CE 272
Traffic Network Equilibrium

Lecture 0

Introduction

Welcome!

Introduction

- What's your name and where are you from?
- Where did you get your undergrad degree from?
- How did you get interested in transportation?
- Tell us something interesting about yourself.

Lecture Outline

Lecture Outline

Overview

Why take this course?

- (CE students) For coursework-based M.Tech. students, this is a core course and you have no choice :) Others may find the course material useful for their research.
- (EECS students) You are interested in Network Games/Algorithmic Game Theory.
- (Others) You want to explore something new. This lecture and the next will give you a glimpse of what to expect.

Overview

Frequently Asked Questions (FAQs)

What will I learn from this course?

- The primary objective of this course is to **predict route choice behaviour** of travellers in large scale urban networks.
- There are several planning and operational problems that benefit from knowing travellers' route choices.

Don't we have software which can do that?

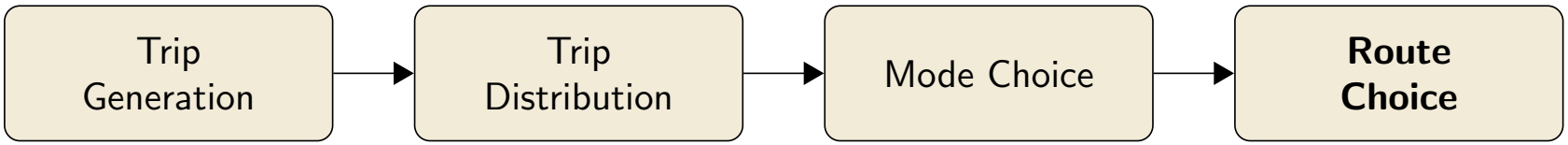
- Yes, software such as TransCAD and CUBE can model route choice behaviour of travellers.
- Instead of using these software as black boxes, our purpose will be to understand what's **behind the scenes**.
- At the end of the course, you will have better insights into network modelling and will be able to write your own code to solve real-world instances.
- You'll also be able to add more features to existing models/formulate new ones that solve problems not addressed by current state-of-the-art tools.

What am I likely to take back from this course?
Almost everything, if you plan to do research in this area. But, in general, **you will develop a habit for**

- Identifying "themes" that are universal to multi-agent systems and a certain style of thinking in addressing related problems using mathematical models.
- Creating control mechanisms and optimizing resources for socially favourable outcomes.
- Finding the right combination of tractability and level of detail needed for a particular problem (there is *never* a one-size-fits-all solution).

Overview

The Big Picture



- The things you'll learn are used in the last part of **the four-step process** that is widely used in transportation planning.
- The first three steps estimate the number of vehicles of different types from different origin-destination (OD) pairs in a network.

Should a street be made one-way or two-way?

You are here: Home » City » B'luru is now City of one-ways

B'luru is now City of one-ways

Bengaluru, June 29, 2015, DHNS:

With 193 such roads, it stands second in the country Bosky Khanna

Bengaluru, referred to as the IT Capital and even Garbage City, has now earnined a new tag - City of one-way roads.

Deccan Herald obtained data from RTOs and traffic management authorities of major Indian cities with a population of more than 75 lakh and vehicular population of over 30 lakh.

According to the data, the City has the second highest number of one-ways in the country. Mumbai stands first with 253 one-ways. According to the Mumbai traffic police and the Municipal Corporation, this is because of the ongoing Metro and Mono Rail construction and after the inclusion of Navi Mumbai. Many one-ways are also introduced during festivals.

BangaloreMirror

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TRAFFIC COPS MAY ADD TO CITY'S 193 ONE-WAYS

By Hemanth Kashyap, Bangalore Mirror Bureau | Oct 31, 2015, 04.00 AM IST

A- A+

Bangalore Traffic Police will review the functioning of one-ways in the city after suggestions were made that some were unwarranted, a few could be reversed and few roads could, in fact, be made into one-ways.

Police Commissioner N S Megharik has passed an order directing traffic police to take a new look at the 193 existing one-ways and make necessary corrections to decongest roads.

THE TIMES OF INDIA

CITY

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For Tech City, One-way the only way

TNN | Dec 17, 2004, 01.48 AM IST

A- A+

Bangalore has become a 'one-way' city — over 260 roads have been declared one-ways, resulting in high fuel bills and more pollution. But with over 25 lakh vehicles crowding city roads every day, only one-ways can keep the traffic moving, DCP Traffic (East) M.A. Saleem tells Azmath.

You have converted around 70 roads into one-ways in the last year. Critics say the city police have become fond of one-ways.

BENGALURU

Traffic woes: Are more one-ways the solution?

Imran Gowhar

BENGALURU APRIL 29, 2015 12:41 IST
UPDATED: APRIL 29, 2015 15:03 IST

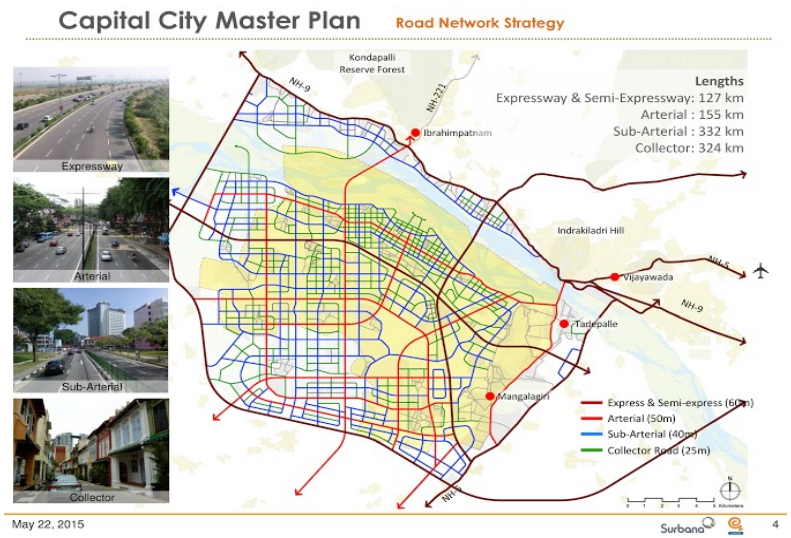
SHARE ARTICLE | PRINT | A | A | A

The plan has already been drafted and also includes reversing the flow of traffic on some roads, such as Richmond Road and Residency Road.

Bumper-to-bumper traffic, the wait for signals to turn green and raised tempers caused by the time taken to cross important stretches in the heart of the city, are issues familiar to any Bengalurean. As a solution to these problems, the traffic police have proposed to implement the one-way rule on several roads in the central business district.

Where should you build new roads/expand capacity?
How would you design the roadway network of a new city?

Capacity Expansion



Amaravati Network Plan

What is the effect of tolls on congestion in urban areas?

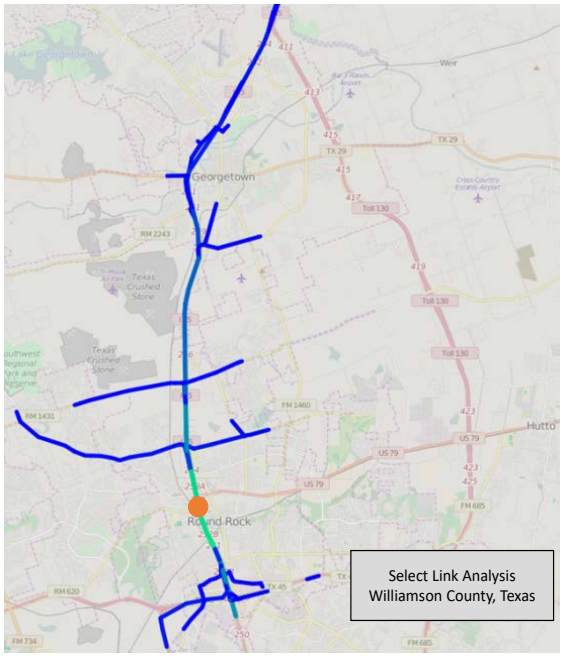
Bandra-Worli Sea Link

Singapore ERP System

London Cordon Pricing

Can we predict the impacts of changes to the network on emissions?

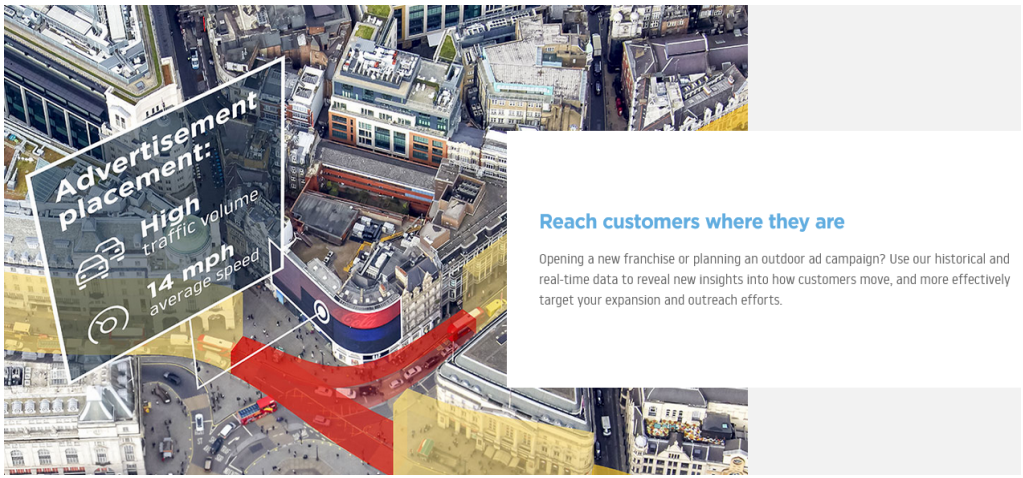
Who are ones using a given roadway link?



Select link analysis is a method that can help quantify **network-level impacts** of a local change. It has applications in congestion pricing and transportation equity.

The figure on the left shows set of links used by travellers taking the orange segment.

Where should you advertise your product?



(Source: TomTom)

Lecture Outline

Course Logistics

Course Logistics

Prerequisites and Texts

While the course does not have assume prerequisites some background in elementary calculus, optimization, and computer programming would be helpful.

The following books can be used as references for this course:

1. Boyles, S. Lownes, N. E., & Unnikrishnan, A. (2020). Transportation Network Analysis. [PDF]
2. Sheffi, Y. (1985). Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods. Prentice Hall. [PDF]
3. Patriksson, M. (2015). The traffic assignment problem: models and methods. Courier Dover Publications. [PDF]

Course Logistics

Written Assignments

- The course will have 5 written assignments.
- You are encouraged to discuss the problems but **you must submit your own solutions**.
- Plagiarizing solutions from your peers or seniors is strictly prohibited.
- Anyone found guilty will of copying or sharing solutions will receive an F grade.
- After the submission deadlines, you may be randomly chosen to explain your solutions.

Course Logistics

Submission Guidelines

You are allowed a total of 5 late submission days which can be spread across the assignments. Assignments turned in after exhausting your quota receive zero points.

- The first two assignments must be prepared in LaTeX. You may use any TeX distribution or Overleaf.
- The remaining assignments can be prepared in any typesetting tool of your choice.

Course Logistics

Programming Assignments

- In addition, there will be a Python programming project comprising of 4 tasks.
- Intermediate deadlines will be provided for you to share your code and get scores and feedback.
- The complete project is due on the day of the final.

Course Logistics

Submission Guidelines

Source codes must be submitted in the form of a Google Colab notebook or .py files.

The programming task will be evaluated based on

- **Correctness**: The expected output will be shared with you and your code must produce similar results.
- **Efficiency**: Good codes must run fast and use as little memory as possible.
- **Styling**: Codes must be well organized and commented. Try and follow the instructions provided in the PEP 8 Style Guide.

Use of ChatGPT and similar tools for writing better programs is permitted, but you must be able to explain every step of your code. A simple programming quiz will be conducted at the end of the semester and your submissions will be graded only if you pass this test.

Course Logistics

Exams and Grading

Examinations

- In-class exams: Mid-semester and End-semester
- End-semester exam is comprehensive

Grading

Component	*Percentage*
Written Assignments	30%
Mid-semester Exam	20%
Project + End-semester Exam	20% + 30%

All submissions must be made via Teams.

Course Logistics

Course Feedback

- The course will be split into modules and at the end of each module, you are required to provide anonymized feedback by answering if 'the contents of the module were clear and easy to understand?'
- Responses are to be provided on a Likert scale (Strongly disagree, Disagree, Neither, Agree, Strongly agree).
- These stats will help me calibrate the course content and also in picking the right questions for the assignments.

Course Logistics

Lecture Material

- Lecture slides for the subsequent weeks will be posted on the course website and MS Teams.
- Please read them in advance before coming to the class.
- Attendance is compulsory. Send me a message in advance in case you are unable to make it to the class.

Course Logistics

Office Hours

- Interactions during the class are strongly encouraged. Feel free to interrupt me any time during the lecture to get your doubts cleared.
- If you have additional course-related queries, we can discuss after the class or drop me a message on Teams to set up a call.
- In addition, the TA for the course will be available between 14:00–15:00 every Monday.

Course Logistics

Modules

The course will be divided into the following modules:

- **Module I: Background**
  In this part, we will cover some background on convex optimization and study shortest path algorithms needed for computing equilibria.
- **Module II: Foundations**
  We then formulate optimization problems for computing the equilibrium solution in large networks and study a few elementary algorithms.
- **Module III: Variants**
  In this segment, we will relax some of the assumptions to formulate and solve problems that are closer to reality.

Course Logistics

Modules

- **Module IV: Advanced Variants**
  We continue relaxing assumptions, but the resulting models become more formidable and require major modifications to solution techniques.
- **Module V: Faster Algorithms**
  In this final part, we will pick up where we left off Module II and study faster equilibrium algorithms and their applications.

Your Moment of Zen

"Does your car have any idea why my car pulled it over?"