



Editorial: special issue on multi-view learning

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This special issue mainly aims to provide a platform for the related researchers and practitioners to communicate the new advancement and successful applications of multi-view learning. This special issue including 24 papers in total are carefully selected and cover a range of topics, including multi-view classification/prediction, multi-view clustering, multi-view representation learning and their applications.

The first category is multi-view classification/prediction. The paper entitled “Co-Clustering based Classification of Multi-View Data” by Syed Fawad Hussain, Mohsin Khan and Imran Siddiqi attempt to respect the consensus principle by learning shared similarity values using transfer learning and the complementary principle by learning the similarity between instances within each view supervised co-clustering measure to improve multi-view classification. The paper entitled “IBMvSVM: An Instance-Based Multi-View SVM Algorithm for Classification” by Shuang Yu, Xiongfei Li, Siru Sun, Hancheng Wang, Xiaoli Zhang and Shiping Chen design an instance-based multi-view SVM algorithm by distributing different weights to different views of an instance. The paper entitled “Multi-View Attention-Convolution Pooling Network for 3D Point Cloud Classification” by Wenju Wang, Tao Wang and Yu Cai propose a multi-view attention-convolution pooling network on multiple 2D views for 3D point cloud classification task. The paper entitled “A Multi-View Multi-Omics Model for Cancer Drug Response Prediction” by Zhijin Wang, Ziyang Wang, Yaohui Huang, Longquan Lu and Yonggang Fu present a multi-view

model on multi-omics data to improve the cancer drug response prediction. The paper entitled “A Multi-Mode Traffic Flow Prediction Method with Clustering based Attention Convolution LSTM” by Xiaohui Huang, Yuming Ye, Cheng Wang, Xiaofei Yang and Liyan Xiong propose a multi-mode traffic flow prediction method with clustering-based attention convolution LSTM to model spatio-temporal data of traffic flow. The paper entitled “A Multi-View Time Series Model for Share Turnover Prediction” by Zhijin Wang, Qiankun Su, Guoqing Chao, Bing Cai, Yaohui Huang and Yonggang Fu propose a multi-view time series model to capture temporal dynamics to predict share turnover values more accurately.

The second category concerns multi-view clustering. The paper entitled “Multi-View K-Proximal Plane Clustering” by Feixiang Sun, Xijiong Xie, Jiangbo Qian, Yu Xin, Yuqi Li, Chong Wang and Guoqing Chao present a multi-view k-proximal plane clustering to deal with data points that are clustered along a straight line. The paper entitled “Semi-Supervised Multi-View Binary Learning for Large-Scale Image Clustering” by Mingyang Liu, Zuyuan Yang, Wei Han, Junhang Chen and Weijun Sun design a multi-view binary learning method to deal with large-scale clustering problem in semi-supervised way. The paper entitled “Nonconvex Low-Rank and Sparse Tensor Representation for Multi-View Subspace Clustering” by Shuqin Wang, Yongyong Chen, Yigang Cen, Linna Zhang, Hengyou Wang and Viacheslav Voronin design a novel multi-view subspace clustering model

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by forming a nonconvex optimization problem involving low-rank and sparse tensor representation. The paper entitled “Incomplete Multi-View Clustering with Multiple Imputation and Ensemble Clustering” by Guoqing Chao, Songtao Wang, Shiming Yang, Chunshan Li and Dianhui Chu propose a novel multi-view clustering model to deal with any missing value case with multiple imputation and ensemble clustering. The paper entitled “Efficient Multi-view Clustering Networks” by Guanzhou Ke, Zhiyong Hong, Wenhua Yu, Xin Zhang and Zeyi Liu aim at promoting the efficiency of multi-view clustering algorithms by designing an alternating process of an approximation and an instruction. The paper entitled “Incomplete Multi-view Clustering based on Weighted Sparse and Low Rank Representation” by Liang Zhao, Jie Zhang, Tao Yang and Zhikui Chen propose an incomplete multi-view clustering algorithm by leveraging subspace learning with double constraints to capture global and local data relationships and adopting a weighting mechanism to reduce the negative impact of missing data. The paper entitled “Robust Deep Multi-View Subspace Clustering Networks with a Correntropy-induced Metric” by Xiaomeng Si, Qiyue Yin, Xiaojie Zhao and Li Yao design a position-aware diversity regularization to make full use of the complementary information inside multi-view data, a correntropy-induced metric to handle complex noise distributions to improve the robustness of deep multi-view subspace clustering networks. The paper entitled “Incomplete Multi-View Clustering with Incomplete Graph-Regularized Orthogonal Non-Negative Matrix Factorization” by Naiyao Liang, Zuyuan Yang, Zhenni Li and Wei Han design an incomplete multi-view clustering algorithm by employing the geometric structure and orthogonal nonnegative matrix factorization.

The third category is about multi-view representation learning. The paper entitled “Deep Mutual Information Multi-View Representation for Visual Recognition” by Xianfa Xu, Zhe Chen and Fuliang Yin propose an auto-encoder network which maximizes the mutual information between the latent representation and the original feature and maximizes the canonical correlation of different view mean vectors to learn a robust representation in visual recognition task. The paper entitled “Trace Ratio Criterion for Multi-view Discriminant Analysis” by Mei Shi, Zhihui Li, Xiaowei Zhao, Pengfei Xu, Baoying Liu and Jun Guo design a trace ratio criterion for multi-view representation learning by taking the intra-view and inter-view correlation across multiple views into consideration.

The fourth category covers multi-view learning applications. The paper entitled “Edge-Enhanced Dual Discriminator Generative Adversarial Network for Fast MRI with Parallel Imaging Using Multi-View Information” by Jiahao Huang, Weiping Ding, Jun Lv, Jingwen Yang, Hao Dong, Javier De Ser, Jun Xia, Tiaojuan Ren, Stephen T. Wong and Guang Yang design a new Generative Adversarial Network framework to

make full use of multi-view information to enhance the edge information to reconstruct the MRI, thus MRI can be obtained fast to assist the diagnosis. The paper entitled “Online Unsupervised Cross-View Discrete Hashing for Large-Scale Retrieval” by Xuan Li, Wei Wu, Yun-Hao Yuan, Shirui Pan and Xiaobo Shen design an online unsupervised cross-view discrete hashing that considers similarity among newly arriving data and old data that is absent by selecting a few anchors. The paper entitled “M-FFN: Multi-Scale Feature Fusion Network for Image Captioning” by Jeripothula Prudviraj, Chalavadi Vishnu and C. Krishna Mohan present a feature fusion network for image captioning task to incorporate discriminative features and scene contextual information of an image. The paper entitled “Sign Language Recognition and Translation Network based on Multi-View Data” by Roghui Li and Lu Meng propose a transformer and graph convolutional network based multi-view model for sign language recognition and translation. The paper entitled “Speech Synthesis with Face Embeddings” by Xing Wu, Sihui Ji, Jianjia Wang and Yike Guo aim to synthesize speech from the same person’s image by designing a model consisting of voice encoder, face encoder and an improved multi-speaker text-to-speech engine. The paper entitled “Cross-View Vehicle Re-identification Based on Graph Matching” by Chao Zhang, Chule Yang, Dayan Wu, Hongbin Dong and Baosong Deng propose a systematic framework to realize the alignment and discrimination of key features from two views by learning high-order relationships and topological information. The paper entitled “Locality Sensitive Hashing with Bit Selection” by Wenhua Zhou, Huawen Liu, Jungang Lou and Xin Chen present a new locality sensitive hashing algorithm by selecting the bits with high importance and less similarity to assist nearest neighbor search in image retrieval field. The paper entitled “Face Aging with Pixel-Level Alignment GAN” by Xing Wu, Yafei Zhang, Qing Li, Yangyang Qi, Jianjia Wang and Yike Guo design a face aging model consisting of age estimation, identity preservation and image de-noising.

Due to its comprehensiveness and robust nature in describing objects, multi-view learning is one of the fundamental tasks of the machine learning community to solve real-world learning problems. With 24 selected papers in the field, this special issue provides a focused discussion about recent advancement in multi-view learning.

Finally, guest editors would like to cordially thank all the authors for their supports and contributions. Our thanks also extend to all the dedicated reviewers assisting in the papers’ evaluation and selection.

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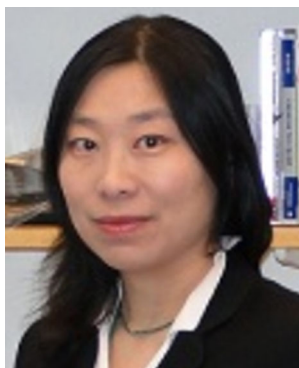
Xingquan Zhu, is a Full Professor in the Department of Computer and Electrical Engineering and Computer Science, Florida Atlantic University. His research interests mainly include artificial intelligence, machine learning, and bioinformatics. Since 2000, he has published over 260 refereed journal and conference papers in these fields, and these publications have received over 15,000 citations. Dr. Zhu is an Associate Editor of the ACM Transactions on Knowledge Discovery from Data (2017-date)

and an Associate Editor of the IEEE Transactions on Knowledge and Data Engineering (2008-2012, 2014-date). He is currently serving on the Editor Board of International Journal of Social Network Analysis and Mining SNAM (2010-date), Journal of Big Data (2013-date), and Network Modeling Analysis in Health Informatics and Bioinformatics Journal (2014-date). He has served (or is serving) as Program Committee Co-Chairs and Program Committee Vice Chair (Senior PC) for many international conferences including ACM SIGKDD-2020, AAAI-2019, ACM SIGKDD-2019, IEEE ICDM-2019, etc. He also served as a conference co-chair for IEEE ICMLA-2012. During his career, Dr. Zhu has received multiple awards, including five Best Paper Awards (ICDM-2020, ICKG-2020, IRI-2018, PAKDD-2013, ICTAI-2005), one Best Student Paper Award (ICPR-2012), Outstanding Engineering Achievement Merit Award (Engineers' Council), Senior Faculty Research Award (FAU College of Engineering and Computer Science), Distinguished Visiting Professor Award, Australian Future Fellowship, and several Service Awards.



Weiping Ding (M'16-SM'19) received the Ph.D. degree in Computation Application, Nanjing University of Aeronautics and Astronautics (NUAA), Nanjing, China, in 2013. He was a Visiting Scholar at University of Lethbridge(UL), Alberta, Canada, in 2011. From 2014 to 2015, He is a Postdoctoral Researcher at the Brain Research Center, National Chiao Tung University (NCTU), Hsinchu, Taiwan. In

2016, He was a Visiting Scholar at National University of Singapore (NUS), Singapore. From 2017 to 2018, he was a Visiting Professor at University of Technology Sydney (UTS), Ultimo, NSW, Australia. Now, Dr. Ding is the Chair of IEEE CIS Task Force on Granular Data Mining for Big Data. He is a member of Senior IEEE, IEEE-CIS, ACM, CCAI and Senior CCF. He is a member of Technical Committee on Soft Computing of IEEE SMCS, on Granular Computing of IEEE SMCS, and on Data Mining and Big Data Analytics of IEEE CIS. He is currently a Full Professor with the School of Information Science and Technology, Nantong University, Nantong, China. His main research directions involve data mining, granular computing, evolutionary computing, machine learning and big data analytics. He has published more than 80 research peer-reviewed journal and conference papers in this field, including IEEE T-FS, T-NNLS, T-CYB, T-SMCS, T-BME, T-II, T-ETCI and T-ITS, etc, and he has held 15 approved invention patents. His four co-authored papers have been selected as ESI Highly Cited Papers. Dr. Ding was an Excellent-Young Teacher (Qing Lan Project) of Jiangsu Province in 2014, a High-Level Talent (Six Talent Peak) of Jiangsu Province in 2016, and a Middle-aged and Young Academic Leaders (Qing Lan Project) of Jiangsu Province in 2019. He was awarded the Best Paper of ICDMA'15. Dr. Ding was a recipient of the Medical Science and Technology Award (Second Prize) of Jiangsu Province, China, in 2017, and the Education Teaching and Research Achievement Award (Third Prize) of Jiangsu Province, China, in 2018. He was the Outstanding Associate Editor of 2018 for IEEE Access Journal. Dr. Ding was awarded two Chinese Government Scholarships for Overseas Studies in 2011 and 2016. Dr. Ding is vigorously involved in editorial activities. He currently serves on the Editorial Advisory Board of *Knowledge-Based Systems* (Elsevier) and Editorial Board of *Information Fusion* (Elsevier), *Applied Soft Computing* (Elsevier), and *Neurocomputing* (Elsevier). He serves as an Associate Editor of *IEEE Transactions on Fuzzy Systems*, *Information Sciences* (Elsevier), *Swarm and Evolutionary Computation* (Elsevier), *IEEE Access* and *Journal of Intelligent & Fuzzy Systems*, and Co-Editor-in-Chief of *Journal of Artificial Intelligence and System*. He is the Leading Guest Editor of Special Issues in several prestigious journals, including *IEEE Transactions on Evolutionary Computation*, *IEEE Transactions on Fuzzy Systems*, *IEEE Transactions on Emerging Topics in Computational Intelligence*, *Information Fusion*, *Information Sciences*, and so on. He has delivered more than 20 keynote speeches at international conferences and has served as the Program Chair, Workshop Chair, or Program Committee Member of several international conferences and symposiums in the area of data mining, fuzzy decision-making, and knowledge engineering, such as IEEE SMC2018, ICDM 2019, IEEE SSCI 2019, IEEE CEC 2019, IJCNN 2019, IEEE BigData 2020, FUZZ-IEEE 2020, IJCNN 2021, CEC2021, IJCAI 2021, and so on.



Jinbo Bi, Frederick H Leonhardt Professor of Computer Science at the University of Connecticut (UConn), received a Ph.D. degree in Mathematics from Rensselaer Polytechnic Institute, USA, and a M.S. degree in Automatic Control from Beijing Institute of Technology, China. She is currently also an associate head of the Department of Computer Science and Engineering at the UConn. She has had 18 years of experience in developing machine learning approaches to meet life science

challenges. First in industry (2003-2010), she conducted cutting-edge research for cancer detection from imaging modalities at Siemens and clinical decision support for trauma patient care at Massachusetts General Hospital at Partners Healthcare. Then in an academic setting at the UConn since 2010, she has been designing innovative and multidisciplinary approaches for computational genomics and refined classification of complex disorders, particularly psychiatric disorders with advanced machine learning and computer vision techniques. She has authored over 100 peer-reviewed articles in leading journals and conferences in the respective fields, including prestigious machine learning journals such as the *Journal of Machine Learning Research* and *IEEE Transactions on Pattern Analysis and Machine Intelligence*, and medical journals such as *BMC Genomics*, *BMC Medical Genomics*, and the *American Journal of Medical Genetics*. Her work in bioinformatics and machine learning has been internationally recognized as innovative and methodologically rigorous, as evidenced by best paper awards (e.g., IEEE BIBM2014) and invited presentations in international forums. Her research findings have been presented in many first-tier international conferences such as *International Conference on Machine Learning (ICML)*, *ACM International Conference on Knowledge Discovery and Data Mining (KDD)*, *Neural Information Processing Systems (NIPS)*, and *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*. She has, annually since 2008, served on program committees for ICML, KDD and NIPS, and recently served as area chair or senior PC for AAAI and IJCAI. She was also an editor for *Computers in Biology and Medicine*, the *International Journal of Bioinformatics Research*, the *British Journal of Health Informatics* and the *Journal of Machine Learning Research*. She organized the workshops on multi-view subtyping methods to categorize complex disease in IEEE BIBM 2014, 2015, and 2016. She is Principal Investigator of two large multi-site NIH R01 projects and also a recipient of NIH's K02 mid-career investigator award. She has had continuous research funding from NSF to develop theory and foundations for advanced machine learning analysis, especially multi-modal/multi-view unsupervised and supervised learning models, longitudinal data analytics, parallel/distributed and federated learning algo-

gorithms to enable the concurrent analysis of massive genomic data, behavioral, physiological features, and diagnostic images to predict an individual's risk for a disorder. Overall, her research interests include machine learning, data mining, bioinformatics and biomedical informatics, computer vision, optimization, and drug discovery. Her google citation is 5117, H-index is 33 and H10-index is 75.



Shiliang Sun, received the B. E. degree from Beijing University of Aeronautics and Astronautics (BUAA), and the M. E. and Ph.D. degrees in Pattern Recognition and Intelligent Systems from Tsinghua University. In 2004, he was awarded Microsoft Fellowship. In 2007, he joined the Department of Computer Science and Technology, East China Normal University (ECNU), and founded the Pattern Recognition and Machine Learning (PRML)

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