ZIHENG DUAN

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EDUCATION

Zhejiang University   Hangzhou, China
B.E. in Control Science and Engineering   Sep 2016 – Jun 2020

- GPA: 3.74/4.00 (top 15%)
- Admitted on basis of performance on the National College Admissions Exam (top 0.1%)
- Double Major: Computer Science and Technology, Chu-Kochen Honors College
- Selected award: Research and Innovation Scholarship (Ranking of research and innovation: 5/77)

PUBLICATIONS

1. Haoyan Xu, **Ziheng Duan**, Jie Feng, Runjian Chen, Qianru Zhang, Yueyang Wang, "Graph Partitioning and Graph Neural Network based Hierarchical Graph Matching for Graph Similarity Computation," Neurocomputing. (arXiv:2005.08008)
2. Boxing Wang, Chunlin Zhou, **Ziheng Duan**, Qichao Zhu, Jun Wu, Rong Xiong, "Untethered Quadrupedal Hopping and Bounding on a Trampoline," Published 2019-10-24, *Frontiers of Mechanical Engineering*.
3. Yueyang Wang, **Ziheng Duan**, Binbing Liao, Fei Wu, Yueting Zhuang, "Heterogeneous Attributed Network Embedding with Graph Convolutional Networks," Published 2019-07-17, *AAAI-2019*.

PREPRINTS

1. **Ziheng Duan***, Haoyan Xu*, Yunsheng Bai*, Yida Huang, Anni Ren, Qianru Yu, Qianru Zhang, Yueyang Wang, Xiaoqian Wang, Yizhou Sun, Wei Wang. "Multivariate Time Series Classification with Hierarchical Variational Graph Pooling," In submission, SDM-2021. (arXiv:2008.07730)
2. **Ziheng Duan***, Haoyan Xu*, Yida Huang, Jie Feng, Xiaoqian Wang, "Multivariate Time Series Forecasting with Transfer Entropy Graph," In submission, ICASSP-2021. (arXiv:2005.01185)
3. **Ziheng Duan***, Haoyan Xu*, Yida Huang, Jie Feng, Anni Ren, Qianru Zhang, Yueyang Wang, Xiaoqian Wang, "Parallel Extraction of Long-term Trends and Short-term Fluctuation Framework for Multivariate Time Series Forecasting," In submission, ICASSP-2021. (arXiv:2008.07730)
4. **Ziheng Duan***, Yida Huang*, Haoyan Xu*, Anni Ren, Jie Feng, Qianru Zhang, Yueyang Wang, Xiaoqian Wang. "Modeling Complex Spatial Patterns with Temporal Features via Heterogenous Graph Embedding Network," In submission, Information Science. (arXiv:2008.08617)
5. **Ziheng Duan**, Daniel Montes, Yangsibo Huang, Dufan Wu, Javier M. Romero, Ramon Gilberto Gonzalez, Quanzheng Li, "Deep Learning-Based Detection and Localization of Cerebral Aneurysms in Computed Tomography Angiography," In progress. (arXiv:2005.11098)
6. Haoyan Xu, Runjian Chen, Yunsheng Bai, **Ziheng Duan**, Jie Feng, Ke Luo, Yizhou Sun, Wei Wang, "Hierarchical and Fast Graph Similarity Computation via Graph Coarsening and Deep Graph Learning," In progress. (arXiv:2005.07115)
7. Jian Xu, Zhehan Liao; Yizhang Yang; Chengfeng Sun; Ruiqi Wu; **Ziheng Duan**; Yueyang Wang; Xipeng Li, "Image-based prediction of granular flow behaviors in a wedge-shaped hopper by combing DEM and deep learning methods," In submission, Powder Technology.

RESEARCH EXPERIENCE

School of Electrical and Computer Engineering, Purdue University   IN, USA
Research Assistant to Prof. Xiaoqian Wang   Mar 2020 – Present
Multivariate Time Series Classification with Hierarchical Variational Graph Pooling

- We are the first to propose a hierarchical graph pooling-abased framework to model MTS and hierarchically generate its global representation for MTS classification.
- Designed "MTPool" as an end-to-end joint framework for graph structure learning, temporal convolution, graph representation learning, and graph coarsening.
- Proposed a novel pooling method, "Variational Pooling." The centroids for cluster assignments are input-related to the input graphs, making the model more inductive and leading to better performance.
- Conducted extensive experiments on MTS benchmark datasets, and the empirical results prove that the proposed method's performance is better than state-of-the-art models in most cases.

Parallel Extraction of Long-term Trends and Short-term Fluctuation for MTS Forecasting
- Proposed to predict the long-term trends and short-term fluctuations in parallel in MTS forecasting.
- Constructed a triplet loss function and integrated more supervision information to guide this task.
- Validated better performance than state-of-the-art models on various benchmark datasets.

Multivariate Time Series Forecasting based on Heterogeneous Network Embedding
- Proposed a heterogeneous graph neural network-based framework that is compatible with taking full advantage of rich relations among MTS variables.
- Conducted extensive experiments on MTS forecasting benchmark datasets. The experimental results validate that the performance of the proposed method is better than state-of-the-art models.

Multivariate Time Series Forecasting with Transfer Entropy Graph
- Proposed the end-to-end deep learning framework that considers multivariate time series as a graph structure with causality. The causality among time series is used as prior information to guide the forecasting task, and a graph neural network is utilized to process this graph structure.
- Used transfer entropy to extract the causality among time series variables and construct the TE graph. A CNN structure is used to extract time series features, as node features in the TE graph.
- Conducted extensive experiments on MTS forecasting benchmark datasets, and the results from the experiment have proved that TEGNN out-performs the state-of-the-art models at that time.

School of Big Data and Software, Chongqing University — Chongqing, China
Research Assistant to Prof. Yueyang Wang — Mar 2020 – Present
Heterogeneous Attributed Network for Recommendation
- Proposed a recommendation system based on heterogeneous attributed network (HANRec).
- Used the nodes' first-order and second-order neighbors to capture structural and feature information.
- Designed a full-attention network for neighbors that have a closer relationship with nodes.
- Conducted experiments on the movie ratings dataset "MovieLens" and the academic network dataset "AMiner." HANRec showed better performance than other recommendation methods.

Graph Partitioning and Graph Neural Network based Hierarchical Graph Similarity Computation
- Proposed the graph partitioning based framework to address the challenging problem of similarity computation between large graphs. This achieves a good trade-off between accuracy and efficiency.
- Proposed a novel model that extract and aggregate local information effectively to conduct a subgraph-level comparison. This can resolve the challenges of limited representation ability or high time complexity of many graph deep learning-based similarity computation models.
- Conducted extensive experiments on a popular graph similarity/distance metric, GED, based on datasets of different sizes. These experiments and theoretical analysis demonstrate the effectiveness and efficiency of the PSimGNN in graph similarity computation tasks.

School of Computer Science, University of California, Los Angeles — CA, USA
Research Assistant to Prof. Yizhou Sun — Mar 2020 – Present
Hierarchical Large-scale Graph Similarity Computation via Graph Coarsening and Matching
- Proposed the first framework, which hierarchically encodes and coarsens graphs and then deploys matching mechanism on the coarsened graph pairs, to address the challenging problem of similarity computation between large graphs.
- Proposed a novel pooling layer "Adaptive Pooling." The generation of centroids in this layer is based on the input graph, which leads to better performance while maintaining permutation invariance.
- Showed significant improvement in time complexity compared to other matching models.
- Conducted extensive experiments on real graph datasets and synthetic datasets consisted of large graphs to demonstrate our proposed framework's scalability, effectiveness, and efficiency.

Harvard Medical School — Boston, MA
Research Assistant to Prof. Quanzheng Li — Aug 2019 – Mar 2020
Deep Learning for Medical Image Analysis
- Proposed an automatic cerebral aneurysm diagnosis system, *DeepBrain*, based on deep learning.
- Used a 3D Faster R-CNN and a U-netlike encoder-decoder structure to detect a candidate's aneurysm.
- Designed a multi-scale 3D CNN to reduce false positives from 2 per scan to 0.3.

Robotics Laboratory, Zhejiang University   Hangzhou, China
Research Assistant to Prof. [Rong Xiong](), Head of the Robotics Laboratory   Oct 2018 – July 2019
Trampoline Jumping of Quadruped Robot

- Used a robot without elastic components jumping on a trampoline to solve the control problem: this required appropriate adjustable components and elaborate control algorithms.
- Designed a control algorithm to balance the contact force and avoid oscillation during jumping.
- Adjusted the time delay and models of leg stretching to control the jump height effectively.
- Designed motion control algorithms to make the robot perform translational and rotational movement.

Artificial Intelligence Laboratory, Zhejiang University   Hangzhou, China
Research Assistant to Prof. [Fei Wu](), the Vice-Dean of College of Computer Science   June 2018 – Sept 2018
Deep Learning for Graph Convolutional Network

- Designed a new network embedding method based on the graph convolution network, *HANE*, which uses network heterogeneity and node attribute to generate high-quality embedding.
- Used a node aggregation method for heterogeneous networks, enabling nodes to keep their characteristics while collecting information about neighboring nodes. Compared with GraphSAGE, this method achieves $1 \sim 4$ percent point gain in Macro-F1 and $1 \sim 2$ percent point gain in Micro-F1.
- Designed an attention mechanism on graph convolutional networks to leverage not only heterogeneity but also the node attributes. Compared with GraphSAGE, this mechanism achieves $4 \sim 6$ percentage point gain in terms of Macro-F1 and $3 \sim 5$ percentage point gain in terms of Micro-F1.

SELECTED PROJECTS

Course Project of Natural Language Processing:
Pointer-Generator Network for Text Summarization [[code]()] [[report]()]   Mar 2019 – June 2019

- Applied pointer-generator network, which facilitates copying words from original texts by pointing to them. Thus, I improved the accuracy and handled out of vocabulary (OOV) while retaining the ability to generate new words. This is a balance between the extractive method and the abstractive method.
- Applied the coverage model to solve the repetition problem for sequence-to-sequence models (words are often repeated, especially when generating multiple sentences).
- This model demonstrated a good performance in the rouge-n evaluation metric.

SELECTED AWARDS AND HONORS

- Star Bridge Program, Microsoft Research Asia   2020
- Research and Innovation Scholarship, Zhejiang University   2019
- Merit Student, Zhejiang University (won three times)   2017~2019
- Academic Excellence Scholarship, Zhejiang University (won three times)   2017~2019
- Third Prize of Zhejiang Physics Competition   2017

SKILLS AND OTHER INFORMATION

Skills

- Major Related Skills: Control Theory, Numerical Analysis, Embedded System, Computer Vision, Natural Language Processing, Machine Learning, Medical Image Analysis
- Basic Science Knowledge: Probability, Mathematic Analysis, Linear Algebra, Physics

Programming Language and Tools

- Python, C/C++, MATLAB, Verilog, Assembly
- Pytorch, Tensorflow, LaTeX

Extracurricular Activities

- **The leader of Characteristic Town Research Project**   Hangzhou, China, 2019
  Investigation on the development of towns with Chinese characteristics.
- **The leader of "Running Man" Students Quality Training Project**   Hangzhou, China, 2019
  Organized students to participate in various sports activities and supplied related knowledge about running, mountaineering, tennis, badminton, etc.

Leadership Activities

- **National Collegiate Honors Council (NCHC) Meeting**   Boston, USA. 2018
  Attended the honors council on behalf of the Chu-Kochen Honors College and made suggestions for college development.