Urban Transportation Planning

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Contents

Foreword

This book contains course notes and assignments for a senior / graduate class in transportation planning and elementary travel modeling. A description for this course is:

> An advanced course in urban transportation planning. Urban transportation as the outcome of an economic system, details and techniques for four-step travel model development, applications of travel models within a legal and regulatory context.

The book is organized into six units:

1. Building Blocks
2. Trip Generation
3. Trip Distribution
4. Mode and Destination Choice
5. Network Assignment and Validation
6. The Planning Process

It may seem strange to put the chapter covering the planning process at the end of the course, after students have learned the details of quantitative travel modeling. The purpose for this is that I assign a term project where the students build and calibrate a four-step model as they learn the techniques to do so, and then complete an alternatives analysis using their models. To create the time and space to do this project, we cover "softer" and conceptual topics in the second half of the course.

The demonstration model the students calibrate and study is a model built in the Cube travel modeling software for the Roanoke, Virginia, metropolitan region. The model is a relatively advanced four-step, trip-based model with only 250 zones. The limited zone size means that the entire model system runs in approximately 15 minutes on a laptop computer. I am grateful to Virginia DOT for allowing my students the use of this model. Directions on how to use the Roanoke model are given in the Appendices.

A handful of assignments require the students to write numerical programs or estimate statistical models. Some guidance on using R and RStudio to accomplish these assignments is also given in the Appendices.

Chapter 1

Building Blocks

This chapter contains concepts, definitions, and mathematical techniques that will be used throughout the semester.

1.1 Planning for Human Systems

If you look out on any sufficiently busy road, you will see a steady stream of vehicles passing by. Each vehicle is largely indistinguishable from the others, and it is easy as an engineer responsible for that road to see the cars driving by as little more than an input to a problem. But the *people* inside the cars should not be indistinguishable from each other. Each person who is driving or riding in each of those cars has their own reasons to be driving on that road. One person might be driving to work; one person might be trying to get home to his or her family. Another car might hold a family going on vacation, or a group of friends heading to a movie.

If you don't recognize that each person who travels is If the road is congested, then the only apparent solution is to "fix" the road by expanding its capacity.

1.2 Travel Model Building Blocks

1.2.1 Travel Analysis Zones

SE Data

1.2.2 Highway Networks

Functional Type

Link capacity

Free-flow speed

Centroid connectors

1.2.3 Matrices

Skim matrices

OD matrices

1.3 Statistical and Mathematical Techniques

1.3.1 Iterative Proportional Fitting

1.3.2 Numerical Optimization

1.3.3 Regression Analysis

Homework

Some of these questions require a completed run of the demonstration model. For instructions on accessing and running the model, see the Appendix

1. With the TAZ layer and socioeconomic data in the demonstration model, make a set of choropleth maps showing: total households; household density; total jobs; job density; density of manufacturing vs office vs retail employment. Compare your maps with aerial imagery from Google Maps or OpenStreetMap. Describe the spatial patterns of the socioeconomic data in the model region. Identify which zones constitute the central business district, and identify any outlying employment centers.

2. With the highway network layer in the demonstration model, create maps showing: link functional type; link free flow speed; and link hourly capacity. Compare your maps with aerial imagery from Google Maps or OpenStreetMap. Identify the major freeways and principal arterials in the model region. *Note*: you will need to run the demonstration model through the network setup step to calculate the capacities and append them to the link.

3. Find the shortest free-flow speed path along the network between two zones. Find the shortest distance path between the same two zones. Are the paths the same? Do the paths match what an online mapping service shows for a trip in the middle of the night?

4. Open the highway assignment report, which shows vehicle hours and miles traveled by facility type. What percent of the region's VMT occurs on freeways? What percent of the region's lane-miles are freeways?

5. Open the output highway network. Create a map of the highway links showing PM period level of service based on the volume to capacity ratios in the table below. How would you characterize traffic in Roanoke? Which is the worst-performing major facility?

Chapter 2

Trip Generation

Chapter 3

Trip Distribution

Chapter 4

Mode and Destination Choice

Chapter 5

Network Assignment and Validation

Chapter 6

The Planning Process

Appendix A

Demonstration Model

A.1 Running the Model

A.2 Files and Reports

A.3 Cube Tips and Tricks

A.3.1 Shortest Paths

A.3.2 Working with Matrices

A.3.3 Writing Custom Scripts

Appendix B

R and RStudio Help

Some students may not feel comfortable working in a console-based application like RStudio. This appendix provides a basic bootcamp for Rstudio, but cannot be a comprehensive manual on RStudio, and it certainly cannot be one for R. Good places to get more detailed help include:

- R help manuals
- Stack Overflow

Some of the sections in this appendix are text-based, and some contain little more than links to YouTube videos created by me or someone else.

B.1 Projects and Directories

B.2 R Packages

B.3 Working with Tables

B.4 Graphics with `ggplot`