

Artificial Intelligence and Machine Learning (AI/ML) in Transportation

DOT's Focus on Innovation

- At the U.S. Department of Transportation - whether we're talking about planes, trains, or automobiles – we're excited about the possibilities innovative technologies and broad sector trends promise for the future. We're headed toward a new, smart transportation system that will increasingly rely on artificial intelligence for safety-critical functions.
- We're at the cusp of monumental changes in transportation. We see the maturing of past research in technologies such as connected vehicles, as they move from demonstration to marketplace. And we see a new wave of emerging technologies, such as automated vehicles, artificial intelligence, robotics, accessible transportation, mobility on demand, and smart communities — all fueled by the power of connectivity, data, advanced analytics and machine learning.
- These technologies have tremendous potential — to reduce congestion, expand our individual mobility, maximize system efficiency — all to improve the quality of our lives. And most importantly, to save lives!

DOT's Role in Artificial Intelligence Innovation

- The U.S. Department of Transportation and the Intelligent Transportation Systems Joint Program Office are committed to transportation innovation and safety. We play a pivotal role in shaping the future of advanced technologies such as artificial intelligence in transportation.
- At their simplest, AI systems blend data and advanced algorithms to imitate the cognitive functions of the human mind. We believe that AI and machine learning are powerful tools that will transform how we analyze data and predict outcomes. This technology is being incorporated into transportation systems today.
- We are seeking to better understand the ways in which artificial intelligence, machine learning, automation, neural networks, fault detection, object and pattern recognition and a plethora of AI tools already on the market can be applied to transportation problems.
- We're working to foster safe integration of AI into the operation of our transportation system across modes — automated vehicles, smart payment, accessible transportation, drones, vertical takeoff and landing aircraft, and smart communities. This includes safe integration of AI-based decision-making, traffic management, routing, transportation network services and other mobility optimization tools.
- As a specific example, the USDOT is playing a key role in building and shaping the future of automated vehicle technology which has artificial intelligence and machine learning at its core. AV technology has the potential to revolutionize the way we travel, transport goods, and connect with one another. It has the potential to weed out some of the 94% of crash events which have human error as a critical factor. Among its other benefits, automated technology may also give traditionally underserved communities—especially older Americans and people with disabilities—greater access to transportation choices, dramatically improving their quality of life.
- At the Department, we have many ways to further innovative AI technology. We act as a convener and facilitator, partnering with a broad coalition of industry; academics; federal, state and local

agencies; safety advocacy groups; and other transportation stakeholders to support the safe development, testing, and deployment of ITS technologies.

- We firmly believe in the power of demonstrations and early deployments of technologies in order to identify and overcome the barriers to realizing a technologies' full potential. Our demonstrations work out the kinks, reduce risk, and pave the way for widespread adoption.
- DOT works with multiple partners as they seek opportunities to apply AI tools and enable their application to improve mission delivery across the transportation enterprise.

Why we are interested in AI for Transportation?

Imagine what we might achieve with an effective investment strategy cementing the Department's leadership role as AI system components are deployed on our roads. The facilitation, research and development, operations oversight, policy synchronization, and regulatory roles of USDOT for the transportation grid require us to be an AI leader. Falling behind in this area of critical innovation in the broader economy is not an option.

- AI is not only integral to vehicles on the ground, in the air, and on the water, but could also:
 - Power virtual assistants to simplify transit fare vending; be multilingual; and project a simple dashboard to guide travelers as they plan, navigate, and pay for multimodal trips;
 - Leverage data produced by smart cities and communities to optimize signal timing, traffic flow, including first responders, in real time;
 - Manage the national airspace based on a wealth of data about weather, aircraft traffic, and ground conditions;
 - Contribute to a huge reduction of collisions and fatalities on the roads;
 - Heighten accessibility and level of service for travelers, particularly for people with restricted mobility; and
 - Improve system efficiency and lower operational costs; not just for transportation services, but for the other public services provided by cities and communities such as public safety, sanitation, health and utilities.
- However, integration of AI tools must be accompanied by the deployment of better systems, designed to manage how they operate in the context of the broader, smarter, connected and data-driven environment to improve the transportation experience.

How are we approaching AI for Transportation?

- To be a leader in understanding, implementing, and overseeing the vast array of applications relying on these AI driven systems and technologies the Department plans to do 3 simple things:
 1. Better understand AI capabilities maturing across the broad economy.
 2. Accelerate safe research, development and deployment of AI capabilities in the transportation system to advance our mission
 3. Use AI and enable ML tools to improve internal operations and research.

So how are we **Accelerating Safe Deployment of AI into Transportation System Operations**

Data for Mission Delivery is one way

- For some time now, the transportation industry, and transportation systems have become more data driven and digital. The US DOT and the broader transportation enterprise, are collecting or can collect, vast quantities of data.
- This is laying a foundation for AI and ML to make significant inroads into the functions of our transportation system, powering not only systems that allow automated vehicles and drones to observe and move through their environment, but also systems that can enable more effective management of transportation networks. Data will be the fuel that powers tremendous insights to enhance our transportation system.
- AI will play a critical role in accessing, managing and using the immense amounts of data generated by each transport network to ensure that users have access to transportation where and when they need it. Anonymous real-time data, ML, and other tools and technologies are helping to pull **information** out of transportation data streams.
- However, we need to leverage, not only the data but the latest analytical tools to effectively use that data to prevent traffic collisions and fatalities, improve operational efficiency, and reduce cost. We must enable better, faster, cheaper analysis of data to solve transportation's largest challenges and deliver information where it is needed.
- One of DOT's roles is to seek opportunities to apply tools or enable their application among state and local partners to improve mission delivery across the transportation enterprise.

We have several ongoing ITS Data initiatives to achieve this.

- **Safety Data Initiative:** This pilot project is integrating established data on crashes and highway design with anonymous data from GPS devices to directly analyze how speed—and speed differentials—as well as roadway characteristics interact to affect the likelihood of crashes.
- **Waze Pilot:** Another pilot project will integrate crash data with data on hazards and conditions from the crowd-sourced app Waze. This effort will determine if it is possible to use a crowd-sourced application as a reliable, timely indicator of traffic crashes, and to estimate crash risk.
- **Computer Vision Tools Applied to Naturalistic Driving Data:** Many of the USDOT's modal administrations rely on naturalistic driving data—typically comprised of forward and driver-facing camera feeds combined with telematics—to understand how humans operate vehicles and issue guidance and regulations accordingly. However, these data sets can often exceed one million hours of video. Processing this volume, to identify specific events or scenarios while protecting the privacy of research subjects is an extremely labor-intensive process. The Federal Highway Administration is developing computer vision tools that can automate these processes, thereby saving time and money and unlocking more significant value in these vast datasets.

Mobility on Demand and Accessible Transportation is another area where we see great potential for AI

- Technologies emerging today promise to make our future transportation system safer, more reliable, more efficient, more environmentally sustainable, and more convenient.

- Connectivity, data, and automation are among several key societal, technological, and mobility trends that will have huge impacts on the way people travel. Communities, large and small, urban and rural, need to reimagine their transportation systems to accommodate the growing needs of users.
- Traffic congestion remains high, particularly in large urban areas. There is enormous potential for new forms of shared mobility to provide people with more options, help to overcome barriers to the use of non-driving forms of transportation, and allow individuals' new travel choices besides dependence on individually owned vehicles.
- Mobility on Demand efforts include incorporating trip planning and booking, real-time information, and fare payment into a single user interface. And we are trying to expand the population of people who can access mobility on demand functions and services.
- Persons with disabilities comprise nearly 13 percent of the U.S. population and nearly 1 in 7 people (43 million) in the U.S. are over 65 years old. This number is expected to reach 72.1 million by 2030. As people live longer, this means that the transportation system must provide quality transportation connections for those who can't -- or who shouldn't drive- to medical care or elsewhere, and allow older Americans to age in place without being homebound and isolated.
- These are not small numbers and ensuring accessible transportation is not a small challenge. We must use our most innovative tools to address it.
- Our Accessible Transportation Technologies Research Initiative (ATTRI) focuses on machine vision, AI, assistive robots augmented and virtual reality and facial recognition software.
- ML and other AI techniques are already being applied to tackle obstacles faced by people with disabilities and to support the growing aging population.
- The more that machines can sense and understand the world around us, the more they can help people with disabilities to overcome barriers.
- We want to ensure that all travelers, no matter their ability or disability, have access to an advanced transportation system that leverages technology to maximize safety, mobility, and environmental performance, at the lowest cost.
- It's critical to expand public knowledge of the benefits of these technologies, and to partner and work together to leverage the best knowledge, insight, and understanding of the needs and possible solutions to the challenges of accessibility in mobility.

So, these are just two examples of

USDOT Approach to AI Investments

- While there are impressive pockets of expertise and research and application-focused activity within the DOT modal administrations, we still must understand how AI is being identified, imported, and integrated into our work streams to ensure that we employ the most innovative, effective, and budget-savvy approaches to intentionally grow our AI/ML infrastructure.
- The Department's challenge is to make the decisions and investments necessary to propel USDOT and modal capabilities to the forefront of the AI/ML world.

There are a few key elements to our AI approach

1. Foster knowledge and coordinate expertise needed to monitor the development and implementation of AI/ML-based technologies in transportation applications.

- To meet this requirement, we must be able to monitor, assess, and coordinate the development and deployment of AI -based tools and applications, across the USDOT modal ecosystem. We will not mandate, but rather work to ensure the tools are available when needed, because of our AI investment strategy.
- As a result, we will be able to oversee and synchronize improved USDOT service delivery through the direct deployment of AI/ML-based tools.

2. We will Monitor foundational research and development and synchronize investment in applied R&D

- The private sector, academia, and certain areas of the public sector such as the military and intelligence communities are actively pursuing foundational AI research and developing new methods and techniques.
- As an operational agency, the USDOT will not duplicate their efforts by funding the development of the underlying tools and techniques that enable ML.
- Instead, the Department will focus its resources and attention on accelerating the deployment of promising or proven applications that are already available or at a mature stage of the development lifecycle. USDOT investments can tailor these broad tools to work in transportation contexts and develop capacity among Federal, state, and local stakeholders to adopt and implement them.
- Alongside these investments in deploying proven applications, USDOT can establish formal mechanisms to monitor and share information about developments in foundational research. These may include forming partnerships with universities and research organizations, sponsoring participation in conferences, and leveraging existing Departmental programs such as the University Transportation Centers program. For example we currently have 20 UTC projects ongoing in artificial intelligence and machine learning.

3. Focus on functions and capabilities where AI applications are truly the best tools

- AI is not a cure-all tool for every data-intensive analysis problem and should be viewed as a solution for certain problems, not as a solution in search of a problem.
- Our investment strategy aims for USDOT to understand where AI is an appropriate tool or solution, as well as the advantages and drawbacks of AI/ML versus other data analytics methods.

4. Invest in applications that can be leveraged and expanded to multiple, broader transportation system uses.

- As a general class of analysis methodologies, AI/ML can be applied to similar analytical challenges in a range of domains and contexts.
- For example, tools that analyze text often use general-purpose language models that are created from aggregates of many different sources of text. They may be developed for one application domain first and then transferred to another.

- To the extent possible, DOT will invest in AI research and development with an emphasis on tools that have multiple potential applications. Specific use cases can serve as proofs-of-concept, but should not, to the greatest extent possible, remain singular, isolated efforts.

5. **Select AI approaches that can be applied to achieve cost effective value and desired outcomes**

- DOT seeks to understand how we can become an effective user of AI and ML. We are conducting an analytic survey within the Department across our modal administrations to understand how the various modes:
 - **Identify and integrate** the right AI methods to apply to their workflows. This phase implies that personnel are skilled in AI methods, understand enough about them to be able to decide which tools are relevant to their modal needs, or have someone advising them.
- **And finally, we will seek to understand the potential pitfalls and system risks when AI approaches are applied to transportation problems.**
 - The potential threats facing transportation are diverse, technology continues to rapidly evolve, and there is not yet a consensus on appropriate means and standards to secure the nation's transportation system. Public agencies and industry are interested in better understanding cybersecurity and other risks in order ensure appropriate mitigation to facilitate public trust and adoption of the technology.

CONCLUSION

- The AI-led transformation being witnessed globally is having a profound impact on the transportation sector. Transportation is becoming increasingly connected and data-rich, providing a robust foundation for AI and ML solutions.
- AI will increasingly integrate into our transportation system, and be powered by data we can collect, aggregate, and analyze. The premise of automated vehicles, UASs, and other emerging transportation technologies are becoming increasingly familiar to the traveling public and promises to significantly transform not only how individuals consume mobility but the structure of the entire transportation system of the future.
- US DOT will work with our partners to proactively prepare for an AI future and to promote the ability of the whole of the transportation system to enhance the individual freedoms and independent mobility it provides us all.

THANK YOU.