Team Homework

Due Date for Jupyter Notebook: 9:30 AM on November 21, 2024
Due Date for Presentation File: 5:00 PM on November 25, 2024

A. Team Information and Presentation Schedule:

The tables below show your assigned team:

Team 1	Team 2	Team 3
• Gabriel Cedraz Diniz • Annette Gisella • Neil Barry • Ariana Garbers	• Jing Luan • Sanjana Mudunuri • Khalid Adebayo • Stefan Garth Faulkner	• Ruining Yang • Steven Emanuel • Ao He • Seunghwan Cha

Team 4	Team 5	Team 6
• Meen-Sung Kim • Julien Maurice • Jamar Sequeira • Jonathan Gaines • Abraham Jesus Pizano	• Alexandra Wu • Anand (AJ) Subudhi • Sara Costello • Jay Mulay	• Seung Eun (Katy) Choi • Grace Fwelo • Tanuj Sheetal Deshmukh • Irene Feijoo Cedillo • Kaifeng Lin

The presentation schedule is as follows:

Nov 26, 2024	Dec 3, 2024
Team 1 Team 2 Team 3	Team 4 Team 5 Team 6

B. Submission details:

(a) Submit **one zip file per team** by 9:30 AM on Nov 21, 2024, on Canvas. The name of the zip file must reflect your team number, e.g., Team_1_Homework. Your zip file must contain the following:

- A Jupyter notebook that includes your analysis and interpretations associated with the assigned problem. Please be thorough in your explanations and interpretations.
- Additional Python or other files used in your analysis (if any).

Please add comments (using # symbol) in your codes whenever needed so that we can understand them clearly. An example follows:

```
### Initialization
pre_node = dict()     # immediate predecessor node
cost = dict()         # travel time
```

If needed, please add an instruction file (could be a text file or a doc file) containing any special instructions needed to run your codes and/or your Jupyter notebook.

(b) Submit **one presentation file per team** (in PowerPoint format) by 5:00 PM on November 25, 2024, on Canvas. We will use this exact file on the day of your presentation. No changes will be allowed after the deadline.

- Each member of a team must present part of that team's presentation in class. Make sure that the presentation is an integrated document.
- Each team will have a total of 25 minutes for the presentation distributed as follows:
  - 15 minutes to present analysis and findings.
  - 10 minutes for questions/comments/discussion.
- Grading will be based on the following:
  - Presentation content (55 points): It should include a brief introduction to the problem, your analysis, and the corresponding insights/findings (i.e., the answers to the questions that have been asked in the Team Homework PDF file sent to you via email).
  - Presentation organization and communication (25 points): It should include well-organized slides and flow, clear articulation, and clear figures/tables.
  - Q & A (20 points)

These presentations are intended to be interactive. So, you should attend both presentation sessions (i.e., on November 26 and December 3); not doing so will be penalized through deductions of points. Each team should ask at least one question when other teams make their presentations; this is an opportunity to earn extra points.

C. <u>Overview:</u>

In previous homework assignments (homework 2 and homework 3), we built the single-class user equilibrium static traffic assignment (UESTA) program step by step. It can solve large-scale single-class UESTA problems. However, to model and analyze the potential changes arising from various emerging technologies, we employ multiclass traffic assignment. In this team homework, you will work with your team members to extend the single-class UESTA implementation to a multiclass UESTA and a multiclass system optimal STA (SOSTA) program, and analyze the potential changes related to the emerging technologies assigned to your team. You can develop your own implementation (e.g., writing codes), or you can find our implementation in the "Single-class STA" folder for single-class UESTA and extend it for multiclass UESTA and SOSTA.

Please go through the specific information identified for your team in section **D** and answer the questions listed in section **E**.

D. Team-Specific Information:

Team 6

	Scenario 1	Scenario 2	Scenario 3
Demand	100% HDV	60% HDV and 40% EV	60% HDV and 40% EV
Network	Eastern-Massachusetts	Eastern-Massachusetts	Eastern-Massachusetts with two EV charging lanes

The link cost functions of link $a \in A$ for HDVs and EVs are:

$$c_{a,H}(x_{a,H}, x_{a,E}) = \frac{l_a}{v_a}\left[1 + \left(\frac{x_{a,H}}{Q_{a,H}} + \frac{x_{a,E}}{Q_{a,E}}\right)^4\right] + \lambda\left(\frac{x_{a,H}}{Q_{a,H}} + \frac{x_{a,E}}{Q_{a,E}}\right),$$

$$c_{a,E}(x_{a,H}, x_{a,E}) = \frac{l_a}{v_a}\left[1 + \left(\frac{x_{a,H}}{Q_{a,H}} + \frac{x_{a,E}}{Q_{a,E}}\right)^4\right] + \kappa_E\lambda\left(\frac{x_{a,H}}{Q_{a,H}} + \frac{x_{a,E}}{Q_{a,E}}\right)$$

respectively, where $x_{a,H}$ and $x_{a,E}$ are HDV link flow and EV link flow, l_a is the link length (defined in the TNTP network file), v_a is the free flow speed on link a (can be derived by using the link length and link free-flow travel time defined in the TNTP network file), $\lambda = 0.1$ is a constant, $\kappa_E = 0.4$ captures the energy consumption reduction using EV's kinetic energy recovery system, $Q_{a,H}$ is the link capacity for HDV-only traffic (it is defined in the TNTP trips file), and $Q_{a,E}$ is the link capacity for EV-only traffic. It is important to note that, in the current *network.py* file in the "Single-class STA" folder, we have considered the BPR function to calculate link costs. You need to consider the aforementioned link cost functions instead of BPR functions when you develop your own implementation or extend the provided single-class UESTA implementation for this multiclass STA problem. You can derive $Q_{a,E}$ from $Q_{a,H}$ using the following equation (Levin and Boyles, 2016):

$$Q_{a,E} = Q_{a,H}\left(\frac{v_a \Delta t_H + \ell}{v_a \Delta t_E + \ell}\right),$$

where the reaction time of EV is $\Delta t_E = 1$ sec, the reaction time of HDV is $\Delta t_H = 1.5$ sec, and the vehicle length $\ell = 15$ ft.

In Scenario 3, assume that all links have two lanes, and one lane on each of the following links is changed to an EV charging lane (only EV is allowed): links from node 4 to node 11 and from node 10 to node 15.

E. <u>Analysis Questions:</u>

(a) Provide a detailed list of changes you made to extend the single-class UESTA implementation to multiclass UESTA and SOSTA.
(b) Compare the UE objective values and the corresponding total system costs across the three scenarios and interpret the results.
(c) Compare the SO objective values across the three scenarios and interpret the results. Compare these values with the corresponding total system costs obtained under UESTA.
(d) Perform sensitivity analysis (i.e., how UE and SO objective values change) by:
   i. Varying the EV penetration rates
   ii. Varying the number of EV charging lanes

<u>Reference:</u>

Levin, M.W. and Boyles, S.D. (2016). "A multiclass cell transmission model for shared human and autonomous vehicle roads," *Transportation Research Part C: Emerging Technologies*, Vol. 62, pp. 103-116.