Autonomy in Transportation Education Workshop

CCAT
CENTER FOR CONNECTED AND AUTOMATED TRANSPORTATION

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UNIVERSITY OF MICHIGAN

Workshop Organizers

Henry Liu

Professor of CEE, Director at MCity

Debra Bezzina

Managing Director at CCAT

Gabor Orosz

Associate Professor of ME

Siqian Shen

Associate Professor of IOE

Neda Masoud

Assistant Professor of CEE

Amir Tafreshian

Postdoctoral Fellow of CEE

Calvin Tuttle

Marketing Communications Specialist at CCAT

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Today's agenda

Before the workshop:

- Survey of experts to identify the gaps
- Four themes for the workshop

During the workshop:

- A lecture on backward learning by CRLT
- List of questions for each theme

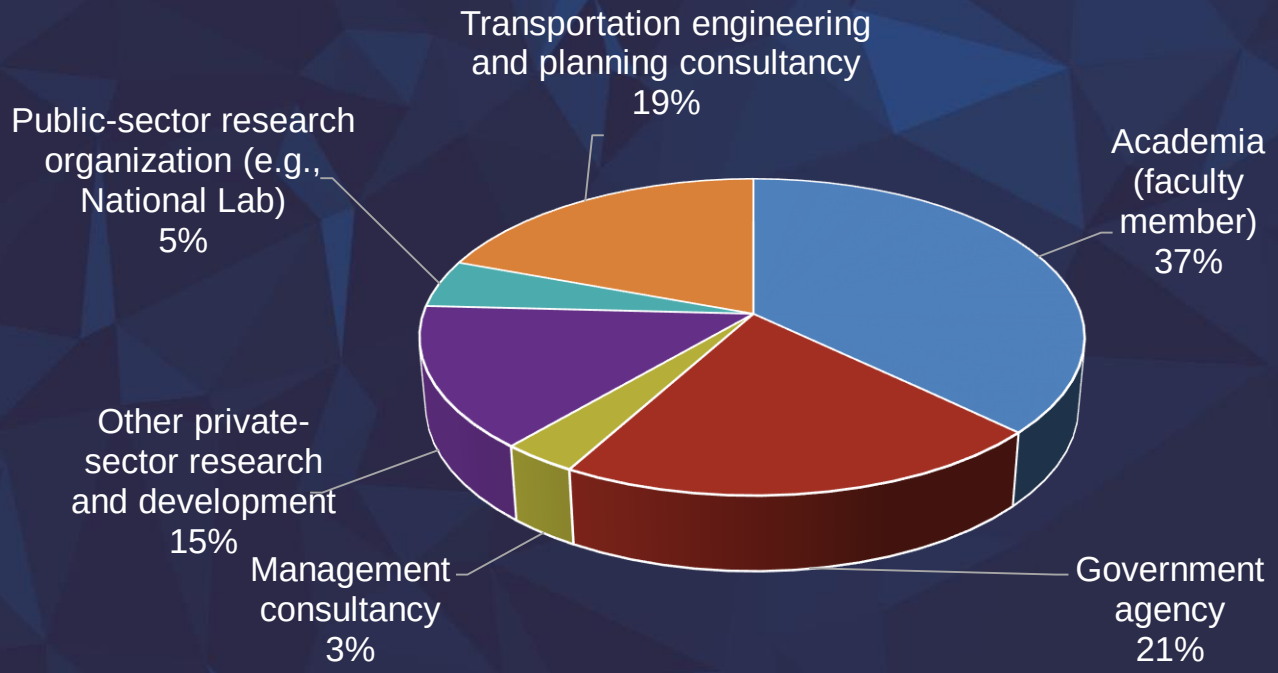
After the workshop:

- Summary of discussions

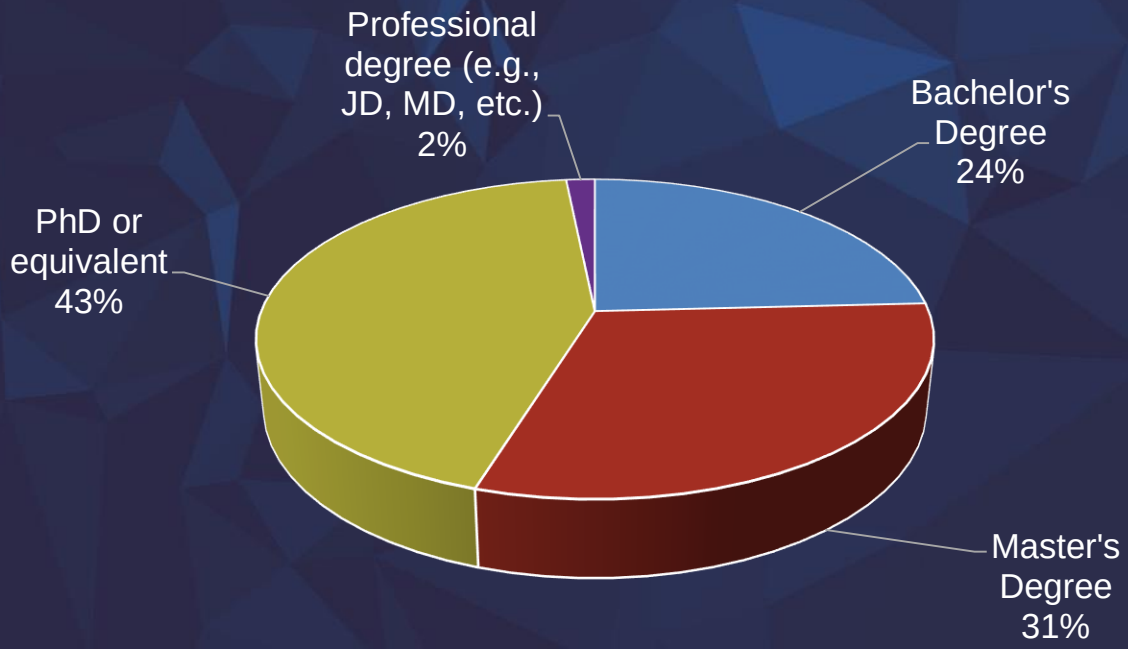
Survey

- Experts from academia and industry
- 75 valid responses

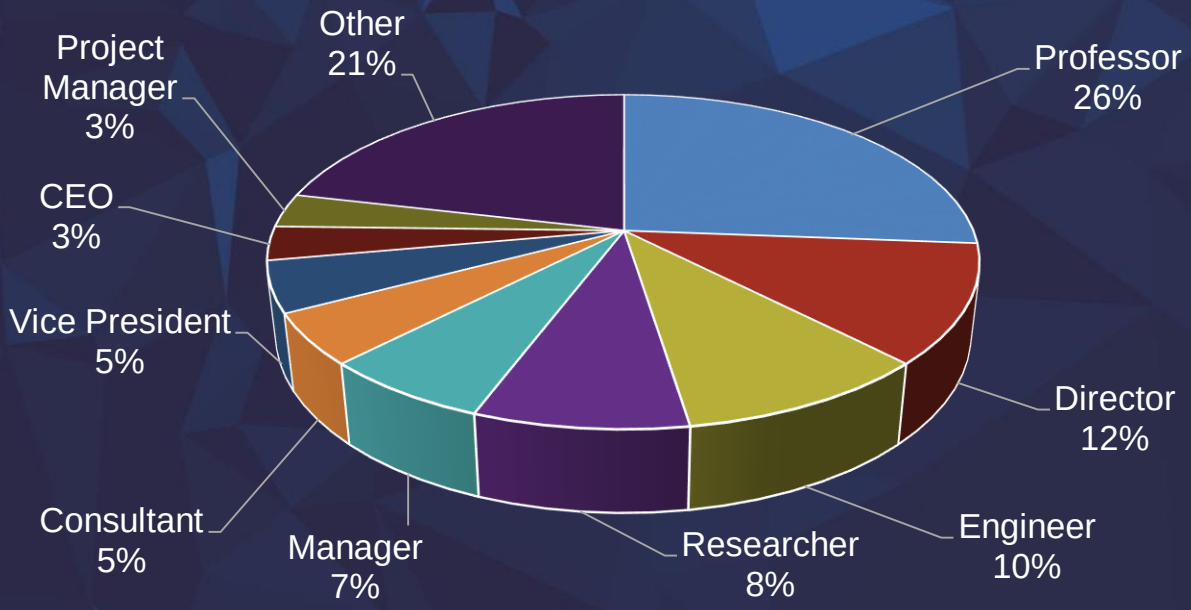
Please indicate your sector



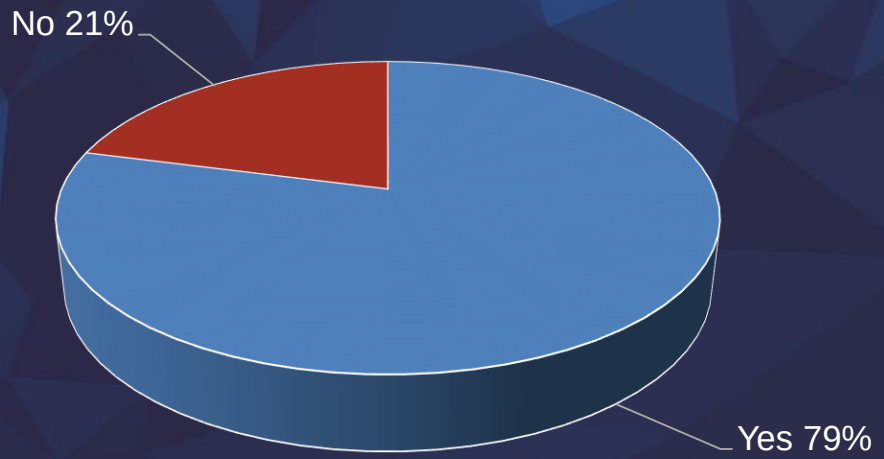
Please state your highest level of education.



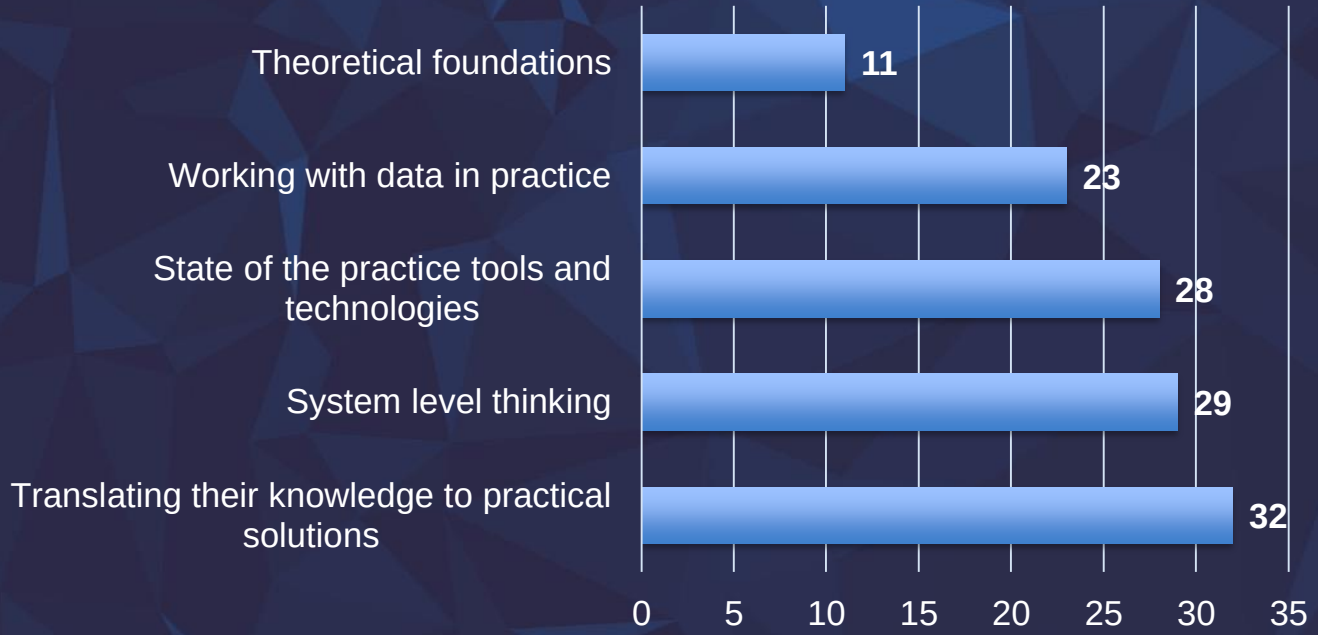
Please state your position within your organization.



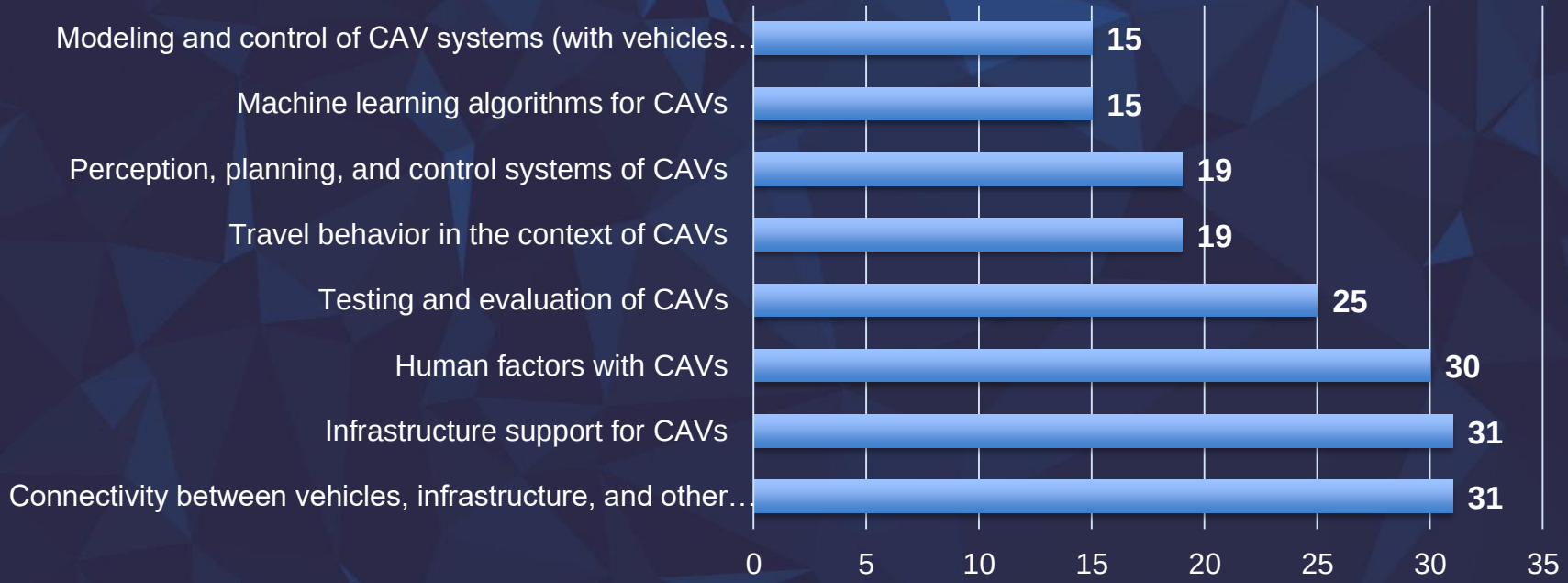
Do you observe a knowledge gap in the skill set of recent graduates in your sector? If no, you will be directed to the end of the survey.



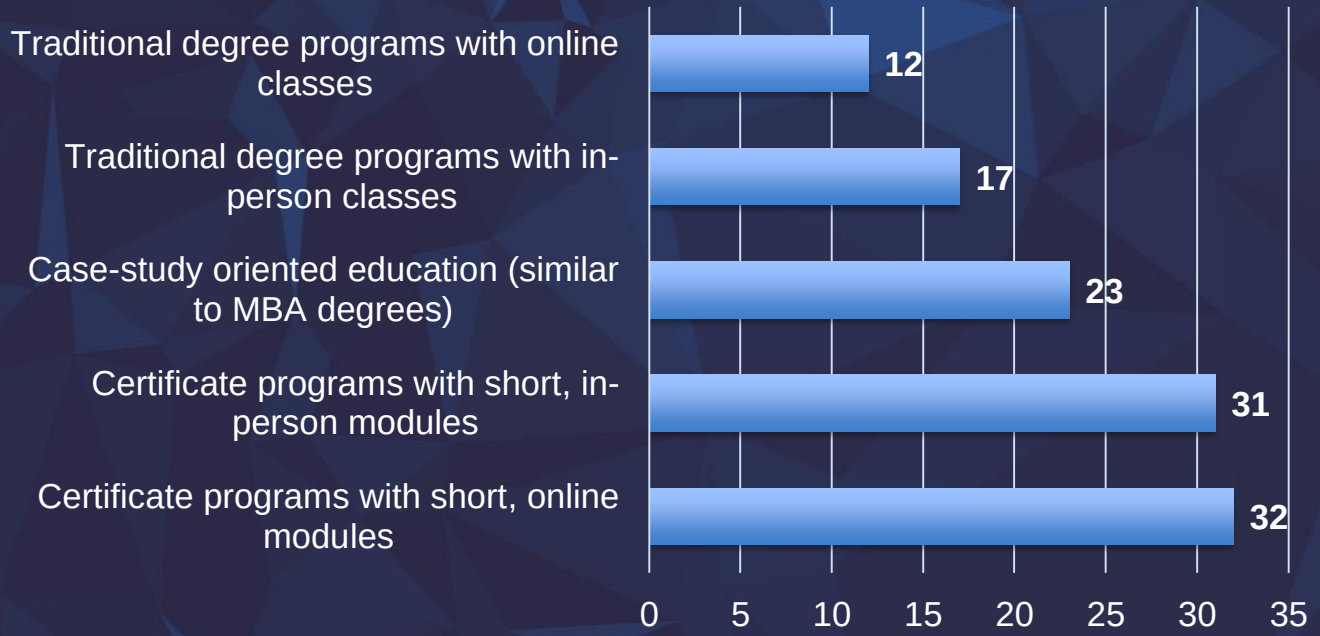
In what areas do you see a knowledge gap in general? Please select all that apply.



What are the knowledge gaps related to Connected and Automated Vehicles (CAVs)? Please select all that apply.



What are the key ways to enhance the skill set?



Workshop Themes and Participants

Next generation infrastructure for CAVs	Human factors with CAVs	Modeling, simulation, and testing of CAVs	Travel behavior in the context of CAVs
Gabor Orosz	**Shan Bao**	**Dan Work**	**Andre Carrel**
Larry Head	Sue Chrysler	Reuben Sharkar	Ram Pendayala
Terry Yang	Brandon Pitts	Michael Zhang	Khandker Nurul Habib
Jiaqi Ma	Linda Boyle	John Kenney	Sharon Di
Xiaopeng Li	Feng Zhou	Jim Misener	Attiya Shaw
Jeremiah Robertson	Jesse Yang	Steve Shladover	Henry Liu
Yafeng Yin		Xuesong Zhou	
Fan Bai		Jeff Ban	
		Marina Sofos	

Breakout Room Discussions

1. What are the existing gaps?
2. Why do knowledge gaps exist?
3. What is the best educational format?
4. What is the prerequisite knowledge?

Theme 1: Next Generation Infrastructure for CAVs

- Interdisciplinary knowledge
- Fundamental knowledge (fundamentals on transportation, optimization, data analysis, dynamics, and control)
- System-level thinking
- The ability to blend theory and application
- Understand institutional arrangement (government policy, funding, etc.)
- The ability of students to learn on their own

Theme 1: Next Generation Infrastructure for CAVs

	Learning Objectives	Educational material exists (Y/N)
1	Understand fundamental knowledge of the field such as traffic diagrams, optimization, control, etc.	Y
2	Effectively communicate with people from other fields and reflect on perspectives from experts in other fields.	N
3	Conduct system level thinking in order to understand institutional arrangements.	N
4	Understand the connection between theoretical knowledge and the realities involved in real-world deployments.	N

Theme 1: Next Generation Infrastructure for CAVs

Barriers:

- No systematic knowledge gap exists, but the challenge is in bringing in other disciplines
- Many core transportation principles on infrastructure were created several decades ago, when data availability was a much more substantial challenge than today

Proposed solutions:

- Revise courses to provide a more modern foundation
- Teach fundamental courses in conjunction with their applications in transportation infrastructure

Theme 1: Next Generation Infrastructure for CAVs

Mode of teaching:

- For students: active learning (In-classroom or online courses with standard university format)
- For practitioners: short courses, half-week summer camps, or certificate programs

Prerequisites:

- Strict requirements are not appropriate due to interest from people with different backgrounds
- Requirements set on fundamentals only (an engineering degree, math/physics classes)

Theme 2: Human Factors with CAVs

- Human factors in transportation is an interdisciplinary field
- Students must understand the fundamental concepts, terminologies, and theories of human factors
- Students must learn about the common research methods in human factors

Theme 2: Human Factors with CAVs

	Learning Objectives	Educational material exists (Y/N)
1	Obtain a relatively comprehensive knowledge of fundamental theories/concepts about human factors.	Y
2	Know how to identify and apply appropriate research methods (including both qualitative and quantitative methods) in solving a specific problem.	Y
3	Know how to apply human-centered design methods to develop and evaluate design solutions.	Y
4	Gain knowledge of specific applications of human factors in transportation as human factors is a multi-disciplinary domain.	Y
5	Appreciate the multi-disciplinary nature of human factors needs in automation and transportation.	N

Theme 2: Human Factors with CAVs

Barriers:

- Existing curriculum is already heavy
- Traditional silos of academic departments can impede interdisciplinary study
- Teaching requires special equipment/tools/testbeds

Proposed solution:

- A course on human factors in CAVs that includes relevant concepts and theories from human factors as well as automation
- Curriculum design needs to take this into consideration the diverse background of students

Theme 2: Human Factors with CAVs

Mode of teaching:

- Traditional programs are the best option for more profound educational purposes
- Certificate programs are appropriate for continuing education purposes
- Online learning for human factors is possible, but a fully remote degree can be limiting

Theme 3: Modeling, Simulation, and Testing of CAVs

- Modeling and testing are complementary approaches
- Students should have knowledge on understanding and testing the assumptions of the model, the context in which it is deployed, and the limitations of the model
- Students are expected to know how to check if models make sense, and how to integrate empirical testing into model setup and evaluation
- Students must be able to communicate with interdisciplinary teams, because this field is multi-faceted and no one can be an expert in every detail
- A rapidly evolving field calls for critical thinking and lifelong learning skills

Theme 3: Modeling, Simulation, and Testing of CAVs

	Learning Objectives	Educational material exists (Y/N)
1	Compose CAV modeling components and analyze the components and the whole system for physical correctness with empirical data.	-
2	Design and execute a test to validate or invalidate a model in a specific domain.	-
3	Learn how to design tests to link empirical testing with modeling concepts.	-
4	Use models to accelerate real-world testing without introducing modeling biases	-
5	Have a basic understanding of core components that underpin the field.	-
6	Identify most important areas of impact and timeline to get there for potential benefits and perils of CAV deployments at scale.	-

Theme 3: Modeling, Simulation, and Testing of CAVs

Barriers:

- Training on modeling, simulation, and testing only pertains to PhD level problems
- The field is rapidly changing

Proposed solutions:

- A great deal of content can be covered in a special electives class at the undergraduate level
- Senior design projects
- Research seminars on emerging topics and certificates that cover core ideas

Theme 4: Travel Behavior in the Context of CAVs

- Students need to learn about discrete choice models, data mining, travel behavior modeling, microeconomics, basic statistics, and parameter estimation technique
- Student should learn to develop models of their own
- Students should be familiar with the passively collected data by AVs
- Students must know how to validate datasets
- Students should know how to effectively utilize the data.

Theme 4: Travel Behavior in the Context of CAVs

	Learning Objectives	Educational material exists (Y/N)
1	Identify and critique various data streams available to study CAV systems, and describe use cases.	N
2	Demonstrate the ability to manage and process traditional (survey-based, experiment-based) and passive data streams.	Y
3	Understand basics of what drives behavior, and factors that influence traveler decision-making (long-term and short-term), given CAV context.	Y
4	Apply foundational knowledge in travel behavior and CAV technologies to design and development of research questions, hypotheses, measurement instruments, and analysis plans.	N
5	Master basic modeling approaches and have foundations for learning advanced modeling techniques in depth; choice models, foundational econometrics, ability to derive composite models/model structures.	Y

Theme 4: Travel Behavior in the Context of CAVs

Barriers:

- Lack of training to work with passively collected data
- Lack of processed datasets

Proposed solutions:

- Students benefit from in-person interactions with their classmates and instructors
- Foundational material *could* be mostly taught in self-contained online courses
- Two types of courses can cover the basis:
  - Methodology core
  - Behavioral core

Common Conclusions

- Interdisciplinary fields
- Fundamentals remain at the forefront
- Theoretical foundations are readily taught, but applications of these fundamental concepts to CAVs is missing
- Modernized traditional degree programs remain the best option for more fundamental education
- Certificate programs/ short courses may be the best option for professionals

Thank You!