Montreal, Quebec H3A 0C3

YUANKAI WU

815 Sherbrooke St W,

(+1)5142198721 ⋄ yuankai.wu@mcgill.ca ⋄ https://kaimaoge.github.io

RESEARCH INTERESTS

- **Deep spatiotemporal modeling**: I focus on using machine learning techniques to understand and model spatiotemporal traffic data.
- **Reinforcement learning based transportation system control**: I am very interested in applying deep reinforcement learning models to tackle challenging transportation control problems.
- **Connected & automated vehicle highway systems**: I am interested in developing vehicle infrastructure cooperative control systems.

EDUCATION AND EXPERIENCE

McGill University , Montreal, Canada
Postdoc Researcher in Department of Civil Engineering *Dec.2019 - Now*

* Advisors: Prof. Lijun Sun & Aurelie labbe (HEC Montreal)

The Joint Research Institute on Internet of Mobility, Southeast Univ. and Univ. of Wisconsin-Madison, Nanjing, China
Research associate *Jun.2019 - Dec.2019*

Beijing Institute of Technology , Beijing, China
PhD of Vehicle Operation Engineering *Sep.2015 - Jun.2019*

* Dissertation: A high dimensional traffic state processing method based on tensorial model
* Advisors: Prof. Hongwen He

University of Wisconsin-Madison , Madison, USA
Visiting PhD in Department of Civil & Environmental Engineering *Dec.2016 - Jun.2017*

- Research: Automated & connected vehicle highway systmes
- Advisors: Prof. Bin Ran

Beijing Institute of Technology , Beijing, China
Master of Transportation Engineering *Sep.2012 - Mar.2015*

- Dissertation: Short-term traffic prediction based on dynamic tensor completion
- Advisors: Prof. Huachun Tan

Shanghai Ocean University , Shanghai, China
Bachelor of Mechanical Engineering *Oct.2008 - Jun.2012*

- Overall Ranking: 3/120

PUBLICATIONS

Journal Papers

[1] Lian, R., Peng, J., **Wu, Y.***, Tan, H., Zhang, H. (2020). Rule-interposing deep reinforcement learning based energy management strategy for power-split hybrid electric vehicle. Energy, 117297.

[2] **Wu, Y.**, Tan, H., Chen, X., & Ran, B. (2019). Memory, attention and prediction: a deep learning architecture for car-following. Transportmetrica B: Transport Dynamics, 1-19.

[3] **Wu, Y.**, Tan, H., Peng, J., Zhang, H., & He, H. (2019). Deep reinforcement learning of energy management with continuous control strategy and traffic information for a series-parallel plug-in hybrid electric bus. Applied Energy, 247, 454-466.

[4] **Wu, Y.**, Tan, H., Li, Y., Zhang, J., & Chen, X. (2018). A fused CP factorization method for incomplete tensors. IEEE transactions on neural networks and learning systems, 30(3), 751-764.

[5] **Wu, Y.**, Tan, H., Qin, L., Ran, B., & Jiang, Z. (2018). A hybrid deep learning based traffic flow prediction method and its understanding. Transportation Research Part C: Emerging Technologies, 90, 166-180.

[6] **Wu, Y.**, Tan, H., Li, Y., Li, F., & He, H. (2017). Robust tensor decomposition based on Cauchy distribution and its applications. Neurocomputing, 223, 107-117.

[7] Li, Q., Tan, H., **Wu, Y.***, Ye, L., Ding, F. (2020). Traffic flow prediction with missing data imputed by tensor completion methods. IEEE Access.

[8] **Wu, Y.**, Tan, H., Peng, J., & Ran, B. (2019). A Deep Reinforcement Learning Based Car Following Model for Electric Vehicle. Smart City Application (Chinese), 2(5).

[9] Tan, H., **Wu, Y.**, Shen, B., Jin, P. J., & Ran, B. (2016). Short-term traffic prediction based on dynamic tensor completion. IEEE Transactions on Intelligent Transportation Systems, 17(8), 2123-2133.

[10] Tan, H., Zhang, H., Peng, J., Jiang, Z., & **Wu, Y.** (2019). Energy management of hybrid electric bus based on deep reinforcement learning in continuous state and action space. Energy Conversion and Management, 195, 548-560.

[11] Tan, H., Liang, X., Wu, Z., **Wu, Y.**, & Tan, H. (2019). Stochastic resonance in two kinds of asymmetric nonlinear systems with time-delayed feedback and subject to additive colored noise. Chinese journal of physics, 57, 362-374.

[12] Ran, B., Tan, H., **Wu, Y.**, & Jin, P. J. (2016). Tensor based missing traffic data completion with spatialtemporal correlation. Physica A: Statistical Mechanics and its Applications, 446, 54-63.

[13] Tan, H., Li, Q., **Wu, Y.**, Wang, W., & Ran, B. (2015). Freeway short-term travel time prediction based on dynamic tensor completion. Transportation Research Record, 2489(1), 97-104.

[14] Tan, H., **Wu, Y.**, Cheng, B., Wang, W., & Ran, B. (2014). Robust missing traffic flow imputation considering nonnegativity and road capacity. Mathematical Problems in Engineering, 2014.

Conference Papers

[1] Tan, H., Zhong, Z., **Wu, Y.**, Chen, X., & Zhang, J. (2018). A Deep Architecture Combining CNNS and GRBMS for Traffic Speed Prediction. In CICTP 2017.

[2] Tan, H., Xuan, X., **Wu, Y.**, Zhong, Z., & Ran, B. (2016). A comparison of traffic flow prediction methods based on DBN. In CICTP 2016.

[3] Tan, H., Wang, P., **Wu, Y.**, Zhang, J., & Ran, B. (2016). High-dimension traffic data imputation based on a square norm. In CICTP 2016.

[4] Tan, H., Li, Q., **Wu, Y.**, Ran, B., & Liu, B. (2015). Tensor Recovery Based Non-Recurrent Traffic Congestion Recognition. In CICTP 2015.

[5] **Wu, Y.**, Tan, H., Peter, J., Shen, B., & Ran, B. (2015). Short-term traffic flow prediction based on multilinear analysis and k-nearest neighbor regression. In CICTP 2015.

[6] Tan, H., **Wu, Y.**, Feng, J., Wang, W., & Ran, B. (2014, November). Traffic missing data completion with spatial-temporal correlations. In 93rd Annual Meeting of the Transportation Research Board, Washington, DC.

[7] Tan, H., **Wu, Y.**, Feng, G., Wang, W., & Ran, B. (2013). A new traffic prediction method based on dynamic tensor completion. Procedia-Social and Behavioral Sciences, 96, 2431-2442.

Preprint Papers

[1] **Wu, Y.**, Tan, H., Jiang, Z., & Ran, B., (2019). ES-CTC: A deep neuroevolution model for cooperative intelligent freeway traffic control. arxiv preprint arXiv: 1905.04083

[2] **Wu, Y.**, Tan, H., Ran, B. (2018). Differential variable speed limits control for freeway recurrent bottlenecks via deep reinforcement learning. arXiv preprint arXiv: 1810.10952

[3] **Wu, Y.**, & Tan, H. (2016). Short-term traffic flow forecasting with spatial-temporal correlation in a hybrid deep learning framework. arXiv preprint arXiv:1612.

Under review papers

[1] Xi, C., Shi, T., **Wu, Y.**, & Sun, L., Efficient Motion Planning for Automated Lane Change based on Imitation Learning and Mixed-Integer Optimization. submitted to ITSC2020

[2] Wang, X., Xu, X., **Wu, Y.**, & Liu, J., A spatiotemporal graph convolution gated recurrent unit model for short-term passenger flow prediction. submitted to ITSC2020

[3] Fan, C., Peng, Y., Peng, S., Zhang, H., **Wu, Y.**, & Wu, S., Detection of Train Driver Fatigue And Distraction Based on Forehead EEG: A Time-Series Ensemble Learning Method. submitted to IEEE Transactions on Intelligent Transportation Systems.

[4] Lian, R., Tan, H., Peng, J., Li, Q., & **Wu, Y*.** Cross type transfer for deep reinforcement learning based hybrid electric vehicle energy management. submitted to IEEE Transactions on Vehicular Technology.

[5] Wang, Y., Peng, J., **Wu, Y*.**, & Tan, H. Hybrid electric vehicle energy management with computer vision and deep reinforcement learning. submitted to IEEE Transactions on Industrial Informatics.

[6] Zhang, H., **Wu, Y*.**,Tan, H., & Ran, B. Disentangled Representation Learning Based Citywide Traffic Flow Prediction with Spatio-temporal Generative Adversary Network. submitted to IEEE Transactions on Intelligent Transportation Systems.

[7] Dong, H., Ding, F., Tan, H., **Wu, Y.**, Qin, L., & Ran, B. Rail transit OD matrix completion via manifold regularized tensor factorization. submitted to IEEE Transactions on Intelligent Transportation Systems.

[8] **Wu, Y.**, Tan, H., Qin, L., & Ran, B. Differential Variable Speed Limits Control for Freeway Recurrent Bottlenecks via Deep Actor-critic Algorithm. Accepted by Transportation Research Part C: Emerging Technologies.

[9] Tan, H., Li, Q., Jiang, Z., **Wu, Y.**, & Ye, L. Non-recurrent Traffic Congestion Detection with a Coupled Scalable Bayesian Robust Tensor Factorization Model. submitted to IEEE Transactions on Intelligent Transportation Systems.

PATENTS

[1] ranked **6**/8. (2019). Connected automated vehicle highway systems and methods for shared mobility. US20190244518A1

[2] ranked **7**/14. (2019). Intelligent road infrastructure system (iris): systems and methods.US201900 96238A1.

[3] ranked **4**/6. (2019). A tensor recovery based non recurrent traffic event detection method. CN1072202 11A.

[4] ranked **7**/12. (2019). A connected autonomous transportation management system for shared mobility. CN109118758A.

[5] ranked **9**/14. (2018). An intelligent road infrastructure system and its application. CN108447291A.

[6] ranked **6**/6. (2017). Method and system for preventing tramcars from collision at intersection. CN107067817A.

[7] ranked **4**/6. (2016). A tensor completion and recovery method. CN107220211A.

PROJECTS EXPERIENCE

Deep Spatiotemporal Modeling for Urban Traffic Data
Ivado Postdoc Funding, (Role: PI. Award CAD 140,000$) *Feb.2020-*

- Characterize the spatiotemporal propagation properties of traffic data by deep spatiotemporal neural networks;
- Decouple interaction between external factors and traffic pattern by disentangle representation;
- Capture the strong regularity in collective travel behavior by low-rank tensor factorization;
- Utilize the cross-variable relationship by deep factors models.

An Open Learning Platform for Smart Transportation
Mitacs Canada and Fundway Technology Inc *Dec.2019-*

- Develop reinforcement learning platform for traffic signal control based on real-world traffic data and scenarios.

Multi-tensor networks for coupled high-dimensional multi-modal big data and its empirical study
National Natural Science Foundation of China, key project *Jan.2018-Aug.2019*

- Research on coupled high dimensional data analysis via multi-tensor/tensor networks factorization.
- Proposed a modified tensor factorization framework that fuses the l2 norm constraint, sparseness (l1 norm), manifold, and smooth information simultaneously.

Multi-dimensional traffic data completion
National Natural Science Foundation of China *Sep.2012-Dec.2016*

- Research on traffic data tensor modeling strategies and its impacts on traffic data imputation performance.
- Developed a tensor decomposition model based on Cauchy distribution for missing data imputation and denoise
- Developed a novel short-term traffic flow prediction approach based on dynamic tensor completionwhich can predict future traffic data and impute missing data simultaneously

Deep reinforcement learning based energy management strategy for plug-in hybrid electric vehicles
National Natural Science Foundation of China *Jun.2018-Aug.2019*

- Research on policy gradient based deep reinforcement learning algorithm and deep neuroevolution algorithm based energy management systems.
- Developed an energy management strategy using continues deep reinforcement learning and traffic information for a plug-in hybrid electric bus.

Design and evaluation of Connected and Automated Vehicle & Highway systems
Research in TOPS lab, University of Wisconsin, Madison *Dec.2016-Aug.2019*

- Case study and road-side unit design for the CAVH systems.
- Development of multiple sensors fusion and multiple road side units control framework using ROS.
- Research on information fusion algorithm for road-side camera and microwave radar
- Research on autonomous driving trajectory planning based on road-side units

Big data platform for key technologies of electric vehicles
SAIC MOTOR open funding *Jan.2016-Dec.2017*

- Research on AI driving coach using big data based on deep reinforcement learning.
- Research on hybrid electric vehicle energy management using traffic information based on deep reinforcement learning.

Research on anti collision system of vehicle based on video processing
Open Fund of State Key Laboratory of Automotive Safety and Energy *Jan.2014-Dec.2015*

- Research on lane detection method.
- Research on vehicle detection method.

Research Internship of the Tencent Map Group
Tencent computer system Co. Ltd. *Jul.2014-Oct.2014*

- Development of a traffic state prediction method using sparse floating car data. The method has been used for congestion broadcasting

AWARDS

Second Prize of Chinese Institute of Electronics (ranked 6/10) *2019*

China National Scholarships for PhD student *Nov.2017*

China Scholarship Council (CSC) scholarships *Jul.2016*

Best paper reward of the 12th academic conference of Beijing Institute of Technology *Oct.2014*

TALKS AND PRESENTATIONS

[1] *Oct. 2019*, Control methods for connected automated vehicle & highway systems, Hunan University, Changsha, China.

[2] *Jun. 2019*, Tensor decomposition and its application on traffic data analysis, Tongji University, Shanghai, China.

[3] *Jun. 2019*, A deep reinforcement learning based car following model for electric vehicle, Proceedings of the 2019 World Transport Convention, Beijing, China

[4] *May. 2019*, Traffic data analysis and data-driven control for connected and automated vehicle & highway systems, Central South University, Changsha, China.

[5] *Jun. 2018*, A hybrid deep learning based traffic flow prediction method and its understanding, Central South University, Changsha, China

[6] *Apr. 2018*, Deep learning method and its application on transportation systems, Beijing Jiaotong University, Beijing, China.

[7] *Aug. 2015*, Short-term traffic flow prediction based on multilinear analysis and k-nearest neighbor regression, CICTP2015, Beijing, China.

[8] *Jan. 2015*, Freeway short-term travel time prediction based on dynamic tensor completion, 94th TRB annual meeting, Washington DC, USA.

[9] *Nov. 2014*, Robust Missing Traffic Flow Imputation Considering Nonnegativity and Road-capacity, Beijing Institute of Technology, Beijing, China.

[10] *Jan. 2014*, Traffic Missing Data Completion with SpatialTemporal Correlations, 93rd TRB annual meeting, Washington DC, USA.

[11] *Aug. 2013*, A new traffic prediction method based on dynamic tensor completion, CICTP2013, Shenzeng, China.

PROFESSIONAL SERVICE

Reviewer

• Transportation Research Part C: Emerging Technologies, • IEEE Transactions on Intelligent Transportation Systems, • IEEE Transactions on Industry Informatics, • IEEE Transactions on Systems, Man, and Cybernetics: Systems, • Artificial Intelligence in Medicine, • Transactions in GIS, • Journal of Cleaner Production, • Applied soft computing, • Journal of Advanced Transportation, • IEEE Sensors Journal, • Neurocomputing, • IEEE Access, • Physica A: Statistical Mechanics and its Applications, • Wireless Sensor Network, • Wireless Communications and Mobile Computing, • IEEE/CAA Journal of Automatica Sinica, • SN Applied Sciences (SNAS), • TRB Annual Meeting - Transportation Research Board, • CICTP.

Member

- IVADO: The institute for data valorization
- Mitacs
- China Highway and Transportation Society