Dr. Xiaocan (Bruce) Li

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EDUCATION

- 2020.9 - 2025.4 Ph.D. in Industrial Engineering, University of Toronto, Canada
  - Research areas: Deep Reinforcement Learning, Intelligent Transportation Systems, Spatiotemporal Prediction
  - Thesis: Regional Traffic Signal Control via Deep Reinforcement Learning
- 2017.9 - 2020.6, MSc in Control Theory and Control Engineering, Chinese Academy of Sciences, Institute of Automation, Beijing, China
  - Research areas: Computer Vision, Robotics, Self-supervised Learning, Contrastive Learning
  - Thesis: Object Orientation Representation Learning based on Self-supervised Learning and Contrastive Learning: Application to Robotic Grasping
- 2013.9 - 2017.6, Bachelor in Flight Vehicle Design and Engineering, Beihang University (a.k.a. Beijing University of Aeronautics and Astronautics), Beijing, China
  - Thesis: Airfield Segmentation and Airplane Recognition with Neural Networks and Machine Learning
- 2015.9 - 2015.12, exchange student with full scholarship, Concordia University, Montreal, Canada

WORK EXPERIENCE

2018.11 - 2019.2 **IBM Intern: Machine Learning Engineer for eCommerce**

- Developed a machine learning model to analyze the impact of various promotion categories on revenue and volume, and forecast future trends for marketing decision-making.
- Implemented an **online learning** model in Python using Scikit-learn, NumPy, and Pandas, ensuring continuous updates with new data.
- Built a software platform for query extraction, data cleaning, feature engineering, modeling, and error handling, streamlining the end-to-end process.
- Collaborated with product managers, software engineers, and UX designers through weekly meetings to align development progress and adjust timelines.

PUBLICATIONS

1. **Xiaocan Li**, Xiaoyu Wang, Ilia Smirnov, Scott Sanner, and Baher Abdulhai (2025). Multi-hop Upstream Preemptive Traffic Signal Control with Deep Reinforcement Learning. In: IEEE Journal of Intelligent Transportation Systems. (Accepted)
2. **Xiaocan Li**, Xiaoyu Wang, Ilia Smirnov, Scott Sanner, and Baher Abdulhai (2024). Generalized Multi-hop Traffic Pressure for Heterogeneous Perimeter Control. In: IEEE Transactions on Intelligent Transportation Systems. (Under Revision)
3. **Xiaocan Li**, Ray Coden Mercurius, Ayal Taitler, Xiaoyu Wang, Mohammad Noaeen, Scott Sanner, and Baher Abdulhai (2023). Perimeter Control Using Deep Reinforcement Learning: A Model-free Approach towards Homogeneous Flow Rate Optimization. In: 2023 IEEE International Intelligent Transportation Systems Conference (ITSC).
4. Ta Jiun Ting, **Xiaocan Li**, Scott Sanner, and Baher Abdulhai (2021). Revisiting Random Forests in a Comparative Evaluation of Graph Convolutional Neural Network Variants for Traffic Prediction. In: 2021 IEEE International Intelligent Transportation Systems Conference (ITSC). IEEE, pp. 1259-1265.
5. **Xiaocan Li**, Yinghao Cai, Shuo Wang, Tao Lu: Learning Category-level Implicit 3D Rotation Representations for 6D Pose Estimation from RGB Images. The IEEE International Conference on Robotics and Biomimetics 2019: 2310-2315.
6. Cui, Shaowei, Junhang Wei, **Xiaocan Li**, Rui Wang, Yu Wang, and Shuo Wang. "Generalized Visual-Tactile Transformer Network for Slip Detection." IFAC-PapersOnLine 53, no. 2 (2020): 9529-9534.
7. Li, Boyao, Tao Lu, **Xiaocan Li**, Yinghao Cai, and Shuo Wang. "An Automatic Robot Skills Learning System from Robot's Real-world Demonstrations." In 2019 Chinese Control And Decision Conference (CCDC), pp. 5138-5142. IEEE, 2019.

RESEARCH EXPERIENCE

1. 2024.2 - 2025.1 **Multi-hop Upstream Preemptive Traffic Signal Control with Deep Reinforcement Learning**
   - Generalized the definition of traffic pressure to multi-hop upstream links using **Markov Chain**, enabling preemptive traffic signal control with the proposed farsighted metric.
   - Formulated the traffic signal control problem as a **Markov Decision Process** (MDP).
   - Experimented on realistic scenarios using a **deep reinforcement learning**-based controller on a traffic simulator.
   - Demonstrated improved controller performance with increasing upstream hop pressure, enhancing traffic flow efficiency.
2. 2023.2 - 2024.2 **Generalized Multi-hop Traffic Pressure for Heterogeneous Perimeter Control**

- Generalized the concept of traffic pressure to multi-hop downstream links using **Markov Chain**, enabling customizable **spatial granularity** and bridging the gap between Macroscopic Fundamental Diagrams (MFDs) and traffic pressure.
- Developed a controller based on multi-hop pressure, achieving effective heterogeneous perimeter control in various demand scenarios.
- Conducted **sensitivity analysis**, demonstrating the robustness of the approach against uncertainties in turning ratio estimations.

3. 2021.9 - 2023.2 **Traffic Perimeter Control via Deep Reinforcement Learning**
   - Formulated the traffic perimeter control problem as a **Markov Decision Process** (MDP).
   - Developed a model-free **deep reinforcement learning** approach, achieving a significant reduction in traffic delays.
   - Analyzed how traffic densities and future demand affect the learned control policy.
   - Validated generalizability and robustness over demands, demonstrating superior performance over model-based approaches.
4. 2020.9 - 2021.8 **Spatiotemporal Prediction: Traffic Flow Prediction using Graph Neural Networks**
   - Developed a traffic flow prediction model using **Graph Attention Networks** (GAT) to capture spatial relations among traffic roads as well as **Gated Recurrent Unit** (GRU) for temporal demand extraction.
   - Integrated GAT and GRU layers with shared or independent weights for each node to enhance flexibility in **spatiotemporal modeling**.
   - Achieved a 20% improvement in prediction accuracy over baseline models through extensive comparative experiments.
5. 2019.3 - 2020.3 **Transformer for Slip Detection in Robotic Grasping**
   - Developed the Generalized Visual-Tactile (GVT) **Transformer** network to detect slip in robotic grasping using unaligned **multimodal spatiotemporal data** from visual and tactile sensors.
   - Proposed a novel solution that handles diverse tactile sensor data formats, overcoming limitations of traditional tactile perception-based methods.
   - Trained and evaluated the model on public and custom visual-tactile grasping datasets, demonstrating its superior performance in slip detection tasks.
   - Validated that the GVT-Transformer outperforms previous visual-tactile learning methods in versatility and applicability to sliding detection.
6. 2017.9 - 2020.7 Master Degree Thesis **6D Object Pose Estimation and Robot Grasping**
   - Proposed a **self-supervised** category-level object rotation **representation learning** model based on **denoising autoencoder**.
   - Integrated **deep contrastive learning** to autoencoder to leverage the relations between training samples.
   - Developed a pipeline of object detection - orientation estimation - grasp pose generation on a real UR5 robot arm.

TEACHING EXPERIENCE

- **Tutorial Lecturer**: Delivered tutorials and prepared practical code examples for students.
- **Project Design and Supervision**: Designed and supervised course projects, ensuring alignment with course objectives.
- **Courses Taught**:
  - ECE1508 Special Topics in Communications: Reinforcement Learning
  - ECE1508 Special Topics in Communications: Applied Deep Learning

DEVELOPMENT SKILLS

- **Programming Language**: Python, MatLab
- **Deep Learning Framework**: PyTorch, TensorFlow
- **Machine Learning Framework**: Ray, Scikit-learn
- **Database Tools**: SQL, NoSQL (MongoDB)
- **Statistics Tools**: NumPy, Pandas, SciPy
- **MLOps**: Weights & Biases, Git Version Control, Docker, Google Cloud Platform
- **Traffic Simulator**: Aimsun Next, SUMO

HONORS & REWARDS

- 3rd Prize of Beihang University Physics Contest
- 2nd Prize of Beihang University Mathematics Contest
- 1st Prize of National Physics Contest, Municipal Level
- 3rd Prize of National Mathematics Contest, Provincial Level
- Academic Excellence Scholarship of Beihang University (multiple times)