Transportation Network Analysis
Fall 2021

Instructor: Steve Boyles
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Course Meeting Time and Place: Tuesday and Thursday, 9:30–11:00, ECJ 1.322
Office Hours: Wednesday and Friday 4:00–5:00 PM **on Zoom** (see Canvas for link)
Course Website: `http://tinyurl.com/boyles392c`, 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.

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. This course will use Python for homework assignments, so past programming experience (MATLAB, C, Python, Java, etc.) is helpful.

Course Materials

The required text for the course is an electronic draft of *Transportation Network Analysis*, by Boyles, Lownes & Unnikrishnan. This text will be posted on Canvas. 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` A classic 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
Reading responses	5%
Homeworks	30%
Exam	30%
Project	35%

These components are designed to work together: the exam focuses on concepts, while the course project involves application and skills involved in engineering practice. The homeworks and lectures give you a chance to learn these skills and practice them throughout the semester. There are two types of assignments. Some are shorter, simpler assignments which are used to give you practice and basic familiarity with the course material. Others are longer and require you to synthesize concepts in a more complex way. The longer assignments will include problems requiring you to write simple Python code. You will be provided with an autograding script which will help you improve and debug your code. You are encouraged to work together on the longer assignments. The problems from the text must be submitted individually, in your own words; Python problems can be submitted either alone or in groups of two. Late work is generally not accepted, but talk to me in advance (at least 48 hours before the due date) if there are unique circumstances that may warrant an exception. **Do not look at solutions from past semesters. I consider this academic dishonesty.**

The **exam** will take place on November 23, 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 29 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.

Most weeks in this course have an associated reading from the textbook or another resource. You are required to compose a short response (250–500 words) to these readings at the start of the week. These responses are free-form and can include questions about things in the reading which are unclear; commentary about related issues in your research or experience; critique of modeling assumptions made or suggestions of alternative assumptions and models; citique of notation, presentation format, and explanations; typos in the text; or anything else which demonstrates that you have read the assigned sections and thought about them. Post each week's response on the Canvas discussion board set up for each week.

If you need to miss class for conferences, research project meetings, religious holy days, etc. please let me know in advance.

Academic dishonesty

You may collaborate with other students **currently taking this course** while solving problems, but textbook questions need to be written up individually. Programming assignments can be submitted either individually or in groups of two. **Under no circumstances can you consult with students who took the course in prior semesters, or view their assignments.**

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/`.

Miscellanea

Due to the ongoing pandemic, this course may be offered in a format to which you are unaccustomed. If you are looking for ideas and strategies to help you feel more comfortable participating in our class, please explore the resources available here: `https://onestop.utexas.edu/keep-learning/`. While we will post information related to the evolving situation on campus, you are encouraged to stay up-to-date on the latest information here: `https://protect.utexas.edu`.

Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA (federal privacy law for students). The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

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/`

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Sharing of Course Materials is Prohibited: No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. Any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

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.

A student who misses classes or other required activities, including examinations, for the observance of a religious holy day should inform the instructor as far in advance of the absence as possible, so that arrangements can be made to complete an assignment within a reasonable time after the absence.

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

All other university policies not explicitly included on this syllabus can be found on the General Information Catalog: `http://catalog.utexas.edu/general-information/`.

Schedule

A tentative class schedule is shown below. All dates and topics are subject to change.

Tuesday		Thursday	
Aug 24th		26th Course orientation and overview	**1**
31st User equilibrium and system optimum	**2**	Sep 2nd Fixed points and equilibria	**3**
7th Variational inequalities	**4**	9th Basic optimization concepts	**5**
14th Basic optimization concepts	**6**	16th Shortest paths on a network	**7**
21st Beckmann formulation and MSA	**8**	23rd Frank-Wolfe and gap measures	**9**
28th Elastic demand concepts	**10**	30th Elastic demand algorithm and examples	**11**
Oct 5th Equilibrium with link interactions	**12**	7th Equilibrium with link interactions	**13**
12th Stochastic network loading	**14**	14th Stochastic user equilibrium	**15**
19th Path-based algorithms	**16**	21st Path- and bush-based algorithms	**17**
26th Bush based algorithms	**18**	28th Path flows and link flows	**19**
Nov 2nd Sensitivity analysis: demand	**20**	4th Sensitivity analysis: supply	**21**
9th Network design	**22**	11th OD matrix estimation	**23**
16th Stochastic networks	**24**	18th Frontiers of network modeling	**25**
23rd **Semester Exam**	**26**	25th **No class: Thanksgiving**	
30th Project presentations	**27**	Dec 2nd Project presentations	**28**