# **Learning with Multimodal Data for Biomedical Informatics**

# *Special Issue Proposal for* *IEEE Transactions on Circuits and Systems for Video Technology*

**Motivation and Theme**

Fast-growing biomedical and healthcare data of multiple modalities have encompassed multiple scales ranging from molecules, individuals, to populations. With increasing sources, bandwidth, depth, and resolution, those data are becoming a key enabler for accelerating basic science discoveries and facilitating evidence-based clinical solutions. Meanwhile, the heterogenous and increasingly more diverse modalities of the data present major barriers toward their understanding, fusion, and translation into effective clinical actions. For example, electronic health records (EHRs) are representative examples of multimodal/multisource data collections; including not only measurements, but also images, videos, audios, and free texts. The diversity of such information sources and the increasing amounts of medical data produced by healthcare institutes annually, pose significant challenges. Other examples include mobile health for remote patient care, where typical data modalities include patient- or caregiver-generated photos, self-reported symptoms of pain, body temperature, and more. While biomedical and healthcare research traditionally focus on the structured measurement data, the growing availability of novel data modalities has created a compelling demand for novel machine learning, image/video/audio/text processing, and multi-modal fusion algorithms that specifically tackle the unique challenges associated with biomedical and healthcare data and allow decision-makers and stakeholders to better interpret and exploit the data.

Our proposed special issue aims at catalyzing synergies among image/video processing, text/speech understanding, machine learning, multi-modal learning and other related fields with the goals to (1) develop novel data-driven models to accelerate knowledge discovery in biomedicine through the seamless integration of medical data collected from imaging systems, laboratory and wearable devices, as well as other related medical devices; (2) promote the development of new multi-modal learning systems to enhance the healthcare quality and patient safety; and (3) promote new applications in biomedical informatics that can leverage or benefits from the integration of multi-modal data and machine learning.

**Relevance and Importance**

The above research has been blooming in the past year, as evidenced by an explosive number of papers in top tier journals and conferences. Here, we list three most notable special issues, that are related to our proposal:

* Special issue on Deep Learning for Medical Imaging and Health Informatics, Pattern Recognition Letters, 2019
* Special Issue on Machine Learning on Scientific Data and Information, MDPI Information, 2020
* Special Issue on Bioinformatics and Computational Biology, MDPI Cells, 2019

Compared to the existing above, we highlight a unique emphasis on multi-modal learning, and encourage the study of new data sources, modalities, and associated challenges & opportunities in biomedical informatics. It is worthy also mentioning that part of the editorial team has been involved in organizing **a serial workshop** with IJCAI with relevant topics: <https://www.ijcai-boom.org/>, from 2016 to 2020. During the past five years, the workshop has established its global reputation as a visible venue and research hub, among interdisciplinary field researchers with their common interests in machine learning for biomedical informatics. That makes the proposal team **well positioned** to develop and promote this special issue.

This proposed special issue will offer a timely collection of information to benefit the researchers and practitioners working in the broad research fields of biomedical informatics applications, signal and image processing, and machine learning community. All the aforementioned issues are covered by the Topic of Interest in **IEEE TCSVT**. To the best of our knowledge, there is not a special issue for this topic or significantly overlapped ones, in IEEE TCSVT or other IEEE transactions before. We are very confident that it will attract more than sufficient high-quality contributions from the community.

**List of Topics**

We welcome high-quality submissions with important new theories, methods, applications, and insights at the intersection of image/video processing, text/speech understanding, machine learning, multi-modal learning, and biomedical informatics. The topics of interest include, but are not limited to, the following inter-linked ones:

* Developing and applying cutting-edge machine and multi-modal learning techniques to tackle real-world medical and healthcare problems.
* Developing new machine learning approaches to improve the quantitative representation of high-dimensional medical images and videos for knowledge discovery in biomedicine
* Designing novel data-fusion methods to integrate multiple data sources and modalities for enhanced visualization, effective biomarker extraction, and optimal medical decision making.
* Addressing challenges and roadblocks in biomedical informatics with reference to the data-driven machine learning, such as imbalanced dataset, weakly-structured or unstructured data, noisy and ambiguous labeling, and more.
* Other closely related technical advances in image processing, video processing, audio processing, text understanding, and multi-modal fusion, with application potential in biomedical informatics.

Our applications of interest include but are not limited to: (1) Computational Biology, including the advanced interpretation of critical biological findings, using databases and cutting-edge computational infrastructure; (2) Clinical Informatics, including the scenarios of using computation and data for health care, spanning medicine, dentistry, nursing, pharmacy, and allied health; (3) Public Health Informatics, including the studies of patients and populations to improve the public health system and to elucidate epidemiology. (4) mobile Health Applications, including the use of mobile apps and wearable sensors for health management and wellness promotion; and (5) Cyber-Informatics Applications, including the use of social media data mining and natural language processing for clinical insight discovery and medical decision making.

**Tentative Timetable**

* Paper Submission: *October 15, 2020*
* First Notification: *December 15, 2020*
* Revised Manuscript: *January 30, 2021*
* Notification of Acceptance: *March 15, 2021*
* Final Manuscript Due: *April 30, 2021*

**Guest Editors:**

We highlight an **interdisciplinary** and **diverse** guest editor team, with gender & geolocation diversity; experience level variability from junior to senior; and complementary expertise from image/video processing, machine learning, medical imaging, bioinformatics, and healthcare modeling. All guest editors have strong prior experience in organizing special issues or other academic events.

* **Zhangyang Wang** is an Assistant Professor of Computer Science and Engineering (CSE), at the Texas A&M University (TAMU), from 2017 to 2020. Starting from August 2020, he will be an Assistant Professor with the University of Texas at Austin. During 2012-2016, he was a Ph.D. student in the Electrical and Computer Engineering (ECE) Department, at the University of Illinois at Urbana-Champaign (UIUC), working under Professor Thomas S. Huang. Dr. Wang’s research has been addressing machine learning, computer vision, image and video processing, as well as their interdisciplinary applications. He has co-authored over 100 papers and has received over 30 awards (including an ARO Young Investigator, an IBM faculty research award, an AWS machine learning research award, and a Young Faculty Fellow of TAMU, and more).

Dr. Wang has significant prior experience organizing special issues, tutorials and workshops. He frequently co-organized various workshops with CVPR, ECCV, ICCV, NeurIPS, and IEEE FG. In particular, he founded and has been co-organizing the IJCAI serial workshop on Biomedical Informatics with Optimization and Machine Learning (BOOM), from 2016 to 2020, whose audience is directly related to this proposed special issue. He was a tutorial speaker in SIAM Imaging Science 2018, CVPR 2017 and ECCV 2016. Dr. Wang is an **associate editor** of IEEE Transactions on Circuits and Systems for Video Technology (**TCSVT**), Springer-Nature [Cognitive Computation](https://link.springer.com/journal/12559), and IET Computer Vision. He also co-organized three journal special issues. He regularly serves as area chairs, TPC members and reviewers for leading machine learning and computer vision venues.

* **Vishal Patel** is an Assistant Professor in the Department of Electrical and Computer Engineering (ECE) at Johns Hopkins University. Prior to joining JHU, he was an A. Walter Tyson Assistant Professor in the Department of ECE at Rutgers University and a member of the research faculty at the University of Maryland Institute for Advanced Computer Studies (UMIACS). He completed his Ph.D. in Electrical Engineering from the University of Maryland, College Park, MD, in 2010, working under Prof Rama Chellappa. His current research interests include signal processing, computer vision, pattern recognition, multi-modal fusion, with applications in biometrics and medical imaging. He has received a number of awards including the 2016 ONR Young Investigator Award, the 2016 Jimmy Lin Award for Invention, A. Walter Tyson Assistant Professorship Award, Best Paper Award at IEEE AVSS 2017 & 2019, Best Paper Award at IEEE BTAS 2015, Honorable Mention Paper Award at IAPR ICB 2018, two Best Student Paper Awards at IAPR ICPR 2018, and Best Poster Awards at BTAS 2015 and 2016. He serves on the Machine Learning for Signal Processing (MLSP) Committee of the IEEE Signal Processing Society. He also serves as the Vice President (Conferences) for the IEEE Biometrics Council.  He is a member of Eta Kappa Nu, Pi Mu Epsilon, and Phi Beta Kappa.

Dr. Patel is an Associate Editor of the IEEE Signal Processing Magazine and the Pattern Recognition Journal. He has co-edited three journal special issues with high visibility: IJCV 2020 Special Issue on “Computer Vision for All Seasons: Adverse Weather and Lighting Conditions” (with D. Dai, R. T. Tan, J. Matas, B. Schiele and L. V. Gool); Pattern Recognition 2019 Special Issue on “Domain Adaptation for Visual Understanding” (with R. Singh, M. Vatsa, and N. Ratha); and Patter Recognition Letters 2017 Special Issue on “Video Surveillance-oriented Biometrics” (with C. Ding, K. Huang and B. C. Lovell).

* **Bing Yao** is an Assistant Professor from School of Industrial Engineering and Management, at Oklahoma State University. She received her Ph.D. degree in Industrial Engineering and Operations Research in 2019 from the Pennsylvania State University, and B.S. degree in Physics from University of Science and Technology of China in 2012. Her research focuses on the interdisciplinary modeling and optimization of complex systems. Specifically, her research interests include machine learning, data mining and multi-modal signal processing, in particular for applications in spatiotemporal complex systems, cardiac electrodynamics, smart health management. Her research is well recognized by several national and international research communities including best paper and poster awards at INFORMS and IISE annual Conferences. She chaired special session for multiple conferences.
* **Steve Jiang** received his Ph.D. in Medical Physics from Medical College of Ohio in 1998. After completing his postdoctoral training at Stanford University, he joined Massachusetts General Hospital and Harvard Medical School in 2000 as an Assistant Professor of Radiation Oncology. In 2007, Dr. Jiang was recruited to University of California San Diego as a tenured Associate Professor to build Center for Advanced Radiotherapy Technologies, for which he was the founding and executive director. He was then promoted to Full Professor with tenure in 2011. In October 2013, Dr. Jiang joined University of Texas Southwestern Medical Center as a tenured Full Professor, Barbara Crittenden Professor in Cancer Research, Vice Chair of Radiation Oncology Department, and Director of Medical Physics and Engineering Division. Dr. Jiang is a Fellow of Institute of Physics and American Association of Physicists in Medicine.

Dr. Jiang's research interest is on the development and deployment of artificial intelligence and image processing technologies to solve medical problems. He was the Local Arrangements Chair and Special Session Chair for the International Conference on Machine Learning and Application (ICMLA) in 2008 in San Diego. In early 2017, together with other 7 PIs, he established the Medical Artificial Intelligence and Automation (MAIA) Lab to innovate, develop, and apply AI technologies to solve important radiotherapy problems. In early 2018, he founded the Program of Excellence in Intelligent Medicine (PEIM) at UT Southwestern, a platform for interdisciplinary research collaborations among clinicians, biologists, and AI researchers. Dr. Jiang's research has been funded by federal, state, charitable, and industrial grants for over 15 million dollars, resulting in over 200 peer-reviewed journal papers with an H-index of 74.

* **Huimin Lu** is an Associate Professor in Kyushu Institute of Technology in Japan, and an Excellent Young Researcher of Ministry of Education, Culture, Sports, Science and Technology. He received the Ph.D. degree in Electrical Engineering from Kyushu Institute of Technology in 2014. From 2013 to 2016, he was a JSPS research fellow (DC2, PD, and FPD) at Kyushu Institute of Technology. His research interests include artificial intelligence, machine vision, internet of things and robotics. He has co-authored 100+ papers in peer-reviewed journals and conferences, including 7 ESI highly cited papers and 2 ESI hot papers. As the lead editor, he has edited 3 books. He has received 20+ awards and 20+ research grants.

Dr. Lu serves as an associate editor for IEEE Access, Applied Soft Computing, etc. He is the Leading Guest Editor for ACM/Springer Mobile Networks and Applications, Optics & Laser Technology, Multimedia Tools and Applications, Applied Soft Computing, among other. He is the General Co-Chair of ISAIR2016-2018, ROSENET2017-2020; the Program Chair of ISAIR2019-2020; the workshop Chair of ICPADS2016, TRIDENTCOM2017, ACPR2017, and ICIMCS2018. He co-chaired the IEEE Computer Society Big Data Special Technical Committee. He is a Fellow of European Alliance for Innovation (EAI) and Senior Member of The Institute of Electrical and Electronics Engineers (IEEE).

* **Yang Shen** is an Assistant Professor in the Department of Electrical and Computer Engineering and the Center for Bioinformatics and Genomic Systems Engineering at the Texas A&M University. He received his B.E. from the University of Science and Technology of China, Ph.D. in Systems Engineering from Boston University, and postdoctoral training in Biological Engineering at the Massachusetts Institute of Technology. His research interests are in optimization and learning algorithms for modeling biological molecules, systems, and data. Applications include protein docking, protein and drug design, systems and synthetic biology, and omics. He is an awardee of Maximizing Investigators’ Research Award (MIRA) from the National Institute of General Medical Sciences of the National Institutes of Health.

Dr. Shen has served as an Editorial Board member for the Journal of Biological Systems since 2018 and an Associate Editor for EURASIP JBSB (2015-2017); a guest editor for EURASIP JBSB and JASP; a co-organizer for IJCAI Workshop on Biomedical Informatics with Optimization and Machine Learning (2016-2020); a proceedings co-chair for ACM-BCB since 2015; and a proceedings committee member for ISMB, the flagship conference of the International Society of Computational Biology, 2014-2017.