Eunhan Ka

Ph.D. Student · Lyles School of Civil Engineering, Purdue University

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Education

Purdue University *United States*

Doctor of Philosophy (Ph.D.), Lyles School of Civil Engineering *Aug. 2020 - present*

- Topic Keywords: Network Traffic Dynamics, Connected and Autonomous Vehicles, Cyber Security, Deep Learning, Network Science
- Advisor: Dr. Satish V. Ukkusuri

Seoul National University *South Korea*

Master of Science (M.S.), Dept. of Civil and Environmental Engineering *Feb. 2018*

- Thesis: A Simulation Study of Demand Responsive Transport for the Disabled to Minimize User Waiting Time
- Advisor: Dr. Chungwon Lee

Seoul National University *South Korea*

Bachelor of Science (B.S.), Dept. of Civil and Environmental Engineering *Feb. 2016*

Research Experience

Research Assistant *Aug. 2020 - Present*

Purdue University

- Develop a pioneering framework to bolster road network resilience against cyber-attacks in extensive road networks and mitigate cyber attack's impact by using defense strategies. **(Sponsor: USDOT)**
- Introduce a groundbreaking framework for modeling traffic dynamics using physics-informed deep learning, enabling predictions of traffic impacts due to connected and autonomous vehicles in cyber-physical systems within large-scale urban areas.
- Predict origin-destination (OD) matrices by using mobile location data **(Sponsor: INDOT)**
- Analyze the traffic impact of movable barrier (Alex Fraser Bridge) in Vancouver by leveraging the mobile location data with static traffic assignment
  (Sponsor: Lindsay Corporation)

Researcher *Mar. 2018 - Aug. 2020*

Seoul National University

- Led a study on designing a cluster-based route of multi-capacity vehicles of demand-responsive transport services for the disabled **(Sponsor: T-Money Welfare Foundation, South Korea)**
- Developed optimal operation strategies of Mobility-as-a-Service (MaaS) for the mobility impaired **(Sponsor: National Research Foundation of Korea, South Korea)**
- Modelled lane change behaviors on freeways and gap acceptance behaviors at roundabouts in real driving situations and virtual reality **(Sponsor: Ministry of Land, Infrastructure and Transport, South Korea)**
- Collaborated and coordinated with faculty members, businessmen, researchers, and graduate students at University of Seoul, Radius Corporation, Korea Land & Housing Institute

Research Assistant *Mar. 2016 - Feb. 2018*

Seoul National University

- Designed a real-time relocation strategy for one-way car-sharing and developed an event-based simulation for one-way car-sharing services **(Sponsor: National Research Foundation of Korea)**
- Led a study on improving demand-responsive transport services for the disabled with shared mobility in Seoul **(Sponsor: T-Money Welfare Foundation, South Korea)**
- Developed an evaluation method to evaluate drivers' behaviors with surrogate safety measures **(Sponsor: Ministry of Land, Infrastructure and Transport, South Korea)**
- Collaborated and coordinated with faculty members, businessmen, and researchers at the Korea Transport Institute, Korea Transportation Safety Authority, and InnoSim

Teaching & Mentoring Experience

Teaching Assistant *Jan. 2021 - Present*

Lyles School of Civil Engineering, Purdue Univeristy

- CE 597 - Network Models for Connected Autonomous Vehicles (Fall 2023, Spring 2023, Spring 2022, Fall 2021, Graduate)
- CE 597 - Smart Logistics (Fall 2021, Graduate)
- CE 597 - Data Science for Smart Cities - CE597 (Fall 2023, Spring 2021, Graduate) [link]

Lecturer *Nov. 2019*

Dept. of Civil and Environmental Engineering, Seoul National University

- Introduction to Civil and Environmental Engineering (Transportation Engineering)

Teaching Assistant *Sep. 2016 - Dec. 2017*

Dept. of Civil and Environmental Engineering, Seoul National University

- Sustainable Transportation Systems (Fall 2017, Undergraduate)
- Advanced Transportation Operation (Spring 2017, Graduate)
- Leadership for Civil Engineers (Spring 2017, Undergraduate)
- Introduction to Transportation Engineering (Fall 2016, Undergraduate)

Publications

In Review & Preparation

3. **Ka, E.** and Ukkusuri. S. V. (Preparation). Strategic Sampling Techniques to Boost Learning Efficiency in Physics-Informed Neural Networks with Traffic Flow Models. .
2. **Ka, E.**, Xue, J., and Ukkusuri. S. V. (Preparation). Finite-based Physics-Informed Neural Networks with Vehicular and Pedestrian Traffic Flows. .
1. Verma, R., **Ka, E.**, and Ukkusuri. S. V. (Preparation). Long-Term Forecasts of Statewide Travel Demand Patterns Using Large-Scale Mobile Phone GPS Data: A Case Study of Indiana. .

Refereed Journal Publications

5. (Accepted) Xue, J., **Ka, E.**, and Ukkusuri. S. V. (2024). Network Macroscopic Fundamental Diagram-Informed Graph Learning for Traffic State Imputation. *Transportation Research Part B: Methodological*.
4. **Ka, E.**, Xue, J., Leclercq, L., and Ukkusuri. S. V. (2024). A Physics-Informed Machine Learning for Estimating Traffic State with a Generalized Bathtub Model in Large-scale Urban Networks. *Transportation Research Part C: Emerging Technologies*, 164, 104661. `https://doi.org/10.1016/j.trc.2024.104661`.

3. **Ka, E.**, Sharma, S., and Ukkusuri, S. V. (2022). Leveraging Location-Based Data for Assessing Network-Level Traffic Impact of Lane Management: A Case Study of Alex Fraser Bridge. *Journal of Transportation Engineering, Part A: Systems*, 148(12), 04022105. `https://doi.org/10.1061/JTEPBS.0000760`. **[2022 Editor's Choice Collections]**.
2. **Ka, E.**, Kim, D. G., Hong, J., and Lee, C. (2020). Implementing Surrogate Safety Measures in Driving Simulator and Evaluating the Safety Effects of Simulator-Based Training on Risky Driving Behaviors. *Journal of advanced transportation*, 2020. `https://doi.org/10.1155/2020/7525721`.
1. Lee, D., Hwang, S., **Ka, E.**, and Lee, C. (2018). Evaluation of the Rain Effects on Gap Acceptance Behavior at Roundabouts by a Logit Model. *Journal of Advanced Transportation*, 2018. `https://doi.org/10.1155/2018/2726732`.

Refereed Conference Proceedings

14. Xue, J., **Ka, E.**, and Ukkusuri. S. V. (2024). Network Macroscopic Fundamental Diagram-Informed Graph Learning for Traffic State Imputation. *ISTTT25: 25th International Symposium on Transportation and Traffic Theory*, Ann Arbor, MI, United States.
13. **Ka, E.**, Xue, J., and Ukkusuri, S. V. (2024). PIDL-PedFlow: A Physics-Informed Deep Learning Approach for Macroscopic Continuum Pedestrian Flow Modelling. *103rd Annual Meeting of the Transportation Research Board*, Washington DC, United States.
12. Xue, J., **Ka, E.**, Mondal, W. U., and Ukkusuri, S. V. (2024). Generating Network-Level Dynamic Traffic Equations Using Symbolic Regression. *103rd Annual Meeting of the Transportation Research Board*, Washington DC, United States.
11. Sharma, S., and **Ka, E.** (2024). Leveraging Location-Based Data for Assessing Network Level Traffic Impact of Lane Management: A Case Study of Alex Fraser Bridge. *103rd Annual Meeting of the Transportation Research Board*, Washington DC, United States. [*The 3rd Journal in REFEREED JOURNAL PUBLICATIONS will be presented*].
10. **Ka, E.**, and Ukkusuri, S. V. (2023). Dynamic Routing Games for Connected and Autonomous Vehicles with Traffic Congestion: A Mean Field Game Approach. *2023 INFORMS Annual Meeting*, Phoenix, AZ, United States.
9. **Ka, E.**, Ka, D., Jung, Y., and Lee, C. (2020). A Cluster-Based Route Design of Multi-Capacity Vehicle in Large-Scale Demand Responsive Transport Service for the Disabled. *99th Annual Meeting of the Transportation Research Board*, Washington DC, United States.
8. **Ka, E.**, Hong, D., Na, Y., and Lee, C. (2018). Analysis of Status in DRT Service for the Disabled in Seoul and Comparison Domestic and Foreign Cases. *International Conference for Road Engineers*, Jeju, South Korea.
7. Hong, D., **Ka, E.**, Ha, S., and Lee, C. (2018). Selection of Appropriate Hyperparameter for Waiting Time Prediction Model for Demand Responsive Transport for the Disabled in Seoul Using Long Short-Term Memory (LSTM) Network. *78th Korean Society of Transportation Conference*, Wonju, South Korea. **[Outstanding Paper Award]**.
6. **Ka, E.**, Ha, S., Hong, J., and Lee, C. (2017). Application of Deep Learning for Demand Forecasting of Call Taxi for the Handicapped in Seoul. *77th Korean Society of Transportation Conference*, Seoul, South Korea.
5. **Ka, E.**, Kim, S., Hong, J., and Lee, C. (2017). A Preliminary Study of Comparison with Lane Changing Model Parameters in Merging Area between Normal and Raining Conditions. *12th International Conference of Eastern Asia's Society for Transportation Studies (EASTS)*, Ho Chi Minh, Vietnam.
4. **Ka, E.**, Woo, D., and Lee, C. (2016). The Importance of Demand Prediction for Vehicle Relocation Strategy Development in One-way Car-sharing System. *3rd International Conference on Computational Science and Engineering*, Ho Chi Minh, Vietnam.
3. **Ka, E.**, Kim, S., Woo, D., and Lee, C. (2016). An Estimation of Critical Gap for Gap Acceptance Model Applied to Lane Change of Surrounding Vehicles in Driving Simulator. *2016 Fall Korea Institute of ITS Conference*, Jeju, South Korea.

2. **Ka, E.**, Lee, S., Lee, J., and Lee, C. (2016). Comparison of Survival Model of Traffic Flow Deterioration due to Traffic Accident according to VDS Aggregation Level. *75th Korean Society of Transportation Conference*, Busan, South Korea.
1. Lee, S., Lee, H., Lee, J., **Ka, E.**, and Lee, C. (2016). Analysis of Traffic Flow Impacts of Highway Traffic Accidents Using Survival Analysis. *74th Korean Society of Transportation Conference*, Jeju, South Korea. **[Outstanding Paper Award]**.

Awards, Fellowships, & Grants

Crooks Travel Scholarship *$ 500* *Sep. 18, 2023*
Lyles School of Civil Engineering, Purdue University

Outstanding Paper Award *Mar. 10, 2018*
78th Conference of Korean Society of Transportation, Korean Society of Transportation

Lecture & Research Scholarship *$ 4,500* *Sep. 2016*
Dept. of Civil and Environmental Engineering, Seoul National University

Brain Korea 21 Plus Scholarship *$ 2,400* *Mar. 2016*
National Research Foundation of Korea

Need-based Scholarship *$ 500* *Mar. 01, 2016*
Dept. of Civil and Environmental Engineering, Seoul National University

Outstanding Paper Award *Feb. 19, 2016*
74th Conference of Korean Society of Transportation, Korean Society of Transportation

Alumni Association Scholarship *$ 3,000* *Oct. 25, 2015*
Alumni Association of Dept. of Civil Engineering, Seoul National University

Bronze Award *$ 400* *June 17, 2013*
6th Science and Technology Writing Excellent Research Paper Presentation Competition, College of Engineering, Seoul National University

Professional Activities

Referee Service

- **Journal Referee**:
  Transportation Research Record: Journal of the Transportation Research Board;
  Journal of Transportation Engineering, Part A: Systems;
  Data Science for Transportation
- **Conference Referee** :
  Transportation Research Board; IEEE Intelligent Transportation Systems Conference (ITSC); ISTTT25 (Co-reviewer)

Skills

Programming

- **Python (w/ TensorFlow, PyTorch, Keras, PySpark, and GeoPandas)**: Machine learning and deep learning models based on TensorFlow, Pytorch, and Keras; Massive data (e.g., mobile phone location data) preprocessing for trip data extraction based on PySpark and GeoPandas
- **R**: Time-series analysis; Data preprocessing; Data clustering; Data visualization; Discrete choice modeling; and Statistical analysis

- **Java (w/ CPLEX)**: Agent-based simulation (demand responsive transport services); Event-based simulation (one-way car-sharing services); Optimization models using the API of CPLEX

Software

MATLAB(w/ Simulink), CPLEX, SPSS, NLOGIT, TransCAD, VISSIM, LaTex, Windows, Linux (Ubuntu), and Mac OS