Welcome to CVL851A/CVL8550: Static Traffic Assignment and its applications!

Pramesh Kumar
IIT Delhi

July 24, 2025

Outline

Prerequisites

For B. Tech. CVL461 is required and M. Tech. CVL741 is required.

- Calculus
- Linear algebra
- Linear programming or willingness to learn
- Computer programming or willingness to learn

Let's start with the introductions

1. Your name and hometown
2. One thing that you like the most about IIT Delhi
3. Reason(s) for signing up for this course
4. Anything interesting about yourself

Outline

Course information

- Meeting time: M and Th Slot A 8-9:30 A.M (No entry after 8:07 A.M.!)
- My office: 322, Block-IV
- Office hours: TBD
- Email: pkk@iitd.ac.in. Include "CVL851A/CVL8550" in the subject line

What is this course about?

What is this course about?

Introduction to the theory and applications of the traffic assignment problem. Topics include but not limited to

- Formulation of User Equilibrium (UE) in transportation networks;
- System optimal assignment, Braess' paradox;
- Variants of UE traffic assignment;
- Solution algorithms for solving traffic assignment problem for large-networks;
- Applications of traffic assignment in congestion pricing, and origin-destination, estimation and network design.

Why is it useful to study traffic assignment?

Traffic assignment

How would you assign travelers going between different geographic locations to the highway network so that you know traveler flow and travel time on each link? Is it possible to do it for large networks such as Delhi?

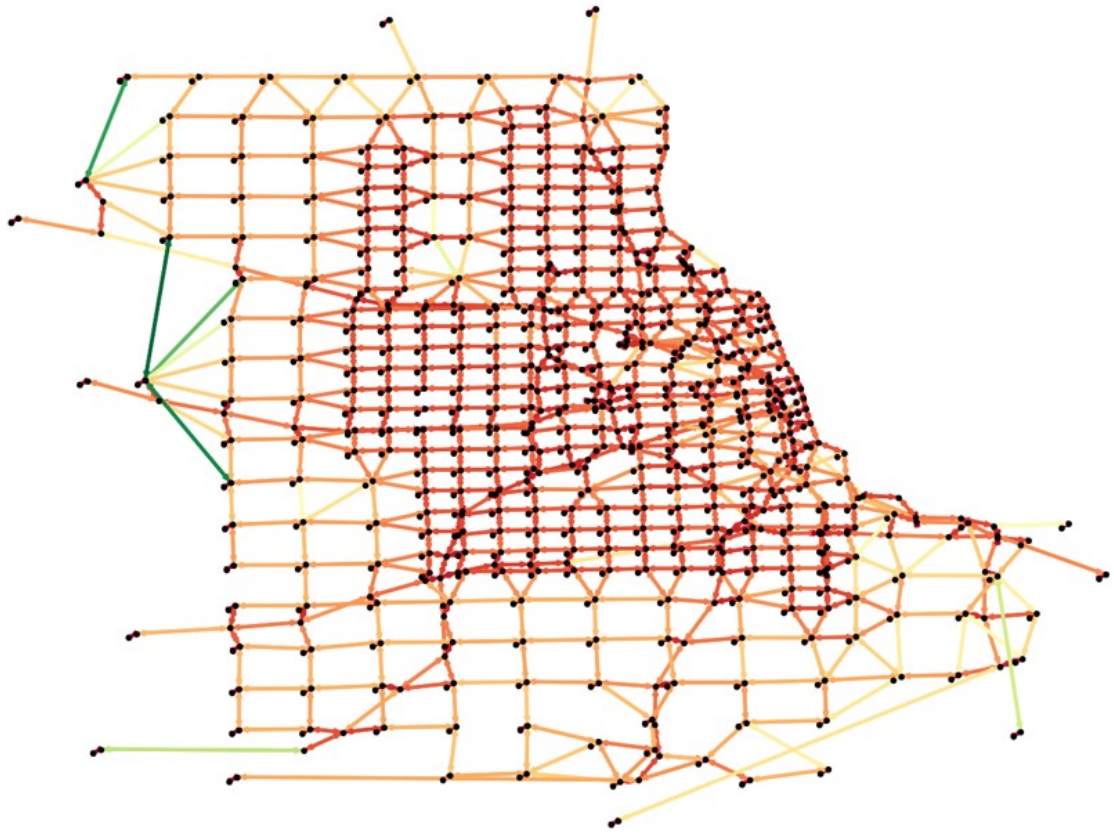


Figure: Travel time on Chicago sketch network

Routing in highway networks

Which path is the shortest path from IIT Delhi to Nizamuddin Railway Station?

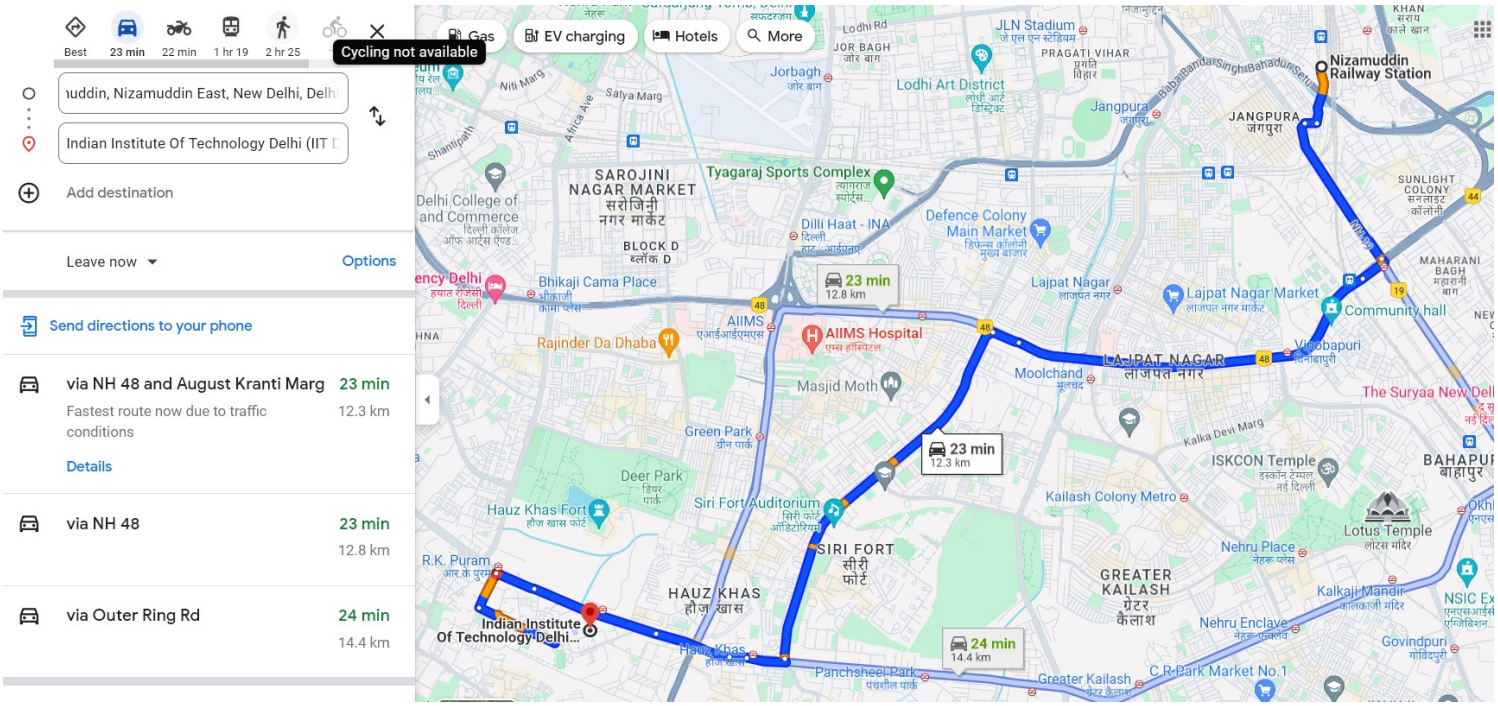


Figure: Shortest path from IIT Delhi to Nizzamuddin Railway Station (Source: Google Maps)

Congestion pricing

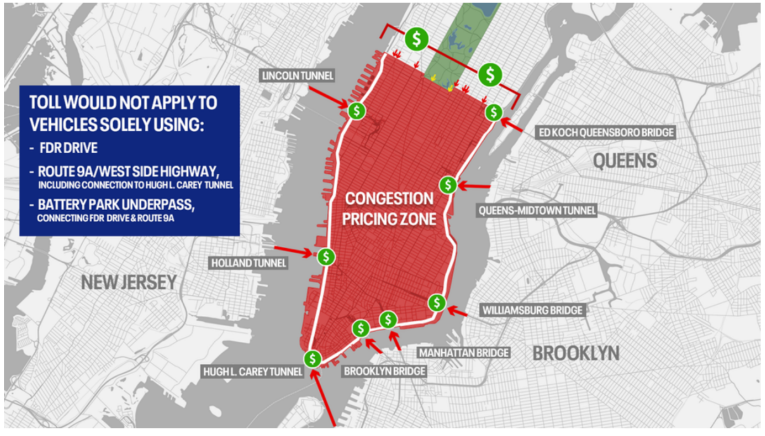
Can we use pricing to reduce traffic congestion? How much toll to levy?

When does NYC congestion pricing start?

Congestion pricing is scheduled to begin on Sunday, Jan. 5, 2025.

Congestion pricing map

Vehicles entering the Manhattan zone, which is local streets and avenues at or below 60 Street – near Central Park – will be charged a toll.



This map shows the proposed zone for New York City congestion pricing.

Drivers on the FDR and West Side Highway passing through the borough will not be charged.

How much will the toll cost?

Most vehicles would pay $9 to enter the congestion zone. It would come on top of the often-hefty tolls drivers pay to enter Manhattan via some bridges and tunnels.

Figure: NYC congestion pricing (Source: fox5ny.com and oecd.org)

Network design

Given limited budget, where should we build (or expand the existing highways) new highways in the network? Will it actually improve the congestion in the network?

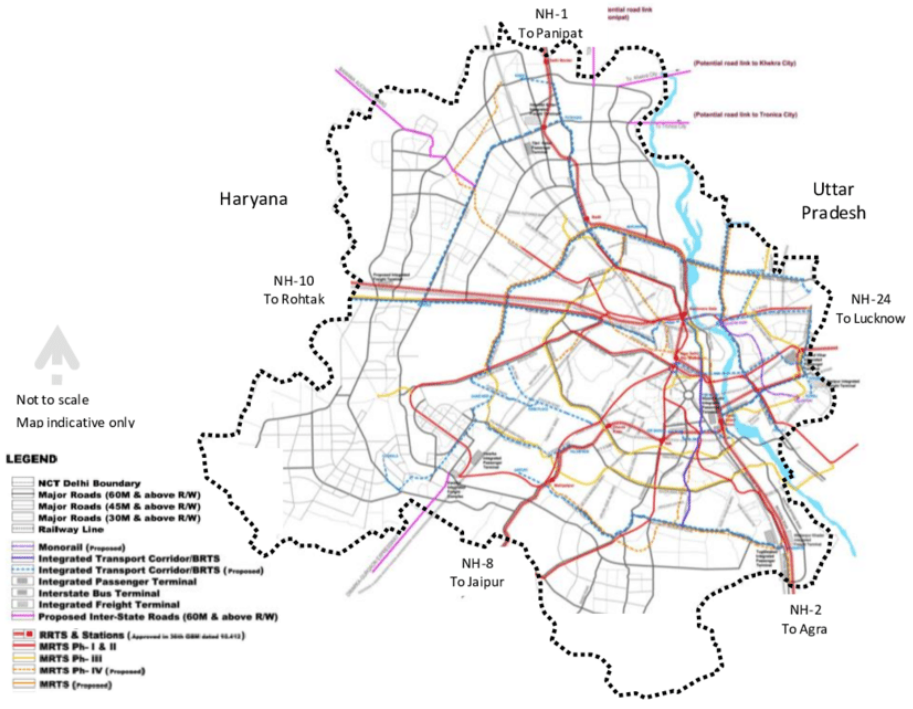


Figure: Delhi highway network (Munshi et al. (2019))

BRT lanes and one-way streets

How will creating a new BRT corridor or converting a street into one-way street impact congestion or emissions in the network?

Figure: (Source: globaldesigningcities.org)

Outline

Grading

1. In-class exercises (20%)
2. Assignments (30%)
3. Minor exam (20%)
4. Major exam[1] (30%)

[1] Major exam will be cumulative

In-class exercises

- I'll ask you to work on some in-class exercises.
- You are encouraged to discuss these with your peers.
- Please submit your exercise sheet right after the class ends. They will not be accepted after the class.

Assignments

- Formulating or solving traffic assignment problems
- Reading and presenting high-quality research articles
- Implement algorithms using a programming language

NetAlgo

A python package developed by me for implementing network algorithms including traffic assignment algorithms.

```python
def getODpairs(self):
    return self.ODpairs

def getNodes(self):
    return self.nodes

def getLinks(self):
    return self.links

def getZones(self):
    return self.zones

def getTSTT(self):

    return sum([self.links[l].getFlow() * self.links[l].getTravelTime() for l in self.links])

def updateTravelTimes(self):
    for l in self.links:
        self.links[l].updateTravelTime()

def getCurrentLinkFlows(self):
    return {l: self.links[l].getFlow() for l in self.links}

def getCurrentTravelTimes(self):
    return {l: self.links[l].getTravelTime() for l in self.links}

def getCurrentTargetLinkFlows(self):
    return {l: self.links[l].getTargetFlow() for l in self.links}
```

Attendance

- You need to attend at least 75% of classes
- Otherwise you will be awarded one grade less than the actual grade

Auditing the course

To get an NP grade

- You need to earn at least 50% (aggregated) of total marks.

Outline

Student learning expectations

- Developing a conceptual understanding of transportation network congestion models
- Translating the conceptual understanding into mathematical modeling
- Large-scale implementation of numerical solution techniques.

Outline

Reference books

There is no required textbook for this course. The following are the references:

- Boyles, S. D., Lownes, N. E., and Unnikrishnan, A. Transportation Network Analysis, Volume I, Version 1.0. (2025) (also referred to as "BLU" book) [Free PDF]
- Sheffi, Yosef. Urban transportation networks. Vol. 6. Prentice-Hall, Englewood Cliffs, NJ, 1985. [Free PDF]
- Patriksson, Michael. The traffic assignment problem: models and methods. Courier Dover Publications, 2015 [Free PDF]
- Ahuja, Ravindra K., Thomas L. Magnanti, and James B. Orlin. Network flows, Pearson; 1st edition (1993). [Free PDF]

Other material will be shared later.

Thank you!