

# Eunhan Ka

POSTDOCTORAL RESEARCHER

Lyles School of Civil and Construction Engineering, Purdue University

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## Education

### Purdue University

United States

PH.D., LYLES SCHOOL OF CIVIL AND CONSTRUCTION ENGINEERING

Dec. 2025

- **Dissertation: Physics-Informed Neural Networks for Secure Connected and Autonomous Traffic Modeling**
- Committee: Satish V. Ukkusuri (Chair), Ludovic Leclercq, Yiheng Feng, Z. Berkay Celik
- Specialties: Physics-Informed Neural Networks, Traffic Dynamics, Network Resilience, User Behavior, Cybersecurity in Transportation Systems

### Seoul National University

South Korea

M.S., DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Feb. 2018

### Seoul National University

South Korea

B.S., DEPT. OF CIVIL AND ENVIRONMENTAL ENGINEERING

Feb. 2016

## Selected Publications & Awards

### Selected Publications

1. **Ka, E.** and Ukkusuri, S. V. (2025). Route Guidance Attacks in Cyber Transportation Networks: A User-Centered Study of Behavioral Sensitivity. *Transportation Research Part F: Traffic Psychology and Behaviour*, 115, 103354.
2. 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*, 189, 102996.
3. **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.
4. **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. [2022 Editor's Choice Collections]

### Selected Awards

1. **Google Cloud Research Credits** - Cloud computing grant, *Google Cloud*. Aug. 2025
2. **2025 ITE Great Lakes District Student Paper Award** - First Place in regional student paper competition, *Great Lakes District of ITE (GLITE)*. June 2025
3. **Honorable Mention, 2025 Clifford Spiegelman Student Paper Competition**, *The Transportation Statistics Interest Group of the American Statistical Association*. Jan. 2025
4. **Kinnier Graduate Scholarship & STV Civil Engineering Graduate Assistantship Endowment**, *Lyles School of Civil and Construction Engineering, Purdue University*. Oct. 2024

## Research Interests

Physics-informed and data-driven modeling of network traffic dynamics and resilience, integrating behavioral models, game theory, and scientific discovery across traffic engineering and machine learning.

- **Themes:** Network Traffic Dynamics, Network Resilience and Reliability, Large-Scale State Estimation, Connected and Autonomous Mobility, Transportation Cybersecurity, Human Behavior and Safety
- **Methods:** Physics-Informed Learning, Graph & Network Learning, Game-Theoretic Modeling, Symbolic Learning and Scientific Discovery, Optimization and Simulation, Spatiotemporal Data Analytics

## Research Experience

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### Postdoctoral Researcher

Jan. 2026 - Present

#### PURDUE UNIVERSITY, UNITED STATES

- Develop modeling and decision-support methods for **network resilience under compound climate and cyber disruptions**, quantifying disruption propagation, reliability loss, and recovery at the city scale.
- Build a **Resilient Mobility Digital Twin** that couples traffic-flow theory with physics-informed learning and data assimilation to estimate network states, quantify uncertainty, and forecast performance under disruptions.
- Design **behavior-aware threat and defense models** for connected/autonomous mobility (e.g., route guidance manipulation), enabling robust detection and mitigation focused on network-level outcomes.
- Develop **scalable algorithms and reproducible pipelines** (multi-resolution modeling and graph-based spatiotemporal inference) to support publication-quality evaluation and proposal-ready deliverables.

### Graduate Research Assistant

Aug. 2020 - Dec. 2025

#### PURDUE UNIVERSITY, UNITED STATES

- ed an integrated framework that enhances road network resilience against cyber threats using physics-informed deep learning for large-scale transportation cyber-physical systems, enabling more precise traffic state estimation (published in **Transportation Research Part B and Part C, 2024; Transportation Research Part F, 2025**). (Sponsor: USDOT University Transportation Center-TraCR)
- Conducted a statewide workforce needs assessment to identify skill gaps and designed training strategies to improve engagement and performance (presented at **Purdue Road School, Mar. 2025**). (Sponsor: INDOT)
- Analyzed network-level impacts of a movable median barrier on the Alex Fraser Bridge using mobile location data (Journal of Transportation Engineering, Part A, 2022; **Editor's Choice**). (Sponsor: Lindsay Corporation)
- Led **proposal development** and managed **project execution** from initiation through major milestones and closeout when applicable **in the capacity of a Graduate Research Assistant** under the supervision of Dr. Satish V. Ukkusuri (Principal Investigator). Engaged project information is as below:
  1. Attracting and Retaining the Transportation Workforce and At Risk Targeted Areas (Sponsor: INDOT. October 1, 2024 to September 30, 2026. \$225,000. Technical leadership share: 50%).
  2. A Multi Resolution Simulation Platform for Transportation System Security Testing and Evaluation (Sponsor: USDOT University Transportation Center TraCR. January 1, 2024 to December 31, 2024. \$340,000 including cost share. Technical leadership share: 25%).
  3. Training Gap Analysis for INDOT Workforce (Sponsor: INDOT. October 15, 2023 to October 14, 2025. \$213,500. Technical leadership share: 35%).

### Researcher

Mar. 2018 - Aug. 2020

#### SEOUL NATIONAL UNIVERSITY, SOUTH KOREA

- Designed cluster-based routes for demand-responsive transport using multi-capacity vehicles to serve passengers with disabilities (presented at **99th TRBAM**). (Sponsor: T-Money Welfare Foundation)
- Modeled lane-changing on freeways and gap-acceptance behavior at roundabouts using real-world data and virtual reality simulations (published in **Journal of Advanced Transportation, 2018**). (Sponsor: Ministry of Land, Infrastructure and Transport, South Korea)

### Graduate Research Assistant

Mar. 2016 - Feb. 2018

#### SEOUL NATIONAL UNIVERSITY, SOUTH KOREA

- Designed a real-time vehicle relocation strategy and an event-based simulation for one-way car-sharing services (presented at **multiple conferences, 2016-2018**). (Sponsor: National Research Foundation of Korea)
- Developed a methodology to evaluate driver behavior using surrogate safety measures (published in **Journal of Advanced Transportation, 2020**). (Sponsor: Ministry of Land, Infrastructure and Transport, South Korea)

## Publications

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### SUBMITTED FOR PUBLICATION

1. **Ka, E.**, Leclercq, L., and Ukkusuri, S. V. (Under Review). Adaptive Spatial-Temporal Domain Decomposition in Physics-Informed Neural Networks for Traffic State Estimation. *Transportation Research Part C: Emerging Technologies*.

2. **Ka, E.**, Mittal, S., and Ukkusuri, S. V. (Under Review). Investigating Career-Stage Variations in Skill Proficiency and Workforce Development Support at a State Department of Transportation. *Journal of Transportation Engineering, Part A: Systems*.
3. **Ka, E.** and Ukkusuri, S. V. (In Revision). Driver Behavior-Aware Resilience of Traffic Networks under Route Guidance Attacks. *Transportmetrica B: Transport Dynamics*.
4. **Ka, E.**, Yeke, D., Celik, Z. B., and Ukkusuri, S. V. (Under Review). Fake Rush Hour: Exploring Bounded-Rational Route Guidance Attacks on Urban Navigation Systems. *47th IEEE Symposium on Security and Privacy*.

## REFEREED JOURNAL PUBLICATIONS

1. **Ka, E.** and Ukkusuri, S. V. (2025). Route Guidance Attacks in Cyber Transportation Networks: A User-Centered Study of Behavioral Sensitivity. *Transportation Research Part F: Traffic Psychology and Behaviour*, 115, 103354.
2. Ukkusuri, S. V.\*, Hamim, O. F.\*, Lei, Z. \*, **Ka, E. \***, Salek, M. S., Chowdhury, M., Amini, M. H., Cardenas, A., and Thuraisingham B. (2025). Cybersecurity for Next-Generation Road Transportation: A Review. *ACM Journal on Autonomous Transportation Systems*. (\*Contributed equally to this research).
3. 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*, 189, 102996.
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.
5. **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. **[2022 Editor's Choice Collections]**
6. **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(1), 7525721.
7. 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(1), 2726732.

## REFEREED CONFERENCE PROCEEDINGS

1. **Ka, E.** and Ukkusuri, S. V. (2025). Analytical Framework for Network-Level Traffic Flow under Route Guidance Attacks: An Extension of the Generalized Bathtub Model. *104th Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
2. **Ka, E.** and Ukkusuri, S. V. (2025). Comparative Analysis of Sampling Methods in Physics-Informed Neural Networks for Traffic State Estimation in Large-Scale Road Networks. *104th Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
3. **Ka, E.**, and Ukkusuri, S. V. (2024). Impact of Cyber Attacks on Traffic State Estimation for Connected and Autonomous Vehicles Systems. *The Inaugural USDOT Future of Transportation (FoT) Summit*, Washington, D.C., United States.
4. 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.
5. **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, D.C., United States.
6. 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, D.C., United States.
7. 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, D.C., United States.
8. **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, D.C., United States.
10. **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.
11. 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]**.
12. **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.
13. **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.
14. 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]**.

#### BOOKS AND TECHNICAL REPORTS

1. **Ka, E.** and Ukkusuri, S. V. (In Revision). Misdirected Guidance and Urban Traffic Network Resilience (*Book Title: Advances in Transportation Cybersecurity and Resilience*). *World Scientific Publishing*.
2. Hamim, O. F., Lei, Z., **Ka, E.**, and Ukkusuri, S. V. (In Revision). Understanding Cyber Threats in Cyber-Physical Mobility Systems (*Book Title: Advances in Transportation Cybersecurity and Resilience*). *World Scientific Publishing*.
3. Verma, R., Luo, H., Deodhar, S., **Ka, E.**, Chahine, R., Natu, P., Malhotra, H., Polisetty, V., Thakkar, D. J., Ukkusuri, S. V., Cai, H., Dunlop, S. R., Iyer, A. V., Gkritza, K. (2023). Forecasting Shifts in Hoosiers' Travel Demand and Behavior. *FHWA/IN/JTRP-2023/28, SPR-4608*.

#### Awards, Fellowships & Grants

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<b>Google Cloud Research Credits (Cloud Computing Grant)</b> Google Cloud	Aug. 2025
<b>2025 ITE Great Lakes District Student Paper Award &amp; GLITE Endowment Fund</b> Great Lakes District of Institute of Transportation Engineers (GLITE)	June 2025
<b>Honorable Mention, 2025 Clifford Spiegelman Student Paper Competition</b> The Transportation Statistics Interest Group of the American Statistical Association	Jan. 2025
<b>2025 KOTAA Travel Grant Award</b> Korean Transportation Association in America (KOTAA)	Jan. 2025
<b>Travel Grant</b> Purdue Graduate Student Government and the Graduate School	Dec. 2024
<b>Student Paper Award</b> ITE Indiana	Dec. 2024
<b>Kinnier Graduate Scholarship</b> Lyles School of Civil and Construction Engineering, Purdue University	Oct. 2024
<b>STV Civil Engineering Graduate Assistantship Endowment</b> Lyles School of Civil and Construction Engineering, Purdue University	Oct. 2024
<b>2024 KOTAA Travel Grant Award</b> Korean Transportation Association in America (KOTAA)	Jan. 2024
<b>Crooks Travel Scholarship</b> Lyles School of Civil Engineering, Purdue University	Sep. 2023
<b>Outstanding Paper Award</b> 78th Conference of Korean Society of Transportation, Korean Society of Transportation	Mar. 2018

## Outstanding Paper Award

Feb. 2016

74th Conference of Korean Society of Transportation, Korean Society of Transportation

## Presentations - Keynotes, Plenary Talks, Invited Seminars

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1. Needs and Gap Assessment of INDOT Workforce Development. *2025 Purdue Road School Transportation Conference and Expo*. March 18, 2025.
2. A Physics-Informed Machine Learning for Generalized Bathtub Model in Large-Scale Urban Networks. *TRBACP50 Committee on Traffic Flow Theory and Characteristics General Webinar Series*. March 17, 2023.

## Teaching & Mentoring Experience

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### Undergraduate Mentorship

Fall 2024 - Spring 2025

LYLES SCHOOL OF CIVIL AND CONSTRUCTION ENGINEERING, PURDUE UNIVERSITY

- Akshit Kumar Bedi, Abrar Ali (resulting in a **poster presentation**, 2025 CERIAS Cybersecurity Symposium)

### Teaching Assistant

Spring 2021 - Fall 2024

LYLES SCHOOL OF CIVIL AND CONSTRUCTION ENGINEERING, PURDUE UNIVERSITY

- CE 661: Algorithms in Transportation (*Graduate; co-developed new course curriculum*) Fall 2024
- CE 597: Network Models for Connected and Autonomous Vehicles (Graduate) Fall 2021 - Fall 2023
- CE 597: Smart Logistics (Graduate) Fall 2021, Fall 2024
- CE 597: Data Science for Smart Cities (Graduate) (*Developed online course on edX*) Spring 2021, Fall 2023

### Lecturer

Fall 2019

DEPT. OF CIVIL AND ENVIRONMENTAL ENGINEERING, SEOUL NATIONAL UNIVERSITY

- Introduction to Civil and Environmental Engineering (Undergraduate)

### Teaching Assistant

Fall 2016 - Fall 2017

DEPT. OF CIVIL AND ENVIRONMENTAL ENGINEERING, SEOUL NATIONAL UNIVERSITY

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

## Academic Service and Professional Activities

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### ACADEMIC SERVICE

- **Journal Referee:** Transportation Research Part B: Methodological; Transportation Research Part C: Emerging Technologies; Transportation Research Part F: Traffic Psychology and Behaviour; Transportation Research Interdisciplinary Perspectives; Transportation; Scientific Reports; The Journal of Supercomputing; Journal of Cloud Computing; 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); ISTTT26 (Co-reviewer)

### PROFESSIONAL ACTIVITIES

- **Association for Computing Machinery (ACM):** Professional Member (Aug. 2025 - Current)
- **American Society of Civil Engineers (ASCE):** Associate Member (May 2025 - Current); Student Member (Sep. 2022 - Apr. 2025); **AI Committee:** Corresponding Member (Aug. 2025 - Current)
- **Institute of Electrical and Electronics Engineers (IEEE):** Student Member (May 2025 - Current)
- **Institute for Operations Research and the Management Sciences (INFORMS):** Student Member (May 2023 - Current)
- **Institute of Transportation Engineers (ITE) Purdue Student Chapter:** Communications Director (Aug. 2024 - July 2025); Member (Aug. 2020 - Current)

## Technical Skills

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### PROGRAMMING

- **Python (with 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 (with 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, CPLEX, SPSS, NLOGIT, TransCAD, LaTeX

### References

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**Satish V. Ukkusuri** (Advisor)

Hubert and Audrey Kleasen Professor,  
Lyles School of Civil and Construction  
Engineering; courtesy appointment in Computer  
Science,  
Purdue University  
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Department of Computer Science,  
Purdue University  
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**Yiheng Feng**

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Engineering,  
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