the first hour after awakening and assessed stress coping capabilities using self-reports. To analyze the relationship between HR(V) parameters and stress coping we performed backward stepwise regression models and trained different machine learning-based regression algorithms to predict positive (SVF_Pos) and negative (SVF_Neg) stress coping capabilities, respectively. Our results show that individuals with higher SVF_Neg scores showed higher SNS activity during the night, whereas higher SVF_Pos scores indicated lower SNS activity. SVF_Pos was predicted with a mean absolute error (MAE) of 1.51±0.73 and SVF_Neg with an MAE of 2.79±1.53. Our findings indicate an association between nightly HR(V) and the individual's capability of coping with stress. This provides further information about how stress influences sleep and might be used for tailored intervention and feedback on successful stress coping.

10:30

Uncertainty Estimation in Deep Bayesian Survival Models

Christian Marius Lillelund, Martin Magris and Christian Fischer Pedersen (Aarhus University, Denmark)

Bayesian methods can express uncertainty about their predictions, but has seen little adaptation in survival analysis using neural networks. Proper uncertainty estimation is important in high-risk domains, such as the healthcare or medical field, if machine learning methods are to be adopted for decision-making purposes, however uncertainty estimation is a known shortcoming of NNs. In this paper, we introduce the use of Bayesian inference techniques for survival analysis in neural networks that rely on the Cox's proportional hazard assumption, for which we discuss a new flexible and effective architecture. We implement three architectures: a fully-deterministic neural network that acts as a baseline, a Bayesian model using variational inference and one using Monte-Carlo Dropout. We show with comprehensive experiments that the Bayesian models improve predictive performance over SOTA neural networks in a test dataset with few samples (WHAS500, 500 samples) and provide comparable performance in two larger ones (SEER and SUPPORT, 4024 and 8873 samples, respectively), however using variational inference comes with longer training times. Our Bayesian models additionally provide quantification of both aleatoric and epistemic uncertainty, which we exhibit by plotting 95% confidence intervals around the survival function and showing a probability density function of the survival time. Our work motivates further work in leveraging uncertainty for survival analysis using neural networks.

10:45

Estimating Treatment Effects Using Costly Simulation Samples from a Population-Scale Model of Opioid Use Disorder

Abdulrahman Ahmed, M. Amin Rahimian and Mark S. Roberts (University of Pittsburgh, USA)

Large-scale models require substantial computational resources for analysis and studying treatment conditions. Specifically, estimating treatment effects using simulations may require a lot of infeasible resources to allocate at every treatment condition. Therefore, it is essential to develop efficient methods to allocate computational resources for estimating treatment effects. Agent-based simulation allows us to generate highly realistic simulation samples. FRED (A Framework for Reconstructing Epidemiological Dynamics) is an agent-based modeling system with a geospatial perspective using a synthetic population constructed based on the U.S. census data. Given its synthetic population, FRED simulations present a baseline for comparable results from different treatment conditions and treatment conditions. In this paper, we show three other methods for estimating treatment effects. In the first method, we resort to brute-force allocation, where all treatment conditions have an equal number of samples with a relatively large number of simulation runs. In the second method, we try to reduce the number of simulation runs by customizing individual samples required for each treatment effect based on the width of confidence intervals around the mean estimates. In the third method, we use a regression model, which allows us to learn across the treatment conditions such that simulation samples allocated for a treatment condition will help better estimate treatment effects in other (especially nearby) conditions. We show that the regression-based methods result in a comparable estimate of treatment effects with less computational resources. The reduced variability and faster convergence of model-based estimates come at the cost of increased bias, and the bias-variance trade-off can be controlled by adjusting the number of model parameters (e.g., including higher-order interaction terms in the regression model).

11:30 – 12:30

Panel: ChatGPT for Medicine: Exploring the Journey from the Past to the Present, and Beyond

12:45 – 13:45

Rapid Fire 1 & Box Lunch

Session Chair: Md Mobashir Hasan Shandhi

12:45

GlySim: Modeling and Simulating Glycemic Response for Behavioral Lifestyle Interventions

Asiful Arefeen and Hassan Ghasemzadeh (Arizona State University, USA)

Effective prevention and management of diabetes relies on maintaining a normal blood glucose level, thus avoiding abnormal events such as hyperglycemia and hypoglycemia. Predicting anomalous events beforehand can potentially help patients and caregivers intervene to prevent such events through modifiable behaviors such as exercise, diet, and medication. Although Continuous Glucose Monitor (CGM) sensors have been used to monitor and forecast blood glucose level, current research lacks a computational approach that recommends a behavioral intervention to bring the glucose level to a normal range. To address this shortcoming, we present GlySim, a CGM simulator that uses multimodal data to not only forecast future glucose readings but also enable a user to examine the impacts of behavior change on glucose response in advance. GlySim creates opportunities for change in food consumption, medication, and physical activity to avoid dysglycemia by pinpointing factors that cause anomalous events using Grad-CAM (Gradient-weighted Class Activation Mapping) and allowing users to observe how adjusting a behavioral factor changes glucose trajectories. We validate GlySim on a dataset of 10 patients with type 1 diabetes and achieve an overall mean absolute error (MAE) as low as 16.5 mg/dl in simulating glycemic response. Furthermore, Glysim detects hyperglycemic events with 0.89 average precision.

12:47

Classification of User Adherence to Home Hand Rehabilitation Technology Using a Feed-Forward Artificial Neural Network

Mohammad Shams (George Mason University, USA); Daniel K Zondervan (Flint Rehabilitation Devices LLC, USA); Quentin Sanders (George Mason University, USA)

Hand impairments resulting from neurological conditions can significantly affect individuals' quality of life. Home-based rehabilitation programs are promising solutions to address these challenges. This study investigated user engagement with MusicGlove, a commercially available wearable grip sensor. We applied deep learning and machine learning techniques to classify users based on their interaction with the device. We categorized users into 'low', 'moderate', and 'power' users and found considerable differences in device usage. For user adherence prediction after one day of device usage, we used a Multi-Layer Perceptron (MLP) deep learning model and traditional machine learning models such as K-Nearest Neighbors (KNN), Support Vector Machines (SVM), and Logistic Regression. The MLP model outperformed other models, achieving an average F1-score of 0.68 in cross validation and a balanced performance on unseen test data with an accuracy of 0.68, precision of 0.66, recall of 0.72, and an F1-score of 0.69 for the 'Low' user class. Our results underscore the need for personalized home-based rehabilitation programs and highlight the effective use of deep

learning algorithms in predicting user adherence in home-based digital rehabilitation. This study contributes to the growing body of evidence supporting machine learning applications in healthcare, particularly in patient outcome prediction and treatment personalization.

12:49

Burnout Prediction and Analysis in Shift Workers: Counterfactual Explanation Approach

Ziang Tang, Zachary King, Alicia Choto Segovia, Han Yu and Gia Braddock (Rice University, USA); Asami Ito, Ryota Sakamoto and Motomu Shimaoka (Mie University, Japan); Akane Sano (Rice University, USA)

Shift work disrupts sleep and causes chronic stress, resulting in burnout syndrome characterized by emotional exhaustion, depersonalization, and decreased personal accomplishment. Continuous biometric data collected through wearable devices contributes to mental health research. However, direct prediction of burnout risk is still limited, and interpreting machine learning models in healthcare poses challenges. In this paper, we develop machine learning models that utilize wearable and survey data, including rhythm features, to predict burnout risk among shift workers. Additionally, we employ the DiCE (Diverse Counterfactual Explanations) framework to generate interpretable explanations for the ML model, aiding in the management of burnout risks. Our experiments on the AMED dataset show that incorporating rhythm features significantly enhances the predictive performance of our models. Specifically, sleep and heart rate features have emerged as significant indicators for accurately predicting burnout risk.

12:51

A Preliminary Investigation into Quantitative Assessment of ADHD Treatment Efficacy on Hyperactivity Levels via Actigraphy

Joshua Putris (San Diego State University, USA); Aybike Aydın, Mustafa Balkanas, Ayşe Söylemezoğlu, Nihal Serdengeçti, Tayyib Kadak and Mahmut Cem Tarakçıoğlu (Istanbul University - Cerrahpasa School of Medicine, Turkey); Hakan Töreyin (San Diego State University, USA)

The diagnosis and assessment of attention deficit hyperactivity disorder (ADHD) in clinical practice heavily rely on subjective and biased scales. This study explores the feasibility of using actigraphy measurements to objectively assess and monitor the treatment response of ADHD in children receiving medication. A cohort of ten children underwent evaluation using three scales, one administered by child-adolescent psychiatrists and two completed by the parents, both pre- and post-medication. In addition, two sets of actigraphy recordings were collected, each spanning seven consecutive days, before and after medication administration. The study revealed that changes in the median, mean, and skewness of accelerations in spherical coordinates exhibited stronger correlations with changes in the scale scores in comparison to other features. Additionally, binary classifications using feature sets with top correlations and PCA features defining 95% variability showed better predictions for ADHD treatment response assessed by TURGAY DSM-IV-S (82%) and WFIRS-life skills (81.4%) scores compared to WFIRS-school behavior (63.9%) scores. These findings represent the first reported correlations between ADHD scales and a broad range of features. Additionally, they demonstrate the feasibility of using actigraphy data to predict ADHD treatment response for the first time.

Clinical Relevance- The utilization of actigraphy for objective and reliable measurement of ADHD symptoms and functional impairment can serve as a valuable complement to subjective evaluations conducted by parents and clinicians, and thus aiding in determining an effective treatment plan and identifying priority areas for intervention.

12:53

Comparative Analysis of Machine Learning Algorithms for Prediction of Adherence to Medication

Miguel Rujas, Beatriz Merino-Barbancho and Peña Arroyo (Universidad Politécnica de Madrid, Spain); Jim Ingebretsen Carlson (PredictBy, Spain); Jaime Barrio Cortes, Ana Isabel Villimar Rodríguez and Andrés Castillo (Fundación para la Investigación e Innovación Biosanitaria en Atención Primaria, Spain); Ana Roca-Umbert (PredictBy Research and Consulting and Universitat Oberta de Catalunya, Spain); Francisco Lupiañez-Villanueva (Associate Professor, Spain); Maria Fernanda Cabrera-Umpierrez and Maria Teresa Arredondo (Life Supporting Technologies; Technical University of Madrid, Spain); Giuseppe Fico (Universidad Politécnica de Madrid, Spain)

Adherence to medication is a critical aspect of healthcare with a significant impact on patient outcomes. This has led to the elaboration of several studies over the years to understand adherence better, evolving to the point of applying Machine Learning techniques, whether to study the relationship of different factors with adherence or to make predictions of levels of adherence. However, due to the diversity of techniques, evaluation metrics and adherence measures utilized, no conclusions have been drawn as to which algorithms are best suited to address prediction problems in this domain. This paper aims to apply the three most widely used algorithms in the literature to a database obtained from a primary care centre. The study evaluates the performance of these algorithms with and without applying a feature selection method and with three different adherence measures, using four different evaluation metrics. The results obtained, although not conclusive for all scenarios due to the limitations of the study, indicate that the algorithm with the best overall performance and consequently the best adapted to the different scenarios is the Logistic Regression. This outcome constitutes a significant progress since it represents the first technical and comprehensive comparison of the

performance that has been conducted in this area. Furthermore, comparative studies with larger datasets and different measures of adherence can validate this finding in the future.

12:55

An Explainable and Robust Deep Learning Approach for Automated Electroencephalography-based Schizophrenia Diagnosis

Abhinav Sattiraju (Tri-Institutional Center for Translational Research in Neuroimaging and Data Science); Charles A Ellis and Robyn Miller (Tri-institutional Center for Translational Research in Neuroimaging and Data Science, USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

Schizophrenia (SZ) is a neuropsychiatric disorder that affects millions globally. Current diagnosis of SZ is symptom-based, which poses difficulty due to the variability of symptoms across patients. To this end, many recent studies have developed deep learning methods for automated diagnosis of SZ, especially using raw EEG, which provides high temporal precision. For such methods to be productionized, they must be both explainable and robust. Explainable models are essential to identify biomarkers of SZ, and robust models are critical to learn generalizable patterns, especially amidst changes in the implementation environment. One common example is channel loss during recording, which could be detrimental to EEG classifier performance. In this study, we develop a novel channel dropout (CD) approach to increase the robustness of explainable deep learning models trained on EEG data for SZ diagnosis to channel loss. We develop a baseline convolutional neural network (CNN) architecture and implement our approach in the form of a CD layer added to the baseline architecture (CNN-CD). We then apply two explainability approaches for insight into the spatial and spectral features learned by the CNN models and show that the application of CD decreases model sensitivity to channel loss. Results further show that our models heavily prioritize the parietal electrodes and the α-band, which is supported by existing literature. It is our hope that this study motivates the further development of models that are both explainable and robust and bridges the transition from research to application in a clinical decision support role.

12:57

Improving Multichannel Raw Electroencephalography-based Diagnosis of Major Depressive Disorder by Pretraining Deep Learning Models with Single Channel Sleep Stage Data

Charles A Ellis (Tri-institutional Center for Translational Research in Neuroimaging and Data Science, USA); Abhinav Sattiraju (Tri-Institutional Center for Translational Research in Neuroimaging and Data Science); Robyn Miller (Tri-institutional Center for Translational Research in Neuroimaging and Data Science, USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

As the field of deep learning has grown in recent years, its application to the domain of raw resting-state electroencephalography (EEG) has also increased. Relative to traditional machine learning methods or deep learning methods applied to extracted features, there are fewer methods for developing deep learning models on small raw EEG datasets. One potential approach for enhancing deep learning performance in this case is the use of transfer learning. While a number of studies have presented transfer learning approaches for extracted EEG features, relatively few approaches have been developed for raw resting-state EEG. In this study, we propose a novel EEG transfer learning approach wherein we first train a model on a large publicly available single-channel sleep stage classification dataset. We then use the learned representations to develop a classifier for automated major depressive disorder diagnosis with raw multichannel EEG. We find that our approach improves model performance, and we further examine how transfer learning affected the representations learned by the model through a pair of explainability analyses. Our proposed approach represents a significant step forward for the domain raw resting-state EEG classification. Furthermore, it has the potential to expand the use of deep learning methods across more raw EEG datasets and lead to the development of more reliable EEG classifiers.

12:59

Uncovering the Effects of Genes, Proteins, and Medications on Functions of Wound Healing: A Dependency Rule-Based Text Mining Approach Leveraging GPT-4

Jayati Halder Jui and Milos Hauskrecht (University of Pittsburgh, USA)

Wound healing is a complex biological process characterized by intricate cellular and molecular interactions. Understanding the underlying mechanisms and the effects of different biological entities, such as genes, proteins, and medications, on the cellular and biological functions of wound healing is of paramount importance for developing effective therapeutic interventions. In this paper, we present a text-mining approach aimed to explore and unravel the complex regulatory relationships of genes, proteins, and medications with the biological mechanisms of wound healing. Our approach relies on a set of predefined dependency rules to identify and capture the relationships between biological entities and their target functions. By leveraging advanced AI technology like Generative Pre-trained Transformer 4 (GPT-4), also known as ChatGPT, we evaluate the accuracy and quality of the extracted relations. We also present a thorough discussion about the encouraging preliminary results that validate the efficacy of our model. Our dependency rule-based text-mining approach, combined with the capabilities of GPT-4, presents a promising avenue for

unraveling the complex web of interactions involved in wound healing. The study underscores the future potential of incorporating multi-word concept embedding of complex functional entities and exploiting synthetic data from GPT-4 for enhanced relation identification. This research offers a new contribution to aid computational biology research by exploiting the power of large language models to facilitate biological text analysis.

13:01

RNA sequencing-based histological subtyping of non-small cell lung cancer with generative adversarial data imputation

Ralph Saber (Polytechnique Montreal, Canada); Bertrand Routy and Simon Turcotte (Université de Montréal, Canada); Samuel Kadoury (Ecole Polytechnique de Montreal, Canada)

Non small cell lung cancer (NSCLC) is the most common type of lung cancer and could be classified into two main histological subtypes: adenocarcinoma and squamous cell carcinoma. The identification of the histological subtype is a crucial step in the diagnosis of NSCLC. RNA sequencing data hold valuable biological information but may contain missing gene expression counts, which limit their potential exploitation in practice. In this work, we address the issue of missing gene expression data in NSCLC histological subtype prediction from RNA sequencing. To this end, we propose a pipeline based on the generative adversarial imputation network (GAIN) for the generation of plausible imputations of missing data and tree-based ensemble models for NSCLC histological subtype prediction. We adopted a nested cross validation scheme for the evaluation of the classification models. The proposed pipeline exhibited an outstanding performance with an area under the receiver operating characteristic curve of 0.98 ± 0.03 and an accuracy of 0.96 ± 0.05 obtained with the Light Gradient Boosting Machine. Experimental results showed that GAIN-derived imputations are useful to boost classification performance. Finally, we used the Shapley Additive Explanations technique and found a set of genes that were the most relevant for NSCLC subtyping across different models.

13:03

Multimodal Fusion of Functional and Structural Data to Recognize Longitudinal Change Patterns in the Adolescent Brain

Rekha Saha (Georgia State University, USA); Debbrata K. Saha (Georgia Institute of Technology, USA); Zening Fu (TReNDS, Georgia State University, USA); Rogers F Silva (TReNDS Center & Georgia State University (GSU), USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

Functional and structural magnetic resonance imaging (fMRI/sMRI) are extensively used modalities for studying brain development. While individual modalities may overlook crucial aspects of brain analysis, combining multiple modalities allows us to leverage the benefits of revealing hidden brain connections. To analyze multivariate change patterns in brain function and structure with increasing age across the entire brain, we employ a symmetric multimodal fusion approach that combines multiset canonical correlation analysis and joint independent component analysis. In this study, we present a novel approach to analyze linked longitudinal change patterns in functional network connectivity (FNC) and gray matter (GM) data derived from the large-scale Adolescent Brain and Cognitive Development dataset. Our approach uncovers significant pattern changes in both modalities. Specifically, we identify highly structured functional change patterns and structural change patterns that include increased brain functional connectivity between the visual and sensorimotor domains in the fMRI data, as well as changes in the bilateral sensorimotor cortex in the sMRI data. Overall, our study demonstrates the strength of our approach in uncovering longitudinal changes in FNC and GM, provides valuable insights into the dynamic nature of brain connectivity and structure during adolescence, and sheds light on potential gender-related differences in these processes.

13:05

Interpretable Disease Prediction from Clinical Text by Leveraging Pattern Disentanglement

Malikeh Ehghaghi (University of Toronto, Canada); Pei-Yuan Zhou (University of Waterloo, Canada); Wendy Yusi Cheng (University of Toronto, Canada); Sahar Rajabi (University of Tehran, Iran); Chih-Hao Kuo and En-Shiun Annie Lee (University of Toronto, Canada)

For artificial intelligence (AI) systems to be adopted in high stake human-oriented applications, they must be able to make complex decisions in an understandable and interpretable manner. While AI systems today have grown leaps and bounds in predictive power using larger datasets with more complex architectures, existing models remain ineffective at generating interpretable insights in the clinical setting. In this paper, we address the challenge of discovering interpretable insights from the clinical text for disease prediction. For this purpose, we apply the clinical notes from the electronic health records (EHR) available in the Medical Information Mart of Intensive Care III (MIMIC-III) dataset, which are labeled with the international classification of diseases (ICD9) codes. Our proposed algorithm combines interpretable text-based features with a novel pattern discovery and disentanglement algorithm. Specifically, our approach encompasses the following: (1) uncovering strong association patterns between clinical notes and diseases, (2) surpassing baseline clustering algorithms in effectively distinguishing between disease clusters, and (3) demonstrating comparable performance to baseline supervised methods in predicting diseases. Our results validate the model's capability to strike a balance between interpretability and outcome prediction accuracy. By unveiling insightful patterns between clinical notes and diseases, our approach upholds a reasonable level of diagnostic accuracy.

13:07

Development of a Framework Dealing with Partial Data Unavailability and Unstructuredness to Support Post-Market Surveillance

Yijun Ren and Enrico G Caiani (Politecnico di Milano, Italy)

Under the European Union Medical Device (MD) Regulation 2017/745, Expert Panel's decision on providing a scientific opinion on the Clinical Evaluation Assessment Report for high-risk MD is required, as part of the conformity assessment procedure. To this aim, the perceived risk of similar MDs already on the market, based on the European Medical Device Nomenclature (EMDN), could help. To generate such information, we propose a generalized framework to automatically collect and display in an aggregated way the publicly available safety notices (SNs), even when characterized by partial unstructuredness and incompleteness. This novel approach was tested on the Dutch data, consisting of 3618 SNs from 2015 to 2022, retrieved from the official government website by Web scraping. After identification of named entities, the best match MD was searched within the Italian and Portuguese datasets of devices using Natural Language Processing techniques. Algorithm performance was tested on potentially equal SNs (472) published by both the Dutch and Italian authorities: assignment of the same EMDN code at level 1 was present in 454 out of 472 (96.19%) SNs, at level 2 in 447 (94.70%) SNs, at level 3 in 433 (91.74%) SNs. The proposed approach was able to cope with data unavailability and incompleteness in the public data, thus providing structured data with appropriate EMDN usable for safety signal detection.

13:09

Enhancing Rare Cell Type Identification in Single-Cell Data: An Innovative Gene Filtering Approach using Bipartite Cell-Gene Relation Graph

Maziyar Baran pouyan (Accenture Technology Labs, USA); Krishnaprasad Thirunarayan, Lingwei Chen and Hossein Mohammadi (Wright State University, USA); Hojjat Torabi Goudarzi (The University of Oklahoma, USA)

Single cell technology refers to a set of scientific techniques that allows researchers to study cellular structures in depth.The behaviors and properties of individual cells may be hidden by traditional biological experiments, which frequently measure averages over a large number of cells. With the aid of single cell technology, scientists may examine each cell separately and gain a much more in-depth understanding of biological processes. Hence, a useful tool for examining cellular diversity is single cell RNA sequencing (scRNA-seq). However, the high dimensionality and technical noise of scRNA-seq data make analysis difficult. To address this issue, gene filtering has been widely adopted to minimize single cell data noise and enhance the quality of subsequent analyses. Nonetheless, existing gene filtering techniques may inadvertently omit critical but rare genes which are necessary for identifying rare cell types that play a pivotal role in comprehending many biological processes. A novel graph-based gene selection technique is suggested in this study with the aim of preserving the informative genes to better identify rare cell types. Our findings demonstrate that this technique enhances the identification of rare cell populations, providing a refined approach for scRNA-seq data analysis and potentially enabling earlier and more reliable disease detection.

13:11

Retrieving Knowledge of Molecular Regulatory Mechanisms from PubMed Titles via an Event Extraction Approach

David A Spellman, Jason Xiaotian Dou, Aaron F Wu, Sumin Jo and Yu-Chiao Chiu (University of Pittsburgh, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

This work tackles three main issues in information extraction (IE) from biomedical literature: 1. How to design models to extract the structured and flexible representation of molecular regulatory mechanisms (MRM) from the literature that captures the biological features comprehensible to an expert. 2. How to overcome the limitation of existing abstract-based solutions for IE that are costly to annotate and insufficient to extract MRMs for answering regulatory questions in downstream tasks. 3. How to overcome the challenges of a lack of annotated training data for MRM such that different machine learning models for extracting MRM can be trained and evaluated. To address these issues, a novel event extraction (EE) driven approach to automatically extract MRM from paper titles is proposed. We have designed an EE template for MRM that homogenizes the characterization of MRM in titles, making the prediction of MRM possible. We have created the first training dataset for MRM with human-annotated event arguments that capture the essential components of the molecular mechanisms. Our comprehensive evaluations have demonstrated strong performance from the tested models. In addition, further strategies for fine-tuning pretrained biomedical language models are proposed. This work suggests a promising direction for an event-based solution for the extraction of molecular mechanisms from biomedical literatures.

13:13

Robust Nonlinear State Space Model Identification for Hemorrhage Resuscitation

Elham Estiri and Hossein Mirinejad (Kent State University, USA)

Fluid resuscitation is a medical intervention commonly used in hypovolemic scenarios to compensate for the lost blood volume and stabilize critically ill patients. Fluid management is currently ad-hoc and dependent on the physician's style and expertise. Such ad-hoc protocols lack the capability of accurately adjusting the fluid infusion dosages due to their empiric nature, especially in the presence of clinical disturbances, posing significant risk of adverse effects such as under- and over-dosing. Thus, treatment performance is compromised due to the lack of appropriate dosage adjustment tools available. This paper presents a novel modeling framework namely, robust nonlinear state space modeling (RNSSM), for predicting hemodynamic responses in hemorrhage resuscitation. The proposed approach innovatively integrates autoencoder learning and variational Gaussian inference (VGI) in a unified framework to develop nonlinear state space models that are highly amenable to the closed-loop control design from limited, noisy critical care data. The goal is to develop subject-specific models that can reliably predict mean arterial pressure (MAP) in response to fluid infusion in hemorrhage scenarios. The RNSSM approach aim to improve (1) model accuracy by considering subject-specific characteristics and drug attributes and (2) model reliability by accounting for uncertainties that inherently exist in clinical data. Enabling reliable, personalized hemodynamic models amenable to the closed-loop control design can potentially lead to development of efficient model-informed precision dosing strategies, promoting patient safety and outcomes in critical care.

13:15

Iterative Geometric Projection Method for Bias Mitigation in Predicting Depression in Early Pregnancy using EMR in a Minority Population

Yongchao Huang, Yang Dai and Peñalver Bernabé Beatriz (University of Illinois at Chicago, USA)

Machine learning (ML) models using Electronic Medical Records (EMRs) have shown promise in predicting obstetric complications, including depression during pregnancy. Despite these advancements, the presence of bias in EMRs can result in ML models that under-predict the risk of conditions influenced by social determinants of health, inadvertently perpetuating health inequalities. This paper introduces a novel bias mitigation strategy that fine-tunes geometric projection methods to combat this pervasive issue. We employed EMRs from a US hospital primarily serving low-income women of color, providing a unique context to assess bias in ML models. Our investigation critically compares the efficacy of our proposed bias mitigation procedure with the original geometric projection and generalized linear models. The comparative evaluation highlights the robust performance of our strategy, revealing its potential to effectively reduce bias. Moreover, our research successfully identifies crucial protected variables associated with race and ethnicity, such as being single and having an unplanned pregnancy, using the SHAP (Shapley Additive exPlanations) method. These findings underscore the potential and necessity of adopting strategic bias mitigation techniques in developing more equitable predictive ML models. As such, this work makes a valuable contribution to the ongoing efforts to achieve greater health equity through the application of more balanced predictive analytics.

13:17

A Microwave-Based Method for Early Detection of Congestive Heart *Failure*

Aditi Anand, Amrutha Vaidyam, Adithya Chandrasekar, Atthin Chandrashekar, Alan Chi, Adam Groneck, Jiayu Luo, Christin Huene, Alec Lucas and Lorenzo Cacciapuoti (Purdue University, USA)

We propose a microwave-based method for the early detection congestive heart failure (CHF). The proposed method is based on the prevalence of pulmonary edema accompanying CHF. Current approaches based on chest radiographs can only detect relatively high levels of pulmonary edema, limiting their efficacy for early diagnosis. We observe that microwaves passing through the thoracic cavity would experience significantly higher attenuation in the presence of fluid. Our detection method consists of a microwave source in the form of a two-dimensional array of low-power emitters placed on one side of the thoracic cavity, a corresponding array of receivers on the other side, and signal processing to compute the attenuation of microwaves as they pass through the body. We develop an electromagnetic simulation model to evaluate the proposed method and apply it to compute microwave attenuation in the absence and presence of various levels of pulmonary edema. Our experiments suggest that the method is sensitive to even mild and moderate levels of pulmonary edema that are difficult to detect using current first-line diagnostic methods. Our work makes a case for microwave-based detection as a safe, low-cost diagnostic method for CHF at earlier stages where there is a good potential for improved patient outcomes.

13:19

Exploring Nutritional Impact on Alzheimer's Mortality: An Explainable AI Approach

Ziming Liu (University of Tennessee, USA); Longjian Liu (Drexel University, USA); Robert Eric Heidel (University of Tennessee, USA); Xiaopeng Zhao (University of Tennessee at Knoxville, USA)

In this study, we employ machine learning (ML) techniques along with explainable artificial intelligence (XAI) to delve into the intricate connection between nutritional status and mortality related to Alzheimer's disease (AD). To conduct the analysis, the Third National Health and Nutrition Examination Survey (NHANES III 1988 to 1994) and the NHANES III Mortality-Linked File (2019) databases are applied in this study. As a foundation for the XAI analysis, the random forest model is chosen as the primary model, and the Shapley Additive Explanations (SHAP) method is implemented to evaluate the significance of various nutritional features collected from blood testing. The findings of this study shed light on the crucial nutritional factors that impact AD and its associated mortality due to AD. Notably, Serum Vitamin B12 and age emerge as significant contributors. These results contribute to a more profound comprehension of the progression of AD and offer valuable insights into the influence of nutrition on the disease. The result demonstrates the potential of ML and XAI in uncovering complex relationships between nutritional status and AD, and providing interpretable explanations. Ultimately, this knowledge can inform interventions and strategies aimed at improving nutritional status and mitigating the mortality risks associated with Alzheimer's disease.

13:21

Enhanced Predicting of Antiviral Treatment Response in Chronic Hepatitis B Utilizing Molecular Graph Embeddings

Jihyeon Song (Handong Global University, Korea (South)); Soon Sun Kim (Ajou University School of Medicine, Korea (South)); Ji Eun Han and Hyo Jung Cho (Ajou University School of Medicine, Korea (South), Korea (South)); Jaeyoun Cheong (University of Ajou, Korea (South)); Charmgil Hong (Handong Global University, Korea (South))

If patients infected with chronic hepatitis B do not receive appropriate treatment, they are at a significantly higher risk of developing severe liver diseases such as cirrhosis and liver cancer, underscoring the critical importance of selecting the most suitable medication for each individual. The primary objective of this research is to accurately predict the reduction in serum HBV DNA levels after 1 year of hepatitis B treatment by leveraging both electronic medical records and the structural information of antiviral drugs, which is extracted through a sophisticated graph neural network model. To demonstrate the effectiveness of the drug embeddings generated by GNN in target prediction, a comprehensive comparison was conducted between the baseline FNN model and the enhanced FNN model trained with fixed embeddings such as ECFP and Mold2. The experimental findings, encompassing the integration of molecular embeddings of the antiviral drugs within the predictive model, exhibited a noteworthy improvement of approximately 3% in terms of AUROC compared to the baseline model. Furthermore, the inclusion of molecular embeddings resulted in a remarkable enhancement of around 9% in balanced accuracy. Consequently, these findings provide conclusive evidence that the utilization of end-to-end drug structure embedding through GNN significantly contributes to the overall performance enhancement of the predictive model.

13:23

Prediction of Antimicrobial Resistance(AMR) Phenotypes using Machine Learning

Gavin Cooper (Arkansas State University, USA); Se-ran Jun (University of Arkansas for Medical Sciences, USA); Doosung Hwang (Dankook University, Korea (South)); Donghoon Kim (Arkansas State University, USA)

Antimicrobial resistance (AMR) is a critical global public health concern, responsible for the rise in hospital-acquired infections and heightened levels of illness and death. The misuse and overuse of antibiotics have contributed to the development of drug resistance among pathogens, creating a pressing need for effective strategies to predict AMR phenotypes. Machine learning techniques have emerged as valuable tools in this endeavor, enabling the analysis of vast datasets to identify patterns and predict the resistance or susceptibility of microorganisms to specific antibiotics. Leveraging machine learning holds promise in combating the growing threat of AMR and improving patient outcomes. The objective of this study is to enhance AMR prediction using machine learning techniques, leveraging insights from the cybersecurity domain due to the similarities between AMR and malware datasets. The approach involves employing k-mer frequency analysis and feature importance algorithms to extract significant features. The experimental results indicate that (1) Our approach demonstrates superior performance compared to the reference paper, (2) The utilization of 10-mers yields better outcomes in comparison to 7-mers, and (3) Our feature design outperforms that of the reference paper. This research has shown that by applying cross-domain research methodologies and capitalizing on the shared characteristics among different datasets, the performance of AMR prediction can be improved.

13:25

Measuring and mitigating racial bias in predicting pediatric urinary tract infections

Joshua W Anderson, Nader Shaikh and Shyam Visweswaran (University of Pittsburgh, USA)

Clinical predictive models that include race as predictors have the potential to introduce disparities in care. When such models are respecified to exclude race as a predictive feature, they must be carefully assessed for both performance and presence of any racial bias. We investigated racial bias and impact of such respecification in a predictive model - UTICalc - which was designed to reduce catheterizations in suspected urinary tract infection of young febrile children. To mitigate the racial bias, the underlying logistic regression model of UTICalc was respecified without race as a predictor and added two more clinical variables in its place. With this adjustment, we compare the two versions of UTICalc using fairness and discriminative performance metrics to study changes in racial bias and model fairness. Additionally, we derived two models for UTICalc to address racial bias by other means. The first method involved reweighting of the original UTICalc predictors using the exponentiated gradient reductions method. This was to investigate if bias mitigation can be achieved without respecifying the model. We discuss the shortcomings of this in-processing mitigation method and alternative methods that could improve performance. Our second model respecifies UTICalc with all available clinical variables to examine changes in bias with additional features.

14:00- 15:45
Oral Session #2
Disease Detection and Diagnosis
Session Chair: Souparno Ghosh

14:00

SiaKey: A Method for Improving Few-shot Learning with Clinical Domain Information

Zhuochun Li, Khushboo Thaker and Daqing He (University of Pittsburgh, USA)

The Few-Shot Learning (FSL) method is enhancing the field of Natural Language Processing (NLP) by requiring only a small amount of labeled data to achieve significant improvements. The supervised models usually need a huge amount of annotated data to train and are computationally expensive. However, the annotation process is difficult and time-consuming for clinical data that exists in large-scale electronic health records (EHRs) and online posts, where only specialists with professional clinical knowledge could annotate them manually. On the other hand, fine-tuning Pretrained Language Model (PLM) always has poor performance on few-shot training data. Thus, we have introduced a novel FSL technique named SiaKey, which utilizes Siamese Networks, and integrates Keyphrases Extraction and Domain Knowledge. The task of post-classification is challenging since online posts typically contain a greater amount of irrelevant information compared to traditional EHRs. We tested Siakey including 5, 10, 15, and 20-shot learning on health-related online post-classification tasks. The results of our experiments demonstrate the effectiveness of our Siakey in capturing text features, and indicate superior performance compared to BioBERT on similar FSL tasks. This paper introduces a novel and efficient approach to automatically identify patients' disease trajectories based on their clinical descriptions and provides inspiration for other related NLP tasks.

14:15

Drug induced Liver Injury Prediction with Injective Molecular Transformer

Geonyeong Choi (Handong Global University, Korea (South)); Hyo Jung Cho, Soon Sun Kim and Ji Eun Han (Ajou University School of Medicine, Korea (South)); Jaeyoun Cheong (University of Ajou, Korea (South)); Charmgil Hong (Handong Global University, Korea (South))

Drug-Induced Liver Injury (DILI), liver damage caused by drugs, represents a significant factor contributing to the failure of clinical trials. Remarkably, the drug development process, which entails an extensive timeline spanning several years and incurring costs of billions of dollars to achieve FDA approval, could greatly benefit from early DILI prediction. Furthermore, through the utilization of DILI prediction, clinicians can obtain valuable insights into the potential risks associated with medication, empowering them to make more informed decisions when prescribing drugs to patients. We employed Graph Neural Networks (GNNs) to predict DILI based on drug structures. GNNs consist of node aggregation, which gathers node representations, and graph pooling, which compiles node representations to portray the graph as a single vector. The graph pooling method built on Set Transformer outperforms existing techniques, but we identified a limitation: Set Transformer, using a random seed vector as the query vector, cannot differentiate between graphs of varied structures. Moreover, it was found to potentially lack expressiveness, being randomly defined without prior knowledge and relying on a limited number of seed vectors. To overcome this issue, we introduced Molecular Transformer which employs the unique molecular representation as the query vector. We found that using drug toxicity information extracted from drug toxicity knowledge-bases as the query vector yielded the best performance.

14:30

Host-directed vibroacoustic biosignature of viral respiratory infection

Andreas Schuh (& Level 42 AI, USA); Michael Morimoto (Level 42 AI, USA); Piotr Kaszuba (Hylomorph Solutions Limited, United Kingdom (Great Britain)); Kevin Hammond (Hylomorph Solutions Ltd. & Input Output Global Ltd, United Kingdom (Great Britain)); Jerry Swan (University of York, United Kingdom (Great Britain)); Krzysztof Krawiec (Poznan University of Technology, Poland); Nelson L Jumbe (Level 42 AI, Inc & Oxford University, USA)

Respiratory infection testing, patient risk, and clinical costs are driven by disease prevalence, direct and downstream costs of false-positive/negative tests. In addition, false-positives decrease with disease prevalence, while -negatives increase. We developed a host response-based, easy to use, fast, low-cost, non-invasive respiratory infection detection system and used COVID-19 as a mechanism for assessing host vibroacoustic biosignatures based accuracy, sensitivity, and specificity to distinguish SARS-CoV-2 carriers from non-carriers in a diverse US, Indian, and African population. A vibroacoustic infrasound-to-ultrasound e-stethoscope that can detect a respiratory infection early in both asymptomatic and vaguely symptomatic, like cough, patients that could be a tool to meet current as well as future needs as viral pathogens come and go, seasonally and within pandemics.

14:45

Dynamic Delirium Prediction in the Intensive Care Unit using Machine Learning on Electronic Health Records

Miguel Contreras, Brandon M Silva, Benjamin Shickel, Sabyasachi Bandyopadhyay, Ziyuan Guan, Yuanfang Ren, Tezcan Ozrazgat Baslanti, Kia Khezeli, Azra Bihorac and Parisa Rashidi (University of Florida, USA)

Delirium is a syndrome of acute brain failure which is prevalent amongst older adults in the Intensive Care Unit (ICU). Incidence of delirium can significantly worsen prognosis and increase mortality, therefore necessitating its rapid and continual assessment in the ICU. Currently, the common approach for delirium assessment is manual and sporadic. Hence, there exists a critical need for a robust and automated system for predicting delirium in the ICU. In this work, we develop a machine learning (ML) system for real-time prediction of delirium using Electronic Health Record (EHR) data. Unlike prior approaches which provide one delirium prediction label per entire ICU stay, our approach provides predictions every 12 hours. We use the latest 12 hours of ICU data, along with patient demographic and medical history data, to predict delirium risk in the next 12-hour window. This enables delirium risk prediction as soon as 12 hours after ICU admission. We train and test four ML classification algorithms on longitudinal EHR data pertaining to 16,327 ICU stays of 13,395 patients covering a total of 56,297 12-hour windows in the ICU to predict the dynamic incidence of delirium. The best performing algorithm was Categorical Boosting which achieved an area under receiver operating characteristic curve (AUROC) of 0.87 (95% Confidence Interval; C.I, 0.86-0.87). The deployment of this ML system in ICUs can enable early identification of delirium, thereby reducing its deleterious impact on long-term adverse outcomes, such as ICU cost, length of stay and mortality.

15:00

Learning Unbiased Image Segmentation: A Case Study with Plain Knee Radiographs

Ahmad P. Tafti, Nickolas Littlefield, Johannes F. Plate, Kurt R. Weiss, Ines Lohse, Avani Chhabra, Ismaeel A. Siddiqui and Zoe Menezes (University of Pittsburgh, USA); George Mastorakos (Cortechs.ai, USA); Sakshi Mehul Thakar, Mehrnaz Abedian, Matthew F. Gong and Luke A. Carlson (University of Pittsburgh, USA); Hamidreza Moradi (North Carolina A&T State University, USA); Soheyla Amirian (University of Georgia, USA)

Automatic segmentation of knee bony anatomy is essential in orthopedics, and it has been around for several years in both pre-operative and post-operative settings. While deep learning algorithms have demonstrated exceptional performance in medical image analysis, the assessment of fairness and potential biases within these models remains limited. Our study revisited implementation of deep learning in knee bony anatomy segmentation of plain radiographs to uncover gender and racial biases and implement strategies for bias mitigation. Within the multiple models we implemented, we found that different bias mitigation strategies present a compromise between fairness and accuracy of predicted knee anatomy segmentation. Optimizing a deep learning model that can fairly account for racial and gender bias in interpretation of knee plain radiographs has significant implications in several areas. The proposed mitigation strategies mitigate gender and racial biases, ensuring fair and unbiased segmentation results. We found that racial and gender bias can be present in knee bony anatomy segmentation models, but that bias mitigation strategies can be effectively implemented. The current contribution offers the potential to advance our understanding of biases, and it provides practical insights for researchers and practitioners in medical imaging. Furthermore, this work promotes equal access to accurate diagnoses and treatment outcomes for diverse patient populations, fostering equitable and inclusive healthcare provision.

15:15

Automated Seizure Detection using Transformer Models on Multi-Channel EEGs

Yuanda Zhu (Georgia Institute of Technology, USA); May Dongmei Wang (Georgia Institute of Technology and Emory University, USA)

Epilepsy is a prevalent neurological disorder characterized by recurring seizures, affecting approximately 50 million individuals globally. Given the potential severity of the associated complications, early and accurate seizure detection is crucial. In clinical practice, scalp electroencephalograms (EEGs) are non-invasive tools widely used in seizure detection and localization, aiding in the classification of seizure types. However, manual EEG annotation is labor-intensive, costly, and suffers from low inter-rater agreement, necessitating automated approaches. To address this, we introduce a novel deep learning framework, combining a convolutional neural network (CNN) module for temporal and spatial feature extraction from multi-channel EEG data, and a transformer encoder module to capture long-term sequential information. We conduct extensive experiments on a public EEG seizure detection dataset, achieving an unweighted average F1 score of 0.731, precision of 0.724, and recall (sensitivity) of 0.744. We further replicate several EEG analysis pipelines from literature and demonstrate that our pipeline outperforms, current state-of-the-art approaches. This work provides a significant step forward in automated seizure detection. By enabling a more effective and efficient diagnostic tool, it has the potential to significantly impact clinical practice, optimizing patient care and outcomes in epilepsy treatment.

15:45 – 16:00
Coffee Break

16:00 – 17:00
Panel: Meet the funding agencies

Panelists:
Mitra Basu, National Science Foundation
Juli Klemm, National Institutes of Health

Moderator: Ranadip Pal, Texas Tech University

17:15 – 19:00
Special Session: Artificial Intelligence (AI) in Critical Care

Organizers: Parisa Rashidi; Azra Bihorac, **Affiliations**: University of Florida

Titles & Speakers:

A. Introduction: Parisa Rashidi (University of Florida)

B. Real-time ICU/preoperative monitoring: Azra Bihorac (University of. Florida)

C. Monitoring Vital Signs of Critically Ill Patients in the AI Era: Gilles Clermont (University of Pittsburgh)

D. Nursing, AI, and Critical Care: Xiao Hu (Emory)

17:15 – 19:00
Poster Session #1

#1

Multi-Modal Physiological Signal Responses to Acute Mental Stress

Jesse Parreira, Azin Mousavi, Yekanth Ram Chalumuri, Mihir Modak and Yuanyuan Zhou (University of Maryland, USA); Jesus Antonio Sanchez-Perez, Asim H Gazi, Anna B Harrison and Omer T Inan (Georgia Institute of Technology, USA); Jin-Oh Hahn (University of Maryland, USA)

We investigated how cardiorespiratory parameters derived from multiple modalities of physiological signals respond to acute mental stress. A human subject study was performed where physiological signals were recorded during mental stressors. The novelty of this study comes from the cross-integration of signals, the use of cardio-mechanical signals with the seismocardiogram (SCG) and the ballistocardiogram (BCG), and the focus on measurement with noninvasive wearables. Candidate features corresponding to

cardiorespiratory parameters were extracted and analyzed. Experimental results give stress signatures that have clear responses to acute mental stress and can be measured noninvasively.

#2

Explainable Survival Analysis for Dementia Prediction

Jacob D Thrasher and Prashnna K Gyawali (West Virginia University, USA)

This study explores different machine learning-based survival analysis approaches to predict the probability of Alzheimer's Disease (AD) dementia progression. We utilize the Alzheimer's Disease Neuroimaging Initiative (ADNI) data and analyze different features to explain their importance in disease progression. The study's findings can help us understand mechanism of AD Dementia, predict the patients' AD shift efficiently and recommend personalized treatment to mitigate or postpone the effects of AD.

#3

Investigating Abnormal Behavior Patterns in Psychiatric Inpatients

Changwon Wang and Hamin Lim (Asan Medical Center, Korea (South)); Sung Woo Joo and Jungsun Lee (University of Ulsan & Asan Medical Center, Korea (South)); Hangsik Shin (University of Ulsan, Korea (South) & Asan Medical Center, Korea (South))

The purpose of this study is to investigate various abnormal behavior which contains self-harm and harm to others that occurs in psychiatric wards. To do this, we developed a survey that contains a total of 21 behaviors and investigated a total of 46 medical staff including psychiatrists and nurses working in psychiatric wards. A survey contains abnormal behaviors that can lead to fatal outcomes such as self-harm or harm to others among inpatients. According to the survey results, the major abnormal behaviors could be categorized as hanging, choking, punching, and biting, and it showed directly related behavior to self-harm or harm to others. Because of behaviors such as hanging, choking, punching, and biting, which are directly related to self-harm or harm to others, may have fatal consequences and it showed that require high attention and observation from medical staff.

#4

Supervised Machine Learning for Psychopathological Classifications: Problems with Low Predictive Validity

Anna M van Oosterzee (Utrecht University & Leiden University, The Netherlands); Anna V Kononova and Thomas Bäck (Leiden University, The Netherlands); Joel Anderson and Sander Werkhoven (Utrecht University, The Netherlands)

Supervised machine learning (ML) can be utilized to classify data with high precision. However, these models depend on the clinicians' labeled ground truths. In psychopathology, clinicians' tools are notorious for their low validity and low predictive power. In this paper, I aim to provide a missing link by translating these shortcomings of psychopathology to the field of AI and explain why it is crucial to be aware of them to avoid models with low validity and no added value to clinical practice.

#5

Machine learning prediction of depression using behavioral features extracted from a short reward/aversion task

Leandros Stefanopoulos (Northwestern University, USA & Aristotle University of Thessaloniki, Greece); Shamal Lalvani (Northwestern University, USA); Byoung Woo Kim, Nicole Vike and Sumra Bari (University of Cincinnati, USA); Martin Block (Northwestern University, USA); Nicos Maglaveras (Aristotle University of Thessaloniki, Greece); Aggelos K Katsaggelos (Northwestern University, USA); Hans Breiter (University of Cincinnati, USA)

We present an innovative approach to predicting depression by combining cognitive science with data-driven machine learning. This study utilized a fast and easy picture rating task to extract behavioral indicators that measure how much people liked, disliked, or were neutral toward various types of pictures. To assess depression levels, the participants provided answers for the Patient Health Questionnaire-9. Gaussian Mixture Models were employed to predict the levels of depression reported by the PHQ-9 using the behavioral features on a sample (N=3476) of the general US population. Our highest performing model achieved 0.73 accuracy, 0.77 sensitivity, 0.70 specificity, and 0.72 precision

#6

Essential Considerations for the External Validation of Artificial Intelligence-Based Clinical Decision Support Systems in Diverse Pilot Environments

Miguel Rujas and Laura Lopez-Perez (Universidad Politécnica de Madrid, Spain); Eugenio Gaeta (UPM Universidad Politecnica de Madrid, Spain); Maria Fernanda Cabrera-Umpierrez and Maria Teresa Arredondo (Life Supporting Technologies; Technical University of Madrid, Spain); Giuseppe Fico (Universidad Politécnica de Madrid, Spain)

The incorporation of Artificial Intelligence into clinical decision support systems has underscored the need for well-defined guidelines pertaining to the external validation of these systems, ensuring their efficacy across diverse clinical environments. Drawing upon the

insights and findings derived from the GATEKEEPER Project, this article delves into crucial considerations for this validation process. Emphasizing the development of harmonized data models, meticulous analysis of the technical specifications associated with various data sources and comprehensive assessment of pilot studies, this research sheds light on vital aspects to be considered when validating Artificial Intelligence-powered clinical decision support systems.

#7

Evaluation of Machine Learning Predictions' Reliability with generative models: towards Trustworthy AI

Giovanna Nicora, Lorenzo Peracchio and Riccardo Bellazzi (University of Pavia, Italy)

Exploiting Machine Learning (ML) predictions to drive clinical decisions requires the implementation of safeguard measures to reduce the risk of patient harm. The reliability of a ML model measures the degree of trust that the prediction of a new instance is correct, thus allowing the user to discard the prediction when the reliability is too low for the specific application. Here, we propose a new method to assess ML classification reliability using generative models and we show the results of the methos on a genomics variant interpretation problem. Our approach holds the promise to provide an effective support to clinicians by spotting potential ML failures during deployment.

#8

Comparing Machine Learning Algorithms of Mortality Prediction

Hayden K Roberts, Dennis Lysov and Scott Kivitz (New York Institute of Technology, USA); Dmitriy Karev (St. Barnabas Hospital, USA); Stephen DiRusso (New York Institute of Technology, USA)

Trauma hospital data was used to generate two mortality prediction models utilizing unique machine learning algorithms. Comparison was conducted using Area under Receiver Operator Characteristic Curves (AuROC), diagnostic accuracy (DA) calculations, and outlier classification. Both models were highly effective. These models have potential to serve as benchmarks for future trauma hospital performance.

#9

Machine Learning Analysis of the CRS-R -Derived Information Mostly Contributing to the Prediction of Consciousness Recovery

Silvia Campagnini (IRCCS Fondazione Don Carlo Gnocchi Onlus, Italy); Roberto Llorens (Neurorehabilitation and Brain Research Group Universitat Politècnica de València, Spain); Maria Dolores Navarro and Carolina Colomer (IRENEA. Instituto de Rehabilitación Neurológica, Fundación Vithas, Valencia, Spain); Andrea Mannini (IRCCS Fondazione Don Carlo Gnocchi Onlus, Italy); Anna Estraneo (IRCCS Fondazione Don Gnocchi ONLUS, Italy); Joan Ferri and Enrique Noé (IRENEA. Instituto de Rehabilitación Neurológica, Fundación Vithas, Valencia, Spain)

The Coma Recovery Scale-Revised (CRS-R) is the most recommended bedside instrument for the diagnosis of individuals with a Disorder of Consciousness (DoC) after a brain injury and its use is increasing in clinical practice worldwide. However, despite the amount of information gathered by the therapists to fill in the instrument, it is commonly interpreted using (only) its total score. It is therefore unknown whether all this information can be exploited to improve the current prognosis of this population. For this reason, this study aims to exploit machine learning-based models to determine which information derived from the CRS-R administered at admission to a long-term neurorehabilitation program can provide a better prediction of the emergence of DoC at discharge.

#10

Machine Learning after Multiple Imputation Techniques: an Application to the Prediction of Post-Stroke Ambulation Recovery

Alice Finocchi and Silvia Campagnini (IRCCS Fondazione Don Carlo Gnocchi Onlus, Italy); Francesca Cecchi (IRCCS Fondazione Don Carlo Gnocchi and University of Florence, Italy); Michela Baccini (University of Florence, Italy); Andrea Mannini (IRCCS Fondazione Don Carlo Gnocchi Onlus, Italy)

Health data analysis faces the challenge of missing data, making Multiple Imputation (MI) techniques a fundamental tool to avoid discarding patients. This study proposes an integrated pipeline to predict independent ambulation at discharge from post-acute rehabilitation, using MI and cross-validation of machine learning algorithms, with predictors collected at admission. The analysis involved 411 patients. With the random forest classifier, a mean accuracy of the aggregated solution of 80.0% was achieved. Compared to single imputation methods, MI improved prognostic performances of 12.9%. This work provided an accurate predictive model for the recovery of ambulation embedding MI methods, opening the way for automatic solutions supporting clinical decisions in stroke rehabilitation.

#11

Exploring context-independent m6A epitranscriptome and its regulatory mechanism in cancers

Sumin Jo and Tinghe Zhang (University of Pittsburgh, USA); Jianqiu Zhang (University of Texas at San Antonio, USA); Shou-Jiang Gao (University of Pittsburgh Medical Center, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

Context-independent N6-methyladenosine (m6A) epitrancritpome profiles in human tissues were studied and 5,626 conserved m6A sites harboring 1,359 genes that are methylated across all 24 tissue types were identified. They showed tissue-independent methylation patterns, suggesting their depositions are likely regulated by intrinsic factors. Also, a marked negative correlation between gene expression and methylation levels from numerous tumor suppressor genes, oncogenes, and immune genes associated with cancer regulation was observed.

#12

Prediction of Frequently Consumed Foods by an Individual Using Information Theory

Yiqiu Ren and Wenyan Jia (University of Pittsburgh, USA); Zhi-Hong Mao (University of Pittsburg, USA); Britney Beatrice and Mingui Sun (University of Pittsburgh, USA)

We have developed a novel approach for food recognition systems by leveraging the strengths of artificial intelligence and wearable technology. To overcome the limited power and data processing capacities of the wearable device-eButton, we propose a personalized dynamic survey system that identifies an individual's frequently consumed foods, utilizing an information theory based method.

#13

Type 2 Diabetes Mellitus Treatment Recommendations System using Reinforcement Learning: Utilizing Routine Electronic Health Records in Thailand

Teepagon Tonggon, Chanchanok Aramrat, Papangkorn Inkeaw, Noratap Muangudom and Chaisiri Angkurawaranon (Chiang Mai University, Thailand)

Type 2 Diabetes mellitus (T2DM) poses a significant burden on Thailand's healthcare system, necessitating improved treatment approaches, particularly in primary care settings with limited options. We developed a Clinical-decision support system for T2DM treatment combining knowledge driven model with data driven model from double deep Q-networks reinforcement learning and routine electronic health records composed of 47,330 T2DM patient data. Short-term and long-term retrospective evaluation showed better glycemic control rates and decreased risk of complications and death in system-concordance treatments. The approach shows promise in enhancing T2DM treatment decision making in low-to-middle income country setting but requires prospective evaluation for real-world implementation.

#14

K-Modes Clustering for Identification of Alpha-1 Antitrypsin Deficiency Patients within Electronic Healthcare Records Database

Sarah J. Aurit (University of Nebraska-Lincoln & Optum Life Sciences, USA)

The utilization of k-modes clustering provided two distinct scoring algorithms attributed to diagnosed Alpha-1 antitrypsin deficiency patients within an EHR database. Variables of interest included a wide range of demographic and clinical characteristics, and the list was finalized based on missing data, number of realizations and correlation. These algorithms were used to score undiagnosed patients, and the probable patients and affiliated providers were subsequently identified.

#15

Investigating Diabetes by Implementing AI/ML Algorithms

Pranav R Bellannagari (IntelliScience Institute & San Jose State University, USA); Sohail Zaidi (San Jose State University, USA); Farwa Z Kazmi (IntelliScience Research Institute, USA)

Diabetes is a prevalent global disease with an estimated 600 million new cases projected within the next fifteen years. This study explores the use of modern machine learning techniques to understand and predict diabetes using data from three different sources. The data includes various diagnostic features such as glucose level, BMI, stroke, and heart disease. Multiple algorithms, including logistic regression, random forest classifier, gradient boosting classifier, and XGB classifier, were employed for prediction. The models showed robust performance with accuracies ranging from 72% to 97.6%. The study also compares the prominent features used in predictive models, which may be influenced by local dietary habits.

#16

Identification of Cancer Driver Events at Residue Level: A Structure-Based Approach

Boshen Wang (University of Illinois at Chicago, USA); Bowei Ye (Univ of Illinois at Chicago, USA); Jie Liang (University of Illinois at Chicago, USA)

A number of bioinformatics methods have been developed to identify cancer driver events, but the majority of them are limited to providing gene-level predictions instead of recognizing specific mutation sites that drive tumorigenesis. To overcome this deficiency, we introduce a novel method Structure-CAcer-Relationship-on-Pathogenicity (SCARP) to provide residue-level identification of candidate driver mutations. SCARP incorporates information of protein structure, sequence evolution, and cancer cohorts to identify cancer driver mutations. With the integration of multiplelayer information, SCARP achieves superior performance in identifying cancer driver events.

#17

Comparative Study of Cognitive Impairment Modeling for Alzheimer's Disease - Longitudinal vs. Cross-Sectional

Mahdi Moghaddami and Mohammad-Reza Siadat (Oakland University, USA); Abbas Babajani Feremi (University of Florida, USA)

This study compares two modeling categories, longitudinal and cross-sectional, for predicting the clinical diagnosis of cognitive impairment in Alzheimer's disease. Various machine learning algorithms from each class are applied to neuroimaging and cognitive assessment features of subjects in the TADPOLE dataset. Statistical tests are utilized to compare the performances of algorithms within and between the two categories. Surprisingly, the study found that, on average, cross-sectional algorithms outperformed longitudinal ones. This contrasts with the expectation that longitudinal algorithms would perform better. The results suggest the need for further development of longitudinal algorithms for cognitive impairment modeling or, more importantly, exploring additional features that more precisely represent the development and progression of cognitive impairment toward Alzheimer's disease.

#18

AI-Based Detection of Parkinson's Disease using Speech Features Analysis

Manasvi Pinnaka (IntelliScience Institute, USA); Farwa Z Kazmi (IntelliScience Research Institute, USA); Sohail Zaidi (San Jose State University, USA)

Parkinson's disease (PD) is a degenerative brain condition leading to complete disability. Speech analysis, accelerated by AI/machine learning, is a non-intrusive diagnostic technique to detect PD. In this study, Kaggle data of speech features of PD patients was analyzed with the IBM Watson Platform to develop predictive models. Based on model accuracies (up to 98.2%), three algorithms (Snap Boosting Machine, LGBM, and XGB classifiers) were selected. The model measures, ROC curves, and confusion matrices for the models were compared, and the significance of top features for each were identified. The potential of ML to develop predictive models for early diagnoses of PD can assist millions of patients.

#19

Machine Learning-based Metabolic Syndrome Identification

Chang Liu and Jingjing Liu (Shanghai Jiao Tong University, China); Zhangdaihong Liu (Oxford-Suzhou Centre for Advanced Research, China & University of Oxford, United Kingdom (Great Britain)); Yang Yang (Shanghai Jiao Tong University, China)

Metabolic Syndrome, as a risk factor for various metabolic diseases, presents certain limitations in its current diagnostic methods. Our research investigated various machine learning methods to identify Metabolic Syndrome (MetS) in diverse populations based on demographic and laboratory testing features. The MLP model performed the best among the examined models, and the impact of weight and height was limited. The results of our study contribute to the improvement of early diagnosis of Metabolic Syndrome while addressing the challenge of model transferability due to differences in population distribution remains a substantial challenge.

#20

Development of a Wearable Cardiovascular Sensor for Clinical Use

Jürgen Fortin (CNSystems Medizintechnik GmbH, Austria & Technical University of Graz, Austria); Christian Fellner and Doris Flotzinger (CNSystems Medizintechnik GmbH, Austria)

Clinicians demand for CV wearable sensors whose principles of measurement have a solid scientific foundation and are validated for accuracy, precision, and reliability in the intended population according to clinical protocols that include typical BP changes while upholding ease of use and patient safety. This document describes the process of developing a clinically acceptable wearable based on the "Vascular Control Technique" (VCT) [1]. The wearable sensor measures the continuous blood pressure (cBP) signal of a patient and derives cardiac output and additional cardiovascular (CV) parameters. The pivotal point of development is a continuous verification / validation strategy.

#21

Discovering Multi-modal Digital Phenotypes of Mental Health Disorders in Young Children

Ryan S McGinnis, Bryn C Loftness, Jenna G Cohen and Ellen McGinnis (University of Vermont, USA)

Childhood mental health problems are common, impairing, and are challenging to detect. We are developing objective markers of mental health conditions in young children based on biological and behavioral responses to short mood induction tasks. Here we demonstrate early evidence that data from two wearable sensors may provide complementary information for detecting children with underlying mental health conditions that a single device cannot capture alone.
Clinical Relevance- Provides promising evidence that wearables data from short mood induction tasks may detect mental health conditions in young children.

#23

Complexities hidden in plain sight: quantifying the impact of tracheal tube pitch, roll and yaw on ability to intubate

Erich B Schulz (University of Queensland & Mater Health, Australia); Robert L Read and Judith Weng Zhu (Public Invention, USA)

Tracheal intubation (TI) consists of passing a curved tube through the mouth, down over a curved laryngoscope blade and passing the tube tip anteriorly between the vocal cords. Failure can result in death or permanent disability, yet even with modern video laryngoscopes, the reported first-attempt failure rate by trained first-responders under optimal circumstances exceeds 10%.
Engineers have developed real-time simulations using dimensional scans, virtual reality, soft-body and rigid body physics coupled with haptic simulators. However, static geometric analysis reveals little described complexities in tube orientation that may explain difficulties experienced simulating TI in a way that feels intuitive to clinicians.
To illustrate this geometry we developed a simple Typescript Babylon JS program. Constraining the tube within a parameterised space bounded by upper teeth and a laryngoscope blade allows measuring optimal anterior tube tip elevation with various tube roll, yaw and pitch orientations.
Postero-lateral tube movement at the mouth causes tip movements in excess of 14mm. At a constant point of contact with the upper teeth, rolling the tube is associated with an unhelpful posterior motion of the tube tip.
Accurately representing these geometric realities may enable engineers to educate clinicians in order to ultimately decrease the failure rate.

#24

A Mobile Application for Improving Emergency Response Times and Patient Outcomes with Real-Time Data Sharing

Areen Al-Bashir, Lamia I. Darwish, Rand Bawwab and Mohannad Othman Abu Shawimeh, engineer (Jordan University of Science and Technology, Jordan)

When it is an emergency case, every second and the available equipments does matter, therefore the idea of smart ambulance came to help paramedics in deciding which hospital can treat the patient better. Hence a mobile application was designed and implemented. The application intends to optimize medical resource allocation, shorten response times, and enhance patient outcomes in emergency scenarios.

#25

Improving Brain-Computer Interface Speller Outcomes Through Imposing Linguistic Rules with a Shared Control Algorithm

Joshua Kosnoff, Kai Yu and Bin He (Carnegie Mellon University, USA)

Current advances in non-invasive brain-computer interfaces (BCIs) are still seeing errors around 20%, making them be challenged for clinical usage. Here, we developed a shared control algorithm that imposes linguistic meaning onto the classifier's output, allowing users to correct the BCIs' initial predictions even when up to 50% of the spellings are incorrect.

#26

Characterizing the Stress-Reducing Effects of Non-Invasive Vagus Nerve Stimulation

Asim H Gazi (Georgia Institute of Technology, USA); Douglas Bremner (Emory School of Medicine, USA); Jin-Oh Hahn (University of Maryland, USA); Christopher Rozell (Georgia Tech, USA); Omer T Inan (Georgia Institute of Technology, USA)

At any given moment, a patient with an anxiety or trauma disorder (e.g., posttraumatic stress disorder) can feel triggered due to some cue in their environment and immediately overcome by debilitating stress (e.g., anxiety attack). A key challenge in mitigating this acute stress is that it generally takes place outside the clinic - away from clinicians who would otherwise be able to detect and intervene to help curb the response. Herein, we overview dynamical modeling efforts to evaluate whether transcutaneous cervical vagus nerve stimulation (tcVNS) can counteract stress within the time frame necessary to mitigate the effects of traumatic memories. We

characterize nine cardiovascular and respiratory physiological markers' responses to tcVNS and trauma recall (the recollection of traumatic memories) to assess the viability of tcVNS as a stress-reducing intervention. We first demonstrate that tcVNS effects occur within 10-15 seconds. We then show that although the physiological markers' dynamics in response to trauma recall are faster and more significant, the dynamics in response to tcVNS oppose these effects, suggesting tcVNS as a potential just-in-time intervention for stress attenuation in the future. Clinical Relevance: TcVNS's effects seem to counteract traumatic stress and may occur fast enough for real-time intervention during everyday life.

#27

Development of a Method for Compliance Detection in Wearable Sensors

Siavash Esfandiari Fard (University of Alabama, USA); Tonmoy Ghosh (The University of Alabama, USA); Delwar Hossain (University of Alabama, USA); Edward Sazonov (The University of Alabama, USA)

One of the crucial elements in studies relying on wearable sensors for quantification of human activities (like physical activity or food intake) is the assessment of wear time (compliance). In this paper, we propose a novel method based on the Automatic Ingestion Monitor v2 (AIM-2), deployed for measuring nutrient and energy intake. The proposed method was developed using data from a study of 30 participants for two days each (US dataset). The signals from the accelerometer sensor of the AIM-2 were used to extract features and train the gradient-boosting tree classifier. To reduce the error in the classification of non-compliance in situations where the sensor changes its position with respect to gravity, a two-stage classifier followed by post-processing was introduced. Previously, we developed an offline compliance classifier, and this work aimed to develop a classifier for a cloud-based feedback system. The accuracy and F1-score of the developed two-phase classifier based on K-fold validation were 95.37% and 96.93%, respectively, showing satisfactory performance results. The trained classifier can be deployed to monitor compliance with device wear in real-time applications.

#28

Building the Digital Biomarker Discovery Project (DBDP): Challenges and Lessons Learned

Md Mobashir Hasan Shandhi, Hayoung Jeong, Bill Chen and Jessilyn Dunn (Duke University, USA)

Digital Biomarker Discovery Project (DBDP) was developed to provide a collaborative, standardized space for digital biomarker research and validation via providing a comprehensive, open-source software platform for end-to-end digital biomarker development. Clinical Relevance- Researchers and clinicians can utilize the tools developed through DBDP to incorporate digital health into clinical workflow.

Digital biomarkers are digitally collected data (e.g., step counts, and mean resting heart rate from a fitness tracker) that are transformed into indicators of health outcomes (e.g., fitness). Digital Health is poised to not only make it possible to rapidly detect, prevent, and manage many diseases, but also ensure equitable healthcare access. However, the progress in digital health has been hindered by the lack of reference standards, transparency, and open resources including data and code.
To address this issue, the Digital Biomarker Discovery Project (DBDP) has developed modular toolkits for the development of digital biomarkers and the validation of existing methods. These modules, along with a curated list of datasets for digital health, are publicly available on DBDP.

From functions to preprocess data to methods for clinical applications such as predicting glycemic health status, clinical lab tests, response to exercise, and inflammation, the DBDP repository offers a range of modules. DBDP is intentionally organized in a modular manner to enable users to simply call the functions and easily integrate the methods into their research. However, we acknowledge familiarity with specific programming languages and frameworks is required to utilize DBDP's code. This prerequisite creates a barrier for important stakeholders such as clinicians and medical researchers who may lack programming experience but wishes to contribute their domain knowledge to research in digital health.
To enable DBDP to be an accessible and useful toolbox for all users regardless of their programming experience, we are developing a visual programming tool that provides no-code access to the DBDP modules. In addition, we regularly publish blog posts to provide various background information (i.e., current trends and challenges in digital health) for users from all backgrounds and expertise. Lastly, DBDP also offers case studies in the format of Google Colab notebooks. These case studies are designed to help users envision how various DBDP modules can be integrated into their research. Each case study is prompted by a research question or adapted from an existing publication that provides publicly available code and data.

#29

A Smartphone Application to Detect and Control Hypertension for the Underserved

Vishaal Dhamotharan (University of Pittsburgh, USA); Cederick Landry (University of Sherbrooke, Canada); Mark Freithaler and Sanjeev G Shroff (University of Pittsburgh, USA); Anand Chandrasekhar (Michigan State University, USA); Ramakrishna Mukkamala (University of Pittsburgh, USA)

A smartphone application utilizing the oscillometric hand-raising technique was developed and evaluated for measuring absolute pulse pressure (PP) in 24 healthy volunteers. The app was learnable and yielded a correlation coefficient of 0.7 against arm cuff PP with good accuracy. Such a smartphone-based PP monitoring device could help improve hypertension awareness and control rates in underserved communities.

#30

Voice Assistants in Healthcare: The case of GlucoCheck

Anh Duong and Maria Valero (Kennesaw State University, USA)

Over the past few decades, there has been significant progress in the development and implementation of voice assistants (VA) in healthcare systems globally. These voice assistants have gained widespread acceptance, making usability a crucial factor to consider. Ensuring effective and accurate performance in the critical and sensitive healthcare environment is essential. In this paper, we present the implementation and interaction of a VA with a device called GlucoCheck, a non-invasive glucose monitor developed at Kennesaw State University. This integration holds significant potential for improving patient care and monitoring glucose levels in a user-friendly

#31

MINDWATCH: A Closed-loop Neural Wearable for Mental Well-being

Saman Khazaei and Rose T. Faghih (New York University, USA)

Smartwatch-like wearables are used to monitor physical health. They can be further developed to provide information about cognitive states and to modulate cognitive arousal and performance via neurofeedback. We design algorithms for a closed-loop neural wearable architecture called MINDWATCH for mental and cognitive well-being. We first infer arousal-related autonomic nervous system (ANS) activations. Employing a Bayesian state-space framework, we model and decode cognitive arousal and performance brain states: the inferred ANS activations and behavioral data can be used as arousal and performance observations, respectively. We use music as a form of neurofeedback to close the loop and maintain the neurobehavioral states within desired ranges. We investigate the role of music in regulating arousal and performance. The methods are validated by analyzing the skin conductance signal and behavioral data in the context of cognitive-stress-related arousal and performance.

#31

Development of a Composite Bone Plate - Towards Biomedical Vibrancy and Economic Viability

Md E. Hoque (Military Institute of Science and Technology, Bangladesh)

Titanium, stainless steel, tantalum etc. are commonly used for bone plates. However, the metallic bone plates inherit some fundamental issues namely, stress shielding, bone atrophy etc. due to their incomparable strength to the natural bones. In addition, the metallic bone plate requires secondary/revision surgery to remove it from the body. This work aims to develop an alternative composite bone plate that should be biofunctional and economical. I. INTRODUCTION Biomaterials are being used to replace or restore the structure and/or functions of damaged organs since the invention of biocompatible and biofunctional materials. For bone fracture treatment, a support structure (called, bone plate) made of biomaterials is essential for a specific time that is needed to heal the broken bone. D. Chandramohan states that, According to a more favorable environment for bone growth brought on by the high corrosion resistance of biopolymers and natural fibers, an increase in bone density is encouraged through the development of biocomposite materials [1]. For example, silk fiber can be used for bone fracture treatment. The fiber of composite silk shows an optimistic result in a sense of biofunctionality as well as biocompatibility

[2].II. METHODS Firstly, different types of composite samples were fabricated using available different natural fibers like jute, silk, kenaf, etc. which were embedded into matrices such as epoxy resin, polypropylene, etc. Secondly, a bone plate was fabricated after obtaining the required bone healing properties in the composite sample. Different tests including mechanical tests (Tensile, Flexural and Compression), cytotoxicity test, microstructural analysis, moisture absorbability, and biodegradability in simulated body fluid, etc. were performed. Besides, the mechanical properties were verified through the finite element analysis module of Ansys. III. RESULTS The kenaf/epoxy biocomposite could be produced from locally available and low-cost resources (natural fiber and epoxy resin), which demonstrates the high potential to be used as an alternative to conventional metallic bone plates. The kenaf/epoxy biocomposite meets the fundamental mechanical property requirements of a bone plate. Thus, the further procedure of finding the potentiality started. This composite material introduces itself as non-cytotoxic, which was evidenced by the cytotoxicity test. The water absorption test and microstructural observation further signified the potentiality of the fabricated composite bone plate. IV. DISCUSSION & CONCLUSION This work verifies the potential of natural fiber-reinforced polymer composites as an alternative to metallic/conventional biomaterials used for bone plates. The renewability, local availability, and biocompatibility of the natural fiber (kenaf), and the non-cytotoxicity of the fabricated composite (kenaf/epoxy) make it suitable for the bone plate application. The mechanical properties of

the composite bone plate were also investigated computationally and experimentally that match with the natural bone properties. The preliminary results suggest that the fabricated composite bone plate is promising for the fixation of bone fracture.

#32

Neural Network Algorithm for Burn Resuscitation

Yi-Ming Kao and Ghazal ArabiDarrehDor (University of Maryland, USA); Babita Parajuli (Uniformed Services University, USA); Bonnie C. Carney, Lauren T. Moffatt and Jeffrey W. Shupp (MedStar Health Research Institute, USA); David M. Burmeister (Uniformed Services University, USA); Jin-Oh Hahn (University of Maryland, USA)

A Neural Network (NN) algorithm is developed to support burn resuscitation. The leave-one-out cross validation is considered and the comparison among conventional burn resuscitation algorithm (e.g. Burn Navigator), NN and NN leave-one-out is conducted as well. The comparison results show the NN algorithm has i) better performance than conventional, ii) robustness in suggesting burn resuscitation status and iii) high possibility of obtaining more robust algorithm once more data is included.

#33

Mental Stress Tracking via Multi-Modal Wearable Physiological Sensing and Collective Inference

Yuanyuan Zhou, Jin-Oh Hahn, Azin Mousavi, Yekanth Ram Chalumuri, Jesse Parreira and Mihir Modak (University of Maryland, USA); Jesus Antonio Sanchez-Perez, Asim H Gazi and Omer T Inan (Georgia Institute of Technology, USA)

We present a mental stress ("stress") tracking algorithm, which can infer stress state from wearable-enabled multi-modal physiological sensing. We selected prominent digital signatures in the multi-modal physiological signals that can track mental stress. Using these prominent signatures, we developed a stress tracking algorithm that can continuously classify stress vs no stress conditions Experimental results suggest that (i) our algorithm can infer stress state using a small number of digital signatures derived from cross-integration of multi-modal physiological signals; (ii) it significantly outperforms stress trackers based on conventional digital signatures; and (iii) collective inference could improve inference of stress state relative to naïve data mining techniques.

#34

Iterative Geometric Projection Method for Bias Mitigation in Predicting Depression in Early Pregnancy using EMR in a Minority Population

Yongchao Huang, Yang Dai and Peñalver Bernabé Beatriz (University of Illinois at Chicago, USA)

Machine learning (ML) models using Electronic Medical Records (EMRs) have shown promise in predicting obstetric complications, including depression during pregnancy. Despite these advancements, the presence of bias in EMRs can result in ML models that under-predict the risk of conditions influenced by social determinants of health, inadvertently perpetuating health inequalities. This paper introduces a novel bias mitigation strategy that fine-tunes geometric projection methods to combat this pervasive issue. We employed EMRs from a US hospital primarily serving low-income women of color, providing a unique context to assess bias in ML models. Our investigation critically compares the efficacy of our proposed bias mitigation procedure with the original geometric projection and generalized linear models. The comparative evaluation highlights the robust performance of our strategy, revealing its potential to effectively reduce bias. Moreover, our research successfully identifies crucial protected variables associated with race and ethnicity, such as being single and having an unplanned pregnancy, using the SHAP (Shapley Additive exPlanations) method. These findings underscore the potential and necessity of adopting strategic bias mitigation techniques in developing more equitable predictive ML models. As such, this work makes a valuable contribution to the ongoing efforts to achieve greater health equity through the application of more balanced predictive analytics.

#35

Enhanced Predicting of Antiviral Treatment Response in Chronic Hepatitis B Utilizing Molecular Graph Embeddings

Jihyeon Song (Handong Global University, Korea (South)); Soon Sun Kim (Ajou University School of Medicine, Korea (South)); Ji Eun Han and Hyo Jung Cho (Ajou University School of Medicine, Korea (South), Korea (South)); Jaeyoun Cheong (University of Ajou, Korea (South)); Charmgil Hong (Handong Global University, Korea (South))

If patients infected with chronic hepatitis B do not receive appropriate treatment, they are at a significantly higher risk of developing severe liver diseases such as cirrhosis and liver cancer, underscoring the critical importance of selecting the most suitable medication for each individual. The primary objective of this research is to accurately predict the reduction in serum HBV DNA levels after 1 year of hepatitis B treatment by leveraging both electronic medical records and the structural information of antiviral drugs, which is extracted through a sophisticated graph neural network model. To demonstrate the effectiveness of the drug embeddings generated by GNN in target prediction, a comprehensive comparison was conducted between the baseline FNN model and the enhanced FNN model trained with fixed embeddings such as ECFP and Mold2. The experimental findings, encompassing the integration of molecular embeddings of the antiviral drugs within the predictive model, exhibited a noteworthy improvement of approximately 3% in terms of

AUROC compared to the baseline model. Furthermore, the inclusion of molecular embeddings resulted in a remarkable enhancement of around 9% in balanced accuracy. Consequently, these findings provide conclusive evidence that the utilization of end-to-end drug structure embedding through GNN significantly contributes to the overall performance enhancement of the predictive model.

#36

Prediction of Antimicrobial Resistance(AMR) Phenotypes using Machine Learning

Gavin Cooper (Arkansas State University, USA); Se-ran Jun (University of Arkansas for Medical Sciences, USA); Doosung Hwang (Dankook University, Korea (South)); Donghoon Kim (Arkansas State University, USA)

Antimicrobial resistance (AMR) is a critical global public health concern, responsible for the rise in hospital-acquired infections and heightened levels of illness and death. The misuse and overuse of antibiotics have contributed to the development of drug resistance among pathogens, creating a pressing need for effective strategies to predict AMR phenotypes. Machine learning techniques have emerged as valuable tools in this endeavor, enabling the analysis of vast datasets to identify patterns and predict the resistance or susceptibility of microorganisms to specific antibiotics. Leveraging machine learning holds promise in combating the growing threat of AMR and improving patient outcomes. The objective of this study is to enhance AMR prediction using machine learning techniques, leveraging insights from the cybersecurity domain due to the similarities between AMR and malware datasets. The approach involves employing k-mer frequency analysis and feature importance algorithms to extract significant features. The experimental results indicate that (1) Our approach demonstrates superior performance compared to the reference paper, (2) The utilization of 10-mers yields better outcomes in comparison to 7-mers, and (3) Our feature design outperforms that of the reference paper. This research has shown that by applying cross-domain research methodologies and capitalizing on the shared characteristics among different datasets, the performance of AMR prediction can be improved.

#37

Enhancing Rare Cell Type Identification in Single-Cell Data: An Innovative Gene Filtering Approach using Bipartite Cell-Gene Relation Graph

Maziyar Baran pouyan (Accenture Technology Labs, USA); Krishnaprasad Thirunarayan, Lingwei Chen and Hossein Mohammadi (Wright State University, USA); Hojjat Torabi Goudarzi (The University of Oklahoma, USA)

Single cell technology refers to a set of scientific techniques that allows researchers to study cellular structures in depth.The behaviors and properties of individual cells may be hidden by traditional biological experiments, which frequently measure averages over a large number of cells. With the aid of single cell technology, scientists may examine each cell separately and gain a much more in-depth understanding of biological processes. Hence, a useful tool for examining cellular diversity is single cell RNA sequencing (scRNA-seq). However, the high dimensionality and technical noise of scRNA-seq data make analysis difficult. To address this issue, gene filtering has been widely adopted to minimize single cell data noise and enhance the quality of subsequent analyses. Nonetheless, existing gene filtering techniques may inadvertently omit critical but rare genes which are necessary for identifying rare cell types that play a pivotal role in comprehending many biological processes. A novel graph-based gene selection technique is suggested in this study with the aim of preserving the informative genes to better identify rare cell types. Our findings demonstrate that this technique enhances the identification of rare cell populations, providing a refined approach for scRNA-seq data analysis and potentially enabling earlier and more reliable disease detection.

#38

Development of a Framework Dealing with Partial Data Unavailability and Unstructuredness to Support Post-Market Surveillance

Yijun Ren and Enrico G Caiani (Politecnico di Milano, Italy)

Under the European Union Medical Device (MD) Regulation 2017/745, Expert Panel's decision on providing a scientific opinion on the Clinical Evaluation Assessment Report for high-risk MD is required, as part of the conformity assessment procedure. To this aim, the perceived risk of similar MDs already on the market, based on the European Medical Device Nomenclature (EMDN), could help. To generate such information, we propose a generalized framework to automatically collect and display in an aggregated way the publicly available safety notices (SNs), even when characterized by partial unstructuredness and incompleteness. This novel approach was tested on the Dutch data, consisting of 3618 SNs from 2015 to 2022, retrieved from the official government website by Web scraping. After identification of named entities, the best match MD was searched within the Italian and Portuguese datasets of devices using Natural Language Processing techniques. Algorithm performance was tested on potentially equal SNs (472) published by both the Dutch and Italian authorities: assignment of the same EMDN code at level 1 was present in 454 out of 472 (96.19%) SNs, at level 2 in 447 (94.70%) SNs, at level 3 in 433 (91.74%) SNs. The proposed approach was able to cope with data unavailability and incompleteness in the public data, thus providing structured data with appropriate EMDN usable for safety signal detection.

#39

Interpretable Disease Prediction from Clinical Text by Leveraging Pattern Disentanglement

Malikeh Ehghaghi (University of Toronto, Canada); Pei-Yuan Zhou (University of Waterloo, Canada); Wendy Yusi Cheng (University of Toronto, Canada); Sahar Rajabi (University of Tehran, Iran); Chih-Hao Kuo and En-Shiun Annie Lee (University of Toronto, Canada)

For artificial intelligence (AI) systems to be adopted in high stake human-oriented applications, they must be able to make complex decisions in an understandable and interpretable manner. While AI systems today have grown leaps and bounds in predictive power using larger datasets with more complex architectures, existing models remain ineffective at generating interpretable insights in the clinical setting. In this paper, we address the challenge of discovering interpretable insights from the clinical text for disease prediction. For this purpose, we apply the clinical notes from the electronic health records (EHR) available in the Medical Information Mart of Intensive Care III (MIMIC-III) dataset, which are labeled with the international classification of diseases (ICD9) codes. Our proposed algorithm combines interpretable text-based features with a novel pattern discovery and disentanglement algorithm. Specifically, our approach encompasses the following: (1) uncovering strong association patterns between clinical notes and diseases, (2) surpassing baseline clustering algorithms in effectively distinguishing between disease clusters, and (3) demonstrating comparable performance to baseline supervised methods in predicting diseases. Our results validate the model's capability to strike a balance between interpretability and outcome prediction accuracy. By unveiling insightful patterns between clinical notes and diseases, our approach upholds a reasonable level of diagnostic accuracy.

#40

A Microwave-Based Method for Early Detection of Congestive Heart Failure

Aditi Anand, Amrutha Vaidyam, Adithya Chandrasekar, Atthin Chandrashekar, Alan Chi, Adam Groneck, Jiayu Luo, Christin Huene, Alec Lucas and Lorenzo Cacciapuoti (Purdue University, USA)

We propose a microwave-based method for the early detection congestive heart failure (CHF). The proposed method is based on the prevalence of pulmonary edema accompanying CHF. Current approaches based on chest radiographs can only detect relatively high levels of pulmonary edema, limiting their efficacy for early diagnosis. We observe that microwaves passing through the thoracic cavity would experience significantly higher attenuation in the presence of fluid. Our detection method consists of a microwave source in the form of a two-dimensional array of low-power emitters placed on one side of the thoracic cavity, a corresponding array of receivers on the other side, and signal processing to compute the attenuation of microwaves as they pass through the body. We develop an electromagnetic simulation model to evaluate the proposed method and apply it to compute microwave attenuation in the absence and presence of various levels of pulmonary edema. Our experiments suggest that the method is sensitive to even mild and moderate levels of pulmonary edema that are difficult to detect using current first-line diagnostic methods. Our work makes a case for microwave-based detection as a safe, low-cost diagnostic method for CHF at earlier stages where there is a good potential for improved patient outcomes.

#41

Multimodal Fusion of Functional and Structural Data to Recognize Longitudinal Change Patterns in the Adolescent Brain

Rekha Saha (Georgia State University, USA); Debbrata K. Saha (Georgia Institute of Technology, USA); Zening Fu (TReNDS, Georgia State University, USA); Rogers F Silva (TReNDS Center & Georgia State University (GSU), USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

Functional and structural magnetic resonance imaging (fMRI/sMRI) are extensively used modalities for studying brain development. While individual modalities may overlook crucial aspects of brain analysis, combining multiple modalities allows us to leverage the benefits of revealing hidden brain connections. To analyze multivariate change patterns in brain function and structure with increasing age across the entire brain, we employ a symmetric multimodal fusion approach that combines multiset canonical correlation analysis and joint independent component analysis. In this study, we present a novel approach to analyze linked longitudinal change patterns in functional network connectivity (FNC) and gray matter (GM) data derived from the large-scale Adolescent Brain and Cognitive Development dataset. Our approach uncovers significant pattern changes in both modalities. Specifically, we identify highly structured functional change patterns and structural change patterns that include increased brain functional connectivity between the visual and sensorimotor domains in the fMRI data, as well as changes in the bilateral sensorimotor cortex in the sMRI data. Overall, our study demonstrates the strength of our approach in uncovering longitudinal changes in FNC and GM, provides valuable insights into the dynamic nature of brain connectivity and structure during adolescence, and sheds light on potential gender-related differences in these processes.

#42

RNA sequencing-based histological subtyping of non-small cell lung cancer with generative adversarial data imputation

Ralph Saber (Polytechnique Montreal, Canada); Bertrand Routy and Simon Turcotte (Université de Montréal, Canada); Samuel Kadoury (Ecole Polytechnique de Montreal, Canada)

Non small cell lung cancer (NSCLC) is the most common type of lung cancer and could be classified into two main histological subtypes: adenocarcinoma and squamous cell carcinoma. The identification of the histological subtype is a crucial step in the diagnosis of NSCLC. RNA sequencing data hold valuable biological information but may contain missing gene expression counts, which limit their potential exploitation in practice. In this work, we address the issue of missing gene expression data in NSCLC histological subtype prediction from RNA sequencing. To this end, we propose a pipeline based on the generative adversarial imputation network (GAIN) for the generation of plausible imputations of missing data and tree-based ensemble models for NSCLC histological subtype prediction. We adopted a nested cross validation scheme for the evaluation of the classification models. The proposed pipeline exhibited an outstanding performance with an area under the receiver operating characteristic curve of 0.98 ± 0.03 and an accuracy of 0.96 ± 0.05 obtained with the Light Gradient Boosting Machine. Experimental results showed that GAIN-derived imputations are useful to boost classification performance. Finally, we used the Shapley Additive Explanations technique and found a set of genes that were the most relevant for NSCLC subtyping across different models.

#43

GlySim: Modeling and Simulating Glycemic Response for Behavioral Lifestyle Interventions

Asiful Arefeen and Hassan Ghasemzadeh (Arizona State University, USA)

Effective prevention and management of diabetes relies on maintaining a normal blood glucose level, thus avoiding abnormal events such as hyperglycemia and hypoglycemia. Predicting anomalous events beforehand can potentially help patients and caregivers intervene to prevent such events through modifiable behaviors such as exercise, diet, and medication. Although Continuous Glucose Monitor (CGM) sensors have been used to monitor and forecast blood glucose level, current research lacks a computational approach that recommends a behavioral intervention to bring the glucose level to a normal range. To address this shortcoming, we present GlySim, a CGM simulator that uses multimodal data to not only forecast future glucose readings but also enable a user to examine the impacts of behavior change on glucose response in advance. GlySim creates opportunities for change in food consumption, medication, and physical activity to avoid dysglycemia by pinpointing factors that cause anomalous events using Grad-CAM (Gradient-weighted Class Activation Mapping) and allowing users to observe how adjusting a behavioral factor changes glucose trajectories. We validate GlySim on a dataset of 10 patients with type 1 diabetes and achieve an overall mean absolute error (MAE) as low as 16.5 mg/dl in simulating glycemic response. Furthermore, Glysim detects hyperglycemic events with 0.89 average precision.

#44

A Preliminary Investigation into Quantitative Assessment of ADHD Treatment Efficacy on Hyperactivity Levels via Actigraphy

Joshua Putris (San Diego State University, USA); Aybike Aydın, Mustafa Balkanas, Ayşe Söylemezoğlu, Nihal Serdengeçti, Tayyib Kadak and Mahmut Cem Tarakçıoğlu (Istanbul University - Cerrahpasa School of Medicine, Turkey); Hakan Töreyin (San Diego State University, USA)

The diagnosis and assessment of attention deficit hyperactivity disorder (ADHD) in clinical practice heavily rely on subjective and biased scales. This study explores the feasibility of using actigraphy measurements to objectively assess and monitor the treatment response of ADHD in children receiving medication. A cohort of ten children underwent evaluation using three scales, one administered by child-adolescent psychiatrists and two completed by the parents, both pre- and post-medication. In addition, two sets of actigraphy recordings were collected, each spanning seven consecutive days, before and after medication administration. The study revealed that changes in the median, mean, and skewness of accelerations in spherical coordinates exhibited stronger correlations with changes in the scale scores in comparison to other features. Additionally, binary classifications using feature sets with top correlations and PCA features defining 95% variability showed better predictions for ADHD treatment response assessed by TURGAY DSM-IV-S (82%) and WFIRS-life skills (81.4%) scores compared to WFIRS-school behavior (63.9%) scores. These findings represent the first reported correlations between ADHD scales and a broad range of features. Additionally, they demonstrate the feasibility of using actigraphy data to predict ADHD treatment response for the first time.

Clinical Relevance- The utilization of actigraphy for objective and reliable measurement of ADHD symptoms and functional impairment can serve as a valuable complement to subjective evaluations conducted by parents and clinicians, and thus aiding in determining an effective treatment plan and identifying priority areas for intervention.

#45

Burnout Prediction and Analysis in Shift Workers: Counterfactual Explanation Approach

Ziang Tang, Zachary King, Alicia Choto Segovia, Han Yu and Gia Braddock (Rice University, USA); Asami Ito, Ryota Sakamoto and Motomu Shimaoka (Mie University, Japan); Akane Sano (Rice University, USA)

Shift work disrupts sleep and causes chronic stress, resulting in burnout syndrome characterized by emotional exhaustion, depersonalization, and decreased personal accomplishment. Continuous biometric data collected through wearable devices contributes to mental health research. However, direct prediction of burnout risk is still limited, and interpreting machine learning models in healthcare poses challenges. In this paper, we develop machine learning models that utilize wearable and survey data, including rhythm features, to predict burnout risk among shift workers. Additionally, we employ the DiCE (Diverse Counterfactual Explanations) framework to generate interpretable explanations for the ML model, aiding in the management of burnout risks. Our experiments on the AMED dataset show that incorporating rhythm features significantly enhances the predictive performance of our models. Specifically, sleep and heart rate features have emerged as significant indicators for accurately predicting burnout risk.

#46

Classification of User Adherence to Home Hand Rehabilitation Technology Using a Feed-Forward Artificial Neural Network

Mohammad Shams (George Mason University, USA); Daniel K Zondervan (Flint Rehabilitation Devices LLC, USA); Quentin Sanders (George Mason University, USA)

Hand impairments resulting from neurological conditions can significantly affect individuals' quality of life. Home-based rehabilitation programs are promising solutions to address these challenges. This study investigated user engagement with MusicGlove, a commercially available wearable grip sensor. We applied deep learning and machine learning techniques to classify users based on their interaction with the device. We categorized users into 'low', 'moderate', and 'power' users and found considerable differences in device usage. For user adherence prediction after one day of device usage, we used a Multi-Layer Perceptron (MLP) deep learning model and traditional machine learning models such as K-Nearest Neighbors (KNN), Support Vector Machines (SVM), and Logistic Regression. The MLP model outperformed other models, achieving an average F1-score of 0.68 in cross validation and a balanced performance on unseen test data with an accuracy of 0.68, precision of 0.66, recall of 0.72, and an F1-score of 0.69 for the 'Low' user class. Our results underscore the need for personalized home-based rehabilitation programs and highlight the effective use of deep learning algorithms in predicting user adherence in home-based digital rehabilitation. This study contributes to the growing body of evidence supporting machine learning applications in healthcare, particularly in patient outcome prediction and treatment personalization.

#47

Exploring Nutritional Impact on Alzheimer's Mortality: An Explainable AI Approach

Ziming Liu (University of Tennessee, USA); Longjian Liu (Drexel University, USA); Robert Eric Heidel (University of Tennessee, USA); Xiaopeng Zhao (University of Tennessee at Knoxville, USA)

In this study, we employ machine learning (ML) techniques along with explainable artificial intelligence (XAI) to delve into the intricate connection between nutritional status and mortality related to Alzheimer's disease (AD). To conduct the analysis, the Third National Health and Nutrition Examination Survey (NHANES III 1988 to 1994) and the NHANES III Mortality-Linked File (2019) databases are applied in this study. As a foundation for the XAI analysis, the random forest model is chosen as the primary model, and the Shapley Additive Explanations (SHAP) method is implemented to evaluate the significance of various nutritional features collected from blood testing. The findings of this study shed light on the crucial nutritional factors that impact AD and its associated mortality due to AD. Notably, Serum Vitamin B12 and age emerge as significant contributors. These results contribute to a more profound comprehension of the progression of AD and offer valuable insights into the influence of nutrition on the disease. The result demonstrates the potential of ML and XAI in uncovering complex relationships between nutritional status and AD, and providing interpretable explanations. Ultimately, this knowledge can inform interventions and strategies aimed at improving nutritional status and mitigating the mortality risks associated with Alzheimer's disease.

#48

Retrieving Knowledge of Molecular Regulatory Mechanisms from PubMed Titles via an Event Extraction Approach

David A Spellman, Jason Xiaotian Dou, Aaron F Wu, Sumin Jo and Yu-Chiao Chiu (University of Pittsburgh, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

This work tackles three main issues in information extraction (IE) from biomedical literature: 1. How to design models to extract the structured and flexible representation of molecular regulatory mechanisms (MRM) from the literature that captures the biological features comprehensible to an expert. 2. How to overcome the limitation of existing abstract-based solutions for IE that are costly to annotate and insufficient to extract MRMs for answering regulatory questions in downstream tasks. 3. How to overcome the

challenges of a lack of annotated training data for MRM such that different machine learning models for extracting MRM can be trained and evaluated. To address these issues, a novel event extraction (EE) driven approach to automatically extract MRM from paper titles is proposed. We have designed an EE template for MRM that homogenizes the characterization of MRM in titles, making the prediction of MRM possible. We have created the first training dataset for MRM with human-annotated event arguments that capture the essential components of the molecular mechanisms. Our comprehensive evaluations have demonstrated strong performance from the tested models. In addition, further strategies for fine-tuning pretrained biomedical language models are proposed. This work suggests a promising direction for an event-based solution for the extraction of molecular mechanisms from biomedical literatures.

#49

Uncovering the Effects of Genes, Proteins, and Medications on Functions of Wound Healing: A Dependency Rule-Based Text Mining Approach Leveraging GPT-4

Jayati Halder Jui and Milos Hauskrecht (University of Pittsburgh, USA)

Wound healing is a complex biological process characterized by intricate cellular and molecular interactions. Understanding the underlying mechanisms and the effects of different biological entities, such as genes, proteins, and medications, on the cellular and biological functions of wound healing is of paramount importance for developing effective therapeutic interventions. In this paper, we present a text-mining approach aimed to explore and unravel the complex regulatory relationships of genes, proteins, and medications with the biological mechanisms of wound healing. Our approach relies on a set of predefined dependency rules to identify and capture the relationships between biological entities and their target functions. By leveraging advanced AI technology like Generative Pre-trained Transformer 4 (GPT-4), also known as ChatGPT, we evaluate the accuracy and quality of the extracted relations. We also present a thorough discussion about the encouraging preliminary results that validate the efficacy of our model. Our dependency rule-based text-mining approach, combined with the capabilities of GPT-4, presents a promising avenue for unraveling the complex web of interactions involved in wound healing. The study underscores the future potential of incorporating multi-word concept embedding of complex functional entities and exploiting synthetic data from GPT-4 for enhanced relation identification. This research offers a new contribution to aid computational biology research by exploiting the power of large language models to facilitate biological text analysis.

#50

Comparative Analysis of Machine Learning Algorithms for Prediction of Adherence to Medication

Miguel Rujas, Beatriz Merino-Barbancho and Peña Arroyo (Universidad Politécnica de Madrid, Spain); Jim Ingebretsen Carlson (PredictBy, Spain); Jaime Barrio Cortes, Ana Isabel Villimar Rodríguez and Andrés Castillo (Fundación para la Investigación e Innovación Biosanitaria en Atención Primaria, Spain); Ana Roca-Umbert (PredictBy Research and Consulting and Universitat Oberta de Catalunya, Spain); Francisco Lupiañez-Villanueva (Associate Professor, Spain); Maria Fernanda Cabrera-Umpierrez and Maria Teresa Arredondo (Life Supporting Technologies; Technical University of Madrid, Spain); Giuseppe Fico (Universidad Politécnica de Madrid, Spain)

Adherence to medication is a critical aspect of healthcare with a significant impact on patient outcomes. This has led to the elaboration of several studies over the years to understand adherence better, evolving to the point of applying Machine Learning techniques, whether to study the relationship of different factors with adherence or to make predictions of levels of adherence. However, due to the diversity of techniques, evaluation metrics and adherence measures utilized, no conclusions have been drawn as to which algorithms are best suited to address prediction problems in this domain. This paper aims to apply the three most widely used algorithms in the literature to a database obtained from a primary care centre. The study evaluates the performance of these algorithms with and without applying a feature selection method and with three different adherence measures, using four different evaluation metrics. The results obtained, although not conclusive for all scenarios due to the limitations of the study, indicate that the algorithm with the best overall performance and consequently the best adapted to the different scenarios is the Logistic Regression. This outcome constitutes a significant progress since it represents the first technical and comprehensive comparison of the performance that has been conducted in this area. Furthermore, comparative studies with larger datasets and different measures of adherence can validate this finding in the future.

19:00 – 20:00
Panel: Meet the BHI leaders

Tülay Adali, University of Maryland, Baltimore County
Mitra Basu, National Science Foundation
Bjoern Eskofier, Friedrich-Alexander-Universität Erlangen-Nürnberg
Andrew F. Laine, Columbia University
Georgia Tourassi, Oak Ridge National Laboratory
Stephen T. Wong, Houston Methodist Hospital & Weill Cornell Medicine
Yonghui Wu, University of Florida
Kathy L. Grise, IEEE Future Directions
Jie Liang, University of Illinois Chicago
May D. Wang, Georgia Tech & Emory University

19:15 – 22:00
Reception

Tuesday, October 17, 2023

8:30 – 17:00
Registration

8:30 – 9:15
Keynote: Yonghui Wu
Large Language Models in Medicine and Healthcare

9:15 – 9:30
Coffee Break

9:30 – 11:15
Oral Session #3
Informatics and Health Systems
Session Chair: Ahmed Metwally

9:30
Point-process based representation learning for Electronic Health Records
Hojjat Karami, Ani Ionescu and David Atienza (EPFL, Switzerland)

Irregular sampling of time series in electronic health records (EHRs) presents a challenge for the development of machine learning models. Additionally, the pattern of missing data in certain clinical variables is not random, but depends on the decisions of clinicians and the state of the patient. Point process is a mathematical framework for analyzing event sequence data that is consistent with irregular sampling patterns. To tackle the challenges posed by EHRs, we propose a transformer event encoder with point process loss that encodes the pattern of laboratory tests in EHRs. We conduct experiments on two real-world EHR databases to evaluate our proposed approach. Firstly, we learn the transformer event encoder jointly with an existing state encoder in a self-supervised learning approach which gives superior performance in negative log-likelihood and future event prediction. Additionally, we propose an algorithm for aggregating attention weights that can reveal the interaction between the events. Secondly, we transfer and freeze the learned transformer event encoder to the downstream task for the outcome prediction (mortality and sepsis shock), where it outperforms state-of-the-art models for handling irregularly-sample time series. Our results demonstrate that our approach can improve representation learning in EHRs and can be useful for clinical prediction tasks.

9:45
Exploring Opportunities and Challenges of AI-incorporated Biomedical Informatics Education: A Qualitative Study
Xiaopeng Zhao (University of Tennessee at Knoxville, USA); Mehmet Aydeniz (University of Tennessee, Knoxville, USA); Fengpei Yuan (University of Tennessee, USA)

This article presents a case study on the integration of AI as a teaching and learning tool in a biomedical informatics course for college education. The article details the design of the course and its methodology, including hands-on learning, in-class activities, and weekly assignments that utilized AI tools. An exploratory qualitative study was conducted with six college students to learn their perceptions and learning experience with this AI-incorporated course. We applied thematic analysis approach to investigate the opportunities and challenges of integrating AI in college education. The course generated positive outcomes, highlighting the potential of AI tools in education and the importance of hands-on learning and critical thinking. The results of thematic analysis agree with that AI allowed students to more efficiently engage in metacognition. The article concludes with a discussion on the implications of using AI in education and the need for continued exploration and assessment of their impact on student learning and success, for example, AI-human collaboration, scaffolding support for AI-incorporated education, and students' expectation for reliance on instructors. Overall, the study course provides a case study of a novel integration of emerging AI tools and education in biomedical informatics, showcasing the potential for personalized and efficient learning experiences.

10:00

Reinforcement Learning Approach to Sedation and Delirium Management in the Intensive Care Unit

Niloufar Eghbali Zarch (Michigan State University, USA); Tuke Alhanai (New York University Abu Dhabi, United Arab Emirates); Mohammad Mahdi Ghassemi (Michigan State University, USA)

Common treatments in Intensive Care Units are distressing and involve prolonged sedation. Maintaining adequate sedation levels is challenging and is prone to errors such as incorrect dosing, omission or delay of sedatives, and administering the wrong sedative. In this study, we applied a reinforcement learning (RL) approach to retrospective data, developing a sedation management agent. The agent's goal is to maintain an adequate level of sedation while also keeping the Mean Arterial Pressure (MAP) as an indicator of the vital sign of the patients in the safe therapeutic range. While most of the prior work has focused on a specific medication - propofol - which has no intrinsic analgesic effect and must be co-administered with an opioid or other analgesics for ICU patients, in this work, we build a recommender system to find the optimal concurrent dosage regimen for three commonly used sedatives(propofol and midazolam) and opioid(fentanyl). To mitigate the potential risk of delirium and the adverse effects of over sedation, we integrated a delirium control variable into the reward function. The results indicate that our approach successfully recommends sedative dosages by improving the maintenance of the patients' target sedative level by 29% compared to the clinicians' policy.

10:15

Classification of Movement Disorders Using Video Recordings of Gait with Attention-based Graph Convolutional Networks

Wei Tang (University of Groningen, The Netherlands & University Medical Center Groningen, The Netherlands); Peter M.A. van Ooijen and Deborah A. Sival (University Medical Center Groningen, The Netherlands); Natasha Maurits (University of Groningen, The Netherlands)

Early Onset Ataxia (EOA) and Developmental Coordination Disorder (DCD) are two pediatric movement disorders characterized by similar phenotypic traits, often complicating clinical differentiation. This resemblance poses substantial challenges in clinical practice as accurate diagnosis, a critical factor in determining appropriate treatment strategies, becomes increasingly intricate due to the similarity of symptoms. Despite the recognized reliability of current clinical scales like the Scale for the Assessment and Rating of Ataxia (SARA), their dependence on specialist expertise, time-consuming nature, and inherent subjectivity can potentially limit their efficacy in assessing movement disorders, thereby underscoring the need for more objective, and efficient diagnostic methods. This study introduces a novel approach that utilizes 2D video recording in the coronal plane coupled with pose estimation to differentiate gait patterns in children with EOA, DCD, and healthy controls. An attention-based Graph Convolutional Network (A-GCN) was proposed for the classification process, achieving an f1-score of 76% at the group level. The model incorporates channel-wise attention to stress the semantic nuances of body joints, and temporal attention to highlight important sequences in gait patterns. These mechanisms enhance the model's ability to accurately classify EOA and DCD. The promising results demonstrate the potential of this method in contributing to improved diagnosis and understanding of these movement disorders, thereby paving the way for more targeted treatment strategies. The code is available at https://github.com/jiudaa/Attention-basedGCN-EOA.git.

10:30

Accounting for Nulliparity in the Prediction of Hypoxic-Ischemic Encephalopathy Using Cardiotocography

Johann Vargas-Calixto (McGill University, Canada); Yvonne W. Wu (University of California San Francisco, USA); Michael Kuzniewicz (Kaiser Permanente, USA); Marie-Coralie Cornet (University of California San Francisco, USA); Heather Forquer and Lawrence Gerstley (Kaiser Permanente, USA); Emily Hamilton (PeriGen Inc, USA, McGill University, Canada); Philip Warrick (PeriGen Inc., USA, McGill University, Canada); Robert E. Kearney (McGill University, Canada)

Nulliparous pregnancies, those where the mother has not previously given birth, are associated with longer labors and hence expose the fetus to more contractions and other adverse intrapartum conditions such as chorioamnionitis. The objective of the present study was to test if accounting for nulliparity could improve the detection of fetuses at increased risk of developing hypoxic-ischemic encephalopathy (HIE). During labor, clinicians assess the fetal heart rate and uterine pressure signals to identify fetuses at risk of developing HIE. In this study, we performed random forest classification using fetal heart rate and uterine pressure features from 40,831 births, including 374 that developed HIE. We analyzed a two-path classification approach that analyzed separately the fetuses from nulliparous and multiparous mothers, and a one-path classification approach that included the clinical variable for nulliparity as a classification feature. We compared these two approaches to a one-path classifier that had no information about the parity of the mothers. We also compared our results to the rate of Caesarean deliveries in each group, which is used clinically to interrupt the progression towards HIE. All the classifiers detected more fetuses that developed HIE than the observed Caesarean rate, but accounting for nulliparity did not improve performance.

10:45

Radar-Based Human Skeleton Estimation with CNN-LSTM Network Trained with Limited Data

Mohammad Mahbubur Rahman, Dario Martelli and Sevgi Z Gurbuz (The University of Alabama, USA)

Radar-based human activity recognition has opened up new opportunities in the design of cyber-physical systems (CPS) for health and safety by providing an ambient, non-contact, non-intrusive way to monitor human movement at any time of the day (24/7). This is important because it can enable the development of RF-based techniques for the early diagnosis and post-treatment monitoring of ailments resulting in symptoms impacting gait, as well as in improving ageing- in-place and quality life by providing gait-based assessments of fall risk - all in a home environment, where the person monitored would be moving in a natural fashion while doing daily activities. As such, it can provide a more realistic assessment of human mobility and gait, where quantitative gait analysis (QGA) methods are often unavailable and a person may not necessarily be walking in this same way as one does outside a doctor's office. Moreover, RF technologies have have the potential to improve the accessibility of care while also reducing healthcare costs. This paper presents a novel framework for human pose estimation using millimeter-wave (mmWave) radar technology, focusing on personalized healthcare applications. The proposed framework utilizes range-azimuth, range-elevation, and range-Doppler maps as inputs to a convolutional neural network (CNN) with a long short-term memory (LSTM) architecture to capture temporal dependencies and achieve improved skeleton estimation. Furthermore, this paper addresses the limitations of current radar-based skeleton estimation techniques, such as inconsistent kinematics and reliance on sparse radar point clouds. Skeleton estimation accuracy attained using diversified simulations is compared with that achieved real RF data, as validated using gold standard Vicon motion capture (MoCap) measurements as ground truth. The results highlight the potential of mmWave radar-based human skeleton estimation for advancing personalized healthcare and improving gait analysis and fall risk assessment.

11:30 – 12:15
Keynote: Tulay Adali
Matrix and Tensor Factorizations for Neuroimaging Data Analysis and Fusion
Chair: Jie Liang

12:25 – 12:55
Meet the JBHI Editor
Session Chair: May D. Wang

13:00 – 13:55
Rapid Fire 2 & Box Lunch
Session Chair: Akane Sano

13:00

BrainTalker: Low-Resource Brain-to-Speech Synthesis with Transfer Learning using Wav2Vec 2.0

Miseul Kim, Zhenyu Piao, Jihyun Lee and Hong-Goo Kang (Yonsei University, Korea (South))

Decoding spoken speech from neural activity in the brain is a fast-emerging research topic, as it could enable communication for people who have difficulties with producing audible speech. For this task, electrocorticography (ECoG) is a common method for recording brain activity with high temporal resolution and high spatial precision. However, due to the risky surgical procedure required for obtaining ECoG recordings, relatively little of this data has been collected, and the amount is insufficient to train a neural network-based Brain-to-Speech (BTS) system. To address this problem, we propose BrainTalker-a novel BTS framework that generates intelligible spoken speech from ECoG signals under extremely low-resource scenarios. We apply a transfer learning approach utilizing a pre-trained self-supervised model, Wav2Vec 2.0. Specifically, we train an encoder module to map ECoG signals to latent embeddings that match Wav2Vec 2.0 representations of the corresponding spoken speech. These embeddings are then transformed into mel-spectrograms using stacked convolutional and transformer-based layers, which are fed into a neural vocoder to synthesize speech waveform. Experimental results demonstrate our proposed framework achieves outstanding performance in terms of subjective and objective metrics, including a Pearson correlation coefficient of 0.9 between generated and ground truth mel-spectrograms. We share publicly available Demos and Code.

13:02

Serious games for a technology-enhanced early screening of handwriting difficulties

Linda G. Dui, Chiara Piazzalunga and Simone Toffoli (Politecnico di Milano, Italy); Stefania Fontolan (University of Insubria, Italy); Sandro Franceschini (University of Padua, Italy); Marisa Bortolozzo (University of Insubria, Italy); Nunzio Alberto Borghese (University of Milan, Italy); Cristiano Termine (University of Insubria, Italy); Simona Ferrante (Politecnico di Milano, Italy)

Early screening of handwriting difficulties is key to start remediation activities that help distinguishing between a simple delay and dysgraphia. Technology is fundamental in this process, as also claimed by guidelines for dysgraphia diagnosis: it allows to implement artificial intelligence techniques to help in the discrimination of the difficulty. To this end, a serious game was leveraged to assess handwriting laws altered in dysgraphia starting from symbols drawing. 66 first and second graders were longitudinally tested both with the serious game and with a handwriting proficiency test. Objective features computed from the game were tested to understand if they significantly differed between children at risk and not at risk of dysgraphia, according to a standardized clinical test used to assess handwriting. Then, machine learning models were leveraged to predict the risk and understand the areas of difficulty. On average, 62% of the features significantly differ between risk levels for first graders, whilst only 35% for second graders, thus revealing a better sensitivity in younger children. This is encouraging for an early observation. As for machine learning, a Logistic classifier was able to predict risk with an area under the precision-recall curve of 0.84 for the risk class and 0.98 for the non-risk class. The results of this study could be a valid help for an artificial intelligence-enhanced screening of dysgraphia.

13:04

The Power of ANN-Random Forest Algorithm in Human Activities Recognition with IMU Data

Nafiseh Ghaffar Nia, Amin Amiri, Ahad Nasab, Erkan Kaplanoglu and Yu Liang (University of Tennessee at Chattanooga, USA)

Human Activity Recognition (HAR) plays a crucial role in numerous applications, ranging from healthcare to sports analytics. This study presents a novel approach to HAR that combines Artificial Neural Networks (ANNs) and Random Forests to enhance the accuracy of HAR in diverse real-world conditions, especially when dealing with noisy and imperfect data. ANNs are known for extracting intricate features from raw data, making them well-suited for classification. Random Forest excels at learning from multiple decision trees and utilizing collective knowledge to make predictions, making it suitable for handling data in real-world applications. Harnessing the power of ANNs in feature extraction, coupled with the collective decision-making capability of Random Forest, the combined model demonstrates improved accuracy in classifying human activities. This study showcases the potential of combining ANN and Random Forest in classifying multi-dimensional Inertial Measurement Unit (IMU) data, a widely-used data source in HAR. By leveraging the strengths of both ANN and Random Forest, the combined model addresses the challenges associated with real, imperfect data, leading to a more robust and accurate classification model. The results highlight the effectiveness of feature extraction by ANNs and underscore the importance of incorporating Random Forest in HAR systems to obtain 98.84% accuracy. The findings of this study offer valuable insights into the synergistic effects of combining ANN and Random Forest for HAR. The outcomes can contribute to developing more reliable and effective HAR systems, with potential applications in healthcare monitoring, activity recognition in smart environments, and other domains requiring accurate human activity classification.

13:06

Transforming Adolescent Healthcare in Rwanda: Sustainable and Scalable Features in Digital Health

Diane Myung-kyung Woodbridge and Tejaswi Samrat Dasari (University of San Francisco, USA); Pratima Satish (University of California, Berkeley, USA); Laetitia Kayitesi, Mary Mbuvi, Fabiola Ishimwe Ngamije and Joseph Kwesiga (YLabs, USA); Robert On (The Agency Fund, USA); Russell Dias (YLabs, USA)

CyberRwanda is a digital health intervention designed to increase knowledge of family planning and reproductive health(FP/RH) and access to youth-friendly services in Rwanda. Previous studies showed high user satisfaction rates through user surveys, success in combating social stigma, and an effective educational impact on adolescents. In order to further enhance user experience and overcome resource limitations, the authors designed and developed new features, including an integrated dashboard and chatbot, leveraging data engineering and natural language processing. The experiments showed that new features substantially reduce the time required to access information for user groups, potentially leading to an improved user experience.

CyberRwanda is a digital health intervention designed to increase knowledge of family planning and reproductive health(FP/RH) and access to youth-friendly services in Rwanda. Previous studies showed high user satisfaction rates through user surveys, success in combating social stigma, and an effective educational impact on adolescents. In order to further enhance user experience and overcome resource limitations, the authors designed and developed new features, including an integrated dashboard and chatbot, leveraging data engineering and natural language processing. The experiments showed that new features substantially reduce the time required to access information for user groups, potentially leading to an improved user experience.

13:08

Providing Hand Use Context for Outpatient Neurorehabilitation with Egocentric Object Detection

Adesh Kadambi and Jose Zariffa (KITE Research Institute - University Health Network, Canada)

Recent advancements in wearable technology and machine learning have the potential to enhance rehabilitation therapy, particularly in outpatient settings. However, to effectively support therapy planning, such technologies need to capture context-specific information about an individual's activities of daily living (ADLs). In this study, we evaluated the performance of two object detection

models, Detic and UniDet, on egocentric videos recorded by individuals with spinal cord injury (SCI). Our evaluations revealed that UniDet, when evaluated on its original 700 classes, achieved a Mean Average Precision (mAP) of 0.0382 for all objects and 0.0988 for active objects. When evaluated on a set of 27 consolidated functional categories, UniDet's performance improved to an mAP of 0.1503 for all objects and 0.1910 for active objects. Detic demonstrated superior performance with an mAP of 0.1772 for all objects and 0.2754 for active objects when evaluated on the 27 functional categories. However, the ground truth labelling strategy resulted in a large number of false positives, suggesting that the model performance is likely higher. Despite challenges posed by low-light conditions and motion blur, this study provides crucial insights into the potential of object detection models in therapy planning, facilitating the integration of wearable technology and machine learning in outpatient rehabilitation and enabling more personalized and effective therapeutic strategies.

13:10

Radar-based Recognition of Activities of Daily Living in the Palliative Care Context Using Deep Learning

Johanna Braeunig, Desar Mejdani and Daniel Krauss (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Stefan Griesshammer (University Hospital Erlangen, Germany); Robert Richer and Christian Schuessler (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Julia Yip, Tobias Steigleder and Christoph Ostgathe (University Hospital Erlangen, Germany); Bjoern M Eskofier (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Martin Vossiek (LHFT, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

The accurate detection and quantification of activities of daily life are crucial for assessing the health status of palliative patients to allow an optimized treatment in the last phase of life. Current evaluation methods heavily rely on subjective self-reports or external observations by clinical staff, lacking objectivity. To address this limitation, we propose a radar-based approach for recognizing ADLs in a palliative care context. In our proof of concept study, we recorded five different activities of daily living relevant to palliative care, all occurring within a hospital bed, from N=14 healthy participants (57 % women, aged 28.6 ± 5.3 years). All movements were recorded using two frequency-modulated continuous wave radar systems measuring velocity, range, and angle. A convolutional neural network combined with long short-term memory achieved a classification accuracy of 99.8 ± 0.4 % across five cross-validation folds. Furthermore, we compare our initial approach, which takes into account all dimensions of the available radar data, to a simplified version, where only velocity information over time is fed into the network. While these results demonstrate the high potential of radar-based sensing to automatically detect and quantify activities in a palliative care context, future work is still necessary to assess the applicability to real-world hospital scenarios.

12:57

AutoHealth: A Wearable Personalized Medical Butler for Parkinson's Disease

Katherine A. Parajes, Ming Zhu, Shengjie Zhai and Luis M Cardenas (University of Nevada Las Vegas, USA)

Parkinson's disease (PD) stands as one of the prevalent neurodegenerative disorders worldwide, affecting millions with varying physical inconveniences, cognitive decline, and inflicting immense psychological stress on patients and their kin. As the disease escalates, vigilant monitoring becomes pivotal in managing the condition effectively, alleviating symptoms, and enhancing the patients' and their family's overall life quality. Capitalizing on the innovation of smartwatches and their inherent biosensors, we introduce AutoHealth - an Internet of Medical Things (IoMT) system designed to perpetually track the movement patterns of PD patients. Our cutting-edge system seamlessly incorporates vector-based learning AI models, providing a personalized approach to early PD detection, tracking, and rehabilitation. Further complementing the user experience, we are excited to incorporate an AI chatbot into the AutoHealth system. This chatbot engages patients in interactive dialogue, promptly responds to queries, and offers guidance, fostering a proactive approach towards managing their health conditions.

Clinical Relevance- Our solution pioneers an automatic, integrated system delivering real-time PD diagnosis, perpetual monitoring, and tailored recommendations, a stride beyond the conventional dependence on multiple devices and manual interventions. The model is built to construct autonomous agents that learn from a user's unique healthcare data and history, tailoring a plan to fit their individual needs. Our system breaks barriers by being a cross-language, cross-platform solution, ensuring accessibility regardless of regional and hardware constraints. Our mission is to deliver affordable, at-home medical assistance through a wearable device, bringing advanced healthcare and diagnostics right to your wrist.

12:59

Markerless RGB-D Hand Pose Estimation for Activity Monitoring of Musculoskeletal Diseases

Vanessa Wirth (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Anna-Maria Liphardt and Birte Coppers (University Hospital Erlangen, Germany); Johanna Braeunig, Simon Heinrich and Sigrid Leyendecker (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Arnd Kleyer and Georg Schett (University Hospital Erlangen, Germany); Martin Vossiek (LHFT, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Bernhard Egger (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Marc Stamminger (FAU, Germany)

Clinical motion capture technologies to monitor the activity of inflammatory musculoskeletal diseases are pri- marily marker-based. This is because markerless hand pose estimation approaches are still heavily tailored to entertainment applications such as VR/AR, which only require coarse, plausi- ble poses instead of accurate and reliable results. To bridge the gap between coarse, interactive hand simulation and accurate but unintuitive marker-based motion capturing, we propose the first markerless RGB-D hand pose and shape tracking method, which considers uncertainty during the estimation process

13:01

URVoice: An Akl-Toussaint/ Graham-Sklansky Optimization for Sign Language Interpretation

Madhumitha V (Indian Institute of Technology Hyderabad, India); Santhi Natarajan (Shiv Nadar University Chennai, India); Bharathi A (BMSIT&M, VTU, India); Manjunath Sargur Krishnamurthy (JP Morgan Chase and Co., USA)

We present URVoice, a vocalizer for the communication impaired, based on the Indian Sign Language Notations. Sign and gesture language, offering an intelligent co-ordination of eye-and-hand and ear-and-mouth, has evolved as an intelligent manifestation of speech for the impaired. However, they have very limited modality and iconicity in accommodating a greater range of linguistically relevant meanings. They also fail to cover the verbal spectrum of temporal and spacial characteristics of communication. Bridging this gap shall strengthen their mental thoughts, avoid reliance on interpreters, and shall also provide access to new technologies. URVoice is an Augmentative and Alternative Communication (AAC) device for real time translation of gesture to text/voice using convex hull based computational geometry.

URVoice pipeline helps in forward communication from signer to collocutor with a novel vision-based model using Akl-Toussaint heuristic and Graham-Sklansky scan algorithms. Our work offers the following contributions: 1) URVoice, Augmentative and Alternative Communication (AAC) device and vocalizer based on the Indian Sign Language Notations, 2) Real time translation of gesture to text/voice using convex hull based computational geometry, 3) Forward communication from signer to collocutor with a novel vision-based model using Akl-Toussaint heuristic and Graham-Sklansky scan algorithms, 4) URVoice benchmark models which we developed in-house, built on conventional machine-learning and deep-learning methods, 5) Datasets created for Indian Sign Language notations for future work and augmentation to URVoice.
The proposed combination is a convex hull optimization technique to identify the key geometrical points in gestures for their recognition. When independently used, the Sklansky scan fails for simple polygons and succeeds for star-shaped polygons, a fact upon which the correctness of the Graham scan relies. The idea of the Graham scan is to make a single scan through a sorted list of points. At each step in the scan, either a point is deleted or retained based on the test. So, if there are n points, a maximum of n points can be deleted. Thus, the algorithm takes O(n) time. The Akl-Toussaint heuristic helps to quickly exclude many points that would not be part of the convex hull. The convex hull method follows, which results in a monotone polygon, followed by Graham-Sklansky scan to obtain the points of convex hull.

We benchmarked the performance of URVoice convex optimization model by developing other standard ML/DL models of URVoice for hand gesture recognition. Although these models performed well, the convex hull optimization technique was preferred over this based on the obtained performance and the type of system we wanted to implement. Using a CNN model would result in designing a GPU based system for hand-held device which is not a feasible solution due to factors like memory usage, size and cost. The experiments performed using convex hull method deduces best results with the features under study and also was able to reliably recognize the gestures in real-time, though there were some limitations imposed by the presence of image noise. Thus, the convex hull optimization technique proves to have better static gesture recognition rates.

13:03

A Transfer Learning-based Homecare Prompting Assistance System for Supporting Everyday Activities in People with Mild Dementia

Xiaowei Chen and Guoliang Fan (Oklahoma State University, USA)

People with dementia (PwD) experience widespread cognitive impairment, leading to challenges in carrying out routine tasks known as activities of daily living (ADLs) and especially more complex instrumental ADLs (IADLs). Without adequate support, PwD become highly susceptible to a loss of independence and vulnerability. Various assistive technologies (ATs) have been proposed to assist PwD with mild conditions to complete IADL tasks. However, most existing AT devices provide limited IADL support to PwD with little or no user-specific customization. This paper presents our early development of a PwD homecare prompting assistance system, called CATcare (Cognitive Assistive Technology Care). Our CATcare system can be operated on a smartphone or smart glasses and customized by a caregiver according to the IADL needs of the care recipient. It is able to provide much-needed IADL-specific step-by-step cueing, prompting, and timely feedback to assist PwD to accomplish the task of interest. Our research leverages the capabilities of the transfer learning and AI technologies in indoor room localization, object detection, and Natural Language Processing (NLP) and shows the

potential and promise of using AI technologies to develop a customizable and personalizable CATcare to improve the life quality of PwD and to reduce the burden of their caregivers.

13:05

Integrating Genetic Information for Alzheimer's Diagnosis through MRI Interpretation

Seungeun Lee (Hanyang University); Jaeyoung Lee (Hanyang University, Korea (South)); Moonhyun Lee (University of Hanyang, Korea (South)); Jintak Choi, Younghoon Kim and Kyungtae Kang (Hanyang University, Korea (South))

Early detection of Alzheimer's disease (AD) is crucial, yet predicting AD in the mild cognitive impairment stage remains challenging. Integrating biological data from genomics and neuroimaging can provide valuable insights into early detection and treatment. Although recent deep learning studies have shown promise in AD prediction tasks, they often lack the interpretation of multimodal data interactions. Therefore, there is a need for further research on deep learning methods that can effectively integrate and interpret multimodal biological data for AD diagnosis and prediction. This study proposes a novel approach for identifying regions where interactions occur in sMRI (structural MRI) and genetic information and for detecting discriminative features in AD progression. Through the use of an attention mechanism and contrastive loss, it effectively models the inter-relationships between these modalities, leading to a more accurate understanding of AD. Our proposed method achieved remarkable performance, with an accuracy of 92%. Additionally, through model interpretation, we were able to identify genetic and brain feature associations in AD progression. This study provides a interpretable approach to AD prediction by integrating imaging and genetic data. By capturing the interplay between imaging and genetic data, the model provides valuable clinical interpretations and enhances its predictive capabilities. This integration also enables the identification of critical biomarkers and signatures for early detection and intervention in AD.

13:07

AI-based Ecological Monitoring of Handwriting to Early Detect Cognitive Decline

Simone Toffoli and Francesca Lunardini (Politecnico di Milano, Italy); Carmen Galán de Isla (FundeSalud - Foundation for Research and Training of Health Professionals of Extremadura, Spain); Simona Ferrante (Politecnico di Milano, Italy)

The early detection of Mild Cognitive Impairment (MCI) is fundamental to initiate treatments for delaying the onset of dementia. Currently, the Mini Mental State Examination (MMSE) is one of the most common clinical scale used by geriatricians to assess cognitive function. A deviation of 1 to 3 points from the maximum score (30) is considered as sign of relevant cognitive decline. However, objective and affordable tools are needed to complement the screening process. The quantitative analysis of handwriting represents a suitable solution, as the gesture is significantly impaired in MCI subjects in terms of time, speed, fluency and applied pressure. This works presents the development and testing of classification models able to separate subjects at risk of cognitive decline (MMSE <= 28) from controls (MMSE > 28), starting from free-content handwriting data acquired with a smart ink pen, used on paper, from which 36 indicators were computed. Data were collected in 2 phases. The former involved 45 subjects and served for models training. In the latter, data were acquired from 23 subjects in a domestic longitudinal framework and were partially used for model refinement, but mainly for testing. Three different algorithms were tried (support vector machine, random forest and catboost) The best test performances on the longitudinal data were obtained by a Catboost classifier, achieving accuracy 93.33%, precision 88.89%, recall 100% and f1 score 94.12%. The results support the use of computerized handwriting analysis as screening tool for cognitive decline detection.

13:09

Multimodal Deep Learning for Pediatric Mild Traumatic Brain Injury Detection

Badhan Mazumder and Deepan Tripathy (Georgia State University, USA); Keith Yeates (University of Calgary, Canada); Miriam Beauchamp (University of Montreal, Canada); William Craig (University of Alberta, Canada); Quynh Doan (University of British Columbia, Canada); Stephen Freedman and Catherine Lebel (University of Calgary, Canada); Roger Zemek (Children Hospital of Eastern Ontario, Canada); Ashley Ware and Dong Hye Ye (Georgia State University, USA)

Despite its prevalence, little is known about the pathophysiology of mild traumatic brain injury (mTBI). This makes it difficult for clinicians to accurately diagnose mTBI and predict outcomes in affected children, thereby highlighting the urgent need to identify novel and efficacious biomarkers of pediatric mTBI. To address this important knowledge gap, this study introduced a multimodal MRI deep learning approach toward the classification of mTBI as compared with mild orthopedic injury (OI) by considering both structural MRI (sMRI) and diffusion tensor imaging (DTI). Firstly, convolutional features were extracted by employing a pre-trained DenseNet to capture the morphological features of both modalities. Next, by employing Deep Canonical Correlation Analysis (DCCA), distinct features obtained from the sMRI and DTI data were integrated into a multi-modal embedding. The obtained DCCA fused compact multimodal features were then fed to a random forest (RF) classifier that was used to classify mTBI versus mild OI. Additionally, to visualize the intra-individually heterogeneous brain regions that DenseNet most heavily relied upon for making classification, Gradient-weighted Class Activation Mapping (Grad-CAM) was applied to the DenseNet outcomes for both modalities. According to the

experimental outcomes on the clinical dataset, the introduced multimodal deep learning strategy improved the classification accuracy by 8.6% (from 75.8% to 84.4%) and 7.8% (from 76.6% to 84.4%) when compared to the unimodal morphological features, as generated from sMRI and DTI.

13:11

Towards Accurate and Clinically Meaningful Summarization of Electronic Health Record Notes: A Guided Approach

Zhimeng Luo, Yuelyu Ji, Abhibha Gupta, Zhuochun Li, Adam Frisch and Daqing He (University of Pittsburgh, USA)

Clinicians are usually under time pressure when they review patients' electronic health records (EHR), therefore, there are great benefits to providing clinicians high quality summarizations of patients' EHR. However, existing summarization algorithms cannot satisfy their needs. In this paper, we present a novel approach to summarize EHR notes using a guided summarization model. Our model integrates a structured template developed with a clinical domain expert, a Named Entity Recognition (NER) model and sentence classification model for guidance extraction, and a fact-checking metric for evaluating the generated summaries. We trained our model on a large de-identified EHR dataset. The results demonstrate that our guidance, which includes Chief Complaint (CC), NER, guidance from the History of Present Illness (HPI) section, and guidance from the Medical Decision Making (MDM) section, can significantly improve the performance of the models in generating accurate and clinically meaningful summaries. The Gsum (CNN) model with all the guidance aforementioned achieved the highest F1 score of 46.4, demonstrating the effectiveness of introducing precise and informative guidance to models from the general domain when the training data on the clinical domain is prohibitively sensitive and expensive. This work contributes to the ongoing efforts to automate the summarization of EHR notes, with the ultimate goal of improving healthcare delivery and patient outcomes.

13:13

An Automatic Grading System for Neonatal Endotracheal Intubation with Multi-Task Convolutional Neural Network

Yan Meng and James K Hahn (The George Washington University, USA)

Neonatal endotracheal intubation (ETI) is an intricate medical procedure that poses considerable challenges, demanding comprehensive training to effectively address potential complications in clinical practice. However, due to limited access to clinical opportunities, ETI training heavily relies on physical manikins to develop a certain level of competence before clinical exposure. Nonetheless, traditional training methods prove ineffective due to scarcity of expert instructors and the absence of internal situational awareness within the manikins, preventing thorough performance assessment for both trainees and instructors. To address this gap, there is a need to develop an automatic grading system that can assist trainees in performance assessment. In this paper, we propose a multi-task Convolutional Neural Network (MTCNN) based model for assessing ETI proficiency, specifically targeting key performance features recommended by expert instructors. The model comprises three modules: a motion recording and visualization module that captures the ETI procedures performed on a standard neonatal task trainer manikin, an automatic grading module that extracts and grades the identified key performance features, and a data visualization module that presents the assessment results in a user-friendly manner. The experimental results demonstrate that the proposed automatic grading system achieves an average classification accuracy of 93.6%. This study establishes the successful integration of intuitive observed features with latent features derived from multivariate time series (MTS) data, coupled with multi-task deep learning techniques, for the automatic assessment of ETI performance.

13:15

Sleep Staging Using Wearables and Deep Neural Networks

Shaun Davidson, Cristian Roman, Jonathan Carter, Mirae Harford and Lionel Tarassenko (University of Oxford, United Kingdom (Great Britain))

There is a well-established association between sleep and health status, but the current gold-standard for analysing sleep, polysomnography, is too disruptive and expensive to enable longitudinal monitoring. There is, therefore, a growing interest in automated sleep scoring, or staging, using a combination of wearable technology to acquire cardio-respiratory vital signs and machine learning to learn how these vital signs vary with sleep state. However, sleep and the associated cardio-respiratory signals also change significantly with age, in part because of age-related changes in the autonomic nervous system, and this impacts the accuracy of wearable sleep staging methods. This paper investigates how the accuracy of a deep neural network model trained on the Sleep Heart Health Study database varies with the age of the subject. We show that the classification accuracy for each sleep stage decreases with age. We also present proof-of-concept analysis of longitudinal sleep data from a COVID-19 Challenge Study with a younger cohort (18 - 29 years of age), and discusses the impact of having trained the deep neural network model on a database with an age range from 40 to 89+ and suggest how this issue may be addressed.

Clinical Relevance - This paper highlights how changes in sleep behaviour with age can affect neural network sleep staging using cardio-respiratory vital signs and machine learning, resulting in less accurate sleep staging in some age groups, and discusses potential methods for addressing this.

13:17

Fractal Bilinear Deep Neural Network Models for Gastric Intestinal Metaplasia Detection

Maria P Silva (INESC TEC, Faculdade de Ciências Da Universidade Do Porto, Portugal); Miguel L. Martins (INESC TEC Faculdade de Ciências Da Universidade Do Porto Portugal, Portugal); Diogo Libanio (University of Porto, Portugal); Mário Dinis-Ribeiro (Instituto Português de Oncologia Porto, Portugal); Miguel Coimbra (University of Porto, Portugal); Francesco Renna (Universidade do Porto, Portugal)

Gastric Intestinal Metaplasia (GIM) is a precancerous gastric lesion and its early detection facilitates patient followup, thus lowering significantly the risk of death by gastric cancer. However, effective screening of this condition is a very challenging task, resulting low intra and inter-observer concordance. Computer assisted diagnosis systems leveraging deep neural networks (DNNs) have emerged as a way to mitigate these ailments. Notwithstanding, these approaches typically require large datasets in order to learn invariance to the extreme variations typically present in Esophagogastroduodenoscopy (EGD) still frames, such as perspective, illumination, and scale. Hence, we propose to combine a priori information regarding texture characteristics of GIM with data-driven DNN solutions. In particular, we define two different models that treat pre-trained DNNs as general features extractors, whose pairwise interactions with a collection of highly invariant local texture descriptors grounded on fractal geometry are computed by means of an outer product in the embedding space. Our experiments show that these models outperform a baseline DNN by a significant margin over several metrics (e.g., area under the curve (AUC) 0.792 vs. 0.705) in a dataset comprised of EGD narrow-band images. Our best model measures double the positive likelihood ratio when compared to a baseline GIM detector.

13:19

Hypertension Detection From High-Dimensional Representation of Photoplethysmogram Signals

Navid Hasanzadeh and Shahrokh Valaee (University of Toronto, Canada); Hojjat Salehinejad (Mayo Clinic, USA)

Hypertension is commonly referred to as ``silent killer", since it can lead to severe health complications without any visible symptoms. Early detection of hypertension is crucial in preventing significant health issues. Although some studies suggest a relationship between blood pressure and certain vital signals, such as Photoplethysmogram (PPG), reliable generalization of the proposed blood pressure estimation methods is not guaranteed yet. This has resulted in some studies doubting the existence of such relationships or considering them weak and limited to heart rate and blood pressure. In this paper, a high-dimensional representation technique based on random convolution kernels is proposed to demonstrate the feasibility of generalization in hypertension detection using PPG signals. Our results provide evidence that this relationship extends beyond heart rate and blood pressure. Additionally, we show that the utilized transform using convolution kernels, as an end-to-end time-series feature extractor method, performs better than the methods proposed in the previous studies and state-of-the-art deep learning models. Clinical relevance- The findings of this study highlight the feasibility of hypertension detection using PPG signals. This could be useful for the early detection of high blood pressure and reducing the risk of hypertension going unnoticed, particularly using wearable devices such as smartwatches equipped with PPG sensors.

13:21

Dynamic Brain Transformer with Multi-level Attention for Brain Network Analysis

Xuan Kan (Emory University, USA); Antonio Aodong Chen Gu (Georgia Institute of Technology, USA); Hejie Cui, Ying Guo and Carl Yang (Emory University, USA)

Recent neuroimaging advancements have highlighted the importance of network-centric brain analysis, particularly with functional magnetic resonance imaging. The emergence of Deep Neural Networks has fostered a substantial interest in predicting clinical outcomes and categorizing individuals based on brain networks. However, the conventional approach involving static brain network analysis offers limited potential in capturing the dynamism of brain function. Although recent studies have attempted to harness dynamic brain networks, their high dimensionality and complexity present substantial challenges. This paper proposes a novel methodology, Dynamic bRAin Transformer (DART), which combines static and dynamic brain networks for more effective and nuanced brain function analysis. Our model uses the static brain network as a baseline, integrating dynamic brain networks to enhance performance against traditional methods. We innovatively employ attention mechanisms, enhancing model explainability and exploiting the dynamic brain network's temporal variations. The proposed approach offers a robust solution to the low signal-to-noise ratio of blood-oxygen-level-dependent signals, a recurring issue in direct DNN modeling. It also provides valuable insights into which brain circuits or dynamic networks contribute more to final predictions. As such, DRAT shows a promising direction in neuroimaging studies, contributing to the comprehensive understanding of brain organization and the role of neural circuits.

14:00 – 15:45
Oral Session #4
Medical Imaging and Sensor Data
Session Chair: Edward Sazonov

14:00

Spectral Analysis of Electroretinography to Differentiate Autism Spectrum Disorder and Attention Deficit Hyperactivity Disorder

Sultan M Manjur and Md Billal Hossain (University of Connecticut, USA); Paul Constable (Senior Lecturer, Australia); Dorothy Thompson (Consultant Clinical Scientist, United Kingdom (Great Britain)); Fernando Marmolejo-Ramos (Research Fellow, Australia); Irene Lee (Data Manager, UCL GOS Institute of Child Health, United Kingdom (Great Britain)); Hugo Posada-Quintero (University of Connecticut, USA)

Autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) are both neurodevelopmental conditions that produce social interaction and executive functioning challenges but require very different therapeutic strategies. For that reason, early and accurate differentiation is important. However, their heterogeneity and overlap in symptoms make ASD and ADHD difficult to differentiate. The current diagnostic procedure to detect and distinguish ASD and ADHD is lengthy as it involves a comprehensive medical, developmental, and behavioral assessment. A more accessible and faster screening tool is needed to avoid delays in treatment. There is evidence that some retinal responses captured by the electroretinogram (ERG) are reduced in ASD subjects compared to neurotypicals whereas an opposite trend has been reported in ADHD, making ERG a promising tool for differentiating ASD and ADHD. However, previous ERG analyses based on amplitude and timing of ERG waves have exhibited limited success in differentiating ASD and ADHD. Recently, it has been found that time-varying spectral analysis of ERG allows for more accurate ASD detection compared to time-domain analysis. In this study, we evaluated the feasibility of differentiation of ASD and ADHD using features obtained by decomposing ERG using variable frequency complex demodulation (VFCDM). We used VFCDM features to train machine learning models and evaluated them using a subject independent validation approach. We achieved a maximum accuracy of 84% accuracy (87% sensitivity, 79% specificity), outperforming previous studies using ERG. Features from higher frequencies were found to be more important than features from lower frequencies.

14:15

Camera-based Plantar Perfusion Imaging for Detecting Lower Limb Arterial Blockage

Yukai Huang (South University of Science and Technology, China); Dongmin Huang (Sustech, China); Jia Wu and Hongzhou Lu (The Third People's Hospital of Shenzhen, China); Min He (Institute of Basic Medicine and Cancer, China); Wenjin Wang (Southern University of Science and Technology, China)

Lower limb arterial blockage (LLAB) is an early symptom of peripheral arterial disease (PAD), a common circulatory problem caused by the accumulation of fat and cholesterol in arteries as a result of atherosclerosis in the lower limbs. PAD can be diagnosed by detecting LLAB, which blocks the blood flow from leg to foot and causes a decrease of plantar blood perfusion. Camera-based photoplethysmographic imaging, a non-contact imaging technique for measuring skin perfusion, is a potential tool to detect LLAB for the early diagnosis of PAD. Cameras have been used for vital signs monitoring, such as heart rate, respiration rate and blood oxygen saturation, but its potential for PAD analysis has not been explored. In this paper, we investigate the new concept of using a regular camera to measure the skin perfusion of plantar for LLAB detection. Instead of imaging the facial skin perfusion as current vital signs camera, we use the camera to analyze the blood perfusion of plantar skin surface. We constructed an imaging setup and designed a lab-simulated experiment involving 20 subjects, where an inflatable cuff is applied to block the blood flow of the left leg to simulate LLAB. The experimental results show that the camera-based plantar perfusion imagers can clearly differentiate between the leg applied with cuff (simulated LLAB) and the leg in the normal state.

14:30

Concept Bottleneck Model for Adolescent Idiopathic Scoliosis Patient Reported Outcomes Prediction

Micky C Nnamdi, Wenqi Shi and Junior Ben Tamo (Georgia Institute of Technology, USA); Henry J Iwinski and Michael J Wattenbarger (Shriners Children, USA); May Dongmei Wang (Georgia Institute of Technology and Emory University, USA)

Post-surgical patient-reported outcomes (PROs) serve as a crucial subjective measure of surgical success for adolescent idiopathic scoliosis (AIS) patients. Leveraging pre-operative patient information to predict post-operative PROs is instrumental in improving pediatric patient care and providing invaluable insights for clinical decision-making. Recently, deep learning techniques have demonstrated encouraging results in developing predictive models for clinical decision support. However, the inherent black-box nature makes them non-interactive and challenging to troubleshoot during the training phase. To mitigate this issue, our study introduces an interactive concept bottleneck model to predict subjective rehabilitation outcomes for AIS patients. We assess three

learning schemas - independent, sequential, and joint - to first comprehend the concepts, which are a set of post-operative radiographic data available during the training phase. Subsequently, these acquired concepts are employed to predict post-operative patient rehabilitation outcomes across five domains: pain, function, general satisfaction, self-image, and mental health. Our results demonstrated improvement compared to the existing baseline, with the joint learning schema yielding the highest F1 score in the function and pain domains, while sequential learning recorded the highest F1 score in the mental health and self-image domains. This proposed framework harbors the immense potential to aid pre-operative surgical planning and further enhance the transparency of AI models, thereby supporting real-world clinical decision-making.

14:45

An Explainable AI model in the assessment of Multiple Sclerosis using clinical data and Brain MRI lesion texture features

Andria Nicolaou (University of Cyprus, Cyprus); Marios Pantzaris (Cyprus Institute of Neurology and Genetics, Cyprus); Christos P Loizou (Cyprus Univesrity of Technology & Electrical Enginerering Departement, Cyprus); Antonis Kakas and Costantinos S. Pattichis (University of Cyprus, Cyprus)

Magnetic resonance imaging (MRI) is an essential visualizing tool in the diagnosis and monitoring of Multiple Sclerosis (MS) disease. However, the neurological examinations and the MRI assessments are insufficient to provide personalized treatment to the patients due to the complexity of the disease. This study implemented an explainable artificial intelligence (AI) model with embedded rules to assess MS disease evolution. Clinical data were used including demographic and neurological measurements. Texture features were extracted from manually delineated and normalized brain MRI lesions. Statistical analysis was employed to select the statistically significant texture features and clinical data. Different models using machine learning algorithms were implemented to differentiate the subjects diagnosed with relapsing-remitting MS (RRMS) from the subjects with progressive MS (PMS). Argumentation-based reasoning was performed by modifying the rules extracted from models with the best evaluation results. The findings indicated that the proposed explainable AI model can predict the clinical conditions of MS disease with high accuracy and provide transparent and understandable explanations with high fidelity. Future work will include further clinical data such as medications, and investigate the correlation of the texture features and clinical data with the neurological impairment. The proposed model should also be evaluated on more MS subjects.

15:00

Wearables for continuous patient monitoring on COVID-19 isolation wards

Cristian Roman, Sarah Vollam, Peter Watkinson and Lionel Tarassenko (University of Oxford, United Kingdom (Great Britain))

An ambulatory monitoring system for the continuous monitoring of heart rate, respiratory rate and oxygen saturation, using wearable devices was implemented at the start of the COVID-19 pandemic on selected isolation wards in a large UK hospital. We have retrospectively analysed the data from two groups of patients on these wards: those whose care was escalated so that they were admitted to the ICU; and those who were discharged home (or to a non-isolation ward).
The analysis of the data provides evidence for the value of wearable monitoring for the early identification of physiological deteriorations in COVID-19 patients. The continuous data from the finger-worn pulse oximeter reveals clinically significant changes between 2 and 3 hours ahead of the regular vital-sign observations by the nursing staff. We also show how a hybrid score (calculated from a mixture of continuous and intermittent vital-sign data) can provide early warning of deterioration for high-risk patients. With this in mind, we are currently in the early stages of a randomized controlled trial whose aim is to test this hypothesis, using real-time wearable monitoring as described in this paper, but with additional alerting based on the real-time computation of the hybrid early warning score.

Clinical Relevance - Clinical deterioration is often preceded by deviations in physiological parameters. Episodes of desaturation, including silent hypoxia, in hospitalized patients with SARS-COV-2 infection are common and often not detected by routine vital-sign observations. Evidence is provided to show that continuous remote monitoring using wearable devices is able to identify patient deterioration early.

15:15

Intelligent Stethoscope using Full Self-Attention Mechanism for Abnormal Respiratory Sound Recognition

Changyi Wu (South University of Science and Technology, China); Dongmin Huang (Sustech, China); Xiaoting Tao (The Third People's Hospital of Shenzhen, China); Kun Qiao (The Third People's Hospital of Shenzhen, Hong Kong); Hongzhou Lu (The Third People's Hospital of Shenzhen, China); Wenjin Wang (Southern University of Science and Technology, China)

Machine learning automates the recognition of abnormal respiratory sounds and pulmonary diseases for wireless stethoscopes. However, most learning-based methods have unbalanced performance between low sensitivity (SEN) and high specificity (SPE). Recently, the full self-attention mechanism-based Transformer made significant progress in various medical tasks, but its role in respiratory sound recognition still remains unknown. It can extract the contextual information from segments with arbitrary length in

a signal, especially with long-range dependencies. This is typically suitable for mining the pattern of temporally-continuous pathological respiratory sounds, including stridor, wheezes, and rhonchi. Thus in this paper, we explore the feasibility of using full self-attention mechanism of Audio Spectrogram Transformer (AST) to improve the performance of respiratory sound recognition, where FNN, CNN and AST are benchmarked on the dataset of ICBHI 2017. In our proposed framework, the input samples are generated by a new respiratory cycle-based segmentation in order to preserve the consistency of input representation; a dual-input AST model is designed to enhance the robustness to disturbances by extracting the complementary information between the spectrograms and log Mel spectrograms. Extensive experiments show that AST outperforms other methods in the task of respiratory sound recognition. Moreover, the proposed respiratory cycle-based segmentation considerably improves SEN by almost 10%.

15:45 – 16:00
Coffee Break

16:00 – 17:00
Panel: Career Panel

Panelists:
Dr. Ahmed Metwally, Google
Dr. Sreeram Balasubramanian, Novasenta
Dr. Ryan Weil, Frederick National Lab
Dr. May D. Wang, Georgia Tech
Kathy L. Grise, IEEE Future Directions

17:15 – 19:00
Special Session: Multimodal Learning in Healthcare: From Wearable Sensing to Clinical AI Decision-Making

Organizers: Lei Lu; Tingting Zhu, **Affiliations**: University of Oxford, United Kingdom

Title & Speakers:

A. Can Image-Text Integration Improve Fact-Checking in Automatic Clinical Report Generation?: Jinge Wu; Honghan Wu (University College London, United Kingdom)

17:15 – 19:00
Poster Session #2

#1
Improving the robustness of IMU-based sit-to-stand detection during simulated real-world activities for different sensor positions
Ann-Kristin Seifer (Friedrich-Alexander Universität Erlangen-Nürnberg, Germany); Friederike Popp and Robert Richer (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Heiko Gaßner (University Hospital, Erlangen, Germany); Bjoern M Eskofier (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

An important indicator of functional mobility are sit-to-stand (STS) transitions. Wearable sensors offer a promising solution for real-world systems to address this issue. In this study, we show that an STS detection algorithm, initially designed for lower-back inertial measurement units (IMUs), can be applied to chest- and ear-worn IMUs by optimizing the tunable parameters to the specific location. Further, we show that machine learning-based post-processing considerably reduces false positive STS detections in real-world activities. Our findings contribute to a better understanding of IMU-based STS detection for different sensor positions and their applicability in real-world settings.

#2
A Smartphone-Based Fluorescent Microscopy System for Cellular & Particle Enumeration at the Point-of-Care
Muhammad Nabeel Tahir and Muhammad A Sami (Rutgers University, USA); Umer Hassan (Rutgers the State University of New Jersey, USA)

Smartphone-based fluorescent microscopes (SFM) have offered a cheap yet effective alternative to benchtop microscopes and have found their applications in modern therapeutics and diagnostics at the point of care. In this study, we present the design of an SFM with micron and submicron resolution levels and the ability to be used in wider clinical and diagnostic settings. The ability to be

interfaced with any smartphone in the designed system can serve as an effective tool in quantification and detection of biomarkers that could be associated with infectious or other diseases e.g., sepsis.

#3

OpenSim: An Open-Source Software Ecosystem for Movement Data

Carmichael F Ong, Jennifer L Hicks and Scott L Delp (Stanford University, USA)

The proliferation of devices that can measure movement enables new opportunities to gain insight into an individual's health status. We describe the principles we have used to create an ecosystem of open-source software that has helped tens of thousands of users analyze movement data.
Clinical Relevance- Open-source projects will help to synergize efforts across the clinical research community, which will increase the impact and accessibility of the field's work.

#4

The Path to a Modular and Standards-based Digital Health Ecosystem

Paul Schmiedmayer, Vishnu Ravi and Oliver Aalami (Stanford University, USA)

Software engineering for digital health applications entails several challenges, including heterogeneous data acquisition, data standardization, software reuse, security, and privacy considerations. We explore these challenges and how our Stanford Spezi ecosystem addresses these challenges by providing a modular and standards-based open-source digital health ecosystem. Spezi enables developers to select and integrate modules according to their needs and facilitates an open-source community to democratize access to building digital health innovations.

#5

Closing the Loop Using Imperfect mHealth Digital Biomarkers of Mental Health

Santosh Kumar (University of Memphis, USA)

Digital biomarkers of mental health hold great potential to transform health and well-being by enabling the delivery of digital interventions that are optimized for each user. But, given a lack of objective and unambiguous labels, AI models trained using digital data with such labels will likely remain imperfect. How can we still make use of them to close the intervention loop that can retain users' trust and engagement over a long period necessary to have a positive impact on their health and well-being?

#6

A Smartphone-Based Device to Predict Fluid Overload

Shipeng Wang (University of Pittsburgh & UPMC, USA); Mark Freithaler, Sanjeev G Shroff, Alisse Hauspurg and Ramakrishna Mukkamala (University of Pittsburgh, USA)

A smartphone-like device was built to measure finger venous pressure (VP) via the oscillometric principle. We utilized techniques to increase the local pressure at the fingertip to further improve the signal-to-noise ratio of the VP oscillation. The device could track local VP changes induced by an arm cuff and could measure VP to help reduce fluid overload hospitalizations.

#7

Proposed Standards in Over-the-Counter Cuffless Blood Pressure Monitor

Toshiyo Tamura (Waseda University & Future Robotics Organization, Japan); Ming Huang (Nara Institute of Science and Technology, Japan)

This paper proposes simple criteria for over-the-counter cuffless blood pressure (CL-BP) monitoring. The main components of CL-BP monitoring are accuracy during the resting condition, accuracy during dynamic blood pressure changes, and long-term stability. In this proposal we recommend intermittent measurement to ensure that active measurement accuracy mirrors resting condition accuracy. A new experimental protocol is proposed to maintain long-term stability. The point of this proposal is that a medically approved automated sphygmomanometer was used as the standard device in this study. In the evaluation testing, the accuracy of resting stage, dynamic changes and long-term stability were similar values to the cuff-based sphygmomanometer. Further research and discussion are necessary to create standards for use by manufacturers; such standards should be readily evaluated and ensure high-quality evidence

#8

Advancing Multimodal Data Modeling Toward Closed-Loop Mental Health Technologies

Akane Sano (Rice University, USA)

This paper explores the challenges and potential directions in designing AI-driven closed-loop systems for mental health, drawing insights from diverse multimodal sensing and modeling studies focused on detecting, predicting, and improving mental health and wellbeing. The identified challenges encompass (1) addressing intense individual differences, noise, and uncertainty in data and labels, (2) adapting models to cope with limited data and labels, (3) delivering effective feedback that considers users' contexts and symptoms, and (4) evolving prediction and feedback systems over time. To overcome these challenges, the paper proposes potential directions that encompass (1) developing diverse and effective data collection methods, (2) developing robust, interpretable, and equitable prediction models, and (3) implementing closed-loop feedback/intervention mechanisms. These directions aim to pave the way for user-centric AI-powered mental health technologies.

#9

Physio-Tracker - supervising therapeutic home exercises

Verena Stieve and Christoph Rußmann (Hochschule Für Angewandte Wissenschaft Und Kunst Hildesheim Holzminden Göttingen, Germany)

Although the execution of home exercise programs is an essential part for the success of physiotherapeutic treatment, adherence rates are often very low. To handle some of the reasons for a low adherence, an application for a camera-computer is developed, which introduces and supervises the exercise execution. The main challenge is the body tracking quality, presuming that the price for the camera shall be low. By subjectively testing existing solutions we have seen that the quality does not suffer. This will be scientifically examined and later we will try to improve the tracking quality for our specific problem.

#10

EHR Question and Answering for Surgical Notes: A Language Model Study

David M. Lee (University of Mississippi Medical Center, USA); Ahmad P. Tafti (University of Pittsburgh, USA); Hamidreza Moradi (North Carolina A&T State University, USA)

This study assesses the precision of employing a pre-trained language model for question and answering tasks in Electronic Health Record (EHR) data. Electronic health records often contain a vast amount of information, making it challenging for medical professionals to quickly access essential patient data. The introduction of large language models (LLM) has enabled the development of sophisticated models capable of understanding and extracting relevant information from written language. By leveraging these advanced language models, we aim to streamline the process of information retrieval from EHRs, facilitating well-informed clinical decisions based on patient backgrounds.

#11

Unfolding Patient Satisfaction: ML Predictions and SHAP Insights in Rotator Cuff Repair Surgeries

Arti Taneja (University of Cincinnati, USA); Thomas M. Talavage (College of Engineering and Applied Science, USA); Sean Catlett (University of Cincinnati Medical Center, USA); Brian Grawe (University of Cincinnati, COM, USA); Sarah C. Kurkowski (University of Cincinnati COM, USA)

This research aims to build an ML model of rotator cuff tear outcomes in a cohort of 189 patients. It leverages five machine learning models and SHAP analysis to identify influential features.Further it offers valuable insights to optimize post-surgical outcomes.These insights inturn help in enhancing the patient care. The study demonstrates the potential of machine learning techniques to improve clinical decision-making in orthopedic interventions.

#12

Characterizing trending features in time-series prediction of clinical event onset

Ran Xiao (Emory University, USA); Matthew Clark (Nihon Kohden Digital Health Solutions, Inc., USA); Nirbhay Modhe (Emory University, USA); Cheng Ding (Georgia Institution of Technology, USA); Delgersuren Bold (Emory University, USA); Timothy Ruchti (Nihon Kohden Digital Health Solutions, Inc., USA); Xiao Hu (Emory University, USA)

The recent advances in electronic health records (EHR) systems have made it possible for AI algorithms to predict adverse clinical events using real-time patient health data. However, most existing algorithms apply a static prediction to a fixed time window of patient measurements, often failing to consider the dynamic shifts in the risk profile over time. In this research, we employ L1 trend filtering analysis to pinpoint piecewise linear trends in risk profiles and examine the predictive power of trend-based features in the

time-series prediction of clinical events. Identifying these trends aids in recognizing the most predictive features and sets the stage for determining whether including these features can enhance prediction performance.

#13

Can Image-Text Integration Improve Fact-Checking in Automatic Clinical Report Generation?

Jinge Wu and Honghan Wu (University College London, United Kingdom (Great Britain))

Clinical text generation using AI-based models holds immense potential in advancing medical research and practice. However, an inherent challenge in this domain is the generation that deviate from factual information, which can significantly impact clinical decision-making. In this study, we propose a novel approach that combines image and text analysis to identify and rectify inaccuracies in AI-generated clinical text. By leveraging a pre-trained image model, we aim to detect discrepancies between generated text and factual evidence, thus improving the overall reliability of AI-generated reports.

#14

Precision Rehabilitation: Predicting Functional Ability Outcomes in Patients Post-Stroke using Machine Learning and Electronic Health Records

Fengyi Gao and Stephen W Shaffran (University of Pittsburgh, USA); Bayan Aldhahwani (University of Pittsburgh, USA & Umm Al-Qura University, Saudi Arabia); Parker E Denny, Allyn M Bove and Yanshan Wang (University of Pittsburgh, USA)

Machine learning models were developed to predict functional ability outcomes in post-stroke patients based on unstructured electronic health records (EHRs). Using a natural language processing (NLP) algorithm, features related to rehabilitation therapies were extracted from the EHRs. The Activity Measure for Post-Acute Care (AM-PAC) score was used to measure functional status. The Random Forest (RF) model performed best, indicating Balance/Vestibular exercises as significant predictors of improvement, showing promise for precision rehabilitation.

#15

Predicting Progression from Undifferentiated Connective Tissue Disease to Definite Connective Tissue Diseases: Survival Analysis with Electronic Health Records

Chia-Wei Chang (National Yang Ming Chiao Tung University, Taiwan); Hsin-Yao Wang (Chang Gung Memorial Hospital at Linkou, Taiwan); Yi-Ju Tseng (National Yang Ming Chiao Tung University, Taiwan & Boston Childrens Hospital, USA)

Identifying undifferentiated connective tissue disease (UCTD) patients progressing into definite connective tissue diseases (CTD) timely might lead to an improved prognosis. We applied survival models to identify individuals at risk of developing CTDs, and the results turned out with promising discriminative power. Our models could be valuable in identifying high-risk individuals.

#16

Correction of prevalence estimators for sampling bias with testing errors

Lili Zhou, Daniel Andrés Díaz-Pachón and Chen Zhao (University of Miami, USA); J. Sunil Rao (University of Minnesota, USA); Ola Hossjer (Stockholm University, Sweden)

Sampling for prevalence estimation of infection is subject to bias by oversampling symptomatic individuals and error-prone tests. This results in naive estimators of prevalence that can be very far from the true proportion of infected. Here, we present a method of prevalence estimation that reduces both the effect of bias due to testing errors and oversampling of symptomatic individuals, eliminating it altogether in some scenarios. This procedure also considers stratified errors in which tests have different error rate profiles for symptomatic and asymptomatic individuals.

#17

Adaptive User Interface Framework Powered by a Large Language Model for Culturally Sensitive Virtual Healthcare Applications

Akash Ghosh (Thompson Rivers University, Canada); Yan Yan (University of Guelph, Canada); Wenjun Lin (Algoma University, Canada)

In this research, we propose the development of an Adaptive User Interface (UI) Framework for virtual healthcare applications, powered by a Large Language Model (LLM). The intention is to revolutionize the way healthcare services are rendered by creating a real-time responsive system that caters to diverse patient needs. Unlike conventional healthcare applications, this framework utilizes various sensors and interactive inputs to continuously adapt to users' feedback. It harnesses the potential of deep learning to process this feedback and make culturally sensitive adaptations, ensuring more personalized and effective care for Indigenous, Black, and People of Colour (IBPOC) populations. A unique aspect of this system is that its adaptations are not predetermined; instead, it dynamically generates changes based on the user feedback analyzed by the LLM. To demonstrate the efficacy of this framework, a

demo healthcare application is being developed. We expect this initiative to significantly contribute to the field of virtual healthcare by introducing a more inclusive, personalized, and adaptive platform, ultimately leading to improved patient care outcomes.

#18

Development of a Mother-Child Database for Pharmacoepidemiology Research in Primary Care

Elena Segundo, Marc Far, Clara Rodríguez, Josep Maria Elorza, Jordi Carrere-Molina, Roger Mallol and María Aragón (IDIAP Jordi Gol, Spain)

The aim of this study was to develop a mother-child linked database consisting of all eligible active records of the Information System for Research in Primary Care (SIDIAP) database. Complementing the SIDIAP database with mother-child links will allow clinical researchers to expand their pharmacoepidemiologic studies with the ultimate goal of improving outcomes for pregnant women and their children

#19

Empowering Healthcare Decision-Making: Leveraging Business Intelligence Tools

Peña Arroyo and Beatriz Merino-Barbancho (Universidad Politécnica de Madrid, Spain); Maria Fernanda Cabrera-Umpierrez and Maria Teresa Arredondo (Life Supporting Technologies; Technical University of Madrid, Spain); Giuseppe Fico (Universidad Politécnica de Madrid, Spain)

This study details the innovative methods used to create a comprehensive monitoring dashboard for seamless technology integration in hospitals, utilizing Key Performance Indicators (KPIs). The results obtained showcase the successful implementation of the dashboard, effectively tracking Key Performance Indicators, promoting closer clinical-technological collaboration, and facilitating the adoption of efficient healthcare solutions and change management.

#20

Medical Data Augmentation via ChatGPT: A Case Study on Medication Identification and Medication Event Classification

Shouvon Sarker and Xiangfang Li (Prairie View A&M University, USA); Xishuang Dong (Prairie View A&M. University, USA)

In the N2C2 2022 competitions, various tasks were presented to promote the identification of key factors in electronic health records (EHRs) using the Contextualized Medication Event Dataset (CMED). This study aims to explore the utilization of ChatGPT for data augmentation to overcome the limited availability of annotated data for identifying the key factors in EHRs. Additionally, different pre-trained BERT models, initially trained on extensive datasets like Wikipedia and MIMIC, were employed to develop models for identifying these key variables in EHRs through fine-tuning on augmented datasets. The experimental results of two EHR analysis tasks indicate that data augmentation based on ChatGPT proves beneficial in improving performance for both medication identification and medication event classification.

#21

Systematic Comparative Analysis of Pre-trained Large Language Models on Contextualized Medication Event Extraction

Tariq Abdul-Quddoos (Prairie View A&M University, USA); Xishuang Dong (Prairie View A&M. University, USA); Xiangfang Li (Prairie View A&M University, USA)

Pre-trained large language models (LLMs) have become the leading approach in modeling medical language for Natural Language Processing (NLP) in clinical notes. This paper presents a systematical comparative analysis on LLMs-based clinical data analytics, where LLMs-based models include Bert Base, BioBert, two variations of Bio+Clinical Bert, RoBerta, and Clinical Longformer on three of tasks of information extraction on Electronic Health Records (EHRs) from Track 1 of Harvard Medical School's 2022 National Clinical NLP Challenges (N2C2). Experimental results demonstrate that these pre-trained LLMs are effective in detecting medication and medication events, while Bert Base, pre-trained on general domain data showed to be the most effective for classifying the context of events related to medications.

#22

Using Large Language Models to Tag Clinical Concepts Extracted from Nursing Notes

Delgersuren Bold and Darren Liu (Emory University, USA); Monique Bouvier (Emory Healthcare, USA); Cheng Ding and Xiao Hu (Emory University, USA)

Nursing notes contain information, complementary to widely used objective measurements including laboratory test results and vital signs, that can enrich structured data used in machine learning models to recognize patient deterioration. To be able to incorporate information from nursing notes into this algorithm framework, we propose to extract various clinical concepts from notes and use them as tokens to represent a given note. However, well-established medical name entity extraction tools may incorrectly detect a

concept, cannot provide temporality of the concept, and does not negate a concept based on the context. Therefore, we tested the ability of general-purpose large language models (LLMs), i.e., GPT3.5 to further tag a clinical concept detected by MetaMap.

#23

The Impact of Scientific Publications on Clinical Care: A Case Study

Riley Marlar (Oklahoma State University, USA); Niloufar Eghbali Zarch (Michigan State University, USA); Justin Lippard, Zheng Han, Dursun Delen, Willliam Paiva and Matt Vassar (Oklahoma State University, USA); Mohammad Mahdi Ghassemi (Michigan State University, USA)

This article examines the influence of scientific knowledge dissemination on medical practices, specifically the shift in appendicitis management from surgical to non-operative approaches. By analyzing CPT codes and publication data from PubMed, we establish a positive relationship between surgery ratio and average citations per publication, indicating higher adoption of non-operative management with increased citations. This study contributes to understanding how knowledge dissemination impacts patient care and drives changes in medical practices.

#24

Machine Learning-based Research on Care-Service Strategies of Elderly Care Institutions during COVID-19

Jingjing Liu, Chang Liu and Yang Yang (Shanghai Jiao Tong University, China); Zhangdaihong Liu (Oxford-Suzhou Centre for Advanced Research, China & University of Oxford, United Kingdom (Great Britain))

During COVID-19, the infection and mortality rates in elderly care institutions were much larger than the average. To investigate the care-service impact in elderly care institutions under infectious diseases like COVID-19, we utilized machine learning method and statistical approach to identify appropriate nursing strategies for the elderly. The result is that the care-service in elderly care institutions, which located in the northern part of Pudong District in Shanghai and with high diarrhea rate should be pay more attention. Moreover, it is important for hospitals to connect with community health institutions in order to grasp the epidemic situations and take prompt actions among the elderly.

#25

Discovering subtype-specific biomarkers from functional MRI scans for autism spectrum disorder via graph neural networks

Yi Hao Chan, Jun Liang Ang, Sukrit Gupta and Jagath Rajapakse (Nanyang Technological University, Singapore)

Autism spectrum disorder (ASD) is known to be heterogeneous, but most existing works do not produce imaging-based biomarkers for each subtype. In this paper, we propose SplitGNN, which produces subtype-specific biomarkers from resting-state functional magnetic resonance imaging (fMRI) scans. Besides uncovering 4 ASD subtypes, each with unique biomarkers, we also identified the connection between the superior temporal gyrus and thalamus as a prominent class-wide biomarker consistently observed across all subtypes.

#26

Sequential Modelling for CT Head Scan Segmentation

Chun Hung How and Jagath Rajapakse (Nanyang Technological University, Singapore)

Existing segmentation models did not emphasize the ability to perform multi-tasking. We trained two MegaByte [3] models as an encoder and decoder to accommodate different input conditions for multi-task segmentation. Our model allows different segmentation tasks to be trained simultaneously and inferred with the task prompt. We demonstrate our method on segmentation of intracranial haemorrhages from computed tomography (CT) head scans and show comparable performance to existing models. For brain tissue segmentation task on CT images, our method outperformed the existing methods.

#27

Learning from Oversampling: A Systematic Exploitation of oversampling to address Data Scarcity issues in Deep Learning based Magnetic Resonance Image Reconstruction

Ibsa K Jalata, Reeshad Khan and Ukash Nakarmi (University of Arkansas, USA)

Recent deep learning (DL) frameworks are data hungry, and demand a large, labeled training data sets. To address the scarcity of training data in MR image reconstruc- tion, we pose the training data oversampling as a one-to-many mapping function and introduce a new loss function based on similarity metric that can be integrated into a DL framework. In addition to solving the scarcity of the available data, this approach makes the learned model more robust to different under-sampling factors.

#28

Learning Rate and Loss Function Impact in Generative Adversarial Networks for Time Series Synthesis: A Comparative Study

Xinyu Li and Marieke Van Vugt (University of Groningen, The Netherlands); Joukje van der Naalt (University Medical Center Groningen, The Netherlands); Natasha Maurits (University of Groningen, The Netherlands)

This study aims to understand how different factors affect the generation of synthetic time series, such as sinusoidal and electroencephalogram (EEG) signals, by Generative Adversarial Networks (GANs). We analyze the impact of learning rate and loss function on GAN performance. Our ultimate goal in generating realistic EEG data is to address the problem of insufficient data in cognitive experiments.

#29

Time-Aware Deep Sequential Models for In-Hospital Code Blue Prediction using Monitor Alarms

Nirbhay Modhe and Ran Xiao (Emory University, USA); Matthew Clark (Nihon Kohden Digital Health Solutions, Inc., USA); Cheng Ding (Georgia Institution of Technology, USA); Duc Do (University of California Los Angeles, USA); Randall Lee (University of California San Francisco, USA); Timothy Ruchti (Nihon Kohden Digital Health Solutions, Inc., USA); Xiao Hu (Emory University, USA)

Bedside monitor alarms are valuable for predicting Code Blue events in hospitals and have led to developments in data-driven approaches aimed at reducing the issue of excessive false alarms (alarm fatigue). We investigate the importance of time-awareness in Code Blue prediction of LSTM models. We select two types of alarm-based datasets for our training and evaluation -- (i) a dataset of raw alarms and (ii) a dataset of super alarms' obtained by using the Co-occuring Token (CoT) framework. We compare simulated online evaluation performance and find improvements with the addition of time-awareness, while also observing notable differences in performance of super alarms' vs. raw alarms.

#30

Weakly supervised ConvMixer for spatiotemporal dense prediction of brain dynamism

Behnam Kazemivash and Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

Spatiotemporal brain dynamics, characterized by changes in neural activity patterns across both space and time, are of utmost importance and less studied for understanding brain function and its links to emotion, cognition, and behavioral responses to external stimuli. In our study, we introduce a novel method for spatiotemporal dense prediction of a sensorimotor network. This is accomplished by leveraging a combination of ICA time-course and spatial map extracted from input fMRI data as prior for weakly supervised training of a deep ConvMixer architecture. Our results show ability of the model to effectively capture brain dynamism and generate dynamic 4D representation map for sensorimotor network which vary over time and subjects. Clinical Relevance- Our research advances the field of neuroscience by generating 4D maps for the sensorimotor network, which captures variability over time and subject and can open up a wide range of possibilities to identify potential biomarkers for different brain disorders. Moreover, it can be extended to explore other brain networks.

#31

A whole-brain data-driven structure-function fingerprint

Aline Kotoski (Georgia State University & TReNDS Center, USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

This study investigates the correlation between brain structure, function and reading ability in young teenagers. We linked a pattern of whole brain structure for a specific subject to the corresponding whole brain functional connectivity pattern for a specific network. Our results revealed significant associations between specific brain areas and reading performance.

#32

Peripheral Artery Disease Diagnosis via Deep Learning-Enabled Analysis of Non-Invasive Arterial Pulse Waveforms

Sina Masoumi Shahrbabak (University of Maryland, USA); Sooho Kim (OnePredict. Inc, Korea (South)); Byeong. D Youn (Seoul National University & OnePredict. Inc, Korea (South)); Hao-min Cheng and Chen-Huan Chen (National Yang Ming Chiao Tung University, Taiwan); Ramakrishna Mukkamala (University of Pittsburgh, USA); Jin-Oh Hahn (University of Maryland, USA)

This paper investigates the feasibility of peripheral artery disease (PAD) diagnosis via the analysis of non-invasive arterial pulse waveforms. We generated synthetic arterial blood pressure (BP) and pulse volume recording (PVR) waveform signals pertaining to PAD at abdominal aorta with a wide range of severity levels using a mathematical model. We developed a deep learning (DL)-enabled algorithm that can diagnose PAD by analyzing brachial and tibial PVR waveforms, and evaluated its efficacy in comparison with the same DL-enabled algorithm based on brachial and tibial arterial BP waveforms as well as the ankle-brachial index (ABI) technique. The results showed that it is possible to detect PAD based on DL-enabled PVR waveform analysis with adequate accuracy, and its detection

efficacy is comparable to when arterial BP is used (positive and negative predictive values: 0.78 vs 0.85 and 0.89 vs 0.94; ROC AUC: 0.90 vs 0.97). In addition, DL-enabled PVR waveform analysis significantly outperformed ABI in PAD detection. In sum, the findings from this paper suggest the potential of PAD diagnosis via DL-enabled non-invasive arterial pulse waveform analysis.

#33

Identifying Tissue Regions of Pathological Phenotypes from In Situ Spatial Single-Cell Transcriptomics Data Using Deep Graph Analysis

Arun Das (University of Pittsburgh, USA & Hillman Cancer Center, USA); Wen Meng (University of Pittsburgh Medical Center, USA); Md Musaddaqul Hasib (University of Pittsburgh, USA); Shou-Jiang Gao (University of Pittsburgh Medical Center, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

Spatial profiling of single cells enables gene expression measurement and spatial localization within tissues at cellular or sub-cellular levels. Spatial gene expression patterns define tissue structures and pathology phenotypes. Existing unsupervised machine learning algorithms fail to capture complex spatial gene expression patterns associated with disease phenotypes. To address this, we propose a novel semi-supervised graph neural network to learn spatial gene expression patterns linked to disease pathologies.

Clinical Relevance- Potential to accurately predict disease pathologies through spatial gene expression patterns, aiding in personalized diagnosis and treatment strategies.

#34

AI-based Ecological Monitoring of Handwriting to Early Detect Cognitive Decline

Simone Toffoli and Francesca Lunardini (Politecnico di Milano, Italy); Carmen Galán de Isla (FundeSalud - Foundation for Research and Training of Health Professionals of Extremadura, Spain); Simona Ferrante (Politecnico di Milano, Italy)

The early detection of Mild Cognitive Impairment (MCI) is fundamental to initiate treatments for delaying the onset of dementia. Currently, the Mini Mental State Examination (MMSE) is one of the most common clinical scale used by geriatricians to assess cognitive function. A deviation of 1 to 3 points from the maximum score (30) is considered as sign of relevant cognitive decline. However, objective and affordable tools are needed to complement the screening process. The quantitative analysis of handwriting represents a suitable solution, as the gesture is significantly impaired in MCI subjects in terms of time, speed, fluency and applied pressure. This works presents the development and testing of classification models able to separate subjects at risk of cognitive decline (MMSE <= 28) from controls (MMSE > 28), starting from free-content handwriting data acquired with a smart ink pen, used on paper, from which 36 indicators were computed. Data were collected in 2 phases. The former involved 45 subjects and served for models training. In the latter, data were acquired from 23 subjects in a domestic longitudinal framework and were partially used for model refinement, but mainly for testing. Three different algorithms were tried (support vector machine, random forest and catboost) The best test performances on the longitudinal data were obtained by a Catboost classifier, achieving accuracy 93.33%, precision 88.89%, recall 100% and f1 score 94.12%. The results support the use of computerized handwriting analysis as screening tool for cognitive decline detection.

#35

URVoice: An Akl-Toussaint/ Graham-Sklansky Optimization for Sign Language Interpretation

Madhumitha V (Indian Institute of Technology Hyderabad, India); Santhi Natarajan (Shiv Nadar University Chennai, India); Bharathi A (BMSIT&M, VTU, India); Manjunath Sargur Krishnamurthy (JP Morgan Chase and Co., USA)

We present URVoice, a vocalizer for the communication impaired, based on the Indian Sign Language Notations. Sign and gesture language, offering an intelligent co-ordination of eye-and-hand and ear-and-mouth, has evolved as an intelligent manifestation of speech for the impaired. However, they have very limited modality and iconicity in accommodating a greater range of linguistically relevant meanings. They also fail to cover the verbal spectrum of temporal and spacial characteristics of communication. Bridging this gap shall strengthen their mental thoughts, avoid reliance on interpreters, and shall also provide access to new technologies. URVoice is an Augmentative and Alternative Communication (AAC) device for real time translation of gesture to text/voice using convex hull based computational geometry.

URVoice pipeline helps in forward communication from signer to collocutor with a novel vision-based model using Akl-Toussaint heuristic and Graham-Sklansky scan algorithms. Our work offers the following contributions: 1) URVoice, Augmentative and Alternative Communication (AAC) device and vocalizer based on the Indian Sign Language Notations, 2) Real time translation of gesture to text/voice using convex hull based computational geometry, 3) Forward communication from signer to collocutor with a novel vision-based model using Akl-Toussaint heuristic and Graham-Sklansky scan algorithms, 4) URVoice benchmark models which we developed in-house, built on conventional machine-learning and deep-learning methods, 5) Datasets created for Indian Sign Language notations for future work and augmentation to URVoice.

The proposed combination is a convex hull optimization technique to identify the key geometrical points in gestures for their recognition. When independently used, the Sklansky scan fails for simple polygons and succeeds for star-shaped polygons, a fact upon which the correctness of the Graham scan relies. The idea of the Graham scan is to make a single scan through a sorted list of points. At each step in the scan, either a point is deleted or retained based on the test. So, if there are n points, a maximum of n points can be deleted. Thus, the algorithm takes O(n) time. The Akl-Toussaint heuristic helps to quickly exclude many points that would not be part of the convex hull. The convex hull method follows, which results in a monotone polygon, followed by Graham-Sklansky scan to obtain the points of convex hull.

We benchmarked the performance of URVoice convex optimization model by developing other standard ML/DL models of URVoice for hand gesture recognition. Although these models performed well, the convex hull optimization technique was preferred over this based on the obtained performance and the type of system we wanted to implement. Using a CNN model would result in designing a GPU based system for hand-held device which is not a feasible solution due to factors like memory usage, size and cost. The experiments performed using convex hull method deduces best results with the features under study and also was able to reliably recognize the gestures in real-time, though there were some limitations imposed by the presence of image noise. Thus, the convex hull optimization technique proves to have better static gesture recognition rates.

#36

Markerless RGB-D Hand Pose Estimation for Activity Monitoring of Musculoskeletal Diseases

Vanessa Wirth (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Anna-Maria Liphardt and Birte Coppers (University Hospital Erlangen, Germany); Johanna Braeunig, Simon Heinrich and Sigrid Leyendecker (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Arnd Kleyer and Georg Schett (University Hospital Erlangen, Germany); Martin Vossiek (LHFT, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Bernhard Egger (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Marc Stamminger (FAU, Germany)

Clinical motion capture technologies to monitor the activity of inflammatory musculoskeletal diseases are pri- marily marker-based. This is because markerless hand pose estimation approaches are still heavily tailored to entertainment applications such as VR/AR, which only require coarse, plausi- ble poses instead of accurate and reliable results. To bridge the gap between coarse, interactive hand simulation and accurate but unintuitive marker-based motion capturing, we propose the first markerless RGB-D hand pose and shape tracking method, which considers uncertainty during the estimation process.

#37

AutoHealth: A Wearable Personalized Medical Butler for Parkinson's Disease

Katherine A. Parajes, Ming Zhu, Shengjie Zhai and Luis M Cardenas (University of Nevada Las Vegas, USA)

Parkinson's disease (PD) stands as one of the prevalent neurodegenerative disorders worldwide, affecting millions with varying physical inconveniences, cognitive decline, and inflicting immense psychological stress on patients and their kin. As the disease escalates, vigilant monitoring becomes pivotal in managing the condition effectively, alleviating symptoms, and enhancing the patients' and their family's overall life quality. Capitalizing on the innovation of smartwatches and their inherent biosensors, we introduce AutoHealth - an Internet of Medical Things (IoMT) system designed to perpetually track the movement patterns of PD patients. Our cutting-edge system seamlessly incorporates vector-based learning AI models, providing a personalized approach to early PD detection, tracking, and rehabilitation. Further complementing the user experience, we are excited to incorporate an AI chatbot into the AutoHealth system. This chatbot engages patients in interactive dialogue, promptly responds to queries, and offers guidance, fostering a proactive approach towards managing their health conditions.

Clinical Relevance- Our solution pioneers an automatic, integrated system delivering real-time PD diagnosis, perpetual monitoring, and tailored recommendations, a stride beyond the conventional dependence on multiple devices and manual interventions. The model is built to construct autonomous agents that learn from a user's unique healthcare data and history, tailoring a plan to fit their individual needs. Our system breaks barriers by being a cross-language, cross-platform solution, ensuring accessibility regardless of regional and hardware constraints. Our mission is to deliver affordable, at-home medical assistance through a wearable device, bringing advanced healthcare and diagnostics right to your wrist.

#38

A Transfer Learning-based Homecare Prompting Assistance System for Supporting Everyday Activities in People with Mild Dementia

Xiaowei Chen and Guoliang Fan (Oklahoma State University, USA)

People with dementia (PwD) experience widespread cognitive impairment, leading to challenges in carrying out routine tasks known as activities of daily living (ADLs) and especially more complex instrumental ADLs (IADLs). Without adequate support, PwD become

highly susceptible to a loss of independence and vulnerability. Various assistive technologies (ATs) have been proposed to assist PwD with mild conditions to complete IADL tasks. However, most existing AT devices provide limited IADL support to PwD with little or no user-specific customization. This paper presents our early development of a PwD homecare prompting assistance system, called CATcare (Cognitive Assistive Technology Care). Our CATcare system can be operated on a smartphone or smart glasses and customized by a caregiver according to the IADL needs of the care recipient. It is able to provide much-needed IADL-specific step-by-step cueing, prompting, and timely feedback to assist PwD to accomplish the task of interest. Our research leverages the capabilities of the transfer learning and AI technologies in indoor room localization, object detection, and Natural Language Processing (NLP) and shows the potential and promise of using AI technologies to develop a customizable and personalizable CATcare to improve the life quality of PwD and to reduce the burden of their caregivers.

#39

BrainTalker: Low-Resource Brain-to-Speech Synthesis with Transfer Learning using Wav2Vec 2.0

Miseul Kim, Zhenyu Piao, Jihyun Lee and Hong-Goo Kang (Yonsei University, Korea (South))

Decoding spoken speech from neural activity in the brain is a fast-emerging research topic, as it could enable communication for people who have difficulties with producing audible speech. For this task, electrocorticography (ECoG) is a common method for recording brain activity with high temporal resolution and high spatial precision. However, due to the risky surgical procedure required for obtaining ECoG recordings, relatively little of this data has been collected, and the amount is insufficient to train a neural network-based Brain-to-Speech (BTS) system. To address this problem, we propose BrainTalker-a novel BTS framework that generates intelligible spoken speech from ECoG signals under extremely low-resource scenarios. We apply a transfer learning approach utilizing a pre-trained self-supervised model, Wav2Vec 2.0. Specifically, we train an encoder module to map ECoG signals to latent embeddings that match Wav2Vec 2.0 representations of the corresponding spoken speech. These embeddings are then transformed into mel-spectrograms using stacked convolutional and transformer-based layers, which are fed into a neural vocoder to synthesize speech waveform. Experimental results demonstrate our proposed framework achieves outstanding performance in terms of subjective and objective metrics, including a Pearson correlation coefficient of 0.9 between generated and ground truth mel-spectrograms. We share publicly available Demos and Code.

#40

Serious games for a technology-enhanced early screening of handwriting difficulties

Linda G. Dui, Chiara Piazzalunga and Simone Toffoli (Politecnico di Milano, Italy); Stefania Fontolan (University of Insubria, Italy); Sandro Franceschini (University of Padua, Italy); Marisa Bortolozzo (University of Insubria, Italy); Nunzio Alberto Borghese (University of Milan, Italy); Cristiano Termine (University of Insubria, Italy); Simona Ferrante (Politecnico di Milano, Italy)

Early screening of handwriting difficulties is key to start remediation activities that help distinguishing between a simple delay and dysgraphia. Technology is fundamental in this process, as also claimed by guidelines for dysgraphia diagnosis: it allows to implement artificial intelligence techniques to help in the discrimination of the difficulty. To this end, a serious game was leveraged to assess handwriting laws altered in dysgraphia starting from symbols drawing. 66 first and second graders were longitudinally tested both with the serious game and with a handwriting proficiency test. Objective features computed from the game were tested to understand if they significantly differed between children at risk and not at risk of dysgraphia, according to a standardized clinical test used to assess handwriting. Then, machine learning models were leveraged to predict the risk and understand the areas of difficulty. On average, 62% of the features significantly differ between risk levels for first graders, whilst only 35% for second graders, thus revealing a better sensitivity in younger children. This is encouraging for an early observation. As for machine learning, a Logistic classifier was able to predict risk with an area under the precision-recall curve of 0.84 for the risk class and 0.98 for the non-risk class. The results of this study could be a valid help for an artificial intelligence-enhanced screening of dysgraphia.

#41

Towards Accurate and Clinically Meaningful Summarization of Electronic Health Record Notes: A Guided Approach

Zhimeng Luo, Yuelyu Ji, Abhibha Gupta, Zhuochun Li, Adam Frisch and Daqing He (University of Pittsburgh, USA)

Clinicians are usually under time pressure when they review patients' electronic health records (EHR), therefore, there are great benefits to providing clinicians high quality summarizations of patients' EHR. However, existing summarization algorithms cannot satisfy their needs. In this paper, we present a novel approach to summarize EHR notes using a guided summarization model. Our model integrates a structured template developed with a clinical domain expert, a Named Entity Recognition (NER) model and sentence classification model for guidance extraction, and a fact-checking metric for evaluating the generated summaries. We trained our model on a large de-identified EHR dataset. The results demonstrate that our guidance, which includes Chief Complaint (CC), NER, guidance from the History of Present Illness (HPI) section, and guidance from the Medical Decision Making (MDM) section, can significantly improve the performance of the models in generating accurate and clinically meaningful summaries. The Gsum (CNN) model with all the guidance aforementioned achieved the highest F1 score of 46.4, demonstrating the effectiveness of introducing

precise and informative guidance to models from the general domain when the training data on the clinical domain is prohibitively sensitive and expensive. This work contributes to the ongoing efforts to automate the summarization of EHR notes, with the ultimate goal of improving healthcare delivery and patient outcomes.

#42

Radar-based Recognition of Activities of Daily Living in the Palliative Care Context Using Deep Learning

Johanna Braeunig, Desar Mejdani and Daniel Krauss (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Stefan Griesshammer (University Hospital Erlangen, Germany); Robert Richer and Christian Schuessler (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Julia Yip, Tobias Steigleder and Christoph Ostgathe (University Hospital Erlangen, Germany); Bjoern M Eskofier (Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany); Martin Vossiek (LHFT, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

The accurate detection and quantification of activities of daily life are crucial for assessing the health status of palliative patients to allow an optimized treatment in the last phase of life. Current evaluation methods heavily rely on subjective self-reports or external observations by clinical staff, lacking objectivity. To address this limitation, we propose a radar-based approach for recognizing ADLs in a palliative care context. In our proof of concept study, we recorded five different activities of daily living relevant to palliative care, all occurring within a hospital bed, from N=14 healthy participants (57 % women, aged 28.6 ± 5.3 years). All movements were recorded using two frequency-modulated continuous wave radar systems measuring velocity, range, and angle. A convolutional neural network combined with long short-term memory achieved a classification accuracy of 99.8 ± 0.4 % across five cross-validation folds. Furthermore, we compare our initial approach, which takes into account all dimensions of the available radar data, to a simplified version, where only velocity information over time is fed into the network. While these results demonstrate the high potential of radar-based sensing to automatically detect and quantify activities in a palliative care context, future work is still necessary to assess the applicability to real-world hospital scenarios.

#43

Fractal Bilinear Deep Neural Network Models for Gastric Intestinal Metaplasia Detection

Maria P Silva (INESC TEC, Faculdade de Ciências Da Universidade Do Porto, Portugal); Miguel L. Martins (INESC TEC Faculdade de Ciências Da Universidade Do Porto Portugal, Portugal); Diogo Libanio (University of Porto, Portugal); Mário Dinis-Ribeiro (Instituto Português de Oncologia Porto, Portugal); Miguel Coimbra (University of Porto, Portugal); Francesco Renna (Universidade do Porto, Portugal)

Gastric Intestinal Metaplasia (GIM) is a precancerous gastric lesion and its early detection facilitates patient followup, thus lowering significantly the risk of death by gastric cancer. However, effective screening of this condition is a very challenging task, resulting low intra and inter-observer concordance. Computer assisted diagnosis systems leveraging deep neural networks (DNNs) have emerged as a way to mitigate these ailments. Notwithstanding, these approaches typically require large datasets in order to learn invariance to the extreme variations typically present in Esophagogastroduodenoscopy (EGD) still frames, such as perspective, illumination, and scale. Hence, we propose to combine a priori information regarding texture characteristics of GIM with data-driven DNN solutions. In particular, we define two different models that treat pre-trained DNNs as general features extractors, whose pairwise interactions with a collection of highly invariant local texture descriptors grounded on fractal geometry are computed by means of an outer product in the embedding space. Our experiments show that these models outperform a baseline DNN by a significant margin over several metrics (e.g., area under the curve (AUC) 0.792 vs. 0.705) in a dataset comprised of EGD narrow-band images. Our best model measures double the positive likelihood ratio when compared to a baseline GIM detector.

#44

Sleep Staging Using Wearables and Deep Neural Networks

Shaun Davidson, Cristian Roman, Jonathan Carter, Mirae Harford and Lionel Tarassenko (University of Oxford, United Kingdom (Great Britain))

There is a well-established association between sleep and health status, but the current gold-standard for analysing sleep, polysomnography, is too disruptive and expensive to enable longitudinal monitoring. There is, therefore, a growing interest in automated sleep scoring, or staging, using a combination of wearable technology to acquire cardio-respiratory vital signs and machine learning to learn how these vital signs vary with sleep state. However, sleep and the associated cardio-respiratory signals also change significantly with age, in part because of age-related changes in the autonomic nervous system, and this impacts the accuracy of wearable sleep staging methods. This paper investigates how the accuracy of a deep neural network model trained on the Sleep Heart Health Study database varies with the age of the subject. We show that the classification accuracy for each sleep stage decreases with age. We also present proof-of-concept analysis of longitudinal sleep data from a COVID-19 Challenge Study with a younger cohort (18 - 29 years of age), and discusses the impact of having trained the deep neural network model on a database with an age range from 40 to 89+ and suggest how this issue may be addressed.

Clinical Relevance - This paper highlights how changes in sleep behaviour with age can affect neural network sleep staging using cardio-respiratory vital signs and machine learning, resulting in less accurate sleep staging in some age groups, and discusses potential methods for addressing this.

#45

Providing Hand Use Context for Outpatient Neurorehabilitation with Egocentric Object Detection

Adesh Kadambi and Jose Zariffa (KITE Research Institute - University Health Network, Canada)

Recent advancements in wearable technology and machine learning have the potential to enhance rehabilitation therapy, particularly in outpatient settings. However, to effectively support therapy planning, such technologies need to capture context-specific information about an individual's activities of daily living (ADLs). In this study, we evaluated the performance of two object detection models, Detic and UniDet, on egocentric videos recorded by individuals with spinal cord injury (SCI). Our evaluations revealed that UniDet, when evaluated on its original 700 classes, achieved a Mean Average Precision (mAP) of 0.0382 for all objects and 0.0988 for active objects. When evaluated on a set of 27 consolidated functional categories, UniDet's performance improved to an mAP of 0.1503 for all objects and 0.1910 for active objects. Detic demonstrated superior performance with an mAP of 0.1772 for all objects and 0.2754 for active objects when evaluated on the 27 functional categories. However, the ground truth labelling strategy resulted in a large number of false positives, suggesting that the model performance is likely higher. Despite challenges posed by low-light conditions and motion blur, this study provides crucial insights into the potential of object detection models in therapy planning, facilitating the integration of wearable technology and machine learning in outpatient rehabilitation and enabling more personalized and effective therapeutic strategies.

#46

An Unsupervised Transformers Approach for Predicting Missing Markers in Human Motion Capture Systems

Goksu Avdan (Southern Illinois University Edwardsville, USA); Sinan Onal (Southern Illinois University, Edwardsville, USA); Chao Lu (Southern Illinois University Carbondale, USA)

Motion capture (MoCap) systems are extensively utilized in the healthcare industry due to their wide range of applications, including monitoring rehabilitation programs, facilitating clinical gait assessments for the diagnosis of early Alzheimer's disease, managing walking disorders, and contributing to the development of exoskeleton suits. However, like many other healthcare technologies, MoCap systems are not without some flaws, like missing marker problem. To address this issue, various deep learning approaches have been introduced in the literature, and yet none of them have utilized the power of transformers. To mitigate the missing marker problem, we proposed an unsupervised transformers framework. To generate the most suitable framework based on our MoCap data, we customized several models and rigorously tested them with different configurations by comparing their mean squared error (MSE) results. Our initial findings indicated that the unsupervised transformers framework with the highest number of parameters has given superior performance at different missing rates. The final MSE results generated as 0.1407, 0.1501, 0.1962, and 0.2606 for the missing rates of 10%, 20%, 30%, and 40%, respectively. In conclusion, this research opens up exciting avenues for further advancements in data analytics and holds substantial promise for the future of motion capture in the medical field.

19:00 – 21:00
Banquet

Wednesday, October 18, 2023

8:30 – 17:00
Registration

8:30 – 9:15
Keynote: Rick L. Stephens
AI for Science, Energy, and Security: DOE Laboratories' Vision for Advanced AI Systems
Chair: Georgia Tourassi

9:15 – 9:30
Coffee Break

9:30 – 11:15
Oral Session #5
Medical Imaging and Sensor Data
Session Chair: Yu-Chiao Chiu

9:30

A Framework for Automated Quantification of Calcified Coronary Artery from Intravascular Optical Coherence Tomography Images
Yiqing Liu (Massachusetts Institute of Technology, USA); Farhad Nezami (Brigham and Women's Hospital, USA); Elazer Edelman (Massachusetts Institute of Technology, USA)

Intravascular Optical Coherence Tomography (OCT) has emerged as a powerful imaging modality for assessing the morphological characteristics of coronary arteries. Quantification of calcified coronary arteries from OCT images is crucial for evaluating the severity and progression of coronary artery disease. However, in current practice, OCT images are interpreted manually which is time-consuming, subjective, and prone to inter- and intra-observer variability. To address these limitations, we propose a framework for automated quantification of calcified coronary arteries from OCT images. By leveraging deep learning techniques, the proposed framework automatically segments lumen and calcified plaque from OCT images. Subsequently, comprehensive morphological analysis of lumen and calcified plaque is performed using advanced image processing algorithms, allowing for retrieval of various dimensions of corresponding structures. Following that, essential shape measurements are derived to ensure adequate characterization of calcified coronary arteries. The efficacy of the proposed framework was validated on a clinical dataset. Extensive experiments have demonstrated high accuracy and consistency of quantitative results estimated by the proposed framework against manual analysis with relative errors of less than 10%. The proposed framework holds great potential to extend its application to characterization of other non-calcified plaques and arteries, aiding in clinical intervention and translational research using OCT.

9:45

Rare Heart Transplant Rejection Classification Using Diffusion-Based Synthetic Image Augmentation
Han Bao, Jie Deng, Shihao Xing, Yishan Zhong and Wenqi Shi (Georgia Institute of Technology, USA); Benoit Marteau (Georgia Institution of Technology, USA); Bibhuti Das (University of Mississippi Medical Center, USA); Bahig Shehata (Wayne State University School of Medicine, USA); Shriprasad Deshpande (Children's National Health System, USA); May Dongmei Wang (Georgia Institute of Technology and Emory University, USA)

Heart Transplant Rejection (HTR) is an exceedingly uncommon condition that necessitates early detection for successful treatment and to prevent lasting damage to the transplanted heart. Unfortunately, the current diagnostic process is time-consuming and lacks consensus among medical professionals. Introducing an automated diagnosis pipeline would greatly streamline the clinical workflow, serving as an additional clinical decision support tool that offers a second opinion to enhance agreement among clinicians. Traditionally, developing an automated image analysis tool of this nature requires a substantial amount of labeled data. However, due to the rarity and inherent case imbalance of HTR, this task becomes particularly challenging. Our dataset comprises 1,614 rejection tile images and ~190 times more non-rejection tile images. To address the scarcity of real-world examples, we present a novel approach featuring synthetic image generation using a diffusion model, where synthetic images of rejection were generated. We conducted a comparative analysis of classification using the dataset both with and without synthetic rejection tiles. The introduction of synthetic augmentation resulted in an improvement in sensitivity from 0.781 to 0.981 and in AUROC from 0.984 to over 0.998.

10:00

An Integrated Approach for Focal Cortical Dysplasia Lesion Validation on Preoperative Assessments

Josue D. Rodriguez, Mercedes Cabrerizo and Marcos A. Bosques (Florida International University, USA); Ilker Yaylali (Oregon Health & Science University, USA); Malek Adjouadi (Florida International University, USA)

In this study, we present an innovative approach that integrates EEG-based functional connectivity analysis and MRI-derived cortical thickness measurements, reflecting the principles of Precision Systems Medicine. This combined methodology enhances the precision of Focal Cortical Dysplasia (FCD) lesion validation in preoperative assessments for pediatric epilepsy, thereby establishing a foundation for improved surgical outcomes. Our case study confirms the consistent detection of the Caudal Middle Frontal region, supporting the potential of our method to increase the accuracy of surgical planning for FCD-related epilepsy. The broader implications extend to neurology and precision medicine, embodying a systems-level understanding of individual patients. While we recognize the need for further large-scale research, our study represents a significant stride towards a comprehensive, patient-centered, and data-driven approach to epilepsy treatment planning. This resonates with the objective of Precision Systems Medicine-delivering highly individualized healthcare based on complex system-level patient understanding.

10:15

ConText-GAN: using contextual texture information for realistic and controllable medical image synthesis

Marc-Adrien Hostin (Aix Marseille Université, France); Shahram Attarian (La Timone, Aix Marseille Université, France); David Bendahan and Marc-Emmanuel Bellemare (Aix Marseille Université, France)

This study proposes an enhancement to the ConText-GAN, an image synthesis model using a controllable texture input. The improvement consists in using a texture feature fusion module to reduce the complexity of the model, and enable the use of the OASIS architecture for image generation.

The ConText-GAN can be used to generate images of fake patients, which are useful in the medical field due to the scarcity of data. An example is given of the generation of images showing pathological muscle tissue in the context of neuromuscular diseases.

10:30

Predicting Quality of Life for Breast Cancer Patients

Christos Raspoptsis (Hellenic Open University, Greece); Eugenia Mylona (Unit of Medical Technology and Intelligent Information Systems, University of Ioannina & FORTH-IMBB, Greece); Konstadina Kourou (Institute of Molecular Biology and Biotechnology, FORTH-IMBB, Greece); Georgios C. Manikis (Foundation for Research and Technology, Greece); Haridimos Kondylakis (Computational Biomedicine Laboratory, FORTH-ICS, Greece); Kostas Marias (FORTH, Greece); Paula Poikonen-Saksela (Helsinki University Hospital, Finland); Panagiotis Simos (School of Medicine, University of Crete, Greece); Evangelos Karademas (University of Crete, Greece); Ketti Mazzocco (University of Milan, Greece); Ruth Pat-Horenczyk (The Hebrew University of Jerusalem, Greece); Berta Sousa (Champalimaud Research and Clinical Centre, Portugal); Dimitris Fotiadis (Institute of Molecular Biology and Biotechnology, FORTH, Greece & University of Ioannina, Greece)

The diagnosis of breast cancer has a significant impact on a patient's quality of life. Several demographic and clinical factors have been reported to affect the quality of life of breast cancer patients. However, few studies have a sufficient sample size for multifactorial assays to be tested. In the present work, we explore a rich set of clinical, psychological, socio-demographic, and lifestyle data from a large multicenter study of breast cancer patients (n = 765), with the aim to predict their global quality of life (QoL) 18 months after the diagnosis and to identify possible QoL-related prognostic factors. For QoL prediction, a set of Machine Learning methods were explored, namely Random Forest (RF), Support Vector Machine (SVM), and K-Nearest Neighbors (KNN). Depending on the model used, prediction accuracy varied between 0.305 and 0.864. Across models, a largely common set of psychological characteristics (optimism, perceived ability to deal with trauma, resilience as a trait, ability to understand the disease), as well as subjective perceptions of personal functionality (physical, social, cognitive function), were identified as key prognostic factors of long-term quality of life after a breast cancer diagnosis.

Clinical Relevance- Predicting QoL is critical for decision-making on cancer care. Early detection of protective and obstructive factors associated with patient well-being would help health professionals to tailor preventive psychological programs aimed at enhancing the ability of breast cancer patients to adapt effectively to the disease.

10:45

Distilling knowledge from high quality biobank data towards the discovery of risk factors for patients with cardiovascular diseases and depression

Vasileios C. Pezoulas (University of Ioannina, Greece); Georg Ehret (University of Geneva, Switzerland); Jos Bosch (Faculty of Social and Behavioural Sciences, University of Amsterdam, The Netherlands); Dimitris Fotiadis (Institute of Molecular Biology and Biotechnology, FORTH, Greece & University of Ioannina, Greece); Antonis Sakellarios (Institute of Molecular Biology and Biotechnology, FORTH, Greece)

Cardiovascular disease (CVD) is the leading cause of death worldwide. Patients with CVD may also suffer from mental disorders, such as, depression which is a common comorbid condition. However, the risk factors for depression in CVD patients have not been extensively investigated in the literature. In this work, we utilized a hybrid and explainable AI-empowered workflow to identify underlying factors for CVD and depression. Towards this direction, we acquired a subset of the UK Biobank (UKB), including 157,302 patients with depression assessment and CVD. At the first step, 701 features were selected from the UKB, upon clinical guidance, including demographics, blood tests, mental examinations, and clinical assessments. An automated biobank data curation pipeline was applied to transform the UKB subset into a high-quality dataset by removing outliers, and genes with increased variability. A hybrid version of the XGBoost classifier was used to classify patients with CVD and depression, where a scalable loss function was utilized to overcome overfitting effects. Our results demonstrate that we can diagnose patients with comorbid conditions of CVD and depression with 0.80, 0.82, accuracy, and sensitivity, respectively, where the mood swings, BMI, and age, were identified as biomarkers, among others. To our knowledge, this is the first case study aiming to distil knowledge from the UKB to identify cost effective risk factors for patients with CVD and depression.

11:30 – 12:15
Keynote: Tansu Celikel
Innovation through Imitation: Designing Artificial Networks with Lessons from Neural Networks
Chair: Bjoern Eskofier

12:45 – 13:45
Rapid Fire 3 & Box Lunch
Session Chair: Arun Das

12:45

Image-based Real-Time Tracking and Registration for AR-Guided Liver Surgery Using Hololens2: A Phantom Study

Serouj Khajarian (University of Applied Sciences Landshut, Germany & University of Freiburg, Germany); Stefanie Remmele (University of Applied Sciences, Landshut, Germany); Oliver Amft (University of Freiburg, Germany and Hahn Schickard, Germany (amft@informatik.uni-freiburg.de))

We investigate AR-based tracking and registration of the liver surface for potential surgical applications. Our approach consists of streaming RGBD data from a Hololens2 device, RGBD segmentation using a deep learning model and registering the acquired partial liver surface point cloud with the corresponding virtual liver model. We aim to derive basic requirements for AR-guided liver surgery, thus consider several test cases of partially occluded liver as it would appear in surgical scenarios. To evaluate our approach, we use a 3D-printed phantom with basic texture and rigid structure. Our results show that the visible liver section has a substantial impact of feature extraction and matching, thus the registration process. Test cases, where specific anatomical features are visible, e.g. the right liver lobe, yielded superior outcomes compared to other cases, e.g. only the left liver lobe visible. Moreover, our results showed that large scale Hololens movements during the tracking process affected the registration performance. Our implementation achieved 2-3 frames per second for tracking and registration. We discuss the potential and limitations of utilizing Hololens2 for real-time tracking and registration of the liver surface. To our knowledge this is the first experimental approach for real-time markerless tracking and registration for AR-guided surgery guidance using the Hololens2 sensors only.

12:47

On Training Model Bias of Deep Learning based Super-resolution Frameworks for Magnetic Resonance Imaging

Mamata Shrestha and Ukash Nakarmi (University of Arkansas, USA); Nian Wang (Indiana University, USA)

Super-resolution is an important technique in various fields, particularly in medical imaging, where it plays a crucial role in understanding and analysis of complex, qualitative, and quantitative characteristics of tissues at high resolutions. However, obtaining high-resolution images often faces practical limitations pertaining to acquisition device limitations, patient motion, or longer acquisition times. The remarkable success of deep learning methods has recently opened doors to their application in image super-resolution tasks as well. These deep learning-based methods heavily rely on a substantial amount of data, which is often unavailable,

especially in the case of Magnetic Resonance Imaging (MRI) scans. Particularly in magnetic Resonance super-resolution, it is often impossible to have low-resolution and high-resolution training image pairs. To address this, deep learning approaches simulate low-resolution images using many image degradation methods mimicking low-resolution images to create training image pairs from the available few high-resolution images. However, models trained on specific degradation simulations exhibit bias, leading to poor performance in real-world scenarios. In this paper, we hypothesize that such deep learning models trained on specific training image pairs with a specific degradation model are biased, we systematically study such biases with different types of degradation, different deep learning frameworks, and training losses. Finally, we advocate ensuring the diversity of degradation models to generate training image pairs controls such biases resulting in a more robust learning framework for MR image super-resolution.

12:49

Learning Seismocardiogram Beat Denoising Without Clean Data

Mohammad Nikbakht (Georgia Institute of Technology, USA); David Lin (Georgia Tech, USA); Omer T Inan (Georgia Institute of Technology, USA)

Noninvasive monitoring of cardiovascular health plays a crucial role in predicting risks and reducing mortality rates, especially in the context of trauma care. The seismocardiogram (SCG) in particular is a noninvasive signal that has been shown to monitor key health parameters related to blood volume loss estimation, suggesting its ability to guide trauma care intervention. Robust extraction of features from SCG signals in noisy environments is challenging due to low signal-to-noise (SNR) ratios. In addition, lack of access to clean ground truth signals makes developing denoising algorithms even more difficult. In this work, we propose a novel deep learning-based approach for denoising SCG signals without requiring access to clean ground truth signals. Experimental results showed (1) enhancement in the signal-to-noise ratio (SNR) (approximately 10 dB and 9 dB increase for AO and AC regions of -10 dB SNR beats respectively), and (2) improvements in feature extraction accuracy (approximately 3x and 1.5x for AO and AC features of -10 dB SNR beats respectively) using the denoising model. Thus, the model effectively reduces noise, and improves the quality of SCG signals, leading to improved accuracy in feature extraction in noisy environments. This is a promising step forward in improving the quality and utility of SCG signals for clinical and research purposes.

12:51

Temporal Phenotype Matrix Engineering for Electronic Health Records - Enhancing Coronary Artery Disease Prediction

Kuan-Hui Liu (Institute of Data Science and Engineering & National Yang Ming Chiao Tung University, Taiwan); Cheng-Yu Chiang (National Central University, Taiwan); Hsin-Yao Wang (Chang Gung Memorial Hospital at Linkou, Taiwan); Yi-Ju Tseng (National Yang Ming Chiao Tung University, Taiwan & Boston Childrens Hospital, USA)

Electronic health records (EHRs) often exhibit sparsity and irregularity due to their inherent nature. It is crucial to consider that imputation and aggregation techniques used during EHRs preprocessing can introduce artificial and unrealistic data and potentially leading to the loss of critical information. In this study, we proposed a temporal phenotype matrix engineering approach with auxiliary data layer (ADL) to extract important hidden information from EHRs. Our proposed approach was applied to the early prediction of coronary artery disease (CAD), one of the leading causes of death worldwide. We evaluated the performance of the LSTM, CNN, and TCN models on the CAD prediction task. Upon applying our proposed matrix engineering technique with ADL, we observed a substantial improvement, with an AUROC (area under the receiver operating characteristic) score of 0.919 ± 0.006 (a 10% increase, compared to when no ADL was included, 0.831 ± 0.011) in CNN model. In conclusion, this study highlights the benefits of the proposed temporal phenotype matrix engineering approach with ADL to address the sparsity and irregularity inherent in EHRs data. Our findings underscore the potential of the proposed temporal phenotype matrix engineering approach with ADL for enhancing the early prediction of CAD, thereby contributing to improved patient outcomes and reduced mortality rates.

12:53

Attention-Based CNN Model for Burn Severity Assessment

Saeka Rahman, Miad Faezipour and Guilherme Aramizo Ribeiro (Purdue University, USA); Elika Ridelman (Childrens Hospital of Michigan Wayne State University, USA); Justin D. Klein (Wayne State University, USA); Beth A. Angst and Christina M. Shanti (Childrens Hospital of Michigan Wayne State University, USA); Mo Rastgaar (Purdue University, USA)

Visual inspection, along with physical examination, is the traditional method to assess burns. However, burn-care providers have different levels of experience and may face challenges in assessing the depth and severity of the wounds. The challenges associated with the traditional approach, such as poor and varying diagnosis/prognosis accuracy, have inspired researchers towards automated burn assessment to ensure effective burn wound management. The current research aims to improve automatic burn wound assessment. It provides an ordered scoring scale to measure burn severity using four characteristics: inflammation, scar, uniformity, and pigmentation. The research also proposes an attention-based Convolutional Neural Network (CNN) model to assess the characteristics of burn wounds. The model is evaluated with 2D color images to assess levels of inflammation, scar, uniformity, and pigmentation with two different datasets, and the performances are compared with other models. The attention mechanism of the

deep learning model selectively focuses on salient parts of the image to improve the understanding of the visual structure and enhance the classification accuracy. The proposed work outperforms most prior related work, achieving 93% in average accuracy. Clinical relevance - This research has significant clinical relevance in assisting accurate, reliable, and on-time diagnosis, treatment, and follow-up of burn wounds and thereby, provides effective burn wound management.

12:55

Multimodal Sequence Classification of force-based instrumented hand manipulation motions using LSTM-RNN deep learning models

Abhinaba Bhattacharjee (Purdue University, Indianapolis); Terry Loghmani (Indiana University, USA); Sohel Anwar (IUPUI, USA); Lexi Whitinger (Purdue University Indianapolis, USA)

T

he advent of mobile ubiquitous computing enabled sensor informatics of human movements leveraged to model and build deep learning classifiers for cognitive AI. Expanding deep learning approaches for classifying instrumented hand manipulation tasks, especially the art of manual therapy and soft tissue manipulation, can potentially augment practitioner's performance and enhance fidelity with computer assisted guidelines. This paper introduces a dataset of 3D force profiles and manipulation motion sequences of controlled soft tissue manipulation stroke pattern applications in thoracolumbar, upper thigh and calf regions of a human subject performed by five experienced manual therapists. The multimodal 3D force, 3D accelerometer and gyro raw data were preprocessed and experimentally fed into a multilayer Long Short-Term Memory (LSTM) based Recurrent Neural Network (RNN) deep learning model to observe sequence classifications of two manipulation motion techniques (Linear "Strumming" motion and curvilinear "J-Stroke" arched motion) of manual therapy performed using a handheld, localizing Quantifiable Soft Tissue Manipulation (QSTM) medical tool. Each of these motion sequences were further labeled with corresponding best practice technique from validated video tapes and reclassified into "Correct" and "Incorrect" practice based on defined criteria. The deep learning model resulted in 90-95% classification accuracy for individual intra-therapist reduced dataset. The classification accuracy varied in between 74%-89% range, when trained with variable feature set combinations for the complete spectrum of inter-therapist dataset. Clinical Relevance-AI guided online practice classifications can be leveraged to curb practice inconsistencies, optimize training using data informed guidelines, and study progression of pain and healing towards advancing manual therapy.

12:57

A Graph Machine Learning approach to Automatic Dementia Detection

Edoardo Stoppa, Guido Walter Di Donato, Isabella Poles and Eleonora D'Arnese (Politecnico di Milano, Italy); Natalie Parde (University of Illinois Chicago, USA); Marco D Santambrogio (Politecnico di Milano & MIT, Italy)

Dementia is a term used to refer to a wide range of diseases that cause a decline in cognitive abilities. This decline is severe enough to impair daily life and it is extremely complex to diagnose in its early stages. In recent years multiple Natural Language Processing solutions have been proposed to automatically detect dementia. One of the main approaches to this problem is based on extracting manually engineered features from a set of patients' conversations and feeding them to traditional Machine Learning models. These features can be divided into very different groups, and we can define specific relations that connect one feature to the other. Thus, we introduce a new way to approach the problem by organizing all the extracted features in a graph structure and using Graph Machine Learning to detect dementia. We validate our method using a well-established score regression task and a newly proposed multi-class classification task. This new task is based on the mapping between the Mini-Mental State Examination score and multiple dementia severity levels. Compared to traditional Machine Learning, our Graph Machine learning technique achieves a relative increase in performance between 2.9% and 8% for the regression task, and between 4.4% and 7.9% for the classification task.

12:59

On How to Unravel Bone Microscale Phenomena: A Mask-Guided Attention SR-microCT Image Classification Approach

Isabella Poles, Eleonora D'Arnese, Federica Buccino and Laura M Vergani (Politecnico di Milano, Italy); Marco D Santambrogio (Politecnico di Milano & MIT, Italy)

The global increase in elderly individuals has led to a rise in fragility fractures and chronic aging-related diseases, including osteoporosis. In this context, Deep Learning (DL) offers the potential to analyze bone images to aid researchers and clinicians in studying its health starting from the microscale. Previous studies demonstrate the effectiveness of DL in segmenting lacunae and classifying bone tissue micro-states from Synchrotron-Radiation micro-Computed Tomography (SR-microCT) images. However, the generalizability of these models, the laborious work in labeling tiny structures in high-dimensional images, and the low inter-class variance in SR-microCT images remain a concern. To fill this void, this paper proposes a Mask-Guided Attention (MGA) approach that combines semi-supervised learning lacunae segmentation and attention methods for healthy and osteoporotic SR-microCT image classification. In particular, semi-supervised learning aims at reducing the number of labeled images required during segmentation. At the same time, the MGA approach exploits the pseudo-labels predicted to focus the network's attention on the informative lacunar structures. Our strategy allows achieving up to 5.64% and 12.17% accuracy improvements over de-facto lacunae image segmentation

and image classification methods, as well as more interpretable results. Clinical relevance---The proposed MGA approach could enhance the understanding of bone microscale phenomena by exploiting SR-microCT images, supporting the study and the diagnosis of osteoporosis in individuals.

13:01

Predicting gender from structural and functional connectomes via brain and population graph neural networks

Yinan He, Yi Hao Chan and Jagath Rajapakse (Nanyang Technological University, Singapore)

Gender differences in terms of structural and functional organization of the human brain have been extensively studied but the existing works have mostly been limited to single modalities. In this paper, we propose a graph attention network architecture (BrainGAT) that uses informative subject-level features extracted from multimodal brain graphs to construct a population graph for gender classification. We show that while the extracted subject-level features can be directly used for classification, using these graph embeddings to construct a population graph further improves model performance. On the gender classification task, BrainGAT outperforms baseline models and existing multimodal modeling approaches, achieving an accuracy of 83.13% on the Human Connectome Project dataset. Salient connections highlighted by BrainGAT include connections between the inferior parietal and dorsolateral prefrontal areas of the cortex for females, while connections within the posterior cingulate cortex are highly salient for males. In sum, BrainGAT enables multimodal data to be modelled via population graphs in a parameter-efficient way.

Clinical Relevance- Several neurological conditions exhibit significant differences across genders and multimodal studies on these diseases are increasingly prevalent. This work highlights gender differences of multimodal connectomes in neurotypical settings. These insights could help to separate multimodal disease biomarkers from fundamental gender differences.

13:03

When System Model meets Image Prior: An Unsupervised Deep Learning Architecture for Accelerated Magnetic Resonance Imaging

Ibsa K Jalata and Ukash Nakarmi (University of Arkansas, USA)

MRI is typically a slow process because of its sequential data acquisition. To speed up this process, MR acquisition is often accelerated by undersampling k-space signals and solving an ill-posed problem through a constrained optimization process. While traditional methods use image priors as constraints, modern deep learning methods use supervised learning with ground truth images to learn image features and priors. However, in some cases, fully-sampled data are not available or difficult to acquire particularly for dynamic contrast enhancement (DCE), 3D cardiac cine, and 4D flow, making supervised learning impractical. To address this issue, we propose an unsupervised deep learning framework for accelerated MRI that does not require ground truth images for training. Our framework combines a system prior derived from the MR acquisition model with generic image priors to build a more effective unsupervised deep learning framework. The system prior enforces data consistency while the generic image priors regulate the neural network parameters. The proposed method provides a valuable solution for situations where obtaining fully-sampled data is challenging or not possible. This approach enables enhanced performance in scenarios where fully-sampled data is scarce or unavailable, offering a practical solution to address these limitations. Our experimental results demonstrate that our proposed unsupervised method outperforms the contemporary unsupervised methods and achieves performance comparable to that of supervised methods that require ground truth images for training.

13:05

Brain Biopsy Imaging using Electrical Impedance Tomography (BBI-EIT)

Arjun B s, Varun Canamedi and Sharmila Sree Vandrangi (Indian Institute of Science, Bangalore, India); Hardik J. Pandya (Indian Institute of Science Bangalore, India)

The article presents the development of a novel approach for brain biopsy imaging and characterization leveraging Electrical Impedance Tomography for margin assessment (BBI-EIT). BBI-EIT performs near real-time and non-destructive imaging of tissue samples that can map tissue heterogeneity based on their distinct electrical properties. The paper outlines the technical specifications, functional details, and comparison of the imaging results with gold-standard histopathology demonstrating its efficacy and potential for evaluating tissue heterogeneity and margin assessment. Clinical Relevance- The technique is proposed as an adjunct to current intraoperative assessment techniques such as frozen section and histopathological examination to see if the tumor margin has been achieved. Intraoperative integration of the BBI-EIT would allow surgeons to accurately identify and demarcate cancerous tissues during surgery, resulting in improved surgical outcomes and reduced patient morbidity. The technology could reduce the likelihood of leaving residual cancer cells behind, decreasing recurrence rates and improving patient outcomes. The BBI-EIT can potentially reduce the time required to identify and remove tumors during surgery by providing real-time imaging. This could decrease the duration of surgical procedures, which is beneficial as longer surgeries often have higher risks of complications.

13:07

Fetal Biological Sex Identification using Machine and Deep Learning Algorithms on Phonocardiogram Signals

Reza Khanmohammadi (Michigan State University, USA); Mitra Sadat Mirshafiee (University of Calgary, Canada); Tuke Alhanai (New York University Abu Dhabi, United Arab Emirates); Mohammad Mahdi Ghassemi (Michigan State University, USA)

Phonocardiogram (PCG) and Fetal Phonocardiogram (FPCG) are technologies that use the sound of the heart to noninvasively assess its mechanical activity. While significant prior work has investigated the utility of PCG signals for the identification of Cardiovascular conditions in adults, relatively less work has been performed using FPCG. Furthermore, it remains unclear if FPCG signals can be mined to infer other attributes that are not directly related to cardiovascular conditions. Fetal biological sex is one such attribute that is challenging to mine because FPCG (1) is not explicitly collected for the identification of biological sex and (2) is subject to significantly more noise than regular PCG. In this work, we demonstrate that fetal biological sex can be robustly inferred from FPCG data. More specifically, using the FPCG data of 102 subjects from the Shiraz University Fetal Heart Sounds Database, we extracted a wide range of previously studied signal and sound features of the PCG signals and assessed the discriminate power of these features in an array of fetal biological sex identification models. Our best performing model substantially outperformed the baseline approach, providing up to 91% accuracy in classifying fetal biological sex of unseen subjects' FPCG signals; 10% better than the best-performing literature baseline.

13:09

Look in Different Views: Multi-Scheme Regression Guided Cell Instance Segmentation

Xinyang Ling (Beihang University, China); Xiubo Sang (Beijing Shijitan Hospital, China); Shuchang Lyu (Beihang University, China); Wenpei Bai (Beijing Shijitan Hospital, China); Guangliang Cheng (University of Liverpool, United Kingdom (Great Britain)); Qi Zhao (Beihang University, China)

Cell instance segmentation aims to jointly detect and segment individual cells within an image. Despite the notable success achieved by existing methods, two inherent weaknesses persist. First, densely packed cells are often erroneously identified as a single cell. Second, elongated cells are frequently misinterpreted as two separate cells. To address these two weaknesses, we propose a novel cell instance segmentation network, termed Multi-Scheme Regression Guidance Network (MSRNet). Specifically, we first propose a point-regression branch to provide guidance on the precise center points of cells, enabling better discrimination of densely packed cells. Then, we propose a Gaussian-regression branch to direct the network's attention towards the middle region of cells, thereby mitigating truncation errors for elongated cells. By employing multi-scheme regression guidance, our network can effectively analyze each cell from different perspectives. We evaluate MSRNet through extensive experiments on benchmark datasets, including DSB2018, CA2.5, CPM17, MoNuSeg, and SCIS. Notably, MSRNet achieves a significant performance improvement on the SCIS dataset, surpassing the state-of-the-art by 3.0% in terms of AP50. The promising results demonstrate that MSRNet establishes a new state-of-the-art performance level. Furthermore, visualization and analysis confirm the interpretability of our proposed method. The source code for our approach is publicly available at https://github.com/cv516Buaa/MSRNet.

13:11

An Unsupervised Transformers Approach for Predicting Missing Markers in Human Motion Capture Systems

Goksu Avdan (Southern Illinois University Edwardsville, USA); Sinan Onal (Southern Illinois University, Edwardsville, USA); Chao Lu (Southern Illinois University Carbondale, USA)

Motion capture (MoCap) systems are extensively utilized in the healthcare industry due to their wide range of applications, including monitoring rehabilitation programs, facilitating clinical gait assessments for the diagnosis of early Alzheimer's disease, managing walking disorders, and contributing to the development of exoskeleton suits. However, like many other healthcare technologies, MoCap systems are not without some flaws, like missing marker problem. To address this issue, various deep learning approaches have been introduced in the literature, and yet none of them have utilized the power of transformers. To mitigate the missing marker problem, we proposed an unsupervised transformers framework. To generate the most suitable framework based on our MoCap data, we customized several models and rigorously tested them with different configurations by comparing their mean squared error (MSE) results. Our initial findings indicated that the unsupervised transformers framework with the highest number of parameters has given superior performance at different missing rates. The final MSE results generated as 0.1407, 0.1501, 0.1962, and 0.2606 for the missing rates of 10%, 20%, 30%, and 40%, respectively. In conclusion, this research opens up exciting avenues for further advancements in data analytics and holds substantial promise for the future of motion capture in the medical field.

13:13

ML Enabled Clinical Inference Tool for High-Risk Lactate Detection using Phagocytic Activity Data

Muhammad Nabeel Tahir (Rutgers University, USA); Kurt Wagner and Umer Hassan (Rutgers the State University of New Jersey, USA)

The relationship between blood lactate levels and the phagocytic activity of neutrophils can serve as a potentially effective clinical tool in understanding and regulating the immune system's response to external pathogens. Phagocytosis is a biological process in which blood cells kill pathogens. Phagocytosis activity of neutrophils could be employed in clinical settings to make effective predictions of the patients' immune sytem and risk stratification. In this study, we report a AI enabled clinical tool that employs machine learning algorithms to classify the phagocytic activity data into two distinct patient groups with lactate levels (low and high-risk). Whole blood samples from 19 patients were collected from Robert Wood Johnson Medical Hospital and were used to collect data on phagocytosis by neutrophils that internalize fluorescently tagged beads. The phagocytic activity monitoring protocol is established and data is transformed into a statistical data matrix which is fed to a set of machine learning algorithms that classify the patients' into two groups (low vs. high risk based on lactate level). A classification accuracy of 78.3% and an area under the curve of 0.78 has been achieved with the trained models. These trained models will help determine if a patient has high or low risk of increased lactate levels; thereby triaging patients coming to the emergency settings.

13:15

Sequential Inference of Hospitalization Electronic Health Records Using Probabilistic Models

Alan D Kaplan (Lawrence Livermore National Laboratory, USA); Priyadip Ray (IIT Kharagpur, USA); Vincent X. Liu and John D. Greene (Kaiser Permanente Division of Research, USA)

In the dynamic hospital setting, decision support can be a valuable tool for improving patient outcomes. Data-driven inference of future outcomes is challenging in this dynamic setting, where long sequences such as laboratory tests and medications are updated frequently. This is due in part to heterogeneity of data types and mixed-sequence types contained in variable length sequences. In this work we design a probabilistic unsupervised model for multiple arbitrary-length sequences contained in hospitalization Electronic Health Record (EHR) data. The model uses a latent variable structure and captures complex relationships between medications, diagnoses, laboratory tests, neurological assessments, and medications. It can be trained on original data, without requiring any lossy transformations or time binning. Inference algorithms are derived that use partial data to infer properties of the complete sequences, including their length and presence of specific values. We train this model on data from subjects receiving medical care in the Kaiser Permanente Northern California integrated healthcare delivery system. The results are evaluated against held-out data for predicting the length of sequences and presence of Intensive Care Unit (ICU) in hospitalization bed sequences. Our method outperforms a baseline approach, showing that in these experiments the trained model captures information in the sequences that is informative of their future values.

13:17

Multilayer Network Analysis of Brain Signals for Detecting Alzheimer's Disease

Sean M Nguyen, Mohammad Amin Basiri and Sina Khanmohammadi (University of Oklahoma, USA)

Human neuroimaging datasets provide rich multi-scale spatiotemporal information about the state of the brain. Most current methods, such as spectral analysis, focus on a single facet of these datasets and do not take full advantage of the inherited spatiotemporal information. Here, we consider a multilayer cross-frequency functional connectivity analysis to capture the complex spatiotemporal features of neural datasets at multiple scales and show that such features could potentially provide a better description of the neural activity. We demonstrate the effectiveness of this approach by applying the proposed method to capture disruptions of multilayer brain networks in Alzheimer's patients. More specifically, we compared the multi-scale features extracted from electroencephalogram (EEG) data with traditional features in a machine learning framework to distinguish Alzheimer's patients from control subjects. Our results show that such multi-scale features improve prediction accuracy compared to standard features.

13:19

Adventitious Pulmonary Sound Detection Using XGBoost

Shiva Shokouhmand, Md Motiur Rahman, Miad Faezipour and Smriti Bhatt (Purdue University, USA)

Pulmonary illnesses and complications are annually reported as highly prevalent. Patient outcomes can, however, be improved through the aid of automated processes for early diagnoses. This study aims to develop an automated method for diagnosing underlying adventitious sounds in respiratory diseases using the data recorded from the lung auscultation process. For this purpose, stethoscope audio signal recordings are initially segmented to merely include either normal or adventitious sounds such as wheezing and crackling. A comprehensive feature set representing the temporal and spectral dynamics in the respiratory events is extracted to identify the respiratory condition. An extreme gradient-based boosting (XGBoost) model is used and evaluated on the ICBHI 2017 dataset recordings based on a five-fold cross-validation approach. Our predictive method suggests specificity, sensitivity, and ICBHI

scores of 91.5%, 79.85%, and 85.67%, respectively, demonstrating superior results, outperforming the state-of-the-art techniques. It is also concluded that Mel-frequency cepstral coefficients (MFCC), spectral centroid, zero crossing rate, and signal intensity are the most consistent discriminating features within the adventitious sounds.

Clinical relevance - This work contributes to the development of advanced smart digital stethoscopes and respiratory monitoring systems that can be used in clinical, telemedicine and personalized healthcare settings for early detection of breathing disorders or pulmonary conditions.

13:30 – 14:00
Data Competition

14:00 – 15:45
Oral Session #6
Medical Imaging and Sensor Data
Session Chair: Lei Lu

14:00
Towards Multi-Functional ECG Smart System based on a Client-Edge-Cloud Architecture
Rajdeep Kumar Nath, Jaakko Tervonen, Johanna Närväinen and Kati Pettersson (VTT Technical Research Centre of Finland, Finland); Jani Mäntyjärvi (VTT, Finland)

This paper presents a novel client-edge-cloud-based framework that integrates the learning of task-invariant ECG feature representations from ultra-short ECG segments ($<$10 sec) and subsequent training of task-specific machine learning (ML) classifiers for different applications. Our proposed framework removes the need for application-specific ECG processing by training a general ECG representation learner in a self-supervised manner. The ECG representation learner is then used for generating feature inputs for the different task-specific applications. The proposed framework distributes the computation across cloud, edge, and client components depending on the resource requirement and time criticality. We demonstrate the feasibility and promise of the proposed approach on two different applications, that is, acute stress type classification, and biometric user identification and authentication. The use cases were analyzed using the computational parameters for the different models and computational tasks along with the overall performance. Our analyses show that the application-specific ML models can perform real-time inference in less than a second and the training time of the ML classifiers at the edge devices are in the order of 10-20 seconds. In the future, the proposed framework can be utilized for developing reliable, secure, and multi-functional ECG-based smart systems.

14:15
Accurate Detection of 3D Choroidal Vasculature Using Swept-Source OCT Volumetric Scans Based on Phansalkar Thresholding
Mohammed Nasar Ibrahim (University of Pittsburgh School of Medicine, USA); Sandeep Chandra Bollepalli (University of Pittsburgh, USA); Amrish Selvam and Vinisha Sant (University of Pittsburgh School of Medicine, USA); Sanjana Harihar (University of Pittsburgh, USA); Jose Alain Sahel and Jay Chhablani (University of Pittsburgh School of Medicine, USA); Kiran Kumar Vupparaboina (University of Pittsburgh, USA)

Various eye ailments associated with the posterior segment of the eye, including age-related macular degeneration (AMD) and central serous chorioretinopathy (CSCR), are caused due to dysfunction of the highly vascular choroid layer. It is responsible for supplying oxygen and nutrients to the retinal outer layers and maintaining the thermal equilibrium of the eye. Clinicians hypothesize that detecting minute volumetric structural changes of the choroidal vasculature enables early diagnosis. To this end, recently introduced swept-source optical coherence tomography (SS-OCT) volume scans provide dense high-resolution imaging of the choroid. However, due to intricate structure, manual segmentation of these vessels is not feasible and clinicians seek algorithmic segmentation and attempts made earlier reported limited performance. In response, we propose a method based on adaptive Phansalkar thresholding to accurately detect choroidal vessels in OCT volumes. Specifically, it increases the contrast between vessel and non-vessel regions within each subblock of the B-Scan. On15 SS-OCT volumes of healthy and diseased subjects, we performed subjective grading-based performance analysis on 2D and 3D vasculatures achieving 92.67% and 94% segmentation accuracy, respectively. Further, the proposed method demonstrated significant improvement over the previously reported method. Finally, we envisage that this method provides ground truth segmentation for training deep learning models.

14:30

ArterialNet: Arterial Blood Pressure Reconstruction

Sicong Huang and Roozbeh Jafari (Texas A&M University, USA); Bobak Jack Mortazavi (Texas A&M University & Center for Outcomes Research and Evaluation - Yale University, USA)

Accurate and continuous monitoring of arterial blood pressure (ABP) is vital for clinical hemodynamic monitoring. However, current methods are either invasive, requiring insertion of catheters, or provide limited information, lacking comprehensive ABP waveforms. Cuffless wearable solutions, combined with deep learning, offer potential but face challenges in accurately reconstructing ABP waveforms and estimating systolic and diastolic blood pressure (SBP/DBP) due to individual variability. We propose a novel custom pre-trained backbone and a tailored optimization function to address these challenges. Our method demonstrates superior performance in ABP waveform reconstruction and accurate SBP/DBP estimations, while significantly reducing subject variance. To validate the effectiveness of our approach, we conducted comprehensive evaluations using both in-clinic data and a pioneering study involving remote health monitoring with cuffless data. Our results surpass previous efforts, demonstrating a root mean square error (RMSE) of 5.41 ± 1.35 mmHg and a minimum of 58% lower standard deviation (SD) across all measurements. These outcomes highlight the robustness and precision of our method in accurately estimating SBP/DBP and reconstructing ABP waveforms. Furthermore, we assessed the performance of our solution in non-clinical settings using the CTRAL BioZ dataset. The evaluation yielded an RMSE of 8.66 ± 1.13 mmHg for ABP, proving the potential of ABP reconstruction under remote health settings.

14:45

Empowering Wearable Seizure Forecasting with Scheduled Sampling

Peikun Guo and Han Yu (Rice University, USA); Sruthi Gopinath Karicheri and Allen Kuncheria (Baylor College of Medicine, USA); Huiyuan Yang (Rice University, USA); Siena Blackwell (Baylor College of Medicine, USA); Zulfi Haneef (Baylor College of Medicine and the VA Medical Center, USA); Akane Sano (Rice University, USA)

The unpredictability of seizures imposes a significant burden on tens of millions of individuals with epilepsy worldwide. The ability to continuously monitor and forecast epileptic seizures would lead to a paradigm shift in epilepsy management. In this paper, we propose a novel progressive, personalized two-stage approach for seizure forecasting using 10-minute wearable time series data from wristbands worn by epilepsy patients. Our method effectively tackles the challenges posed by class imbalance and the complex nature of physiological signals. By measuring and ranking the reconstruction error and energy the normal samples present to a deep autoencoder and employing scheduled sampling, we demonstrate superior performance over existing deep learning models, anomaly detection methods, and class balancing during training. The proposed approach offers a promising solution for seizure forecasting and has potential applications in other medical problems characterized by imbalanced data and physiological signals of high variability. The source code of this project will be open-sourced upon acceptance.

Clinical relevance: The study demonstrates the potential for seizure forecasting using wearable data and individualized treatment planning. Its findings also highlight the value of adaptive learning mechanisms in training deep learning models for imbalanced physiological healthcare data.

Key words: seizure forecasting; wearable data; scheduled sampling.

15:00

Joint Embedding of Food Photographs and Blood Glucose for Improved Calorie Estimation

Lida Zhang, Sicong Huang, Anurag Das and Edmund Do (Texas A&M University, USA); Namino Glantz (Santa Barbara County Education Office, USA); Wendy Bevier and Rony Santiago (Sansum Diabetes Research Institute, USA); David Kerr (Diabetes Technology Society, USA); Ricardo Gutierrez-Osuna (Texas A&M University, USA); Bobak Jack Mortazavi (Texas A&M University & Center for Outcomes Research and Evaluation - Yale University, USA)

Type 2 diabetes has a significant impact on individuals' health and well-being, and diet monitoring is an important tool in treating individuals. Accurate estimation of meal intake is essential for promoting diet and behavior interventions. While continuous glucose models (CGMs) have demonstrated the ability to estimate carbohydrate quantities in meals, CGMs alone have been insufficient in capturing other meal nutritional information due to the different types of food and people's health conditions. Therefore, we propose a multi-modality model for augmenting CGM-based inverse metabolic models by using both CGM captured interstitial glucose data and food image data. A late fusion approach is used to aggregate the extracted glucose information from the attention-based Transformer and Gaussian area under the curve (gAUC) features, and image information from the vision transformer. We test our model on a dataset collecting Freestyle Libre Pro CGM data and meal photographs of breakfasts and lunches on 27 participants, with meals with known fixed caloric content. Our joint embedded approach to learning calorie estimations from both CGM data and image data achieved an average Normalized Root Mean Squared Error (NRMSE) of 0.34 for calorie prediction, with a correlation of 0.52, a 15.0 % improvement over CGM only models and 17.1 % over image only models.

15:45 – 16:00
Coffee Break

16:00 – 17:45
Special Session: State-of-the-Art in Predictive Analytics for Inpatient Care

Organizers: Joo Heung Yoon, Michael R. Pinsky, **Affiliations**: University of Pittsburgh

Titles & Speakers :

A. Prediction of Hypotension in the Intensive Care Unit with Physiologic Data: Joo Heung Yoon (U. Pittsburgh)

B. USA Identifying Thresholds for Hypotension in the Operating Room: Michael Schnetz (U. Pittsburgh)

C. Prediction of Hypotension Using Hypotension Prediction Index (HPI): Simon Vistisen (Aarhaus University Hospital, Aarhus, Denmark)

D. Value of Monitoring Heart Rate Characteristics for Pediatric Sepsis and Shock: Randall Moorman (U. Virginia)

E. Prediction of Sepsis and Its Multicenter Validation Process for hospitalized patients: Matthew Churpek (U. Wisconsin)

16:00 – 17:45
Poster Session 3

#1
Extracting m6A Regulatory Mechanisms from Literature using ChatGPT-based Prompt Engineering
Yiming Zeng (UPMC Hillman Cancer Center, USA); Arun Das (University of Pittsburgh, USA & Hillman Cancer Center, USA); Sumin Jo (University of Pittsburgh, USA); Yu Ma (Carnegie Mellon University, USA); David A Spellman (University of Pittsburgh, USA); Adam Ferris and David Gao (UPMC Hillman Cancer Center, USA); Jianqiu Zhang (University of Texas at San Antonio, USA); Yu-Chiao Chiu (University of Pittsburgh, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

This research focuses on information extraction (IE) from the titles of research publications, concerning N6-methyladenosine (m6A) regulatory mechanisms. Instead of employing traditional approaches like BERT-base Pretrained Language Model (PLM) with a neural classifier trained on a molecular regulatory mechanism event extraction task to extract the titles, we explore the use of Large Language Models (LLMs) like ChatGPT for this task. The key to achieving more precise results lies in the prompt design, which is explored through three versions: (1) the prompt containing only the definitions of arguments and explicit request to doublecheck two of the arguments extracted, (2) the prompt containing the definitions of arguments and explicit request to doublecheck all the arguments, and (3) In-context learning (ICL) prompts, where LLMs make predictions based on augmented contexts with a few examples. Our findings indicate that the ICL approach outperforms the other prompt versions in terms of prediction accuracy. The results of this study contribute to improving information extraction techniques in the context of m6A-related regulatory mechanisms and offer potential applications in various domains where precise information extraction is critical.

#2
Prediction of the efficacy of repetitive transcranial magnetic stimulation for patients with treatment-resistant depression using a brain image database
Yutaro Soejima (The University of Tokyo, Japan); Masataka Wada, Shiori Honda, Mayuko Takano and Shinichiro Nakajima (Keio University School of Medicine, Japan); Masaki Sekino (The University of Tokyo, Japan); Yoshihiro Noda (Keio University School of Medicine, Japan)

While repetitive transcranial magnetic stimulation (rTMS) is effective in patients with treatment-resistant depression, individual differences in treatment effects are significant. Therefore, prediction of treatment response in advance is important. However, the lack of magnetic resonance imaging (MRI) data linked to the rTMS intervention has hindered the improvement of prediction accuracy. This study proposes methods to predict efficacy with high accuracy even with a small number of the data with rTMS intervention using an external open brain imaging database that includes non-intervention data. We implemented and validated two methods, clustering-based label addition and correlation-based feature selection, and found that the clustering-based method showed improved accuracy compared to the conventional method without using external data.

#3

Spatial Changes of the Default Mode Network During the First Six Months of Life

Masoud Seraji (TReNDS Center & University of Texas at Austin, USA); Sarah Shultz (Emory University, USA); Zening Fu (TReNDS, Georgia State University, USA); Armin Iraji (Georgia State University, USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA)

Our study involving 158 infants suggests that the default mode network (DMN) undergoes a reduction in spatial map variation as they grow older. This implies a decrease in the extent of changes and fluctuations in brain activity distribution and configuration within the DMN over time. In other words, the DMN becomes more established and less variable over the course of development.

#4

Spatial Propagation of Brain Network in Resting fMRI Data

Biozid Bostami (Georgia Institute of Technology & Georgia State University, USA); Vince Calhoun (Tri-Institutional Research Center in Neuroimaging and Data Science, USA); Armin Iraji (Georgia State University, USA)

Neural activity propagates coherently across the brain to process information. There has been much effort in understanding how spontaneous neural activity evolves in resting-state functional magnetic resonance imaging (rsfMRI). However, studies have not examined the spatial propagation in large-scale network patterns that evolve over time. This study will explore how the default mode network (DMN) propagates and whether the different spatial dynamic states contain significant information. We proposed a lagged windowed correlation approach to capture multiple propagating states in DMN. Results reveal multiple spatiotemporally varying DMN patterns. Statistical tests show that a subset of these vary in patients with schizophrenia. This study provides a framework for a comprehensive study of brain network propagation.

#5

Lung Pleura Classification Integrating Shallow and Deep Learning

Ivar V. Belizario and Alexandre T. Fabro (University of São Paulo, Brazil); Paulo M Azevedo-Marques (University of São Paulo & Ribeirão Preto Medical School, Brazil); Agma J. M. Traina (University of Sao Paulo, Brazil)

This work presents a method based on artificial intelligence for the classification of the pleura in lung histopathology (LH) images, which is aimed at helping the physicians in diagnostic tasks. First, regions of interest (ROIs) were segmented. Next, deep learning (DL) and traditional machine learning (ML) models were trained on the ROI information to provide the classification more precisely

#6

Analysis of the Complexity of the Spine's Vertebrae for the Diagnosis of Fragility Fractures

Thiago F. C. da Fonseca (Federal University of Rondônia, Brazil); Jamilly G. Maciel (University of Sao Paulo, Brazil); Marcello Nogueira-Barbosa (University of São Paulo, Brazil); Caetano Traina-Jr and Agma J. M. Traina (University of Sao Paulo, Brazil); Carolina Y. V. Watanabe and Jonathan S. Ramos (Federal University of Rondônia, Brazil)

Degenerative bone diseases, such as Osteopenia and Osteoporosis, collaborate with the emergence of Vertebral Fragility Fractures (VFF). Studies using artificial intelligence models show excellent results in the prediction/diagnosis of these fractures. However there are still issues to be investigated, such as the impact of the Regions of Interest (ROI) on the performance of these models, which is the target of this work.
Clinical Relevance - Today, the diagnosis of VFFs is carried out based on the analysis of Bone Mineral Density (BMD) from the Double X-Ray Absorptiometry (DXA) exam, a technique considered the gold standard, however reaches only 50% of sensitivity on the diagnosis of said disease. By analyzing the impact of ROIs on the performance it is possible to reduce extraction details, increasing efficiency and reducing effort.

#7

Tube-Load Modeling of Aorta with Abdominal Aortic Aneurysm

Donghyeon Kim (University of Maryland, USA); Divyesh Narayanan (University of Pittsburgh, USA); Jin-Oh Hahn (University of Maryland, USA); Hao-min Cheng and Chen-Huan Chen (National Yang Ming Chiao Tung University, Taiwan); Shih-Hsien Sung (National Yang-Ming University, Taiwan); Chang-Sei Kim (Chonnam National University & School of Mechanical Engineering, Korea (South)); Ramakrishna Mukkamala (University of Pittsburgh, USA)

This paper investigates the potential of tube-load model in classifying patients with abdominal aortic aneurysm (AAA) before and after endovascular aortic repair (EVAR). We analyzed carotid and femoral artery tonometry waveforms collected from 43 AAA patients before and after EVAR. The results indicated that pulse transit time and reflection coefficient inferred for pre- vs. post-EVAR by fitting a tube-load model to pre- vs. post-EVAR tonometry waveforms were significantly different ($p<0.05$).

#8

Abdominal skin temperature measurements taken during sleep as a simpler alternative to monitor basal body temperature rhythm

Yoshinobu Murayama, Hikaru Sato and Hiroto Igari (Nihon University, Japan)

Measurement of basal body temperature is an important means of monitoring the menstrual cycle and ovulation rhythm in women. However, to accurately measure the basal body temperature, a woman must remain at rest in bed after waking up and wait for at least 5 minutes with the tip of a thermometer inserted under the tongue. If their basal body temperature can be measured automatically during sleep without them being conscious of it, they will be free from the cumbersomeness of measurements, enabling them to monitor their health more easily. It was previously reported that the menstrual cycle and ovulation rhythm can be monitored by measuring wrist, finger, and tympanic temperatures using wearable devices. In the present study, we focused on abdominal skin temperature (AST) and demonstrated that automatic measurement of AST over time using a wearable device shows a temperature rhythm that is not significantly different from that obtained using the conventional method of sublingual measurement and that it can determine the date of transition from the low-temperature to the high-temperature phase with comparable accuracy.

#9

The Effect of Sensor Location on Estimation of Spatiotemporal Parameters of Gait

Julian Low, Jessica Xu, Kristen Seballos, Jose Garcia, Gabriel Botero, Lauren Parola and Eni Halilaj (Carnegie Mellon University, USA)

Gait analysis is valuable for the assessment of people with mobility limitations. Wearables, like inertial measurement units (IMUs), offer a scalable alternative to current laboratory-bound tools, but questions on optimal sensor locations currently limit data interpretation across clinical studies. We, therefore, investigated the accuracy of gait spatiotemporal parameters estimated with IMUs placed at different body locations. Walking data from five subjects were collected with IMUs, optical motion capture, and commercial devices (Apple Watch and iPhone). We found that IMU location had a significant effect on accuracy. Most temporal parameters were estimated with high accuracy. For velocity, IMUs closer to the center of mass were more accurate.

#10

Exploring Oscillation Area Variations in Oscillometric Blood Pressure Measurement

Vishaal Dhamotharan (University of Pittsburgh, USA); Hao-min Cheng (National Yang Ming Chiao Tung University, Taiwan); Chen-Huan Chen and Shih-Hsien Sung (National Yang-Ming University, Taiwan); Cederick Landry (University of Sherbrooke, Canada); Mark Freithaler, Sanjeev G Shroff, Aman Mahajan and Ramakrishna Mukkamala (University of Pittsburgh, USA)

A mathematical model was formulated to establish the relation between area oscillations and external pressure. The model-derived formula for the peak of the area oscillations predicts the measured data with a correlation coefficient of 0.88. Clinical Relevance- The formula for the peak position of the area oscillations may help improve blood pressure estimation accuracy

#11

Diagnostic Features in Compressed Physiological Data Using Persistent Homology

Xiaoxiao Sun and Paul Sajda (Columbia University, USA)

Persistent Homology (PH) is a robust method in computational topology for data compression and feature extraction. Yet to be explored is how PH can be used on physiological time series, such as wearable sensing data, potentially enabling more compact data representations for health monitoring and prediction. In this study, we investigate the application of PH as a feature extraction technique to effectively reduce data storage while maintaining and even enhancing prediction performance. Our experiments demonstrate that PH can effectively capture essential multi-scale topological structures inherent to the physiological signal using a low-dimensional representation that is more efficient than PCA. Furthermore, when we evaluate, using machine learning models, the reduced representation constructed by PH we find the predictive accuracy of these models is comparable to, and in some cases, even superior to, those trained in the original high dimensional space. The findings of this study highlight the potential of using PH as a feature extraction technique that simultaneously deals will the challenge posed by the storage of the continuous time series of wearable sensing data.

#12

Combining recurrent and convolutional neural networks for muscle surrogate modeling

Bogdan Milicevic (University of Kragujevac & Bioengineering Research and Development Center BioIRC, Serbia); Milos Ivanovic and Boban Stojanovic (University of Kragujevac, Faculty of Science, Serbia); Miljan Milosevic (Bioengineering Research and Development Center BioIRC & Metropolitan University Belgrade, Serbia); Vladimir Simic and Milos Kojic (Bioengineering Research and Development Center BioIRC, Serbia); Nenad Filipovic (University of Kragujevac, Serbia)

The muscle model developed by Huxley is applicable to the modeling of non-uniform contractions. This model's primary shortcoming is that it requires a significant amount of processing power, particularly when applied to multi-scale finite element simulations. To resolve this, we created surrogate models of Huxley's muscle model, which imitate it but use less computational time and memory. Our surrogate models are constructed using recurrent and convolutional neural networks. A time series consisting of muscle activation, stretch, stress, and instantaneous stiffness in previous time steps was used as an input to our neural networks. Once the network is successfully trained, it predicts stress and instantaneous stiffness for the current time step, of finite element analysis, based on the input time series. Based on achieved similarities between original and surrogate model, along with achieved speed-up, it can be concluded that our model can be used as a replacement of Huxley's muscle model. To demonstrate the potential of our surrogate models we simulated cardiac cycle of echocardiography-based left ventricle model.

#13

Ophthalmic Segmentation and Analysis Software for manual and semi-automatic analysis of clinical meibography images

Ved Shivade, Naomi Joseph, Jiawei Chen, Ian Marshall and David Wilson (Case Western Reserve University, USA); Dominique Jennings (BlueRock Therapeutics, USA); Thomas Stokkermans and Harry Menegay (Case Western Reserve University, USA); Emma Avery (Cornea Image Analysis and Reading Center, USA); Ramkumar Ramamirtham (Novartis Institutes for Biomedical Research, USA); Beth Benetz (Case Western Reserve University, USA)

Meibomian Gland Dysfunction (MGD) is the prevalent cause of dry eye disease and a result of gland atrophy. The current 0-5 Pult-grade used to quantify MGD is subjective. OASIS (Ophthalmic Segmentation and Analysis Software) is an interactive Python application, combining Attention U-Net for eyelid and gland segmentation with manual editing and metric calculation. OASIS reduces analysis time by 67-75% while achieving high dice metrics for glands (0.78) and eyelids (0.91).

#14

Source Imaging of Epileptogenic Zone from Scalp EEG pSpikes

Colton B Gonsisko, Zhengxiang Cai and Xiyuan Jiang (Carnegie Mellon University, USA); Boney Joseph and Gregory Worrell (Mayo Clinic, USA); Bin He (Carnegie Mellon University, USA)

This work highlights noninvasive source localization performance in a group of 222 spikes from 12 patients using interictal spikes with riding high-frequency oscillations Using the fast spatiotemporal iteratively reweighted edge sparsity (FAST-IRES) method, we achieve estimations that are highly concordant with the successful resection. This holds clinical relevance as pSpikes could be a potential biomarker for epilepsy.

#15

Spatial Statistics for Analysis of Subcellular Patterns

Hugh M Galloway (University of Pittsburgh, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

This work proposes a systematic evaluation of spatial statistics for characterizing subcellular structures in single molecule spatial transcriptomics datasets. These subcellular patterns are then analyzed with respect to tumor structures in the nanoString CosMx liver cancer dataset to draw connections between subcellular organization and cellular patterns in tumors. This provides a novel link between the subcellular organization of individual molecules and biology at the level of an entire tissue.

#16

CASTpFold: Computed atlas of surface topography of proteins

Bowei Ye (Univ of Illinois at Chicago, USA); Wei Tian (Salk Institute for Biological Studies, USA); Boshen Wang and Jie Liang (University of Illinois at Chicago, USA)

Characterizing geometric and topological properties of protein structures to quantify surface pockets, interior cavities, and cross channels can aid in understanding the functional roles of proteins. Over the years, the Computed Atlas of Surface Topography of proteins (CASTp) web server has played an important role in offering online services to locate, delineate, and quantify these essential features since its inception in 2003. Here we present the CASTpFold server, which continues to provide reliable and comprehensive identifications and quantifications of protein topology. In addition, it now provides (I) Enlarged Database incorporating Alphafold2

Predicted Protein Structures, (ii) Protein function prediction and functional site prediction, and (iii) Pockets similarity search, which allows users to explore and compare surface pockets across different protein structures (see http://sts.bioe.uic.edu/castp/ and updates).

#17

Sampling Rate Requirement for Accurate Calculation of Heart Rate and Its Variability Based on the Electrocardiogram

Yuanyuan Zhou (University of Maryland, USA); Bryndan Lindsey (Johns Hopkins Applied Physics Laboratory, USA); Samantha Snyder and Elizabeth Bell (University of Maryland, USA); Lucy A. Reider (Johns Hopkins Applied Physics Laboratory, USA); Michael F Vignos and Eyal Bar-Kochba (Johns Hopkins University Applied Physics Laboratory, USA); Jesse Parreira and Azin Mousavi (University of Maryland, USA); Casey Hanley (Johns Hopkins Applied Physics Laboratory, USA); Jae Kun Shim and Jin-Oh Hahn (University of Maryland, USA)

We present analytical formulas to aid the selection of the electrocardiogram (ECG) sampling rate to calculate heart rate (HR) and heart rate variability (HRV) with a desired level of accuracy: (i) one relating HR and sampling rate to a bound on HR error and (ii) the other relating sampling rate to a bound on HRV error. We validated the formulas using experimental data collected from 58 young healthy volunteers. The results suggest the validity of the analytical formulas and their tightness. Hence, the analytical formulas may guide in selecting sampling rates for the ECG tailored to various applications of HR and HRV.

#18

Development of a One Dollar Blood Pressure Monitor

Yinan Xuan and Ava Fascetti (University of California San Diego, USA); Colin Barry and Edward J Wang (University of California San Diego & Billion Labs Inc., USA)

BPClip is an ultra-low-cost cuffless blood pressure monitor. As a universal smartphone attachment, BPClip leverages the computational imaging power of smartphones to perform oscillometry based blood pressure measurements. This paper examines different design considerations in BPClip's development. The cost and accuracy of blood pressure measurements are the central design goals. Both of these requirements are achieved with the initial prototype that achieves a $0.80 USD material cost and a mean absolute error of 8.72 and 5.49 mmHg for systolic and diastolic blood pressure, respectively. Since a main motivator to develop BPClip is making blood pressure monitoring more accessible, usability is also central to the design. User studies were conducted throughout the design process to inform the most intuitive and accessible design features. In this paper, we demystify the design process to share effective design practices with future developers working towards expanding health monitoring access beyond traditional clinical settings.

#19

Study the Combination of Brain MRI Imaging and Other Datatypes to Improve Alzheimer's Disease Diagnosis

Jonathan W Stubblefield, Alan Kronberger, Jason Causey, Jake Qualls and Jennifer Fowler (Arkansas State University, USA); Kaiman Zeng (Arkansas Tech University, USA); Karl Walker (University of Arkansas Pine Bluff, USA); Xiuzhen Huang (Arkansas State University, USA)

Alzheimer's Disease (AD) is a degenerative brain disease and is the most common cause of dementia. Despite being a common disease, AD is poorly understood. In this study, we evaluated models on the data provided by the Alzheimer's Disease Neuroimaging Initiative (ADNI). Experiment results show that models using multiple data types have the potential to serve as valuable diagnostic tools for patients with suspected AD.

#20

Non-Dermoscopic Skin Lesion Analysis: Enhanced Diagnostic

Yempabe Noupokou (USA); Paul L. Bigliardi (University of Minnesota, USA)

This paper proposes the integration of hyperspectral imaging and a deep learning architecture for skin lesions analysis. By leveraging the detailed information harnessed from hyperspectral imaging in form of data cubes, convolutional neural networks can be used to extract discriminative features, identify specific compounds and materials therefore enhancing clinical decision-making in dermatology

#21

Development of HRnV-Calc for heart rate variability analysis

Chenglin Niu, Dagang Guo, Garion Koh, Marcus Ong and Nan Liu (Duke-NUS Medical School, Singapore)

We developed the HRnV-Calc software for heart rate variability (HRV) and heart rate n-variability (HRnV) metrics analysis and calculation. HRnV-Calc was built upon the PhysioNet Cardiovascular Signal Toolbox (PCST), a widely used open-source toolbox. This software is designed to facilitate collaborative investigations between clinicians and researchers to study HRnV in various contexts and applications.

#22

Predicting Ythdf2-mediated mRNA Degradation By m6A-BERT

Tinghe Zhang and Sumin Jo (University of Pittsburgh, USA); Jianqiu Zhang (University of Texas at San Antonio, USA); Shou-Jiang Gao (University of Pittsburgh Medical Center, USA); Yufei Huang (University of Pittsburg Medical Center, USA)

N6-methyladenosine (m6A) is the most abundant mRNA modification in mammalian cells. It plays a critical role in regulating RNA degradation by recruiting reader protein, particularly YTHDF2. However, YTHDF2 binding to m6A site alone is insufficient to induce decay of the methylated mRNA. Determining if YTHDF2-binding would result in mRNA decay is still an open question. To address this question, we developed a computation tool for predicting YTHDF2-medicated m6A degradation. To capture comprehensive m6A context from RNA sequence, we employed a pretraining step using the BERT model on single-based m6A sequences, which we named m6ABERT. Subsequently, we finetuned m6ABERT to predict YTHDF2-mediated degradation. In comparison to existing methods, our model achieved at least a 2.6% improvement in accuracy, a 1.5% improvement in AUC, and a 0.05 improvement in the MCC.

#23

Predicting Intraocular Pressure using Highly Nonlinear Solitary Waves and Machine Learning

Madison Hodgson, Samuel J Dickerson and Piervincenzo Rizzo (University of Pittsburgh, USA)

Treatment personalization makes it possible for patients to receive the best possible care. One of the primary methods for continuous patient monitoring, which rose in popularity due to the COVID-19 pandemic, is at-home testing. Current at-home tonometers assume a single, standard cornea thickness, not individualized cornea features from the patient. However, the cornea thickness is a distinct factor that directly impacts the intraocular pressure (IOP). Using the device proposed in this work, IOP is measured using a highly nonlinear solitary wave (HNSW) transducer, a method that has never been used in tonometry before. Features of the solitary wave change with IOP and can be represented as a spectrogram, allowing the two primary characteristics of the wave, the time of flight (ToF) and frequency, to be visualized. The spectrogram is then fed into a Convolutional Neural Network (CNN) which predicts the estimated IOP and conveys this pressure back to a software application that is accessible to physicians. This paper aims to demonstrate the viability of using a combination of HNSW transducers, a CNN and spectrograms to make accurate IOP predictions.

#24

Remote and Continuous Assessment of Exercise Capacity in Pulmonary Arterial Hypertension with a Wrist-Worn Accelerometer

Federico Parisi (Janssen Research & Development, USA); Rana Zia Ur Rehman (Janssen Research & Development, United Kingdom (Great Britain)); Meenakshi Chatterjee (Janssen Research & Development, USA); Nikolay V Manyakov (Janssen Pharmaceutica, Belgium); Tarik Yardibi, Mona Selej, Preston Dunnmon and Tommaso Mansi (Janssen Research & Development, USA); Dzmitry A Kaliukhovich (Janssen Pharmaceutica, Belgium)

Reduced exercise capacity in patients with pulmonary arterial hypertension (PAH) is associated with poor quality of life and decreased survival. Existing clinical assessments such as the 6-minute walk distance (6MWD) test only provide a snapshot in time of patients' exercise capacity and require in-person visits. Here we examined convergent validity and test-retest reliability of multiple metrics derived from a wrist-worn accelerometer and intended for monitoring exercise capacity in patients with PAH. Our results show that the examined metrics can continuously and robustly capture daily physical activity of patients with PAH, have high test-retest reliability, and correlate with the 6MWD.

#25

Dissection of the characteristics of the Tumor Microenvironment Using High-Resolution Spatial Transcriptomics

Karla D Paniagua, Yufang Jin and Mario Flores (University of Texas at San Antonio, USA)

We present a deep learning (DL) approach for dissecting the tumor microenvironment using single-cell spatial transcriptomics data. Our DL approach captures the relationship across gene expression levels, morphology images, cell types, and the spatial context of cells. Results show the effectiveness of the proposed DL approach to identify different niches spatially for potential tumor microenvironment.

#26

Multiple Simultaneous Exercise Monitoring and Classification Using a mmWave FMCW Radar

Victor G. Rizzi Varela and Changzhi Li (Texas Tech University, USA)

This work presents a radar-based physical activities monitoring strategy using only a monostatic radar. The objective is to detect, classify, and count the repetitions of multiple human subjects doing different exercises simultaneously in the radar's field of view, providing a solution to enhance the performance of athletes using a lightweight, low cost and small wireless sensor. The experiments also present static and moving clutters to approximate the detection to a real scenario.

#27

A Transfer Function Method to Improve the Reproducibility of Valsalva Maneuver Responses

Mahdi Jazini (University of Pittsburgh, USA); Sila Yavan and Alyssa Smith (University of Pittsburgh Medical Center, USA); Cederick Landry (University of Sherbrooke, Canada); Ramakrishna Mukkamala and Alisse Hauspurg (University of Pittsburgh, USA)

The Vasalva maneuver (VM) tests cardiovascular function but is not very reproducible. We developed a transfer method and showed that it could improve reproducibility of VM responses from 7±18% to 5±5% in 31 patients (150 trials). The transfer function method could help increase the use of the VM in clinical practice.

#28

A machine learning pipeline to evaluate resting-state EEG features in the prediction of recovery from neurological disorders

Michael Lassi and Andrea Bandini (Scuola Superiore Sant'Anna, Italy); Stefania Dalise and Carmelo Chisari (University Hospital of Pisa, Italy); Alberto Mazzoni (Scuola Superiore Sant'Anna, Italy); Silvestro Micera (Scuola Superiore Sant'Anna, Italy & EPFL, Switzerland)

EEG is a valuable tool to assess brain function after a neurological disorder occurs. However, limited validation of quantitative EEG biomarkers is available using completely data-driven tools. Here, we present a machine learning pipeline that extracts candidate predictive markers of the recovery after brain injury, selects the most predictive ones, feeds them into a cross-validated and optimized model and gives estimate of the future recovery. We demonstrate its use in the context of stroke recovery.

#29

Pulsed Field Ablation Efficiency with Nanosecond Pulses

Vincent Yi (Ocean Lake High School, Virginia Beach, USA); Mohammad Shahab Uddin and Shu Xiao (Old Dominion University, USA)

Electrical pulsed field ablation (PFA) is a versatile and minimally invasive technique that holds great potential for ablating various types of unwanted tissues, including cancers. In this study, we focused on using a plant tissue model (Yukon Gold potato) and two-needle electrodes to investigate the characteristics of ablation zones produced by three different pulse waveforms: IRE (unipolar 100 µs), bipolar nsEP (±300 ns), and unipolar nsEP (300 ns). This study aims to investigate the influence of pulse waveforms on the size of tissue ablation, the homogeneity of the ablation, and the presence of a distinct boundary of the ablation area.

#30

Spectral Image Classification for Arrhythmia Detection with Wearable Electrocardiogram

Bill Chen, Md Mobashir Hasan Shandhi, Amanda Breton, Ke Wang, Jiamu Yang, Lauren Arney, Sean Pokorney and Jessilyn Dunn (Duke University, USA)

Utilizing computer vision models with time-frequency transformation of electrocardiogram (ECG) signals, we can develop efficient automated remote arrhythmia classification algorithms using real-world ECG datasets. Clinical Relevance-Simple computer vision models demonstrated effective performance in arrhythmia detection.
Combining wearable Holter monitors with recent advancements in convolutional neural networks (CNNs) holds promising potential for detecting cardiac arrhythmia in remote settings. While recent studies have explored various CNN architectures, there remains a gap in understanding the impact of transfer learning on both model performance and the generated feature space, particularly within real-world datasets where these systems are most likely to be implemented.

#31

Hypertension Detection in Pregnancy Using One-Dimensional Doppler Ultrasound: Exploring Fetal-Maternal Blood Flow

Nasim Katebi and Gari D Clifford (Emory University, USA)

Accurate measurement of blood pressure (BP) during pregnancy is crucial for effective antenatal care, particularly in identifying conditions such as hypertension and preeclampsia. However, the conventional methods of manual auscultation and oscillometric cuff measurements, although accurate when performed correctly, are prone to errors when used by non-experts. Additionally, arterial occlusion is hard to ignore, and this makes them unsuitable for continuous monitoring, and relying on infrequent measurements from cuff-based methods may lead to highly biased results, based on the sampling. To address these challenges, we present a novel and affordable approach to non-invasive hypertension detection during pregnancy using a one-dimensional Doppler- based method. Our study included 326 five-minute Doppler recordings and paired blood pressure measurements from both arms, collected using an Omron M7 oscillometric cuff in a supine position, from the indigenous Mayan population. To accurately classify hypertension in pregnancy, we developed a deep learning model using supervised contrastive learning. The model achieved an area under the receiver-operator curve (AUC) of 0.78 through five-fold cross-validation.

#32

DC PPG to Improve the Accuracy of the Oscillometric Finger Pressing Method for Smartphone-Based Blood Pressure Monitoring

Mark Freithaler and Hadi Daher (University of Pittsburgh, USA); Cederick Landry (University of Sherbrooke, Canada); Vishaal Dhamotharan (University of Pittsburgh, USA); Anand Chandrasekhar (Michigan State University, USA); Sanjeev G Shroff and Ramakrishna Mukkamala (University of Pittsburgh, USA)

We hypothesized that DC PPG from oscillometric finger pressing may be useful for computing blood pressure (BP). A DC PPG derived fiducial marker, collected from 18 subjects, correlated well (r=0.87) with arm cuff systolic BP. This is clinically relevant because DC PPG enhanced smartphone-based BP measurement may lead to ubiquitous BP monitoring.

#33

The Smartphone-Based Oscillometric Finger Pressing Method: Modeling Finger Artery Viscoelasticity For Improved Blood Pressure Computation

Cederick Landry (University of Sherbrooke, Canada); Mark Freithaler, Vishaal Dhamotharan, Sanjeev G Shroff and Ramakrishna Mukkamala (University of Pittsburgh, USA)

A Hammerstein model was used to model finger artery viscoelasticity during oscillometric finger pressing. The model parameters were identified with 10 participants and exhibited important viscoelastic properties. The model was used to evaluate typical oscillometric BP computation algorithms and showed potential underestimation of systolic BP. Clinical Relevance- This model can potentially be used for accurate oscillometric finger BP computation algorithms.

#34

Sequential Inference of Hospitalization Electronic Health Records Using Probabilistic Models

Alan D Kaplan (Lawrence Livermore National Laboratory, USA); Priyadip Ray (IIT Kharagpur, USA); Vincent X. Liu and John D. Greene (Kaiser Permanente Division of Research, USA)

In the dynamic hospital setting, decision support can be a valuable tool for improving patient outcomes. Data-driven inference of future outcomes is challenging in this dynamic setting, where long sequences such as laboratory tests and medications are updated frequently. This is due in part to heterogeneity of data types and mixed-sequence types contained in variable length sequences. In this work we design a probabilistic unsupervised model for multiple arbitrary-length sequences contained in hospitalization Electronic Health Record (EHR) data. The model uses a latent variable structure and captures complex relationships between medications, diagnoses, laboratory tests, neurological assessments, and medications. It can be trained on original data, without requiring any lossy transformations or time binning. Inference algorithms are derived that use partial data to infer properties of the complete sequences, including their length and presence of specific values. We train this model on data from subjects receiving medical care in the Kaiser Permanente Northern California integrated healthcare delivery system. The results are evaluated against held-out data for predicting the length of sequences and presence of Intensive Care Unit (ICU) in hospitalization bed sequences. Our method outperforms a baseline approach, showing that in these experiments the trained model captures information in the sequences that is informative of their future values.

#35

Learning Seismocardiogram Beat Denoising Without Clean Data

Mohammad Nikbakht (Georgia Institute of Technology, USA); David Lin (Georgia Tech, USA); Omer T Inan (Georgia Institute of Technology, USA)

Noninvasive monitoring of cardiovascular health plays a crucial role in predicting risks and reducing mortality rates, especially in the context of trauma care. The seismocardiogram (SCG) in particular is a noninvasive signal that has been shown to monitor key health parameters related to blood volume loss estimation, suggesting its ability to guide trauma care intervention. Robust extraction of features from SCG signals in noisy environments is challenging due to low signal-to-noise (SNR) ratios. In addition, lack of access to clean ground truth signals makes developing denoising algorithms even more difficult. In this work, we propose a novel deep learning-based approach for denoising SCG signals without requiring access to clean ground truth signals. Experimental results showed (1) enhancement in the signal-to-noise ratio (SNR) (approximately 10 dB and 9 dB increase for AO and AC regions of -10 dB SNR beats respectively), and (2) improvements in feature extraction accuracy (approximately 3x and 1.5x for AO and AC features of -10 dB SNR beats respectively) using the denoising model. Thus, the model effectively reduces noise, and improves the quality of SCG signals, leading to improved accuracy in feature extraction in noisy environments. This is a promising step forward in improving the quality and utility of SCG signals for clinical and research purposes.

#36

Brain Biopsy Imaging using Electrical Impedance Tomography (BBI-EIT)

Arjun B s, Varun Canamedi and Sharmila Sree Vandrangi (Indian Institute of Science, Bangalore, India); Hardik J. Pandya (Indian Institute of Science Bangalore, India)

The article presents the development of a novel approach for brain biopsy imaging and characterization leveraging Electrical Impedance Tomography for margin assessment (BBI-EIT). BBI-EIT performs near real-time and non-destructive imaging of tissue samples that can map tissue heterogeneity based on their distinct electrical properties. The paper outlines the technical specifications, functional details, and comparison of the imaging results with gold-standard histopathology demonstrating its efficacy and potential for evaluating tissue heterogeneity and margin assessment. Clinical Relevance- The technique is proposed as an adjunct to current intraoperative assessment techniques such as frozen section and histopathological examination to see if the tumor margin has been achieved. Intraoperative integration of the BBI-EIT would allow surgeons to accurately identify and demarcate cancerous tissues during surgery, resulting in improved surgical outcomes and reduced patient morbidity. The technology could reduce the likelihood of leaving residual cancer cells behind, decreasing recurrence rates and improving patient outcomes. The BBI-EIT can potentially reduce the time required to identify and remove tumors during surgery by providing real-time imaging. This could decrease the duration of surgical procedures, which is beneficial as longer surgeries often have higher risks of complications.

#37

Temporal Phenotype Matrix Engineering for Electronic Health Records - Enhancing Coronary Artery Disease Prediction

Kuan-Hui Liu (Institute of Data Science and Engineering & National Yang Ming Chiao Tung University, Taiwan); Cheng-Yu Chiang (National Central University, Taiwan); Hsin-Yao Wang (Chang Gung Memorial Hospital at Linkou, Taiwan); Yi-Ju Tseng (National Yang Ming Chiao Tung University, Taiwan & Boston Childrens Hospital, USA)

Electronic health records (EHRs) often exhibit sparsity and irregularity due to their inherent nature. It is crucial to consider that imputation and aggregation techniques used during EHRs preprocessing can introduce artificial and unrealistic data and potentially leading to the loss of critical information. In this study, we proposed a temporal phenotype matrix engineering approach with auxiliary data layer (ADL) to extract important hidden information from EHRs. Our proposed approach was applied to the early prediction of coronary artery disease (CAD), one of the leading causes of death worldwide. We evaluated the performance of the LSTM, CNN, and TCN models on the CAD prediction task. Upon applying our proposed matrix engineering technique with ADL, we observed a substantial improvement, with an AUROC (area under the receiver operating characteristic) score of 0.919 ± 0.006 (a 10% increase, compared to when no ADL was included, 0.831 ± 0.011) in CNN model. In conclusion, this study highlights the benefits of the proposed temporal phenotype matrix engineering approach with ADL to address the sparsity and irregularity inherent in EHRs data. Our findings underscore the potential of the proposed temporal phenotype matrix engineering approach with ADL for enhancing the early prediction of CAD, thereby contributing to improved patient outcomes and reduced mortality rates.

#38

On Training Model Bias of Deep Learning based Super-resolution Frameworks for Magnetic Resonance Imaging

Mamata Shrestha and Ukash Nakarmi (University of Arkansas, USA); Nian Wang (Indiana University, USA)

Super-resolution is an important technique in various fields, particularly in medical imaging, where it plays a crucial role in understanding and analysis of complex, qualitative, and quantitative characteristics of tissues at high resolutions. However, obtaining high-resolution images often faces practical limitations pertaining to acquisition device limitations, patient motion, or longer acquisition times. The remarkable success of deep learning methods has recently opened doors to their application in image super-resolution tasks as well. These deep learning-based methods heavily rely on a substantial amount of data, which is often unavailable, especially in the case of Magnetic Resonance Imaging (MRI) scans. Particularly in magnetic Resonance super-resolution, it is often impossible to have low-resolution and high-resolution training image pairs. To address this, deep learning approaches simulate low-resolution images using many image degradation methods mimicking low-resolution images to create training image pairs from the available few high-resolution images. However, models trained on specific degradation simulations exhibit bias, leading to poor performance in real-world scenarios. In this paper, we hypothesize that such deep learning models trained on specific training image pairs with a specific degradation model are biased, we systematically study such biases with different types of degradation, different deep learning frameworks, and training losses. Finally, we advocate ensuring the diversity of degradation models to generate training image pairs controls such biases resulting in a more robust learning framework for MR image super-resolution.

#39

Attention-Based CNN Model for Burn Severity Assessment

Saeka Rahman, Miad Faezipour and Guilherme Aramizo Ribeiro (Purdue University, USA); Elika Ridelman (Childrens Hospital of Michigan Wayne State University, USA); Justin D. Klein (Wayne State University, USA); Beth A. Angst and Christina M. Shanti (Childrens Hospital of Michigan Wayne State University, USA); Mo Rastgaar (Purdue University, USA)

Visual inspection, along with physical examination, is the traditional method to assess burns. However, burn-care providers have different levels of experience and may face challenges in assessing the depth and severity of the wounds. The challenges associated with the traditional approach, such as poor and varying diagnosis/prognosis accuracy, have inspired researchers towards automated burn assessment to ensure effective burn wound management. The current research aims to improve automatic burn wound assessment. It provides an ordered scoring scale to measure burn severity using four characteristics: inflammation, scar, uniformity, and pigmentation. The research also proposes an attention-based Convolutional Neural Network (CNN) model to assess the characteristics of burn wounds. The model is evaluated with 2D color images to assess levels of inflammation, scar, uniformity, and pigmentation with two different datasets, and the performances are compared with other models. The attention mechanism of the deep learning model selectively focuses on salient parts of the image to improve the understanding of the visual structure and enhance the classification accuracy. The proposed work outperforms most prior related work, achieving 93% in average accuracy. Clinical relevance - This research has significant clinical relevance in assisting accurate, reliable, and on-time diagnosis, treatment, and follow-up of burn wounds and thereby, provides effective burn wound management.

#40

Adventitious Pulmonary Sound Detection Using XGBoost

Shiva Shokouhmand, Md Motiur Rahman, Miad Faezipour and Smriti Bhatt (Purdue University, USA)

Pulmonary illnesses and complications are annually reported as highly prevalent. Patient outcomes can, however, be improved through the aid of automated processes for early diagnoses. This study aims to develop an automated method for diagnosing underlying adventitious sounds in respiratory diseases using the data recorded from the lung auscultation process. For this purpose, stethoscope audio signal recordings are initially segmented to merely include either normal or adventitious sounds such as wheezing and crackling. A comprehensive feature set representing the temporal and spectral dynamics in the respiratory events is extracted to identify the respiratory condition. An extreme gradient-based boosting (XGBoost) model is used and evaluated on the ICBHI 2017 dataset recordings based on a five-fold cross-validation approach. Our predictive method suggests specificity, sensitivity, and ICBHI scores of 91.5%, 79.85%, and 85.67%, respectively, demonstrating superior results, outperforming the state-of-the-art techniques. It is also concluded that Mel-frequency cepstral coefficients (MFCC), spectral centroid, zero crossing rate, and signal intensity are the most consistent discriminating features within the adventitious sounds.

Clinical relevance - This work contributes to the development of advanced smart digital stethoscopes and respiratory monitoring systems that can be used in clinical, telemedicine and personalized healthcare settings for early detection of breathing disorders or pulmonary conditions.

#41

Multilayer Network Analysis of Brain Signals for Detecting Alzheimer's Disease

Sean M Nguyen, Mohammad Amin Basiri and Sina Khanmohammadi (University of Oklahoma, USA)

Human neuroimaging datasets provide rich multi-scale spatiotemporal information about the state of the brain. Most current methods, such as spectral analysis, focus on a single facet of these datasets and do not take full advantage of the inherited spatiotemporal information. Here, we consider a multilayer cross-frequency functional connectivity analysis to capture the complex spatiotemporal features of neural datasets at multiple scales and show that such features could potentially provide a better description of the neural activity. We demonstrate the effectiveness of this approach by applying the proposed method to capture disruptions of multilayer brain networks in Alzheimer's patients. More specifically, we compared the multi-scale features extracted from electroencephalogram (EEG) data with traditional features in a machine learning framework to distinguish Alzheimer's patients from control subjects. Our results show that such multi-scale features improve prediction accuracy compared to standard features.

#42

17:45 – 18:00
Awards & Closing Ceremony