NORTHWESTERN UNIVERSITY Winter Quarter 2023
Transportation Systems Analysis and Planning Amanda Stathopoulos

Civil and Environmental Engineering 480-1 – Travel Demand Analysis and Forecasting

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Credits:	1
Room:	Tech LG66
Time:	MW 2:00–3:50
Instructor's Office:	Tech, Room A312
Office Hours:	Friday 1pm – 1.45pm or by appointment
E-mail:	a-stathopoulos@northwestern.edu
TA/Grader:	Maher Said

Course Description

This course will provide an introduction to the statistical, econometric, and behavioral choice model research techniques used to study and forecast travel demand. The course will give students an introduction to the theory of travel demand along with practical tools and methods to model data and make decisions to improve transportation systems. Instruction will be based on studying practical transportation problems and handling real data. The course will make an introduction to statistical programming languages R and Biogeme, training students in model formulation, estimation and use of models in travel prediction for real problems. The overall course goal is to prepare students to navigate model decisions and be able to use models

Learning Objectives

1. Demonstrate knowledge and understanding of the main theories and concepts (e.g. random utility theory, maximization, alternative decision-making, 4-step model, etc.) used to analyze travel demand

2. Demonstrate understanding of the mathematical and econometric formulations (e.g. logit formula, probability formula, error term assumptions, scale/identification) used in the travel demand modeling process.

3. Demonstrate hands-on skills in handling real data and using relevant software for statistical analysis and demand modeling (including data exploration, hypothesis testing, building disaggregate models of travel choices, testing for non-linear variable effects).

4. Show skills in the art and science of demand model building: showing ability to theorize model ideas, build models, interpret results/outputs, improving/correcting models, and detecting signals and noise in modeling

5. Show ability to use model results and 'apply' models for forecasting and policy insight (e.g. sample enumeration, willingness-to-pay, elasticity, segmentation, revenue optimization).

6. Become familiar with advanced modeling concepts, formulation and interpretation (e.g. nested logit, random parameter specifications, behavioral realism, latent variables)

7. Communication skills. Demonstrate skills in effective audience-specific written, graphic/visual, oral and interpersonal communication

8. Show critical thinking skills. In this course this is centered on: a) consideration of different theories, perspectives, explanations; b) ability to 'read' models critically: who and for whom? Are findings robust? Can the model be misused or misunderstood? What are the limitations of the model?

9. Skills in teamwork. Students will show the ability to work effectively in teams. This is centered on demonstrating: a) participation in group decision-making and coordination, b) prioritizing team project plans, schedules, and equitable management of people.

Course Format

Classes are combination of lectures, discussions and analysis of estimation examples and case-studies. Students are expected to read assigned texts before class and to participate in class discussions. Homework assignments will be given and analysis of these assignments will be the basis for some class discussion during the class immediately following their due date, so it is essential to complete assignments **on time**. Students are also expected to give a lecture in the course covering an academic paper. These lectures are expected to be of high quality and students are expected to master the work and give a high quality expository lecture, that other students can learn from.

Below is a list of class topics covered in each week.

Course Schedule

The class will meet on Monday and Wednesday 2-3.50. The class will be canceled for MLK day. Class meetings will focus on shorter instruction activities along with application, critical thinking, lab sessions and discussion sessions around the class topics. Therefore, students need to stay up to date with their preparation and go over announced material in advance to get the most out of classes[1]

[1]There will be no class during MLK day Monday Jan 16th.

Table 1: Class topics

Topics	Focus
1. Modeling Transportation demand	The travel demand process. Choices stages
2. Statistics & estimation: software	Exploratory statistics. Assumptions in data-analysis. Hypothesis testing. Software for demand analysis.
3. Fundamentals of choice theory	Theory of rational choice. Micro-economics of demand. Discrete choice. Probabilistic and deterministic models. 4-step model. Trip generation. Multiple regression model
4. The Logit model	Binary choice model. Systematic utility and error terms. Maximum likelihood estimation. Mode choice model. Generic/specific attributes.
5. Multinomial Logit	Specification of models. Non-linear utility. Interactions. Heteroscedasticity. Segmentation
6. Specification testing	Specification testing. Goodness-of-fit. Test parameters. Nested & Non-nested hypotheses.
7. Aggregation and forecasting	Aggregation. Sample enumeration. Forecasting. Revenue optimization. Willingness-to-pay
8. Generalized Extreme Value	Limitations of logit. IIA. Nested logit
9. Mixed Logit & simulation	Flexible model structure. Panel data. Random parameter logit. Latent variables.

Texts & Books

The overall text-book of the course will be:

- Ortúzar, Juan de Dios, and Luis G. Willumsen (2011) Modelling Transport, 4th Edition. (there is also a Kindle Edition Amazon, that you can also read on most tablets and computers).

Readings will be drawn further from different sources which will be made available online:

- Train, Kenneth (2009) Discrete Choice Methods with Simulation. Cambridge University Press `http://elsa.berkeley.edu/books/choice2.html`
- T. Domencich and D. McFadden, Urban Travel Demand: A Behavioral Analysis, North-Holland, New York, 1975. An online version is available from `http://eml.berkeley.edu/~mcfadden/travel.html`
- Koppelman & Bhat A Self Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models `http://www.ce.utexas.edu/prof/bhat/courses/lm_draft_060131final-060630.pdf`

plus distributed notes and supplemental readings posted on Canvas or e-mailed to you. Assigned readings for particular classes will be announced in advance, either in class or in the announcements section on Canvas. Students should check Canvas regularly to get updates and class notes as they become available.

Evaluation

The grade is based on a series of assignments of various nature, both individual and group homework assignments, class presentation, participation and written exams. The goal of the homework assignments is education, not evaluation, and most of the assignments require judgment and critical thinking, as well as knowledge of theory and coding.

For individual homework assignments students may collaborate but need to prepare and present results and interpretations independently. For group homework assignments a single collective report is handed in and students choose their preferred method to collaborate. Assignments will be handed in to Canvas not emailed to facilitate the administration. Evaluation rubrics and detailed instructions will be posted on canvas. The overall course grade will consist of the weighted grade from multiple components, namely;

	Assignments	grading weight
IR1	Individual regression model: report with exploratory statistics, trip making regression models and interpretation	15
TW1	Team-work choice model, basic specification, socio-demographics, attributes delivered as joint report	15
TW2	Team-work advanced modeling and policy application delivered as joint report	20
	Presentation and discussion of selected theme papers: professional and well prepared presentation and discussion points	10
	Final presentation of choice model project	10
	Attendance and engagement in class activities	10
	Final written exam: open book exam with about 10 problems to solve	20

Late policy

The date and cutoff time for all assignments listed in table 3 are posted on Canvas (most assignments are due at midnight but some are due ahead of class time). Any late submissions will be assigned a penalty of 10% of the grade per day late. However, if you have a serious conflict with another class[2], software problems, or some other personal issues, deadlines can be extended when a request for such an extension is made *before* the due date. Also, keep in mind that given the focus on assignments in this class, they are generally going to be more extensive and rigorous than problem sets in other classes. High quality and thoughtful work is expected; leaving assignments to the last few hours before the deadline will likely not yield good results.

[2]That fact another professor has assigned a homework assignment also due on the same date is not a serious conflict if the due date is still more than a week away.

Figure 1: Grading scheme

Grading Scale (% to letter grades) CIV_ENV_480-1		
Percentage	Letter grades	Expected Performance
93 -100	A	Excellent
90 -92.9	A-	Very Good, very minor mistakes
86 -89.9	B+	Good
83 -85.9	B	Solid but some room for improvement
80 -82.9	B-	Consistent Issues
76 -79.9	C+	
73 -75.9	C	Significant weakness
70 -72.9	C-	
66 -69.9	D+	
63 -65.9	D	Passing but many failed elements/tasks
60 -62.9	D-	
0 -59.9	F	

Participation policy

Attendance in the class sessions and team discussions is essential since that is where we do active learning, discussion, reflection, and work through examples and case studies. If you are unable to attend please let me know as soon as possible so I can make sure you get support and instructions for alternative assessment modes. Please drop me an email as soon as you can titled 'CEE480 Absent'. Please do not come to class if you are experiencing symptoms of illness. For a missed class you can make up for it by providing a 1-page summary or 3 slides reflecting the main takeaways of the reading/resources and class activities. Please send these to me by email with the header 'CEE480 missed class makeup'. The class participation section of the grade does not just measure attendance in class, but reflects the student's understanding of the subject matter, as reflected through insightful questions and discussion in class.[3] The grading scheme used is found in figure 1.

Office Hours

Office hours are held every other Th from 1-2pm and on demand by students. Most questions arise when using software to estimate models for homework assignments, and not on a regular schedule. As such, it is usually quickest to communicate questions and resolve issues via e-mail to me and to our grader or programming TA and/or the class via the canvas discussion board. Additionally, students should feel welcome to set up an appointment with me, by emailing me at a-stathopoulos@northwestern.edu. E-mail responses can be expected within 24 hours, but questions about homework will not be answered if they are asked 24 hours or less before due date of the homework.

[3] Although regular attendance is required to achieve this goal, attendance alone without active participation in class discussions will not result in a stellar grade.

Acknowledgments

Some material in the course, including notes, homework assignments, and data draws on material used in prior years by Frank S. Koppelman, and for some recent editions by Jeffrey Newman and Andreas Frey. I am grateful to them for letting me use their material in developing this course. The use of homework or example data beyond this course without permission is prohibited. Any students desiring to use data for publication purposes must check with the instructor to ensure appropriate permissions to use the data is obtained.

Learning provisions

Communication modus operandi

We will use Canvas as the main platform for communication and to distribute readings, assignments, and grades. The Modules page shows the organization of the class for each week. The syllabus and schedule will be updated on Canvas. Assignments and Activity boards will be announced here, and all submissions and grading will be done on Canvas. This might be replaced with a Canvas announcement based on class feedback.

Academic integrity – specific stipulations for remote learning period

This text draws from Provost guidance: Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.