NSF IRES: AI ANALYTICS

in

Smart Transportation

Learn the fundamentals of AI and analytics pertaining to smart transportation

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National Science Foundation International Research Experiences for Students
Advanced Transportation Infrastructure Informatics Institute (ATI^3)

Overview

A revolutionary shift in smart transportation has been catalyzed by the transition from a reactive to a proactive approach, fundamentally driven by the adaptive capabilities of Artificial Intelligence (AI). This shift has not only triggered a proliferation of innovative transportation solutions but has also significantly enhanced their accessibility to the public use of real-time decision-making processes. Acknowledging the multifaceted, interconnected, and user-centered mixed mobility scenarios, there is an imperative need to incorporate digital intelligence into the existing infrastructure frameworks, aiming to form a transportation system that is more efficient, more responsive, and capable of adapting to evolving demands.

In response to the urgent concern, the Advanced Transportation Infrastructure Informatics Institute (ATI³) has been launched at the Korea Advanced Institute of Science and Technology (KAIST) in South Korea. Structured as a three-year series, the program is dedicated to pioneering research in smart transportation, emphasizing AI analytics, AI-driven decision-making, and AI-empowered simulation. Its objective is to cultivate a future workforce proficient in intelligent transportation planning and advanced AI techniques, while simultaneously elevating critical thinking and problem-solving abilities through applied real-world data analytics.

IRES fellows from diverse disciplines will immerse themselves in an enriching international action-learning research environment at KAIST. Each ATI³ program at KAIST is meticulously designed to be both incremental and transformative, thereby steering the future trajectory of transportation. Consequently, our student recruitment strategies are carefully devised to attract a diverse yet highly competitive pool of students and institutions. As a cornerstone of their academic and professional development, ATI³ promises to be an invaluable resource for IRES fellows, empowering them to impact society through contributions to global transportation solutions and policy-making across both professional and academic spheres.

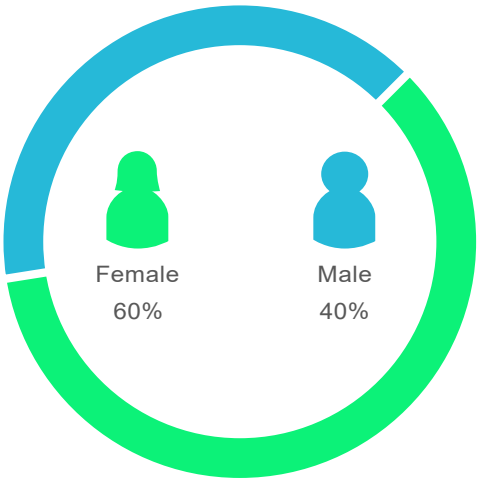
NSF IRES US-KOREA BY THE NUMBERS

According to the 2023 Global Innovation Index (GII), South Korea was ranked among the top ten most innovative countries worldwide. One notable institution contributing to this achievement is the “AI x Mobility” lab, led by Dr. Hwasoo Yeo at KAIST. The lab has gained international recognition for its expertise and pioneering research in data-driven AI modeling, smart city applications, and autonomous vehicles.

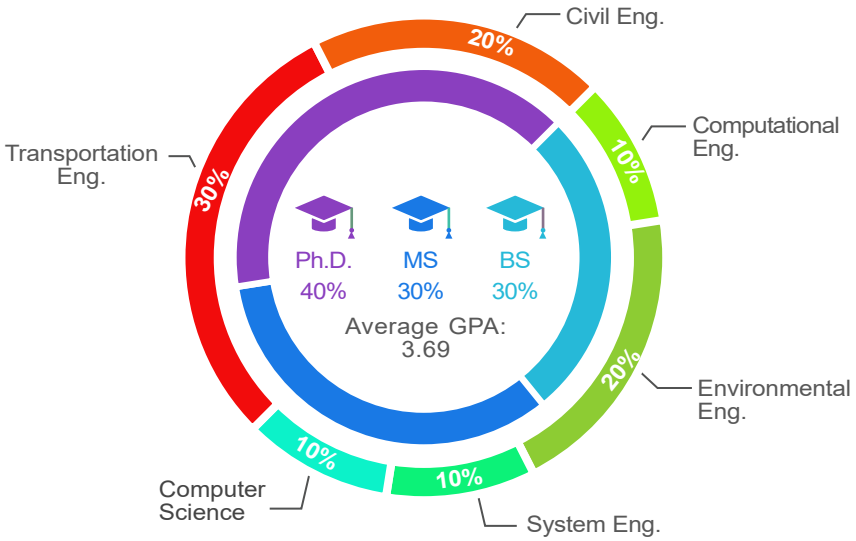
KAIST is hosting the NSF IRES US-Korea ATI³ program, which aims to provide potentially transformative action-learning experiences. This program follows a student-centered approach, allowing students to gain knowledge about a specific research topic by collaborating in groups to solve open-ended problems. Each group comprises two IRES fellows and one KAIST local student who will collaboratively work on research projects addressing identified questions and problems.

PARTICIPANT PROFILE

Demographics



Education



Research Expertise

Selected IRES fellow students have a wide variety of expertise and research interests in:

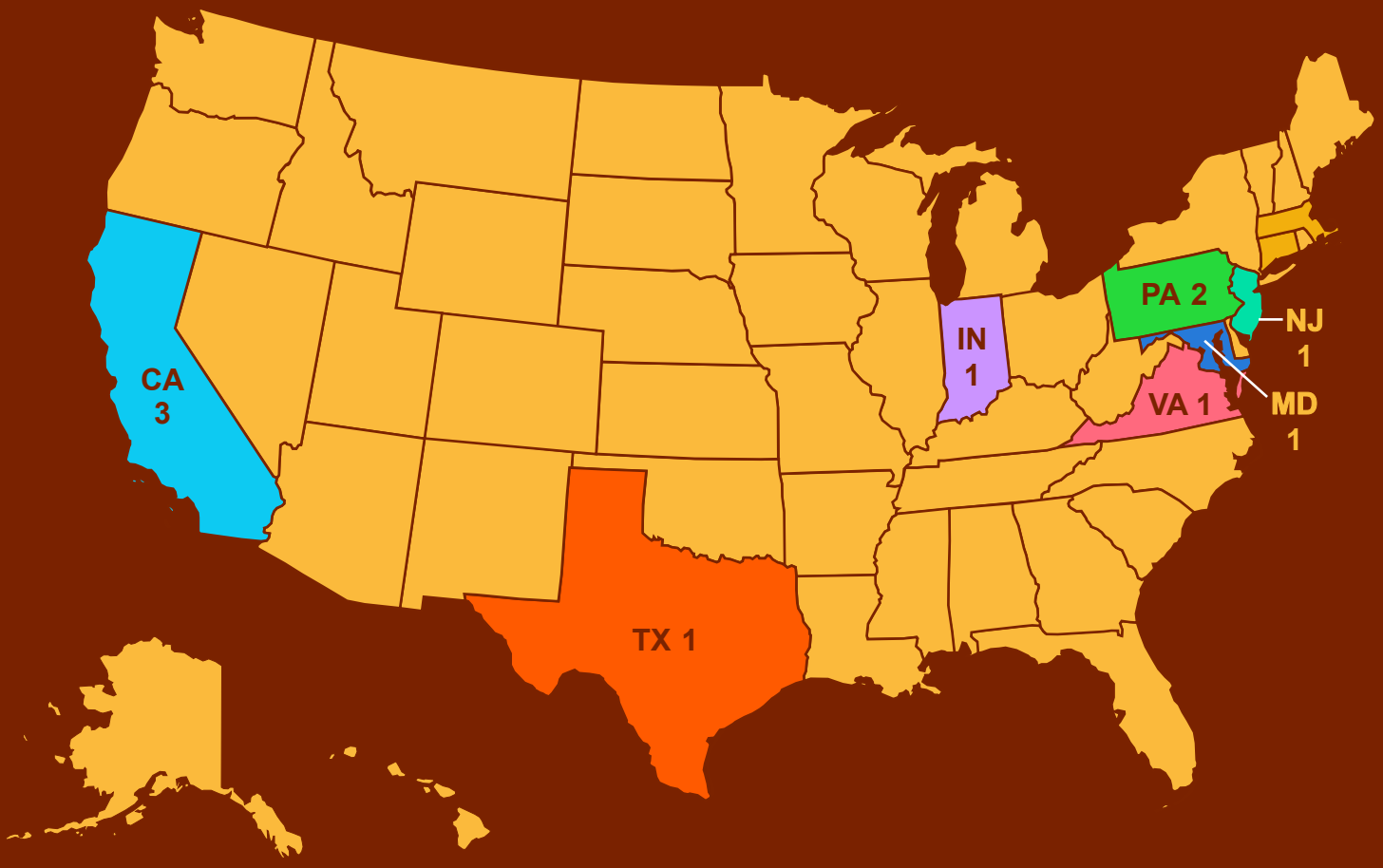
- Quadrupedal robotics
- VR-based modeling
- Cyber-human interaction
- AV simulations
- AI-empowered simulation
- Transportation equity
- Micro transit system
- Sustainable transportation
- AV system control
- Urban planning regulations
- ML video analytics
- Information security
- Transportation safety
- Network analysis
- Traffic mobility resilience

Participants Skillsets

Selected IRES fellow students possess the following skill sets:

- Scikit-learn and matplotlib
- OpenCV
- Advanced data visualization
- Autodesk software
- Advanced GIS
- Advanced NLP
- PTV-Vissim & SUMO
- Python network modeling
- Gazebo
- Data security & integrity
- Natural hazard mitigation methods
- Energy efficiency analysis

PARTICIPANT ORIGIN



PURDUE UNIVERSITY · VIRGINIA TECH · TEXAS The University of Texas at Austin · Berkeley UNIVERSITY OF CALIFORNIA · Penn University of Pennsylvania · JOHNS HOPKINS UNIVERSITY · NJIT New Jersey Institute of Technology

YOUR LEARNING JOURNEY

This course is designed to support your pursuit of professional degrees by providing you with a comprehensive skill set. In addition to acquiring theoretical foundations in AI, the program offers advanced, practical training in the emerging field of AI and transportation analytics, with a specific emphasis on machine learning and simulation modeling techniques. The primary objective of this course is to develop and evaluate integrated decision-support simulation models capable of improving the accuracy and reliability of the mobility and safety impact assessments. Throughout the course, you will encounter real-life challenges that require your ingenuity and problem-solving skills. By the end of the program, you will be equipped to apply these techniques to your own research area. The course aims to empower you with the knowledge and expertise necessary to tackle complex problems and contribute to advancements in the field.

Week 1 Fundamentals of AI & AI Analytics Part I

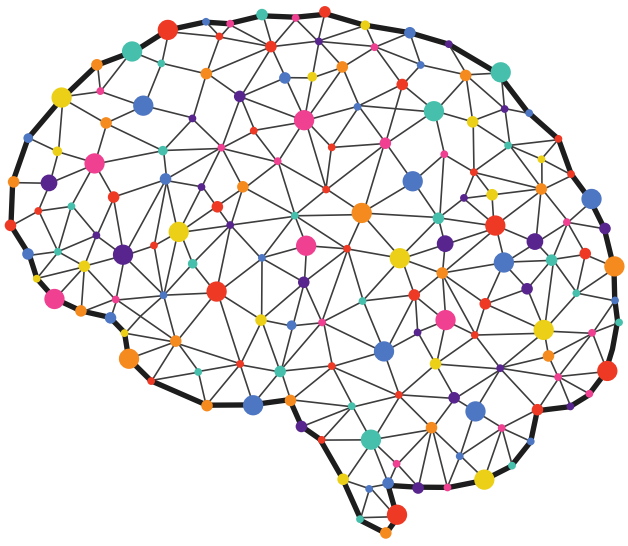
- Machine Learning Basic
- Regression, SVM, and Classification
- RNN/LSTM
- AI-based Transportation Analytics
- ITS Applications

Week 2 AI Analytics Part II & Simulations

- RNN+CNN
- Traffic Theory Simulation
- Transportation Analytics
- SUMO Simulation Exercise
- ITS Applications

Week 3 AI Digital Twins & Decision Making

- Digital Twin Applications
- Traffic Prediction and Control
- AV Control
- Road Pavement Analytics
- Pedestrian Travel Behavior Applications



STUDENT LEARNING OUTCOMES

Critical thinking and creativity

Develop unique ideas that can significantly contribute to the existing knowledge and practice.

- Learn the fundamental techniques of machine learning and simulation modeling
- Summarize existing knowledge and find areas that can still be improved
- Find logical and innovative ways to contribute to the existing knowledge

Requirement #1: Develop a research proposal.

Ability to solve complex problems

Demonstrate the ability to solve complex problems through problem-based research-oriented learning.

- Compare the ability of different methods to improve simulation accuracy and performance
- Make better predictions, based on your simulation results and desired outcome
- Use the right approaches to deal with computational complexity

Requirement #3: Deliver a final research paper.

Knowledge of real-world issues

Have a working knowledge of current issues through community involvement.

- Ask the right research question
- Know which tools to use to answer the question
- Use appropriate simulation methods to extract answers from the results

Requirement #2: Provide an interim presentation.

Transformational Learning

COURSE TIMELINE

Week 1

Program Lead

Dr. Choi

Dr. Yeo

Dr. Zhang

June 24th — First Day of Program

June 24th — Course Overview & Team Formulation

June 24-26th — 1 — Fundamentals of AI & AI Analytics Part I

June 27th — Proposal Presentation & Field Trip I

June 28th — Reading Day

Week 2

Program Lead

Dr. Yeo

Dr. Kim

July 1-3rd — 2 — AI Analytics Part II & Simulations

July 4th — Field Trip II

July 5th — Reading Day

Week 3

Program Lead

Dr. Yeo

Dr. Lee

Dr. Lim

Dr. Choi

July 8-10th — 3 — AI Digital Twins & Decision Making

July 10th — Research Paper Due

July 11th — Final Presentation & Award Ceremony

Post-Program Followup — Revisions and Publications

Note: NSF-IRES Program reserves the right to change the curriculum and delivery of the program to improve the participant experience.

CALENDAR OF ACTIVITIES

Note: This is a tentative schedule and is subject to change at the discretion of the NSF IRES program faculty.

Lecture Date	Session 1 9:00-9:50	Session 2 10:00-10:50	Session 3 11:00-11:50	Afternoon Project Session
Week 1	**Fundamentals of AI & AI Analytics Part I**			
June 24 (Mon)	Introduction to Course & Teaming (KC)	Making the Most of Your Presentation (KC)	Research Formulation (KC)	Campus Tour & Social Mixer (KC)
June 25 (Tue)	Introduction to Machine Learning (HY)	Regression, SVM, and Classification (HY)	Machine Learning Exercise (HK)	Research
June 26 (Wed)	AI-Based Analytics 1 (YZ)	AI-Based Analytics 2 (YZ)	Guest Lecture: Traffic Analytics 1 (Dr. Sunghoon Kim)	Research
June 27 (Thu)	Proposal Presentation & Field Trip: Daejeon Central Market			
Week 2	**AI Analytics Part II & Simulations**			
July 1 (Mon)	Deep Learning Basics (HY)	RNN & CNN (HY)	Deep Learning Exercise (HK)	Research
July 2 (Tue)	RNN & CNN Exercise (HK)	Traffic Theory and Simulation (HY)	Guest Lecture: Traffic Analytics 2 (Dr. Sehyun Tak)	Research
July 3 (Wed)	Traffic Analytics Exercise (HC)	Sumo Exercise 1 (IK)	Sumo Exercise 2 (IK)	Research
July 4 (Thu)	Field Trip: TBA			
Week 3	**AI Digital Twins & Decision Making**			
July 8 (Mon)	Digital Twin and Traffic Applications (HY)	Traffic Prediction and Simulations (YK)	Traffic Prediction Exercise (HK)	Research
July 9 (Tue)	Public Transit Data Analysis 1 (JL)	Public Transit Data Analysis 2 (JL)	Public Transit Data Analysis Exercise (JL)	Research
July 10 (Wed)	Pedestrian Travel Behavior (LL)	AV Behavior Modeling 1 (HPY)	AV Behavior Modeling 2 (HPY)	Research
July 11 (Thu)	Final Presentation & Commencement Ceremony (All Faculty Members & Students Led by KC)			

Professors:	*Dr. Kunhee Choi (KC)* *Dr. Inhi Kim (IK)*	*Dr. Hwasoo Yeo (HY)* *Dr. Jinwoo Lee (JL)*	*Dr. Yunlong Zhang (YZ)* *Dr. Lisa Lim (LL)*
Mentors:	*Dr. Yeeun Kim (YK)*	*Dr. Hwapyeong Yu (HPY)*	
TAs:	*Hyunsoo Kim (HK)*	*Haechan Cho (HC)*	

RESEARCH THEME: FUTURE OF WORK

In line with McKinsey's report on the Future of Work (available at *https://www.mckinsey.com/featured-insights/future-of-work*), this year's research theme aligns perfectly with one of the NSF's 10 Big Ideas: **Future of Work at the Human-Technology Frontier (FW-HTF)**. Student teams will focus on timely topics within the umbrella theme of FW-HTF in smart transportation.

Intelligent transportation is undergoing significant technological transformations due to rapid advancements in AI and technology. This affects various workers, such as planners, engineers, policy decision-makers, daily commuters, and job-site crews. It's crucial to understand how these evolving technologies shape their lives, while also recognizing that individuals have the power to shape these technologies within their work context.

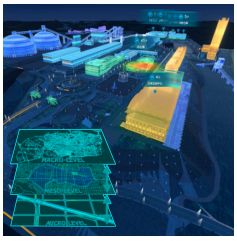
The future of work in intelligent transportation requires a collaborative trans-disciplinary approach that includes researchers from engineering, social science, management, and computer science. This also explains the core strategy of our student recruitment plan for the NSF IRES US-Korea program. By leveraging scientific findings, we can inform evidence-based policies, shape technological developments, and/or implement strategies that provide equitable opportunities for workers. Toward this end, your research project aims to provide valuable insights into the convergence of technology and human interactions in the workplace of intelligent transportation.

Proposed Research Topics

Each research team is asked to develop a research synthesis paper that explores the theme of **FW-HTF**, such as the followings:

1

Digital Twinning Infrastructure



State-of-practice of digital twinning technologies for transportation infrastructure

2

Advanced Air Mobility

Future of advanced air mobility

3

Smart City Transportation

Future of smart city and transportation-trends, obstacles, and potential benefits

4

AV & Public Transportation

Impact of autonomous vehicle (AV) on public transportation and business enterprises

5

Human-in-the-Loop (HITL)

HITL-ChatGPT partnership toward improving the level of prediction confidence

PROGRAM FACULTY

The US-Korea ATI[3] team is uniquely well-prepared to undertake this NSF IRES program because of their extensive and successful track record in smart transportation research and education. These efforts include a longstanding collaboration with state transportation agencies, involving collection of massive amounts of traffic sensor data, generating pilot models, developing and testing machine-learning algorithms, implementing developed algorithms in traffic simulation models, and incorporation of these research findings into the classroom. Each of the program faculty is widely regarded as a dedicated teacher and educator who works tirelessly to foster a next-generation workforce equipped with the tools and skills necessary to accelerate the discovery and development of advanced solutions.

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Dr. Lisa Lim
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CERTIFICATE

Earn recognition! After successfully completing the program, participants of the NSF IRES US-Korea program will be awarded a Certificate of NSF IRES Fellowship, acknowledging their accomplishment. The program is graded on a scale of A to F, and participants must achieve a grade of "B" or higher to qualify for the certificate of fellowship.

To celebrate outstanding performance, a special **Best Paper Award** ceremony will be held to honor the highest achieving students, who will receive an honorarium in recognition of their exceptional dedication and achievements.

Advanced Transportation Infrastructure Informatics Institute (ATI^3)

Sponsored by
National Science Foundation

DURATION

June 24 - July 11
3 weeks
4 days per week
3 hours per day

LOCATION

KAIST, Daejeon,
South Korea

TRAVEL SUPPORT

$2,300 + Lodging+
Field Trip

"We develop a diverse, globally engaged workforce with world-class skills."

- NSF IRES Program -