UP 431: Urban Transportation Modeling

Spring 2025, Department of Urban and Regional Planning, University of Illinois at Urbana-Champaign

CLASS MEETINGS:	Tuesdays and Thursdays, 11:00 pm – 12:20 pm, TBH 227
INSTRUCTOR:	Bumsoo Lee, bumsoo@illinois.edu
OFFICE HOURS:	12:30 – 1:20 pm on Thursdays and by appointment, TBH 227/M206
CREDIT HOURS:	**4 credit hours** for **graduate** students and **3 credit hours** for **undergraduate** students

COURSE OVERVIEW

"All models are wrong; some are useful." – George Box

This course provides foundational skills for transportation planners to analyze travel behavior and predict travel demand. Travel demand models are essential tools that guide and support decisions on transportation investments by producing precise estimates of trip-making patterns. However, the process by which these models translate inputs to outputs is often opaque, relying on assumptions that may or may not accurately reflect reality. In this course, you will gain practical skills in travel demand modeling applications while also developing a critical understanding of the contributions and limitations of these models.

Learning objectives

By the end of the course, you will be able to:

- Navigate the world of transportation data and craft compelling narratives about travel patterns.
- Apply behavioral theory and discrete choice models to analyze and predict travel behavior.
- Understand how travel demand models transform input data to predictions, including the assumptions underpinning the process.
- Analyze the outcomes of planning scenarios using CUBE, a travel demand modeling software.

COURSE AT A GLANCE

Week	Dates	Topic	Assignment Due
1	Jan 21, 23	Introduction; Travel behavior fundamentals	
2	Jan 28, 30	Transportation data collection & analysis	
3	Feb 4, 6	Review of statistics 1	Assignment 1 (Feb 6)
4	Feb 11, 13	Review of statistics 2	
5	Feb 18, 20	Discrete choice analysis 1	Assignment 2 (Feb 20)
6	Feb 25, 27	Discrete choice analysis 2	
7	Mar 4, 6	Discrete choice analysis 3; Guest lecture	Grad term paper plan (Mar 4)
8	Mar 11, 13	Discrete choice analysis 3; TDM overview	Assignment 3 (Mar 13)
	Spring Break		
9	Mar 25, 27	Trip generation	Grad progress report (Mar 27)
10	Apr 1, 3	Trip distribution	
11	Apr 8, 10	Mode choice	
12	Apr 15, 17	Trip assignment	Assignment 4 (Apr 15)
13	Apr 22, 24	Evaluating alternatives and related models	
14	Apr 29, May 1	Grad term paper/Final project presentations	
15	May 6	Final project presentations	
			Final project report (May 12, Noon)
			Grad term paper (May 16, Noon)

PREREQUISITE

- UP 430 (or CEE 417) or UP 460, or consent of instructor.
- **Junior standing** is required for undergraduate students.
- Familiarity with basic **statistics** (e.g. regression analysis) and **R coding** is required for a success in UP 431. LinkedIn Learning courses listed in weeks 2, 3 & 4 will be helpful for self-teaching R.

EVLUATION

	Undergraduate students	Graduate students
4 homework assignments	60 %	40 %
Final (travel demand forecast) team project	30 %	30 %
Term paper research	-	20 %
Participation and attendance	10 %	10 %

Graduate students are required to conduct an **empirical study on travel behavior**, using the NHTS or other travel survey data, in addition to common course requirements. Detailed guidelines will follow.

RUBRIC:

A: Demonstrates original thought and synthesis of ideas and cogent analysis, and is clearly written and presented. Outstanding work.
B: Presents above average analysis with appropriate evidence to support ideas, and is clearly written or presented. Good work.
C: Shows a basic level of understanding, with analysis limited to obvious arguments. Writing is competent. Adequate work.
D: Misunderstands or misrepresents the material, or is so poorly written or presented as to obscure the analysis. Inadequate work.

Transformation of numerical grade to letter grade will be according to the schedule below:

A+	97-100		
A	93-96.9	C+	77-79.9
A-	90-92.9	C	73-76.9
B+	87-89.9	C-	70-72.9
B	83-86.9	D+	67-69.9
B-	80-82.9	D	60-66.9

COURSE REQUIREMENTS

Homework Assignments (All Students): Four homework assignments will be given throughout the semester. All assignments are due by **11am** on the specified due date unless noted otherwise. Late submissions will incur a penalty of 10% deduction per day, up to a maximum of 50%.

Travel Demand Forecast Team Project (All Students): Students will forecast and analyze future travel demand in the Champaign-Urbana region for the horizon year 2040 based on alternate scenarios for the region. Working in a team of three to four members, students will present their project outcomes in class and submit a final project report. The report should detail the research process, the results of the model, policy implications, and any challenges encountered during the project. To ensure effective collaboration, it is recommended that each team includes at least one graduate student member to take on a leadership role. Detailed guidelines for the project will be provided later in the semester.

Term Paper Research & Presentation (Graduate Students): Graduate students are required to conduct research, present their findings, and submit a 10-page term paper. The paper must be an empirical study investigating travel behavior, using travel survey data. While students are encouraged to select a travel behavior topic that aligns with their interests, they should aim to apply a discrete choice model learned during the course. Detailed guidelines on the term paper will follow.

Multiple **deadlines** for the term paper research, including the one-page study plan, three-page progress report, presentation, and final paper submission, are listed on the table on page 1, "Course at a Glance".

POLICIES

ACADEMIC INTEGRITY

This course follows the guidelines set forth by the University student code. See https://studentcode.illinois.edu/article1/part4/1-401/ for specific guidelines, examples, and punishment associated with academic dishonesty.

PLAGIARISM

Plagiarism in this class is unacceptable. Any accidental or willful use of words, work, or ideas of another without appropriate quotation and citation will be penalized by a failing grade on the paper and/or a failing grade in the course. Please see the definition of plagiarism here: https://studentcode.illinois.edu/article1/part4/1-402/. Be reminded that all your submissions to the Canvas will go through plagiarism checking.

USE OF GENERATIVE AI TECHNOLOGY

The use of Generative AI tools, including ChatGPT and Bard, is **permitted** for these limited activities:
- Brainstorming and refining your ideas
- Finding information on your topic
- Identifying r coding examples
- Checking grammar and style

Activities for which the use of generative AI is **not permitted** include:
- Writing a draft of a writing assignment
- Writing entire sentences, paragraphs or papers to complete class assignments
- Completing group work that your group has assigned to you
- Generating tables and figures to include in class assignments

You are responsible for the information you submit based on an AI query (for instance, that it does not violate intellectual property laws, or contain misinformation or unethical content). Your use of AI tools must be **properly documented and cited** in order to stay within university policies on academic honesty mentioned above. Any use outside of this permission will be considered academic dishonesty.

ATTENDANCE POLICY

Regular attendance at all scheduled classes (lectures and labs) is crucial for success in the course. If you must miss class for a religious observance or an approved reason, you need to contact the instructor at least one week prior to the absence to discuss arrangements and provide a proper absence documentation (e.g. Request for Accommodation for

Religious Observances). In case of serious illness or family emergencies, inform the instructor via email as soon as possible.

SPECIAL ACCOMMODATIONS

This course will accommodate students with documented disabilities. Please refer to https://www.disability.illinois.edu/academic-accommodations-and-supports/academic-accommodations for more information and provide the appropriate documentation at the beginning of the semester.

CLASS CLIMATE

The Department of Urban and Regional Planning (DURP) is committed to creating an environment of inclusion and opportunity that is rooted in the very goals and responsibilities of practicing planners. Conduct that interferes with the rights of another or creates an atmosphere of intimidation or disrespect is inconsistent with the environment of learning and cooperation that the program requires. By enrolling a course in the Department of Urban and Regional Planning, students agree to be responsible for maintaining a respectful environment in all DURP activities, including lectures, discussions, labs, projects, and extracurricular programs. We will be governed by the University Student Code. See Student Code Article 1—Student Rights and Responsibilities, Part 1. Student Rights: §1-102 In the Classroom.

EMERGENCY RESPONSE RECOMMENDATIONS

The Department of Homeland Security and the University of Illinois at Urbana-Champaign Office of Campus Emergency Planning recommend the following three responses to any emergency on campus: **RUN > HIDE > FIGHT**
For more information, https://police.illinois.edu/em/run-hide-fight/.

COUNSELING CENER

The Counseling Center is committed to providing a range of services intended to help students develop improved coping skills in order to address emotional, interpersonal, and academic concerns. The Counseling Center provides individual, couples, and group counseling. All of these services are paid for through the health services fee. The Counseling Center offers primarily short term counseling, but they do also provide referrals to the community when students could benefit from longer term services.
https://counselingcenter.illinois.edu/

READING ASSIGNMENTS

Notes:
NCHRP 716 = National Academies of Sciences, Engineering, and Medicine. 2012. *Travel Demand Forecasting: Parameters and Techniques*. Washington, DC: The National Academies Press. NCHRP Report 716. https://doi.org/10.17226/14665.
Ortuzar & Willumsen (2011) = de Dios Ortúzar, Juan, and Luis G. Willumsen. 2011. *Modelling Transport*. West Sussex, UK: Wiley. [Available as e-book from the University Library] https://i-share-uiu.primo.exlibrisgroup.com/discovery/fulldisplay?docid=alma9965604381220589 9&context=L&vid=01CARLI_UIU:CARLI_UIU&search_scope=MyInstitution&tab=LibraryCatalog&lang=en.
Koppelman & Bhat (2006) = Koppelman, Frank S. and Chandra Bhat. 2006. *A Self Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models*. Pdf posted on Canvas.

Giuliano & Hanson (2017) = Giuliano, Genevieve and Susan Hanson. 2017. *The Geography of Urban Transportation*, 4th ed. New York and London: The Guilford Press.

Week 1: Introduction to travel demand models and planning; Travel behavior fundamentals

Giuliano & Hanson (2017), Miller, Harvey. Ch 5 Theories and models in transportation planning, 113-138.

Giuliano & Hanson (2017), Boarnet, Marlon. Ch 7 Land use, travel behavior, and disaggregate travel data, pp. 164-182.

[Optional] Dill, J., Mohr, C., & Ma, L. (2014). How can psychological theory help cities increase walking and bicycling? *Journal of the American Planning Association*, 80(1), 36-51.

Week 2: Transportation data collection and analysis

Federal Highway Administration. 2018. Chapters 1-3 in *2017 NHTS Data User Guide*. Washington DC: US Department of Transportation. https://nhts.ornl.gov/assets/2017UsersGuide.pdf

NCHRP 716, Chapter 3. Data needed for modeling, pp. 14-26.

[Optional] Ortuzar & Willumsen (2011), Chapter 3. Data and Space.

LinkedIn Learning Course:

R for Data Science: https://www.linkedin.com/learning/learning-r-2/r-for-data-science?u=43607124

Week 3 & 4: Review of statistics—Ordinary least square (OLS) regression

Welch, S. and J. Comer. 2006. *Quantitative Methods for Public Administration: Techniques and Applications 3rd ed*. Long Grove, IL: Waveland Press. Chapters 8 & 9, pp. 212-259.

LinkedIn Learning Courses:

Statistics Foundations 2—Probability: https://www.linkedin.com/learning/statistics-foundations-2-probability/the-importance-of-probabilities?u=43607124

Statistics Foundations 3—Using Data Sets: https://www.linkedin.com/learning/statistics-foundations-3-using-data-sets/discover-samples-confidence-intervals-and-hypothesis-testing?u=43607124

Statistics Foundations 4—Advanced Topics: https://www.linkedin.com/learning/statistics-foundations-4-advanced-topics/the-power-of-advanced-statistics?u=43607124

Weeks 5, 6 & 7: Introduction to discrete choice analysis

Levinson, David, et al. n.d. "Choice Modeling." In *Fundamentals of Transportation*. Wikibooks. https://en.wikibooks.org/wiki/Fundamentals_of_Transportation/Choice_Modeling.

Koppelman & Bhat (2006), Chapters 3 & 4.

CCRPC Modeling Suite and LRTP 2045: https://ccrpc.gitlab.io/lrtp2045/vision/model/; https://ccrpc.gitlab.io/lrtp2045/

[Optional] Wang, Yiyuan, Bumsoo Lee, Andrew Greenlee. 2021. The role of smart growth in residential location choice: Heterogeneity of location preferences in the Chicago region. *Journal of Planning Education and Research*. May 2021. doi:10.1177/0739456X211017652.

[Optional] Kim, Junghwan and Bumsoo Lee. 2021. Campus commute mode choice in a college town: An application of integrated choice and latent variable (ICLV) model. Submitted to *Travel Behavior and Society*.

Week 8: TDM and Introduction to modeling software

Giuliano & Hanson (2017), Sciara, Gian-Claudia and Susan Handy. Ch 6 Regional transportation planning, pp. 113-138.

Review Citilabs Learning Center for relevant resources. http://www.citilabs.com/support/learning-center/.

[Optional] Miller and Meyer. 2001. "Chapter 5. Demand Analysis". In *Urban Transportation Planning*, 2nd edition. New York: McGraw-Hill. [Come back to this over the next 5 weeks.]

Weeks 9: Trip generation

NCHRP 716, Sections 4.3 and 4.4.
[Optional] Chapter 4 in **Ortuzar & Willumsen (2011).**

Weeks 10: Trip distribution

NCHRP 716, Sections 4.5 and 4.6.
[Optional] Chapter 5 in **Ortuzar & Willumsen (2011).**

Week 11: Mode choice

NCHRP 716, Section 4.7
[Optional] Chapter 6 in **Ortuzar & Willumsen (2011).**

Week 12: Trip assignment

NCHRP 716, Sections 4.8, 4.9, 4.11, and 4.12.
[Optional] Chapter 10 in **Ortuzar & Willumsen (2011).**

Week 13: Evaluating alternatives and related models

Bartholomew, Keith and Reid Ewing. 2008. Land use-transportation scenarios and future vehicle travel and land consumption: A meta-analysis. *Journal of the American Planning Association*, 75 (1), 13-27.
Cervero, Robert. 2006. Alternative approaches to modeling the travel-demand impacts of smart growth. *Journal of the American Planning Association*, 72 (3), 285-295.
Clifton, K.J., Singleton, P.A., Muhs, C.D., and R.J. Schneider. 2016. Representing pedestrian activity in travel demand models: Framework and application. *Journal of Transport Geography*, 52, 111-122.

[Optional] NCHRP 716, Chapter 6. Emerging modeling practices
[Optional] Aoun, A. et al. 2015. *Bicycle and Pedestrian Forecasting Tools: State of the Practice*. Pedestrian and Bicycle Information Center.
http://www.pedbikeinfo.org/resources/resources_details.cfm?id=4931.

Week 14: Graduate student term paper presentations/Final project presentations
Week 15: Final project presentations