Transportation Network Analysis
Fall 2017

Instructor: Steve Boyles
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Course Meeting Time and Place: Tuesday and Thursday, 12:30–2:00, ECJ B.226
Office Hours: Tuesday and Thursday 3:00–4:00; please notify me if you will be stopping by
Course Website: http://tinyurl.com/ce392c-fa17, homework submission and grades posted on Canvas

Welcome to CE 392C! This course will expose you to the basic concepts of transportation network analysis, as well as explore some applications. Network analysis answers questions such as, "where will people change their routes if I build a new bridge across the river?", "where will the congestion hotspots be 30 years from now?", or "how will traffic patterns change if a bypass toll road is built for I-35 around Austin?" Basically, any problem which requires a "big-picture" view of what routes people will take relies on a network model. The focus is on a large area, such as a city or metropolitan region, rather than on a specific intersection or roadway.

By the end of this course, you will have the tools to answer these questions. You will be able to formulate a variety of transportation planning problems as network models, and have the practical knowledge needed to solve them. Furthermore, you will have a conceptual understanding of these models which allows you to understand and critically evaluate model results which others may present to you. This course will require you to understand both the basic concepts of transportation network analysis, and to apply them in a project involving an oral presentation and written report.

Prerequisites

This course has no formal prerequisites, but does require a significant amount of calculus — if your calculus is a bit rusty, it may not be a bad idea to review. Programming skills (MATLAB, C, Java, etc.) are helpful but not required, and the specific language is not important. If you don't feel comfortable with any programming language, then homeworks and the project may require a bit of spreadsheet work.

Course Materials

The required text for the course is a set of course notes which I will distribute to you during the first week of class. You may find the following optional textbooks useful for additional background and detail on specific topics.

- Sheffi, Y. (1985). *Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods.* Available for free download: http://web.mit.edu/sheffi/www/urbanTransportation.html The best introductory textbook to transportation network analysis, although it is a bit dated.
- Ahuja, R., T. Magnanti, and J. Orlin. (1993). *Network Flows.* Prentice-Hall. Very good textbook on computer implementation of network algorithms, and applications beyond the transportation domain.
- Patriksson, M. (1994). *The Traffic Assignment Problem — Models and Methods.* VSP International Science. Very comprehensive ($>$ 1000 references). Provides an excellent history of the topic and is a great jumping-off place for a literature review on a specific topic, but not always aimed at those new to the field.
- Bell, M. G. H. and Y. Iida. (1997). *Transportation Network Analysis.* Wiley. More recent than Sheffi's text, but not as detailed in its explanations.

Grading

Final course grades are determined by performance on homeworks, an in-class exam, a term project, and a final exam. +/− grading will be used. The weight of each of these factors is as follows:

Category	Weight
Homeworks	35%
Exam	30%
Project	35%

Five **homeworks** will be assigned throughout the semester, each worth 6% of your final grade. All assignments must be submitted on Canvas in PDF form. **This is a graduate course, and your assignments must be prepared in a professional and readable manner. Points may be deducted for assignments which are hard to read or follow, with spelling errors, and so forth. I encourage you to use drafts on scratch paper before preparing your final submissions.** You are encouraged to work together on homeworks, but you must submit solutions in your own words. These homeworks will require a significant amount of time and effort — do not wait until the night before to start! Late homeworks are only accepted if you notify me of a time conflict or need for extension before the due date.

The **exam** will take place on November 30, and is comprehensive. No final exam is scheduled during finals week. You may bring any *handwritten* notes to this exam, and no calculators will be needed. The project will culminate in oral presentations and a written report, both due in the last week of class.

Depending on class size, I will decide whether **projects** will be done on an individual or group basis. Potential project topics include application of one or more of these network models to a real-world scenario, presenting one or more important journal papers (please discuss with me beforehand), comparison of different solution methods for the same problem, development of a computer tool to automate a solution method, or another related topic of interest. Please send your project topic to me for approval by October 31 at the very latest, but you are strongly encouraged to start earlier. At the end of the semester, you will be required to present your project to the rest of the class, and complete a written report documenting all of your work.

Attendance is not part of the final grade calculation, but students are rarely successful in this course without regular lecture attendance and participation.

Miscellanea

The University of Texas at Austin provides, upon request, appropriate academic accommodations for qualified students with disabilities. For more information, contact the Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259 (Videophone: 512-410-6644) or `http://diversity.utexas.edu/disability/`.

An evaluation of the course and instructor will be conducted at the end of the semester using the approved UT course/instructor evaluation forms.

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. For further information, please visit the Student Judicial Services website at `http://deanofstudents.utexas.edu/conduct/`.

From the 1st through the 4th class day, graduate students can drop a course via the web and receive a refund. During the 5th through 12th class day, graduate students must initiate drops in the department that offers the course and receive a refund. After the 12th class day, no refund is given. No class can be added after the 12th class day. From the 13th through the 20th class day, an automatic Q is assigned with approval from

the Graduate Advisor and the Graduate Dean. From the 21st class day through the last class day, graduate students can drop a class with permission from the instructor, Graduate Advisor, and the Graduate Dean. Students with 20-hr/week GRA/TA appointment or a fellowship may not drop below 9 hours.

Schedule

A tentative class schedule is shown below. All dates and topics are subject to change. The readings listed for a given day are to be done *before* the class, in preparation for that lecture. The readings are sections from the course notes.

Date	Topic	Assignment	Reading
8/31	Course overview and introduction to networks		1.1–2.3
9/5	User equilibrium and system optimum		5.1–5.4, 6.3.1, 6.4.1
9/7	Fixed points and equilibria	HW 1 assigned	3.2.1
9/12	Variational inequalities		3.2.2
9/14	Basic optimization concepts	HW 1 due	4.1–4.4.2
9/19	Basic optimization concepts		4.4.3-4.5
9/21	Beckmann formulation and MSA	HW 2 assigned	6.1, 6.2.1, 7.2, 7.2.1
9/26	Shortest paths on a network		2.4
9/28	Frank-Wolfe and gap measures	HW 2 due	7.1, 7.2.2–7.2.4
10/3	Elastic demand concepts		9.1–9.1.4
10/5	Elastic demand algorithm and examples	HW 3 assigned	9.1.5
10/10	Equilibrium with link interactions		9.2–9.2.2
10/12	Equilibrium with link interaction		9.2.3
10/17	Stochastic network loading	HW 3 due	9.3.1–9.3.3
10/19	Stochastic user equilibrium	HW 4 assigned	9.3.4
10/24	Gradient projection		7.3, 7.3.2
10/26	Algorithm B	HW 4 due	7.4–7.4.2
10/31	Algorithm B	Project topic due	7.4.3
11/2	Path flows and link flows	HW 5 assigned	6.2.2
11/7	Sensitivity analysis: demand		8.1–8.2.1
11/9	Sensitivity analysis: supply		8.2.2
11/14	Network design		8.3
11/16	OD matrix estimation	HW 5 due	8.4
11/21	Stochastic networks		TBA
11/28	Frontiers of network modeling		TBA
11/30	**IN-CLASS EXAM**		
12/5	Project presentations		
12/7	Project presentations	Report due	