# 2021 CAMMSE Virtual Research Symposium

# FINAL PROGRAM

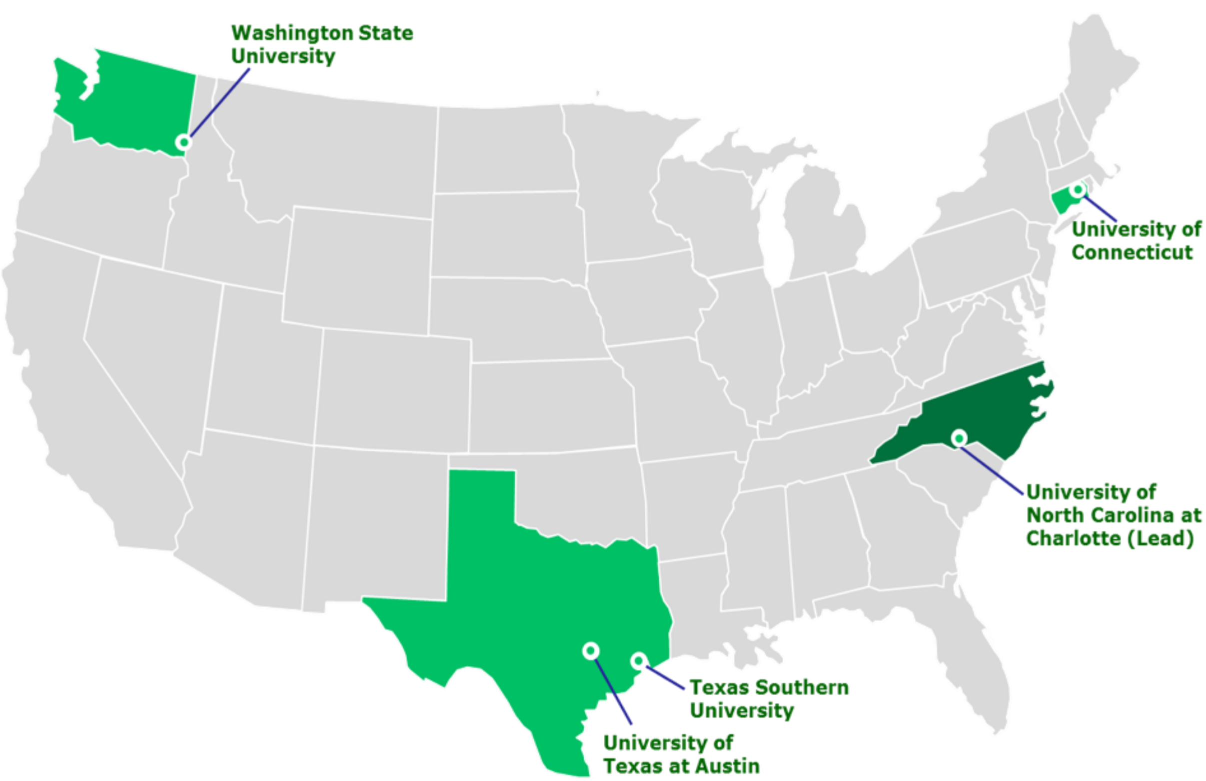
November 4-5, 2021

Charlotte, NC, USA

**Center for Advanced Multimodal Mobility Solutions and Education**

A Consortium of Five Universities:

The University of North Carolina at Charlotte (Lead)
The University of Texas at Austin
University of Connecticut
Washington State University
Texas Southern University



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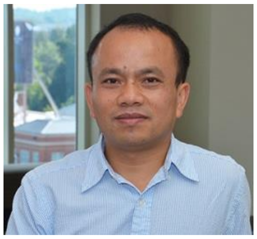


**Welcome Message from CAMMSE Director**

It is truly an honor to welcome you, our dear CAMMSE family members, colleagues and friends, and general participants that are coming from the Northwest, Southwest, and Northeast to the Southeast part of the country. Even though we are unable to meet in person during this unprecedented time, I am truly glad that we can still hold this important event remotely! Thank you for attending our Fourth Annual CAMMSE Research Symposium with the main purpose to share results and findings of recent and ongoing research funded by the Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE). CAMMSE is a six year multi-campus Tier 1 University Transportation Center (UTC) funded by USDOT that began operations in November 2016 under the FAST ACT. We are a consortium of five universities, including The University of North Carolina at Charlotte (UNCC) as the lead, the University of Texas at Austin (UT Austin), the University of Connecticut (UConn), Washington State University – Pullman (WSU), and Texas Southern University (TSU) each with unique records as education and research hubs engaging diverse populations and nurturing the success of our students. The main focus or theme of CAMMSE is to address the FAST Act research priority area of "***Improving Mobility of People and Goods***" by conducting multi-disciplinary, multi-modal research, education and workforce development, and technology transfer. It has already been almost five years since CAMMSE was established at UNCC back in November 2016 and significant progress has been made in all activities, including research, education and workforce development, and technology transfer. I am confident that this symposium will provide a great opportunity for CAMMSE researchers, graduate students, and the community at-large who are interested in multimodal mobility to share their recent and on-going research in multimodal mobility solutions.

This booklet provides the symposium program and general information we hope is useful to you as you explore the event. We have two outstanding keynote lectures. The morning keynote is on "Near Term Steps to Accelerate Deep Decarbonization of United States Transportation" by Dr. Chris Hendrickson of Carnegie Mellon University. And an afternoon keynote lecture on "Forecasting and Estimating Transportation Metrics in the COVID-19 and CAV Era" by Dr. Laurence Rilett of Auburn University. We also have one invited speakers' session on the Connected and Automated Vehicles in the afternoon, in which four excellent invited speakers, including Dr. Jianming Ma of Texas Department of Transportation, Dr. Xuesong Zhou of Arizona State University, Dr. Lili Du of University of Florida, and Dr. Brian Park of University of Virginia, will present and generously share their expertise and knowledge. The one and a half day program also includes three technical sessions and two student lightning presentation sessions. On the first day, the morning sessions will be on "emerging mobility services, planning and operations" and "improving multimodal mobility and equity using data analytics", and the afternoon session will focus on "connected and autonomous vehicle and machine learning applications". On the second day, we will have two graduate student lightning presentation sessions where we hope students and faculty can engage in productive discussions with constructive feedback to our students. All keynote presentations, invited speakers' session and technical sessions will offer Professional Development Hours (PDHs).

In closing, I hope that this virtual event will provide an opportunity to exchange ideas, foster collaborations, and generate new ideas. Participants from industry and the government are highly encouraged as they will further enable opportunities for technology transfer. On behalf of the symposium organizing committee, we are glad to have you join us and I hope that you will enjoy this symposium. Thank you very much and again and stay safe!

Sincerely,

Wei (David) Fan

# Symposium Planning Committees

**General and Technical Chair:** Dr. Wei Fan, UNC Charlotte

**Organizing and Planning Committee:**

Dr. Wei Fan, UNC Charlotte

Dr. Martin Kane, UNC Charlotte

Dr. David Weggel, UNC Charlotte

Ms. Kim Wilson, UNC Charlotte

**Student Lightning Session Committee:**

Dr. Wei Fan, UNC Charlotte

Mr. Li Song, UNC Charlotte

Mr. Shaojie Liu, UNC Charlotte

**Technical Support:**

Mr. Shaojie Liu, UNC Charlotte

Mr. Li Song, UNC Charlotte

## Fourth Annual CAMMSE Research Symposium - FINAL PROGRAM

**Day 1:** Thursday, November 4 (8:00AM-5:00PM)

8:00-8:15AM **Welcome and Opening Remarks** (Moderator: Dr. Wei Fan)
8:00-8:10AM **Dr. Robert S. Keynton**, Dean, College of Engineering, UNCC
8:10-8:15AM Dr. Wei Fan, CAMMSE Director

8:15-8:55AM **Keynote Presentation No. 1** (Moderator: Dr. Wei Fan)
Title: **"Near Term Steps to Accelerate Deep Decarbonization of United States Transportation"**
Speaker: **Dr. Chris Hendrickson**, Carnegie Mellon University

**Registration Link:** https://uncc.zoom.us/webinar/register/WN_QwrGh7NhT3qVjlI4P8oYeg
**Notes: Participants can join this Zoom meeting as early as 7:45 AM (EDT); however, our symposium will not start until 8:00 AM (EDT).**

8:55-9:00AM **Break**

9:00-10:20AM **Technical Session #1: *Emerging Mobility Services, Planning and Operations***
*Moderator: Dr. John Ivan, University of Connecticut*

"Developing Smart Traffic Signal Control"
Speaker: Randy Machemehl, Ph.D., P.E., University of Texas at Austin

"Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors"
Speaker: John Ivan, Ph.D., P.E., University of Connecticut

"An Innovative Signal Timing Strategy for Implementing Contraflow Left-Turn Lanes at Signalized Intersections with Split Phasing"
Speaker: Dr. Yi Qi, Texas Southern University

"Exploring the Impacts of Transportation System on Human Behaviors during Disasters using Mobility Data"
Speaker: Jin Zhu, Ph.D., University of Connecticut

**Registration Link:** https://uncc.zoom.us/webinar/register/WN_jG1Rse1gRWmD9KSjS168fw
**Notes: Participants can join this Zoom meeting as early as 8:45 AM (EDT); however, our symposium will not start until 9:00 AM (EDT).**

10:20-10:30AM **Break**

10:30-11:50AM **Technical Session #2: *Improving Multimodal Mobility and Equity Using Data Analytics***
*Moderator: Dr. Yi Qi, Texas Southern University*

"Captive Drivers & Choice Riders: The Overlooked Constituencies in Transportation Planning"
Speaker: Carol Atkinson-Palombo, Ph.D., University of Connecticut

"Modeling and Evaluating Public Transit Equity and Accessibility by Integrating General Transit Feed Specification Data"

Speaker: Wei (David) Fan, Ph.D., P.E., University of North Carolina at Charlotte

"Using Computational Biology to Mitigate Path Overlap in Transit Assignment"
Speaker: Timothy James Becker, Ph.D., University of Hartford

"Analysis of Intermodal Vessel-to-Rail Connectivity"
Speaker: Mehdi Azimi, Ph.D., P.E., Texas Southern University

**Registration Link:** https://uncc.zoom.us/webinar/register/WN_fauBxqWSTfaVKA2gconhkw
**Notes: Participants can join this Zoom meeting at 10:15 AM (EDT); however, this second technical session will not start until 10:30 AM (EDT).**

11:50AM-1:00PM **Lunch**

1:00-1:40PM **Keynote Presentation No. 2** (Moderator: Dr. Wei Fan)
Title: **"Forecasting and Estimating Transportation Metrics in the COVID-19 and CAV Era"**
Speaker: **Dr. Laurence Rilett**, Auburn University

1:40-1:45PM **Break**

1:45-3:20PM **Invited Speakers' Session: *Connected and Automated Vehicles***
*Moderator: Dr. Wei Fan, University of North Carolina at Charlotte*

"Texas Connected Freight Corridors"
Speaker: Jianming Ma, Ph.D., P.E., Texas Department of Transportation

"CAV Modeling Rising Up with Digital Twin: Transforming the Interconnection between Open data, Researchers and City Planners"
Speaker: Xuesong Zhou, Ph.D., Arizona State University

"System Optimal Vehicle Platooning Control for Eco-driving at Signalized intersection Built upon Hybrid MPC System, Online Learning and Distributed Optimization"
Speaker: Lili Du, Ph.D., University of Florida

"Cooperative Platooning along with Human Driven Vehicles"
Speaker: B. Brian Park, Ph.D., University of Virginia

**Registration Link:** https://uncc.zoom.us/webinar/register/WN__NOsuZfJSI-pcBZBnnMTQg
**Notes: Participants can join this Zoom meeting at 12:45 PM (EDT); however, this second technical session will not start until 1:00 PM (EDT).**

3:20-3:30PM **Break**

3:30-4:50PM **Technical Session #3: *Connected and Autonomous Vehicle and Machine Learning Applications***
*Moderator: Dr. Randy Machemehl, University of Texas at Austin*

"Two-stage Robust Facility Location Problem with Drones"
Speaker: Stephen Boyles, Ph.D., University of Texas at Austin

"Effect of Multimodal Connected Vehicle App on Transit Stop Catchment Area"
Speaker: Xianming Shi, Ph.D., P.E, Washington State University

"Skeleton-Graph: Long-Term 3D Motion Prediction from 2D Observations Using Deep Spatio-Temporal Graph CNNs"
Speaker: Claudel Christian, Ph.D., University of Texas at Austin

"Effect of Connected and Autonomous Vehicles on Supply Chain Performance"
Speaker: Ji Yun Lee, Ph.D., Washington State University

4:50-5:00PM **Recap of Day 1** (*Dr. Wei Fan, CAMMSE Director*)

**Registration Link:** https://uncc.zoom.us/webinar/register/WN_PBb1ymuoQ6-Vht5X9hHmLg
**Notes: Participants can join this Zoom meeting at 3:15 PM (EDT); however, this third technical session will not start until 3:30 PM (EDT).**

5:00PM **End of Day 1**

**Notes:** - End of Day 1 marks the end the keynotes and faculty presentations component of the CAMMSE Research Symposium. Student research presentations will be offered in Day 2.

**Day 2:** Friday, November 5 (8:00AM-12:00PM)

8:00-8:05AM **Opening Remarks** (*Dr. Wei Fan, CAMMSE Director*)

8:05-9:35AM **Student Lightning Presentations: Session #1**
*Moderator: Mr. Li Song, University of North Carolina at Charlotte*
(*See Student Lightning section in Page 29 of this booklet for more information on presentation titles. For the abstracts see pages 31 to 39.*).

9:35-9:45AM **Break**

9:45-11:15AM **Student Lightning Presentations: Session #2**
*Moderator: Mr. Shaojie Liu, University of North Carolina at Charlotte*
(*See Student Lightning section in Page 29 of this booklet for more information on presentation titles. For the abstracts see pages 40 to 48.*).

11:15 -11:30AM **Break**

11:30-11:50AM **Student Awards Ceremony**
**Notes:** - Announcement of Student Lightning Presentation Awards (Top 8) will be made.

11:50-12:00PM **Closing Remarks** (*Dr. Wei Fan, CAMMSE Director*)

12:00PM **Conference Ends**

**Registration Link:** https://uncc.zoom.us/webinar/register/WN_75sm396_SKuJtogKSwgSSA
**Notes: Participants can join this Zoom meeting as early as 7:45 AM (EDT); however, our symposium will not start until 8:00 AM (EDT).**

# 2021 CAMMSE RESEARCH SYMPOSIUM - KEYNOTE SPEAKERS:

**Keynote No. 1 (Morning Presentation): Thursday November 4, 8:15 - 8:55 AM**

**Dr. Chris Hendrickson, Carnegie Mellon University**
**Title:** ***"Near Term Steps to Accelerate Deep Decarbonization of United States Transportation"***
**Location: Virtual**
**Moderator: Dr. Wei Fan, UNC Charlotte**

**Abstract:** The world is experiencing increasing effects of climate change, including droughts, extreme weather events and gradual warming. There is considerable worldwide interest in reducing greenhouse gas emissions. In the United States, the transportation sector has the largest emissions of greenhouse gases. Steps can and are underway to reduce these emissions, such as electrification of vehicles, reducing emissions in the power sector, and expanding the innovations. These steps should also be pursuing socio-economic goals of economic development, equity, and cost effectiveness. This talk will discuss near term steps than can be undertaken in these areas with an emphasis on the role of transportation professionals.

**Speaker Bio**: Chris Hendrickson is the Hamerschlag University Professor Emeritus, Director of the Traffic 21 Institute at Carnegie Mellon University, member of the National Academy of Engineering and Editor-in-Chief of the ASCE Journal of Transportation Engineering Part A - Systems. His research, teaching and consulting are in the general area of engineering planning and management, including design for the environment, system performance, construction project management, finance and computer applications. He has co-authored eight books. In addition, he has published numerous articles in the professional literature. Dr. Hendrickson pioneered models of dynamic traffic equilibrium, including time-of-day departure demand models. He was an early contributor to the development of probabilistic network analysis for lifeline planning after seismic events. His work in construction project management emphasized the importance of the owner's viewpoint throughout the project lifecycle. With others at Carnegie Mellon's Engineering Design Research Center, he developed a pioneering, experimental building design system in the early 1990s that spanned initial concept through construction scheduling and animation.

**Join Dr. Chris Hendrickson's keynote Zoom Meeting via**
**https://uncc.zoom.us/webinar/register/WN_QwrGh7NhT3qVjlI4P8oYeg.**
***Technical Support: Shaojie Liu* or *Li Song***

**Keynote No. 2 (Afternoon Presentation): Thursday November 4, 1:00 - 1:40 PM**

**Dr. Laurence R. Rilett, Ph.D., P.E., F.ASCE., Director, Auburn University Transportation Research Institute, and Ginn Distinguished Professor**
**Title: "*Forecasting and Estimating Transportation Metrics in the COVID-19 and CAV Era*"**
**Location: Virtual**
**Moderator: Dr. Wei Fan, UNC Charlotte**

**Abstract:** Transportation system operators historically have had a deep interest in estimating and forecasting transportation system metrics. In the past most techniques focused on traditional measures (speed, volume, etc.) and recently this interest has expanded to reliability and resiliency measures. These transportation-related metrics may be based on central tendency (e.g. mean, median), dispersion (e.g. variance, percentile), or a combination of other metrics (e.g. reliability index). In addition, the techniques have been developed for both empirical data and simulation data. For example, the Highway Capacity Manual, Sixth Edition (HCM6) has recently adopted new 1) passenger car estimation methods that are based on the microsimulation model VISSIM, and 2) urban arterial reliability estimation methods that are based on a Monte Carlos simulation technique. This paper will discuss a number of issues related to estimating and forecasting transportation metrics. Specific examples from real-world test beds will be provided including using the HCM6 methodology to model the impact of Connected and Autonomous Vehicles (CAV) on highway capacity values and analyzing the impact of the COVID-19 pandemic using travel time reliability measures. The focus of the talk will be on lessons learned and areas of future research.

**Speaker Bio:** Dr. Laurence R. Rilett is the Ginn Distinguished Professor of Civil Engineering at Auburn University and Director of the Auburn University Transportation Research Institute. Rilett's research is in the field of transportation system analysis. His specific research focus may be divided into two main areas: Intelligent Transportation Systems applications and large-scale transportation system modeling. Rilett has been a principal investigator or co-principal investigator on more than 40 research projects with total funding in excess of $50 million. His sponsors have included the US Department of Transportation, the Nebraska Department of Transportation, the Texas Department of Transportation, the Environmental Protection Agency, US Department of Defense Transportation Command, and the National Science Foundation.

Dr. Rilett has authored or co-authored 100 refereed journal papers and over 100 conference papers based on his research. The American Society of Civil Engineering (ASCE) awarded Rilett the Arthur M. Wellington Prize in 2019 and the Frank M. Masters Transportation Engineering Award in 2021 for "contributions to innovative research on transportation systems and collaborative leadership to develop a diverse workforce in transportation engineering". In 2019, Rilett was honored with the Transportation Research Board Committee on Highway Capacity and Quality of Service (AHB40) Best Paper Award. He is currently the Managing Editor of the ASCE Journal of Transportation-Part A. Rilett was elected President of the Council of University Transportation Centers for 2021-2022.

**Join Dr. Laurence Rilett's keynote Zoom Meeting via**
**https://uncc.zoom.us/webinar/register/WN__NOsuZfJSI-pcBZBnnMTQg.**
***Technical Support:* *Shaojie Liu* or *Li Song***

# 2021 CAMMSE RESEARCH SYMPOSIUM - INVITED SPEAKERS: CONNECTED AND AUTOMATE VEHICLES SESSION

Invited Speaker No. 1: **Thursday November 4, 1:45 - 3:20 PM**

**Dr. Jianming Ma, P.E., PMP®, Texas Department of Transportation**
**Title: *"Texas Connected Freight Corridors"***
**Location: Virtual**
**Moderator: Dr. Wei Fan, UNC Charlotte**

**Abstract:** The Texas Connected Freight Corridors (TCFC) project is the largest connected vehicle deployment in Texas. The TCFC project, funded by the USDOT Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program, is a collaborative effort with public and private stakeholders to deploy connected vehicle technologies to commercial vehicles to improve traveler information, asset condition management and system performance. Goals of the project include increasing the safety of the traveling public, reducing truck-related crashes, and reducing the time trucks spend in congestion. The project will test five connected vehicle applications, such as Work Zone Warning, Queue Warning, Freight Signal Priority and Wrong Way Driving Alert, along the Texas Triangle routes of I-10, I-30, I-35, and I-45. In the long term, these applications can be transferred to other highway corridors where similar safety and mobility challenges exist. Trucks are a significant portion of the traffic on Texas highways. Improving freight operations in these corridors improves mobility, reliability, and safety, while reducing environmental impacts, not only for freight operations, but for all travelers and vehicles operating on these highways.

**Speaker Bio**: Jianming Ma holds a Ph.D. degree in Civil Engineering from the University of Texas at Austin. Dr. Ma coordinates connected and automated vehicle activities at the Texas Department of Transportation (TxDOT), whether demonstration, pilot projects, national studies and university research. Dr. has served as Project Manager for innovative technology deployment projects (e.g., Texas Connected Freight Corridors Project, I-10 Truck Parking Availability System Project) funded by the Federal Highway Administration (FHWA). Dr. Ma has over twenty-five years of professional and research experience in connected and automated vehicle (CAV), econometric modeling, human factors, intelligent transportation systems (ITS), systems engineering, traffic engineering, and traffic safety. He has over 40 technical papers and reports published in the above-mentioned areas. He is the Research Coordinator for the Transportation Research Board (TRB) Committee on Safety Performance and Analysis (ACS20), and a member of TRB's Traffic Signal Systems (ACP25). Dr. Ma is the Research Development and Implementation Coordinator for the American Association of State Highway and Transportation Officials (AASHTO) Committee on Transportation System Operations (CTSO). He served as a liaison for SAE DSRC Technical Committee.

Dr. Ma was the recipient of the Intelligent Transportation Society of Texas Individual Award in 2020, and the recipient of the M.D. "Mac" Shelby Award for Exceptional Leadership in 2017. He has been invited to serve on numerous research panels such as TxDOT, the National Cooperative Highway Research Program (NCHRP), the Strategic Highway Research Program 2 (SHRP2), the AASHTO CAV Working Group, Cooperative Automated Transportation (CAT) Coalition, and the Connected Vehicle Pooled Fund Study (CV PFS). Dr. Ma served as the Editor-in-Chief for the International Journal of Smart Vehicles and Smart Transportation (IJSVST) and Associate Editor for the 15th International IEEE Conference on Intelligent Transportation Systems.

**Join Invited Speakers' Session's Zoom Meeting via**
**https://uncc.zoom.us/webinar/register/WN__NOsuZfJSI-pcBZBnnMTQg.**
***Technical Support: Shaojie Liu* or *Li Song***

**Invited Speaker No. 2: Thursday November 4, 1:45 - 3:20 PM**

**Dr. Xuesong Zhou, Associate Professor, Arizona State University**
**Title:** ***"CAV Modeling Rising Up with Digital Twin: Transforming the Interconnection between Open data, Researchers and City Planners"***
**Location: Virtual**
**Moderator: Dr. Wei Fan, UNC Charlotte**

**Abstract:** The recently emerging trend of digital twin technology and high-performance computing is creating a revolutionary paradigm shift in the coming years. For smart city and regional mobility applications, the pairing of the virtual and physical world allows analysis of data and monitoring of systems, evaluating different CAV-oriented improvement strategies, and planning the future by using models and simulators. A long-term goal of Smart City Digital Twin (SCDT) is to create sustainable urban systems that benefit the citizens and societies at large.

This talk and related interactive demonstration aim to introduce our efforts in developing an Open data hub and Open-source simulation framework for transportation-focused Open-SCDT applications. We will demonstrate how to deliver rapid prototyping of SCDT and enable smarter multimodal policy decisions.

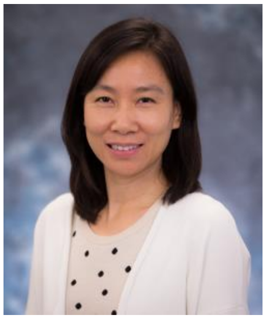
This presentation aims to help planners understand a system prototype of Open-SCDT based on OpenStreeetMaps and open standard of general model network specifications (GMNS) by Volpe/FHWA, for creating and sharing of macro, meso and microscopic networks, and multi-source heterogeneous traffic data; Specifically, we will demonstrate a smart community-oriented DT prototype, namely CAVLite, for metropolitan planning organizations to fully utilize available simulation platforms through open-source ecosystems. This tool could help planners work with community partners to evaluate the benefit of data-driven decision-making.

The proposed open-data-based and open-source enabled framework also intends to create a user community of thought leaders in this emerging area across different geographically distributed communities. Within the Open-SCDT context, large-scale agent-based simulators such as A/B Street and GMNS based modeling tools aim to engage citizens with local transportation planning by making it as easy as possible to imagine how changes might affect a person's commute. It could be used by city authorities to interactively communicate proposed and ongoing projects, by the general public to explore and submit ideas for improving their community, and by advocacy groups to educate people about options for reducing automobile dependency.

**Speaker Bio**: Dr. Xuesong (Simon) Zhou from Arizona State U. (ASU) is an expert in dynamic traffic simulation and maintains an open-source mesoscopic traffic simulator DTALite and an open-source traffic visualization tool NEXTA. As a leading open-source development team for US DOT, the ASU team has been developing a broader set of seamlessly integrated open-source computational engines, e.g., OSM2GMNS, Grid2Demand tools. DTALite has been applied in Maryland State-wide model with 26 million agents, and open-source tools have been downloaded by more than 20K times.

**Join Invited Speakers' Session's Zoom Meeting via**
**https://uncc.zoom.us/webinar/register/WN__NOsuZfJSI-pcBZBnnMTQg.**
***Technical Support:*** ***Shaojie Liu*** **or** ***Li Song***

**Invited Speaker No. 3: Thursday November 4, 1:45 - 3:20 PM**



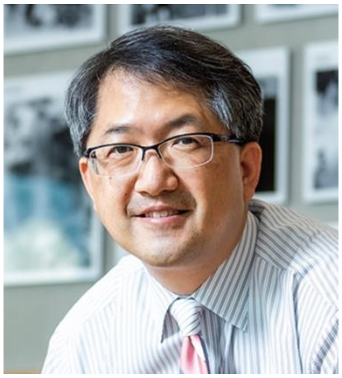
**Dr. Lili Du, Associate Professor, University of Florida**
**Title: *"System Optimal Vehicle Platooning Control for Eco-driving at Signalized intersection Built upon Hybrid MPC System, Online Learning and Distributed Optimization"***
**Location: Virtual**
**Moderator: Dr. Wei Fan, UNC Charlotte**

**Abstract:** The recent advancement of connected and autonomous vehicle (CAV) technologies provides tremendous opportunities to mitigate urban traffic congestion through innovative traffic flow control and operations. Particularly supported by advanced sensors, communication, and portable computing devices, CAVs can sense, share, and process real-time mobility data and conduct cooperative or coordinated driving. This has led to a surging interest in self-driving technology. However, the self-driving technology focusing on assisting individual driving maneuvers mainly ensures neighborhood traffic efficiency and an individual vehicle's safety; it does not always ensure traffic flow efficiency when a group of self-driven vehicles is packed in a complex freeway system with multiple lanes, on-ramps, and off-ramps, etc. Motivated by this view, our research team seeks to develop new resolutions: system optimal platoon-oriented driving control, leveraging online learning, and distributed optimization. This talk will present our recent research on coordinated vehicle platooning control with a focus on eco-driving at a signalized intersection. The methodology development combines traffic flows, MPC, optimization, machine learning, and distributed computation. Our numerical experiments confirmed that platoon-oriented driving would significantly improve traffic efficiency, smoothness, and safety.

**Speaker Bio**: Dr. Du is an associate professor in the Department of Civil and Coastal Engineering, University of Florida. Before joining UF, she worked as an assistant and then an associate professor at the Illinois Institute of Technology from 2012-2017. Dr. Du received her Ph.D. degree in Decision Sciences and Engineering Systems with a minor in Operations Research and Statistics from Rensselaer Polytechnic Institute in 2008. Dr. Du's research is characterized by applying operations research, network modeling, big data analytics, and machine learning approach into transportation system analysis, network modeling, and control. She currently focuses on several interdisciplinary research areas, including CV/AV/CAV/EV network modeling and platooning control, resilient civil infrastructure networks, sustainable multimodal transportation systems, mobility as services, and traffic flow analysis. Dr. Du's studies have been well funded by NSF, state DOT, and University Transportation Research Centers such as NEXTRANS, STRIDE, and FMRI, and Toyota InfoTechnology Center. Dr. Du is a recipient of the NSF CAREER award in 2016. Her project Driverless City won the First Nayar Prize at IIT in 2015. Dr. Du currently serves as an editor for Transportation Research Part B, Associate Editor for IEEE ITS, editorial board member on Transportation Research Part C. She chairs TRB subcommittee on Emerging Technologies in Network Modeling (AEP40-5) and ASCE AI in Transportation Committee. She is also a member of ASCE CAV impacts committee.

**Join Invited Speakers' Session's Zoom Meeting via**
**https://uncc.zoom.us/webinar/register/WN__NOsuZfJSI-pcBZBnnMTQg.**
***Technical Support: Shaojie Liu* or *Li Song***

**Invited Speaker No. 4: Thursday November 4, 1:45 - 3:20 PM**



**Dr. B. Brian Park, University of Virginia**
**Title: *"Cooperative Platooning along with Human Driven Vehicles"***
**Location: Virtual**
**Moderator: Dr. Wei Fan, UNC Charlotte**

**Abstract:** It is exciting that connected and automated vehicles are coming to us. While it has of great potential, full benefits can only be realized with 100% connected automated vehicles. Thus, it is important to realize as much benefit as possible during the transition period (i.e., mixed traffic of connected, automated and human-driven vehicles.

This talk will present the development of cooperative platooning algorithms for mixed traffic of connected automated vehicles and conventional human-driven vehicles. Recent development of connected and automated vehicle technology allows a group of such vehicles to travel closely one after another in a safely manner (known as, cooperative platooning), which greatly improves mobility and energy efficiency. However, when a human-driven vehicle exists within the group, the cohesion of vehicle platoon is not possible, due to uncertain human driver behavior. The proposed algorithms enable connected and automated vehicles to safely follow human-driven vehicles at shorter headways while mitigated traffic disturbances. These algorithms will also be able to assist a human driver in connected-but-not-automated vehicle by complementing human's imperfect behaviors. As such, the cooperative platooning can be efficiently operated at low market penetration of connected automated vehicles.

**Speaker Bio**: Brian Park is a Professor of Engineering Systems and Environment Department and a member of Link Lab at the University of Virginia. Prior to joining the University of Virginia, he was a Research Fellow at the National Institute of Statistical Sciences and a Post-Doctoral Research Associate at North Carolina State University.

Dr. Park is a recipient of the 2014 George N. Saridis Best Transactions Paper Award for Outstanding Research from the IEEE ITS Society, the PTV America Best Abstract Award, Outstanding Reviewer Award from the American Society of Civil Engineers, Jack H. Dillard Outstanding Paper Award from the Virginia Transportation Research Council and Charley V. Wootan Award (for best Ph.D. dissertation) from the Council of University Transportation Centers. He is an ASCE ExCEEd teaching fellow. He is an Editor in Chief of the International Journal of Transportation, an Associate Editor of the American Society of Civil Engineers Journal of Transportation Engineering and the KSCE Journal of Civil Engineering, and an editorial board member of the International Journal of Sustainable Transportation, and Journal of Engineering. Furthermore, he is a member of TRB (a division of the National Academies) Artificial Intelligence and Advanced Computing Applications committee.

**Join Invited Speakers' Session's Zoom Meeting via**
**https://uncc.zoom.us/webinar/register/WN__NOsuZfJSI-pcBZBnnMTQg.**
***Technical Support: Shaojie Liu* or *Li Song***

## TECHNICAL SESSIONS & ABSTRACTS FOR FACULTY PRESENTATIONS:

**Technical Session #1**: - November 4, 9:00-10:20AM
***Emerging Mobility Services, Planning and Operations***
**Registration Link: https://uncc.zoom.us/webinar/register/WN_jG1Rse1gRWmD9KSjS168fw**
**Notes: Participants can join this Zoom meeting as early as 8:45 AM (EDT); however, our symposium will not start until 9:00 AM (EDT).**

9:00 – 9:20 AM:
Developing Smart Traffic Signal Control
Speaker: Randy Machemehl, Ph.D., P.E., University of Texas at Austin
***Abstract Page 17***

9:20 – 9:40 AM:
Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors
Speaker: John Ivan, Ph.D., P.E., University of Connecticut
***Abstract Page 18***

9:40 – 10:00 AM:
An Innovative Signal Timing Strategy for Implementing Contraflow Left-Turn Lanes at Signalized Intersections with Split Phasing
Speaker: Yi Qi, Ph.D., Texas Southern University
***Abstract Page 19***

10:00 – 10:20 AM:
Exploring the Impacts of Transportation System on Human Behaviors during Disasters using Mobility Data
Speaker: Jin Zhu, Ph.D., University of Connecticut
***Abstract Page 20***

**Technical Session #2**: - November 4, 10:30-11:50AM
***Improving Multimodal Mobility and Equity Using Data Analytics***
**Registration Link: https://uncc.zoom.us/webinar/register/WN_fauBxqWSTfaVKA2gconhkw**
**Notes: Participants can join this Zoom meeting at 10:15 AM (EDT); however, this second technical session will not start until 10:30 AM (EDT).**

10:30 – 10:50 AM:
Captive Drivers & Choice Riders: The Overlooked Constituencies in Transportation Planning
Speaker: Carol Atkinson-Palombo, Ph.D., University of Connecticut
***Abstract Page 21***

10:50 – 11:10 AM:
Modeling and Evaluating Public Transit Equity and Accessibility by Integrating General Transit Feed Specification Data
Speaker: Wei (David) Fan, Ph.D., P.E., University of North Carolina at Charlotte
***Abstract Page 22***

11:10 – 11:30 AM:
Using Computational Biology to Mitigate Path Overlap in Transit Assignment
Speaker: Timothy James Becker, Ph.D., University of Hartford
***Abstract Page 23***

11:30 – 11:50 PM:
Analysis of Intermodal Vessel-to-Rail Connectivity
Speaker: Mehdi Azimi, Ph.D., P.E., Texas Southern University
***Abstract Page 24***

**Technical Session #3**: - November 4, 3:30-4:50PM
***Connected and Autonomous Vehicle and Machine Learning Applications***
**Registration Link: https://uncc.zoom.us/webinar/register/WN_PBb1ymuoQ6-Vht5X9hHmLg**
**Notes: Participants can join this Zoom meeting at 3:15 PM (EDT); however, this third technical session will not start until 3:30 PM (EDT).**

3:30 – 3:50 PM:
Two-stage Robust Facility Location Problem with Drones
Speaker: Stephen Boyles, Ph.D., University of Texas at Austin
***Abstract Page 25***

3:50 – 4:10 PM:
Effect of Multimodal Connected Vehicle App on Transit Stop Catchment Area
Speaker: Xianming Shi, Ph.D., P.E, Washington State University
***Abstract Page 26***

4:10 – 4:30 PM:
Skeleton-Graph: Long-Term 3D Motion Prediction from 2D Observations Using Deep Spatio-Temporal Graph CNNs
Speaker: Claudel Christian, Ph.D., University of Texas at Austin
***Abstract Page 27***

4:30 – 4:50 PM:
Effect of Connected and Autonomous Vehicles on Supply Chain Performance
Speaker: Ji Yun Lee, Ph.D., Washington State University
***Abstract Page 28***

**Developing Smart Traffic Signal Control**

***Technical Session #1*: *Emerging Mobility Services, Planning and Operations***

***9:00 – 9:20 AM - Speaker: Randy Machemehl, Ph.D., P.E., University of Texas at Austin***

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**Abstract:**
The traffic signal was invented more than a contrary ago. Since then, the transportation system has become more efficient and safer with continued development of traffic signal control systems as concepts evolve and new technology is developed and implemented.

Due to space limitations adding capacity to urban transportation facilities by adding new lanes or new alignments is very difficult. However, capacity additions through enhanced urban traffic signal control systems are very possible and much less expensive than adding lanes or alignments. With the rapid development of machine learning technologies and lower costs of computing power, combining machine learning technologies with traffic signal control systems represents a great opportunity to cost effectively ameliorate urban congestion. There are three broad machine learning categories, however, reinforcement learning is the one most suitable for traffic signal control system improvement. Considerable research has been done in the field of improving traffic signal control methods to enhance intersection performance by implementing reinforcement learning methods as well as its variations to single intersections, corridors, and networks. However, a robust traffic signal controller based on reinforcement learning has not been studied enough to make it practical for both normal and special conditions such as traffic disturbances due to special events and traffic incidents.

This research focuses on building a robust machine learning based traffic control algorithm and a microsimulation platform to test a robust traffic signal controller based on reinforcement learning technologies. A free open-source simulation software, SUMO, is being used as the micro simulator to test the performance of the proposed reinforcement learning traffic signal controller. A variety of network configurations are being used to test its generality, including single intersections, corridors, and networks. The outcome of this research will produce a platform to link field implementation and lab simulations to help practitioners better understand the benefits of AI-based traffic signal controllers in the real world.

**Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors**

***Technical Session #1**: Emerging Mobility Services, Planning and Operations*

***9:20 – 9:40 AM - Speaker: John Ivan, Ph.D., P.E., University of Connecticut***

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**Abstract:**
Walking as a primary mode of transportation is a goal for urban areas to improve environmental sustainability and has become an important consideration in municipal traffic planning. Providing safe conditions for pedestrians to cross at intersections is crucial to maintaining the economic and social sustainability of the area. This project seeks to estimate a model which can be used to predict pedestrian compliance to traffic signals at intersections as a function of both explicit and implicit variables such as traffic, demographic, geospatial, and road design factors. Observed pedestrian compliance to traffic signal phasing is associated with census-reported population data, data describing the nearby land development pattern and data describing crosswalk site and roadway characteristics, along with pedestrian and vehicle traffic counts. Building an understanding of pedestrian compliance to traffic signals can assist in maintaining or improving pedestrian safety. The objective of this study is to estimate a model for predicting pedestrian compliance to “walk/don’t walk” or “person walking/raised hand” at both urban and suburban locations. 42 different locations provide the necessary data to create the model by exposing the model to a variety of different intersection characteristics. Explicit variables used in the model prediction including intersection design factors, pedestrian and vehicle counts, and pedestrian behavior. Implicit factors also play a role in this study and include census-reported demographics (such as population density) and data of nearby land development. A binary logistic regression model is used to estimate pedestrian compliance since compliance is a binary phenomenon. The model produced by this study provides the ability to understand and predict pedestrian compliance which can be used to achieve the highest possible level of safety.

**An Innovative Signal Timing Strategy for Implementing Contraflow Left-Turn Lanes at Signalized Intersections with Split Phasing**

***Technical Session #1*: *Emerging Mobility Services, Planning and Operations***

***9:40 – 10:00 AM - Speaker: Yi Qi, Ph.D., Texas Southern University***

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**Abstract:**
Contraflow Left-Turn Lanes (CLLs) have the potential of being a solution for mitigating congestions at signalized intersections where split phasing is recommended or required. However, the current signal timing strategy for the intersections with CLLs cannot be directly applied at the signalized intersections with split phasing (SIWSP). To address this problem, this study proposed an innovative signal timing strategy, which is referred to as Counterclockwise Split Phasing (CSP) signal timing, for implementing the CLLs at the SIWSPs. A traffic simulation-based case study was conducted and the results indicate that, by using the proposed CSP signal timing plan, CLLs can be implemented at the SIWSP and can significantly reduce the traffic congestions caused by the high left-turn demand at this type of intersection. In addition, since the proposed CSP signal timing design procedure has fully considered the clearance time requirements for the left-turn vehicles on the CLLs, the risk associated with the use of CLLs can be controlled which makes it safe to use this innovative intersection design at SIWSPs.

## Exploring the Impacts of Transportation System on Human Behaviors during Disasters using Mobility Data

***Technical Session #1*: Emerging Mobility Services, Planning and Operations**

***10:00 – 10:20 AM - Speaker: Jin Zhu, Ph.D., University of Connecticut***

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**Abstract:**
Transportation infrastructure system affects human behaviors during disasters. A more diverse and well-developed transportation infrastructure system is critical to enhance human resilience for disaster evacuation, response and relief. The objective of this study is to explore the impacts of transportation systems on human behaviors during disasters. To this end, mobility data based on cell-phone positions were used to capture human mobility patterns. Point-of-interest (POI) data from SafeGraph, a data provider for places data, were aggregated at the zip code level to represent the mobility pattern in a certain geographical area. The POI data during the disaster periods were compared with the business-as-usual days to quantify the human behavior change due to disasters. The human mobility behavior changes in different zip code areas under disasters were examined to capture the potential impact of transportation infrastructure system. A case study of the six zip code areas in the city of Hartford, CT under several natural disasters occurred in 2018 and 2019 was conducted. Results showed that the level of diversity in transportation systems influences human behaviors during disasters. The impacts are different under different types of disasters, such as hurricanes and tornadoes.

## Captive Drivers & Choice Riders: The Overlooked Constituencies in Transportation Planning

***Technical Session #2: Improving Multimodal Mobility and Equity Using Data Analytics***

***10:30 – 10:50 AM - Speaker: Carol Atkinson-Palombo, Ph.D., University of Connecticut***

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**Abstract:**
In this study we propose the Transportation Choice/Captivity Matrix as a framework to approach transportation spending patterns in the United States. This matrix describes households as four distinct characterizations of socio-economic and built environment characteristics, represented by financial resource availability and vehicle ownership. Measures of transportation costs are complex, and often fail to address the needs of key constituencies. Using data from the Bureau of Labor Statistics Consumer Expenditure Survey, we examine distinct patterns in working household spending, namely that captive drivers, vehicle owners in lower deciles, allocate more than 15 cents of every dollar to vehicle ownership and use. Their peers, captive riders, those in lower deciles with no household vehicle, spend less than 5 cents of every dollar on vehicle use. Choice households, those in higher deciles, spend a smaller proportion of their income on transportation. There are limited places in the United States that support the needs of choice riders, higher decile households that do not own a vehicle, with 24.4% of those in New York. Encouraging transportation diversity in more places could do much to lessen the hardships faced by captive drivers and promote more households to become choice riders. The Transportation Choice/Captivity Matrix provides a different framework for the further development of equitable and sustainable places in the United States.

**Modeling and Evaluating Public Transit Equity and Accessibility by Integrating General Transit Feed Specification Data**

***Technical Session #2: Improving Multimodal Mobility and Equity Using Data Analytics***

***10:50 – 11:10 AM - Speaker: Wei (David) Fan, Ph.D., P.E., University of North Carolina at Charlotte***


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**Abstract:**
This study models and evaluates the accessibility to public transit and public transit equity by integrating the general transit feed specification (GTFS) data. A transit gap index (TGI) and a geographic information system (GIS)-based methodology are developed to conduct the assessment. The TGI is developed by taking into consideration demographic features, as well as spatial and temporal transit service characteristics. A case study in the city of Charlotte is conducted and a comprehensive gap analysis based on the proposed methodology is performed. Results show that the transit supply provides higher service coverages in the central business district of Charlotte and decreases as the distance to downtown Charlotte increases. Most of the identified transit-dependent areas are suburban and rural communities located on the fringe of the city. A sensitivity analysis is also conducted to examine the impact of different walking distances on transit gaps. Guidelines are developed and best-practice recommendations for the use of GTFS data as a main data source are made to better understand and assess public transit equity and accessibility for public transportation planning and operation. Several policy implications are also drawn in terms of enhancing the public transit system equity and accessibility.

**Using Computational Biology to Mitigate Path Overlap in Transit Assignment**

***Technical Session #2: Improving Multimodal Mobility and Equity Using Data Analytics***

***11:10 – 11:30 AM - Speaker: Timothy James Becker, Ph.D., University of Hartford***

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**Abstract:**
In the past thirty years, transit assignment has grown from a niche theoretical exercise to a rigorous field of study with novel models and methodologies designed to incorporate the unique decision-making process of transit trips in the planning process. A significant boon to the transit modeling community came with the advent of the General Transit Feed Specification (GTFS) in 2006. The motivation of having transit systems searchable on Google Maps proved great enough to convince hundreds of transit systems around the globe to develop their own GTFS feed and make it openly available. Because GTFS presents these trips as spatio-temporal sequences, it presents an opportunity to leverage prior work with biological DNA sequences to potentially improve on the path generation phase of the dynamic transit passenger assignment problem (DTPA). One open issue with existing DTPA frameworks is the presence of path overlap. Path overlap occurs when two or more paths in a path choice set contain similar features with slight variations, violating independence assumptions in any logit-based path choice model and resulting in poor representation of transit path selection behavior.

We have formulated a metric and algorithmic process to mitigate the path overlap problem. Our solution uses the sequence to sequence comparison algorithm know as Longest Common Subsequence (LCS) adapted for transit assignment to form a GTFS trip similarity metric. We are able to use this metric to drive a dual optimization function to select *k*-paths from the total potentials that encompass the lowest cost to the most unique and the *k-2* interpolated paths that lie between. We make use of real 2016 bus survey data in CT to demonstrate that our open-source software implementation can be used to effectively characterize and approximate the 59 unique passenger trips that reported as having at least one transfer for an inbound workday Hartford, CT commute.

**Analysis of Intermodal Vessel-to-Rail Connectivity**

***Technical Session #2*: Improving Multimodal Mobility and Equity Using Data Analytics**

***11:30 – 11:50 AM - Speaker: Mehdi Azimi, Ph.D., P.E., Texas Southern University***

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**Abstract:**
Port of Houston is a fast-growing and important port because of its large tonnage handling capacity and its impact on the nation's economy. With the growth in the economy which results in increased port activities, the Port of Houston is gradually approaching capacity and sees the need for expansion of the required infrastructures. This study compared the competitiveness of the Port of Houston among the similar ports by collecting the information from the port officials and the public database, and pinpointed the gap between the existing condition of the port and state of the art practices. It also identified the critical components of a vessel-to-rail intermodal system, and analyzed the significance of each component. The study has focused on the feasibility of the rail intermodal system compared to the truck freight in the Port of Houston. Based on the analysis, it was found that drayage cost is the driving factor in making the rail more competitive with the truck freights.

**Two-stage Robust Facility Location Problem with Drones**

***Technical Session #3*: Connected and Autonomous Vehicle and Machine Learning Applications**

***3:30 – 3:50 PM - Speaker: Stephen Boyles, Ph.D., University of Texas at Austin***

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**Abstract:**
The past few years have witnessed the increasing adoption of drones in various industries such as logistics, agriculture, military, and telecommunications. In this paper, we consider a short-term post-disaster unmanned aerial vehicle (UAV) humanitarian relief application where first-aid products needs to be delivered to the customer demand points. The presented problem, two-stage robust facility location problem with drones (two-stage RFLPD), incorporates the demand uncertainty using demand scenarios. The objective of this problem is to find a location-allocation-assignment plan that has minimal two-stage total cost in the worst-case scenario of all the possible demand outcomes. Two different models of the problem are proposed, one of which incorporates a more realistic UAV electricity consumption model while the other one has greater operational flexibility. The column-and-constraint generation method and Benders decomposition are used to solve the two models and a thorough comparison among the deterministic FLPD models and two proposed models are also presented. Numerical analysis results show that the proposed model has significantly less average cost in the simulation runs compared to deterministic FLP.

**Effect of Multimodal Connected Vehicle App on Transit Stop Catchment Area**

***Technical Session #2*: *Connected and Autonomous Vehicle and Machine Learning Applications***

***3:50 – 4:10 PM - Speaker: Xianming Shi, Ph.D., P.E, Washington State University***

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**Abstract:**
Transit service accessibility improvement is an important topic among transit planners and policymakers. Connected Vehicle (CV) applications such as a multimodal app that disseminates real-time transit information to the users/riders have the potential to increase transit accessibility. CV applications can also impact transit services by increasing ridership, decreasing stop wait time, and decreasing the overall travel time of the passengers. Quantifying these transit services and their network-wide temporal distribution in the presence of CV application is critical for the informed transit planning and operations decisions. Previous studies assessed the benefits of real-time transit information (RTI) sharing mostly by analyzing the survey data or by a simulation-based method. This study collected field trip data to analyze transit trips with a CV multimodal app (i.e., intervention group) compared to the trips without the app (i.e., control group) to quantify the transit stop wait time reduction in the presence of the multimodal app. The multimodal app disseminated RTI to the users (i.e., location, speed, weather, and road condition information). This study found that the average reduction of transit stop wait time after the app use was about three minutes on a selected transit route in Morgantown, WV. The wait time saving was applied to calculate the increase in buffer area for each transit stop and route level service area. With the app, the transit route service area was increased by 37%. The calculated origin-destination-based transit supply index (odSI) indicates that the network-wide transit supply can be increased by 14% with the use of the multimodal app. The reduced wait time at transit stops reduced the average trip time, and riders can walk from further distances to reach the transit stops. In other words, the long-standing first- and last-mile problem can be improved by using the CV multimodal app that shares real-time transit information. The higher odSI value indicates that the transit system can be more sustainable when RTI of transit services is disseminated to users. The findings of this study justify more widescale use of the multimodal app in an urban and rural environment, which can lead to a sustainable transportation system (especially during times of extreme weather).

**Skeleton-Graph: Long-Term 3D Motion Prediction From 2D Observations Using Deep Spatio-Temporal Graph CNNs**

***Technical Session #2: Connected and Autonomous Vehicle and Machine Learning Applications***

***4:10 – 4:30 PM - Speaker: Claudel Christian, Ph.D., University of Texas at Austin***

**Authors**:

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**Abstract:**
Better understanding of pedestrian paths leads to safer and more efficient interactions between pedestrians and vehicles. A key subproblem associated with trajectory prediction is the problem of predicting human motion in 3D. This prediction is often done from 2D-derived poses that are easier to capture with cameras. Recently, a new problem was introduced, with the objective of predicting 3D human poses sequences from observed 2D sequences. For this task, we propose Skeleton-Graph, a deep spatio-temporal graph CNN model that predicts the 3D skeleton poses in a single pass from 2D observations. Unlike prior works, Skeleton-Graph focuses on modeling the interaction between the skeleton joints exploiting their spatial configuration by learning a proper graph adjacency kernel function. By design, Skeleton-Graph predicts future 3D poses without divergence on the long-term unlike prior works. We also introduce a new metric that measures the divergence of predictions on the long-term. Our results show a final displacement error improvement of at least 27 % and an average displacement error improvement of 4 % on both the GTA-IM and PROX datasets. More importantly, the long-term divergence is greatly reduced by the proposed algorithm.

**Effect of Connected and Autonomous Vehicles on Supply Chain Performance**

***Technical Session #3: Improving Multimodal Mobility: Leveraging Data and Advanced Analytics***

***4:30 – 4:50 PM - Speaker: Ji Yun Lee, Ph.D., Washington State University***

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**Abstract:**
Connected and autonomous vehicles (CAVs) are an emerging technology that has great potential for increasing road capacity and reducing traffic accidents, congestion, fuel/energy consumption as well as emissions, all of which may support safer and more reliable and efficient (and potentially sustainable) transportation systems. Given that transportation network plays a key role in a supply chain system in terms of its performance and cost, CAVs will ultimately change many aspects of a supply chain system. While the effects of CAVs on transportation network have been extensively studied through simulations or experimental data, only a limited number of studies have been conducted to investigate potential opportunities (or challenges) that may arise from the introduction/adoption of CAVs in the context of supply chain design, operation and performance. Moreover, their quantitative effect on a supply chain system has yet to be explored in any depth.

This study proposes a model that quantitatively assesses the direct and indirect effects of CAVs on a supply chain system by varying the levels of CAV market penetration and driverless truck adoption. We first investigate the effect of CAVs on transportation network and incorporate it into supply chain analysis to evaluate how it would change routing decisions, travel time between major nodes, and restrictions on the distances that commodities can travel. Moreover, the changes brought about by the adoption of driverless trucks are quantitatively assessed through the updated input and intermediate variables in supply chain analysis. Finally, the assessment model is applied to a hypothetical potato supply chain network whose supply nodes are located in Washington State. This supply chain system is selected because the expedited and efficient product delivery is of vital importance due to product quality degradation over time. The results indicate that CAVs can greatly improve supply chain performance by reducing product delivery costs and time, while emissions reduction is primarily due to the use of driverless trucks in the supply chain network. The effect of CAVs on supply chain performance becomes even greater when commodities travel longer distances. The research outcomes would help supply chain managers better utilize the opportunities and address possible challenges that may arise as a result of CAVs to maximize their benefits while minimizing related costs.

## STUDENT LIGHTNING SESSIONS & ABSTRACTS FOR PRESENTATIONS:

**Lightning Sessions**: Friday, November 5 (8:00AM-12:00PM)
(Coordinators: Mr. Li Song and Mr. Shaojie Liu)
**Registration Link:** **https://uncc.zoom.us/webinar/register/WN_75sm396_SKuJtogKSwgSSA**
**Notes: Participants can join this Zoom meeting as early as 7:45 AM (EDT); however, our symposium will not start until 8:00 AM (EDT).**

**Lightning Session #1**: 8:00-9:30 AM

| ID | Authors | Title | Institution |
|---|---|---|---|
| L01 | Jie Zhao | Effect of Connected and Autonomous Vehicles on Supply Chain Performance | WSU |
| L02 | Sruthi Mantri | Prioritizing people – Mixed Equilibrium Assignment for AV Based on Occupancy | UCONN |
| L03 | Md Tanvir Ashraf | Impacts of Multimodal Connected Vehicle App on Transit Service Catchment Area | WSU |
| L04 | Li Song | Traffic Signal Control in Connected and Automated Environment: A Transfer-Based Deep Reinforcement Learning Approach While Accounting for Mixed Traffic Flow on Varying Information Levels | UNCC |
| L05 | Saki Rezwana | A modified Social Force Model (SFM) for the pedestrian behavior with Connected Autonomous Vehicle (CAV) | UCONN |
| L06 | Abduallah Mohamed | Skeleton-Graph: Long-Term 3D Motion Prediction From 2D Observations Using Deep Spatio-Temporal Graph CNNs | UT Austin |
| L07 | Shaojie Liu | Platooning-Based Trajectory Planning of Connected and Autonomous Vehicles at Superstreets | UNCC |
| L08 | Sudipta Chowdhury | Developing a Future-proofed Transportation Infrastructure Planning Framework Using Topic Modeling and Association Rule Mining | UCONN |
| L09 | Kun Qian | Multi-Robot Dynamical Source Seeking in Unknown Environments | UT Austin |

**Lightning Session #2**: 9:45-11:15 AM

| ID | Authors | Title | Institution |
|---|---|---|---|
| L10 | Jennifer Hall | Modeling Impacts of Covid-19 On Capital Metro Ridership | UT Austin |
| L11 | Juan Li | The Impact of COVID-19 Pandemic on Maritime Transportation and Port Operation | TSU |
| L12 | Asadul Tanvir | Using Computational Biology to Address the Path Overlap in Transit | UCONN |

| | | | |
|---|---|---|---|
| | | Path Generation | |
| L13 | Olivia Willis | Inspiring Transportation Careers with K-12 Curriculum Activities | WSU |
| L14 | Quinn Packer | Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors | UCONN |
| L15 | Bo Qiu | Travel Time Forecasting on a Freeway Corridor: a Dynamic Information Fusion Model based on the Random Forests Approach | UNCC |
| L16 | Karen M Kalter | Predicting Interchange Ramp Volumes from Interchange Characteristics | UT Austin |
| L17 | Lijie Zhou | A Study of the Impact of Infrastructures on Public Bicycle-Sharing System Demand | TSU |
| L18 | Zakiya Percy | Investigate Age Impacts on Controlled Flight into Terrain (CFIT) Crashes in General Aviation | TSU |

*See Abstracts for lightning presentations in Pages 31 through 48.*

# Abstracts for Student Lightning Presentations:

## Lightning L01:

**Effect of Connected and Autonomous Vehicles on Supply Chain Performance**

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**Abstract:**
Connected and autonomous vehicles (CAVs) are an emerging technology that has great potential for increasing road capacity and reducing traffic accidents, congestion, fuel/energy consumption as well as emission, all of which may support safer and more reliable and efficient (and potentially sustainable) transportation systems. Given that transportation network plays a key role in a supply chain system in terms of its performance and cost, CAVs will ultimately change many aspects of a supply chain system. While the effects of CAVs on transportation network have been extensively studied through simulations or experimental data, only a limited number of studies have been conducted to investigate potential opportunities (or challenges) that may arise from the introduction/adoption of CAVs in the context of supply chain design, operation and performance. Moreover, their quantitative effect on a supply chain system has yet to be explored in any depth.

This study proposes a model that quantitatively assesses the direct and indirect effects of CAVs on a supply chain system by varying the levels of CAV market penetration and driverless truck adoption. We first investigate the effect of CAVs on transportation network and incorporate it into supply chain analysis to evaluate how it would change routing decisions, travel time between major nodes, and restrictions on the distances commodities can travel. Moreover, the changes brought about by the adoption of driverless trucks are quantitatively assessed through the updated input and intermediate variables in supply chain analysis. Finally, the assessment model is applied to a hypothetical potato supply chain network whose supply nodes are located in Washington State. This supply chain system is selected because the expedited and efficient product delivery is of vital importance due to product quality degradation over time. The results indicate that CAVs can greatly improve supply chain performance by reducing product delivery costs and time, while emissions reduction is primarily due to the use of driverless trucks in the supply chain network. The effect of CAVs on supply chain performance becomes even greater when commodities travel longer distances. The research outcomes would help supply chain managers better utilize the opportunities and address possible challenges that may arise as a result of CAVs to maximize their benefits while minimizing related costs.

## Lightning L02:

**Prioritizing people – Mixed Equilibrium Assignment for AV Based on Occupancy**

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**Abstract:**
Autonomous Vehicles (AV) have the potential to revolutionize transportation operations mode choice. As and when the AV are available in the market, a significant portion of the AV fleet will be owned by the private households. Regular traffic assignment in mixed environment including human-driven vehicles, occupied AVs and unoccupied AVs will cause an issue with the selfish routing of the unoccupied vehicles. This study proposes a mixed equilibrium traffic assignment to minimize the impacts of the unoccupied AVs on occupied vehicles without disproportionally hurting households that own an AV. In this paper, user equilibrium route assignment for occupied versus system optimum route assignment for unoccupied vehicles for three different scenarios were experimented while considering impacts of unoccupied AV route choice on AV owners. Two networks – Sioux Falls and Eastern Massachusetts networks were used to conduct the experiments. The results of the experiments show that a) Most of the occupied vehicles are facing less travel times than the regular traffic assignment. b) None of the AV owners are facing any significant delays c) Total system is performing better with less total travel time.

## Lightning L03:

### Impacts of Multimodal Connected Vehicle App on Transit Service Catchment Area

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**Abstract:**
Transit service accessibility improvement is an important research topic among transit planners and policymakers. Connected Vehicle (CV) application such as real-time transit information (RTI) sharing via smartphone app has several benefits (e.g., lower wait time at the transit stops and higher transit accessibility). A multimodal CV app was developed in this study which disseminated RTI of the transit buses among its users to quantify the app's benefits in terms of transit accessibility improvement. The multimodal app shared real-time bus location, speed, weather, and road condition information to the users. This study indicates that the average reduction of transit stop wait time after the app use was about three minutes on a selected transit route in Morgantown, WV. The calculated origin-destination-based transit supply index (*odSI*) indicates that the network-wide transit supply can be increased by 14% with the use of the multimodal CV app. The reduced wait time at transit stops reduced the average trip time, and riders can walk from further distances to reach the transit stops. Furthermore, the RTI sharing via the multimodal CV app can be used for trip planning, especially during the winter season when transit services face more uncertainties because of the inclement weather. The findings of this study justify more widescale use of the multimodal CV app, which can lead to a sustainable transportation system.

## Lightning L04:

**Traffic Signal Control in Connected and Automated Environment: A Transfer-Based Deep Reinforcement Learning Approach While Accounting for Mixed Traffic Flow on Varying Information Levels**

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**Abstract:**
With the development of the vehicle to infrastructure (V2I) technology and increasing popularity of the deep reinforcement learning (DRL) approach, the traffic signal control (TSC) system could be more intelligent based on the use of information provided by the connected and automated vehicles (CAVs). As the direct training procedure of the DRL is time-consuming and hard to converge, this study improves the training procedure of the Deep Q Network (DQN) by transferring the well-trained action policy of a previous DQN model into a target model under similar traffic scenarios. Different reward parameters, exploration rates, and action step lengths are tested. The transfer-based DQN models are implemented in scenarios with different traffic demands and market penetration rates (MPRs) of CAVs. Compared to direct training models, transfer-based models could improve the training efficiency and model performances. Meanwhile, with a 100% MPR of CAVs, the transfer-based DQN approach could significantly improve the system performance compared to fixed signal-controlled schemes. In high traffic scenarios, the total waiting time, $CO_2$ emission, and fuel consumption still decrease about 38%, 34%, and 34%, respectively. Also, this paper tests the validity of the transfer-based DQN method by considering different information levels of vehicles. The transfer-based TSC system performs better than fixed signal-controlled schemes after 20% to 40% MPRs of CAVs under different traffic demands. Moreover, when transferring models at higher information levels, the transfer-based models could take better actions that could not be suggested by directly trained models. The insights of this study should be helpful in designing intelligent signal intersections, improving training efficiency and performance, and providing guidance for engineering applications of the DQN TSC systems.

## Lightning L05:

### A Modified Social Force Model (SFM) for the Pedestrian Behavior with Connected Autonomous Vehicle (CAV)

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**Abstract:**
The social force model is a widely used method to design pedestrian behavior in a public place like a park, shopping mall, roadway, and others. In this research work, a modified social force model is developed to understand pedestrian behavior in a signalized pedestrian crosswalk. Research has indicated that pedestrians will feel more unsafe towards the driverless 'ghost vehicles' like CAVs (Connected and Autonomous Vehicles) than the regular human-driven vehicles. Hence, pedestrian behavior needs to be simulated before full-scale implementation of the CAVs in the real-world roadways. In this research work, pedestrian behavior is predicted in a simulation software where it is assumed that only CAVs are on the road. The Vadere software-based simulation result indicates the strong repulsive behavior of the pedestrians towards the CAVs. At last recommendation is suggested to reduce the repulsive behavior of the pedestrians towards the CAVs.

## Lightning L06:

**Skeleton-Graph: Long-Term 3D Motion Prediction From 2D Observations Using Deep Spatio-Temporal Graph CNNs**

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**Abstract:**
Several applications such as autonomous driving, augmented reality and virtual reality require a precise prediction of the 3D human pose. Recently, a new problem was introduced in the field to predict the 3D human poses from observed 2D poses. We propose Skeleton-Graph, a deep spatio-temporal graph CNN model that predicts the future 3D skeleton poses in a single pass from the 2D ones. Unlike prior works, Skeleton-Graph focuses on modeling the interaction between the skeleton joints by exploiting their spatial configuration. This is being achieved by formulating the problem as a graph structure while learning a suitable graph adjacency kernel. By the design, Skeleton-Graph predicts the future 3D poses without divergence on the long-term unlike prior works. We also introduce a new metric that measures the divergence of predictions on the long-term. Our results show an FDE improvement of at least 27\% and an ADE of 4\% on both the GTA-IM and PROX datasets respectively in comparison with prior works. Also, we are 88\% and 93\% less divergence on the long-term motion prediction in comparison with prior works on both GTA-IM and PROX datasets.

## Lightning L07:

### Platooning-Based Trajectory Planning of Connected and Autonomous Vehicles at Superstreets

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**Abstracts:**
Connected and autonomous vehicles (CAVs) are one of the main technological trends in the transportation field due to their promising potentialities in improving performances of existing transportation system. With shorter headways and enhanced communication capability with other vehicles and infrastructures, CAVs can outperform human-driven vehicles (HDVs) in reducing traffic delay and fuel consumption. Although there have been many efforts to investigate the implications of CAVs at conventional intersections and on highway/ramps by proposing various control frameworks, little attention has been given to alternative intersections. Alternative intersection designs are popular existing strategies that can be used for handling large traffic in the U.S., and research on the performance of CAVs in the alternative intersection design can complement our knowledge on the impact of CAVs. Hence, this research attempts to mitigate such a research gap through a simulation-based study on a superstreet, one of the popular alternative intersection designs. A real-world superstreet is selected for the simulation-based study with collected traffic volumes and average speeds. HDVs are modeled using Wiedemann 99 with calibrated parameters while CAVs are modeled using the intelligent driver model (IDM). Platooning and trajectory planning capabilities of CAVs are modeled in the designed simulation. The simulation results show that the proposed framework for CAVs can successfully reduce fuel consumption in different market penetration rates and traffic scales. Nevertheless, the impacts of proposed platooning and trajectory planning control may have certain adverse effects on the traffic delays in certain scenarios.

## Lightning L08:

**Developing a Future-proofed Transportation Infrastructure Planning Framework Using Topic Modeling and Association Rule Mining**

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**Abstract:**
Transportation infrastructure planning is a complex process, which requires the consideration of a multitude of factors. While many existing studies have investigated the impacts of different factors individually, a holistic framework that encompasses a comprehensive list of influencing factors on transportation infrastructure planning and their inter-relationships is still missing. Especially, many forward-looking factors are often overlooked in current planning frameworks. To this end, this study aims to develop a future-proofed transportation infrastructure planning framework with a focus on roadways, bridges, and transit. The research methodology adopted in this study includes two specific text mining techniques: topic modeling and association rule mining (ARM). Topic modelling technique was used to identify a list of important factors from transportation infrastructure planning literature. ARM was then used to explore the inter-relationships among the identified factors. The developed framework includes a four-level taxonomy of critical factors for transportation infrastructure planning, and 13 pairs of significant inter-relationships between specific factors. This framework could guide transportation infrastructure planners and decision makers to have a holistic approach to plan, build, and manage our transportation infrastructures in the face of future risks and opportunities. This study demonstrates the potential of using text mining techniques to explore new knowledge in transportation infrastructure planning.

## Lightning L09:

### Multi-Robot Dynamical Source Seeking in Unknown Environments

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**Abstract:**
Over the last few decades, extremum seeking, also known as source seeking, has been a fundamentally crucial problem and attracted increasing attention, due to its numerous applications including surveillance, environment and health monitoring, disaster response, to name a few. Extremum seeking involves locating one or several spots, associated with the maximum/minimum values of interest, in a possibly unknown and noisy environment. Oftentimes, those extremum spots are of particular importance in many real-world applications.

This study presents an algorithmic framework for the distributed on-line source seeking, termed as 'DoSS', with a multi-robot system in an unknown dynamical environment. Our algorithm, building on a novel concept called dummy confidence upper bound (D-UCB), integrates both estimation of the unknown environment and task planning for the multiple robots simultaneously, and as a result, drives the team of robots to a steady state in which multiple sources of interest are located. Unlike the standard UCB algorithm in the context of multi-armed bandits, the introduction of D-UCB significantly reduces the computational complexity in solving subproblems of the multi-robot task planning. This also enables our 'DoSS' algorithm to be implementable in a distributed on-line manner. The performance of the algorithm is theoretically guaranteed by showing a sub-linear upper bound of the cumulative regret. Numerical results on a real-world methane emission seeking problem are also provided to demonstrate the effectiveness of the proposed algorithm.

## Lightning L10:

### Modeling Impacts of Covid-19 on Capital Metro Ridership

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**Abstract:**
This paper examines impacts of the COVID-19 pandemic upon bus ridership through autoregression and multi-linear regression models. Measuring the impacts of the pandemic upon the bus transportation system is important because public transportation authorities can use this modeling approach to recognize how COVID-19 affects system ridership. The models developed use 2019 and 2020 ridership data from three high frequency routes run by the Capital Metro Transportation Authority in Austin, TX. Each route's autoregression model revealed that daily ridership can be explained by lagging the 2019 to 2020 ridership data by 5, 7, 12, and 14 days ($R^2$ = ~75%). These lags capture major trend changes, such as when the first case of COVID-19 appeared in Travis County. The weekday and weekend multi-linear regression models used 2020 COVID-19 daily confirmed case and fatality data as the independent variables. The weekday models show a significant decrease in bus ridership from the increase in COVID-19 cases and fatalities during the business week. On Saturdays, ridership is not significantly related to the COVID-19 variables. However, the Sunday models show a significant relationship between increasing fatalities and decreasing daily ridership. One conclusion is that trips happening on Saturday are more essential and are not as significantly affected by the spread of the virus in comparison to trips happening during the weekdays and Sundays.

## Lightning L11:

**The Impact of COVID-19 Pandemic on Maritime Transportation and Port Operation**

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**Abstract:**
COVID-19 pandemic was unraveling the economy nationally and globally as most of the world moved toward a lockdown that entails the closure of significant portions of both the service and manufacturing industries. As the backbone of international trade and global economy, the maritime transportation and industry have been deeply affected as a result of the upheaval caused by the coronavirus and its impact. Due to the pandemic outbreak, ports have seen many "blank sailings" - ships scheduled to arrive that never finished their journeys. Scheduled vessel calls in many ports have been canceled by shipping lines. Ocean carriers worldwide have scrubbed voyages due to dwindling demand by shippers for vessel space. Many ports saw sharp falls in activity. This study will investigate the impact of pandemic outbreaks on maritime transportation, especially on port operation. It is important to study how to mitigate the myriad of issues which arise in such events. This may provide the authorities and stakeholders in ports and maritime transportation the better understanding of the vulnerability of the maritime domain to the future pandemic outbreaks and the external shocks to the system.

## Lightning L12:

**Using Computational Biology to Address the Path Overlap in Transit Path Generation**

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**Abstract:**
Path overlap is a well-recognized issue in transit route choice modeling. Modeled passengers often fail to identify the level of independence in routes when choice sets have overlapping segments or shared characteristics. This is prevalent in schedule-based transit assignment models where incorrect path estimation can occur systemically. Several modifications to the logit models (i.e. path-size logit) have been proposed so far for overcoming this issue.

In this study, an alternative approach is proposed which will capture the direct dependency of the paths both sequentially and spatially in the path generation step. All the viable paths between OD pairs are generated first using an importance sampled branching tree search algorithm. The pairwise comparison of all the paths is then computed using the longest common subsequence similarity (LCSS) algorithm. Based on the similarity metric found from this pairwise LCS comparison, the paths of similar costs and attributes are then bundled together as k-dissimilar paths. A dimensional reduction technique such as multi-dimensional scaling (MDS) plots can be used to visualize the k-dissimilar path outputs. This method is much more robust and it calculates the level of spatially overlapped stops ahead of time in the preprocessing stage, this will eliminate the need for overlap correction factor used in the existing transit route choice models.

## Lightning L13:

**Inspiring Transportation Careers with K-12 Curriculum Activities**

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**Abstract:**
Workforce shortages in the transportation industry have resulted in an increasing need for employees with diverse backgrounds in multimodal and sustainable transportation. Previous research on this project worked directly with students by hosting a table at a large science event where students would stop at tables for short periods of time to complete activities, or by working with a group of students for a designated block of time for consecutive days utilizing hands-on activities and demonstrations. The effects that gender, screen time, self-efficacy, sense of belongingness, and stereotypes about science and scientists had on the learning for middle and high school aged students was to be studied in a classroom outreach setting when Covid-19 forced the project to move online. A virtual outreach activity was created in Qualtrics consisting of pre-activity content questions, questions pertaining to the factors being analyzed, short answer questions about the stereotypes students had about science and scientists, a video showing what a transportation engineer does, a video describing a transportation engineering topic, a transportation game, questions to engage the students with the activities, post-activity content questions that were identical to the original content questions, and an optional essay question where students could provide feedback and explain what they learned. The survey was distributed through local middle and high school teachers and the national Upward Bound summer program to obtain a broad sample of data from around the country. 116 responses in total were collected. T-tests and correlational analyses were applied to the data. Responses to questions about stereotypes showed that 52% of students had a stereotypical view of a scientist that included words such as “white lab coat.” 89% of students believed that anyone could become a scientist if they wanted, but 11% thought only specific groups of people could follow this career path. The t-test for the before and after scores showed that the results were significant with a p-value of 8.5859E-6. Results may have been influenced by students completing the activities in their own home environment. Future research will explore the stereotypes students have of scientists more extensively.

## Lightning L14:

**Estimation of Pedestrian Compliance at Signalized Intersections Considering Demographic and Geographic Factors**

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**Abstract:**
Walking as a primary mode of transportation is a goal for urban areas to improve environmental sustainability and has become an important consideration in municipal traffic planning. Providing safe conditions for pedestrians to cross at intersections is crucial to maintaining the economic and social sustainability of the area. This project seeks to estimate a model which can be used to predict pedestrian compliance to traffic signals at intersections as a function of both explicit and implicit variables such as traffic, demographic, geospatial, and road design factors. Observed pedestrian compliance to traffic signal phasing is associated with census-reported population data, data describing the nearby land development pattern and data describing crosswalk site and roadway characteristics, along with pedestrian and vehicle traffic counts. Building an understanding of pedestrian compliance to traffic signals can assist in maintaining or improving pedestrian safety.

The objective of this study is to estimate a model for predicting pedestrian compliance to "walk/don't walk" or "person walking/raised hand" at both urban and suburban locations. 42 different locations provide the necessary data to create the model by exposing the model to a variety of different intersection characteristics. Explicit variables used in the model prediction including intersection design factors, pedestrian and vehicle counts, and pedestrian behavior. Implicit factors also play a role in this study and include census-reported demographics (such as population density) and data of nearby land development. A binary logistic regression model is used to estimate pedestrian compliance since compliance is a binary phenomenon. The model produced by this study provides the ability to understand and predict pedestrian compliance which can be used to achieve the highest possible level of safety.

## Lightning L15:

**Travel Time Forecasting on a Freeway Corridor: a Dynamic Information Fusion Model based on the Random Forests Approach**

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**Abstracts:**
As the traffic conditions often greatly change, the prediction results are often unsatisfactory. In order to improve the accuracy of short-term travel time prediction in freeway network, a heavily feasible and computation efficient RF prediction method for real-world freeway by using probe traffic data is generated. In addition, the variables' relative importance is ranked, which provides an investigation platform to gain a better understanding of how different contributing factors might affect travel time on freeways. This research develops an RF method to predict the freeway travel time by using the probe vehicle-based traffic data and weather data. Detailed information about the input variables and data pre-processing is presented. To measure the effectiveness of proposed travel time prediction algorithms, the MAPEs are computed for different observation segments combined with different prediction horizons from 15 to 60 minutes. The parameters of the RF model are estimated by using the training sample set. After the parameter tuning process is completed, the proposed RF model is developed. The features' relative importance shows that the variable (travel time 15 minutes before) and TOD (time of day) contribute the most to the predicted travel time results. The model performance is evaluated and compared against the extreme gradient boosting method, and the results indicates that the RF always produces more accurate travel time prediction.

## Lightning L16:

**Predicting Interchange Ramp Volumes from Interchange Characteristics**

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**Abstract:**
The Dallas-Fort-Worth region has many freeway interchanges with ramps marked for future construction work that do not currently have any routine data collection devices. This research aims to predict ramp volumes based on interchange characteristics (e.g., main lane volumes) for the purposes of identifying ideal times for ramp closures for construction. Some models from this research show feasibility for use for predicting interchange ramp volumes.

## Lightning L17:

### A Study of the Impact of Infrastructures on Public Bicycle-Sharing System Demand

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**Abstract:**
A bicycle-sharing system (public bicycle system, or bike-share scheme) is a service in which bicycles are made available for shared use to individuals on a short-term basis for a price or free. To study the impacts of bike infrastructures on bicycle sharing system demand, particularly bike lanes and bike paths, autoregressive integrated moving average (ARIMA) with exogenous factors is proposed to capture the relationship in a longitudinal analysis among the variables. The results show that every mile of bike lane added to the bike share system will result in a 38 average daily ridership increase per week (7 days), 37 and 82 daily average ridership increase per weekday (5 days), and 82 daily average ridership increase per weekend (2 days). By adding every bike share station to the public transportation mode, the average daily ridership will increase by 16 every week, 17 every weekday, and 34 on weekends. Moreover, active stations can affect daily average ridership of seven days per week and five days per weekday more severe than two days per weekend. The impact caused by the built environment on the daily average ridership of weekends is double than the weekday ridership and weekly average ridership, which indicates the double needs of bike share on weekends. Regarding the influence of the weather variables, temperature and wind speed have no impact on daily average trip counts. However, precipitation displays a significant negative impact on daily average ridership.

## Lightning L18:

**Investigate Age Impacts on Controlled Flight into Terrain (CFIT) Crashes in General Aviation**

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**Abstract:**
Controlled Flight into Terrain (CFIT) crash is defined as an unintentional collision with terrain (the ground, a mountain, a body of water, or an obstacle) while an aircraft is under positive control. It is one of three high-risk accident occurrence categories identified by the International Civil Aviation Organization. Although advanced technologies have dramatically reduced the number of General Aviation CFIT crashes over the past 20 years, CFIT crashes continue to occur and at least half of them are fatal. Therefore, it is quite momentous to identify the contributing factors and recommend countermeasures to prevent or mitigate CFIT crashes. This research will utilize the General Aviation CFIT crash data collected from National Transportation Safety Board (NTSB) and pilots' information from Federal Aviation Administration (FAA), to perform statistical analysis to reveal the impacts of pilots' age and other pilot related contributing factors on the occurrence of CFIT crashes in General Aviation. Based on the analysis, technology-based and policy-level countermeasures will be proposed to reduce the CFIT crashes. The research findings will help policymakers to better understand the underlying reasons for General Aviation CFIT crashes and update their current practices and regulations.