Mitigating the impact of selfish routing: An optimal-ratio control scheme (ORCS) inspired by autonomous driving(2018)

1 Network Data

Attribute	Value
Network	Sioux Falls
Links, nodes and OD pairs	76, 24 and 528
TSTT under UE	7480225
TSTT under SO	7194922
Total flow demand	360600

2 Model

Control a proportion of travelers for each OD pair to gain TSTT savings.

$$\min \quad \gamma||\tilde{\mathbf{q}}||_1 + z_2(\mathbf{x}^*) \tag{8}$$

$$s.t. \quad \mathbf{q}^- \leqslant \tilde{\mathbf{q}} \leqslant \mathbf{q}^+ \tag{9}$$

$$T(\mathbf{x}^*)\cdot(\mathbf{x}-\mathbf{x}^*) \geqslant 0\ , \forall\ \mathbf{x} \in \Omega(\tilde{\mathbf{q}}) \tag{10}$$

where γ is control intensity.

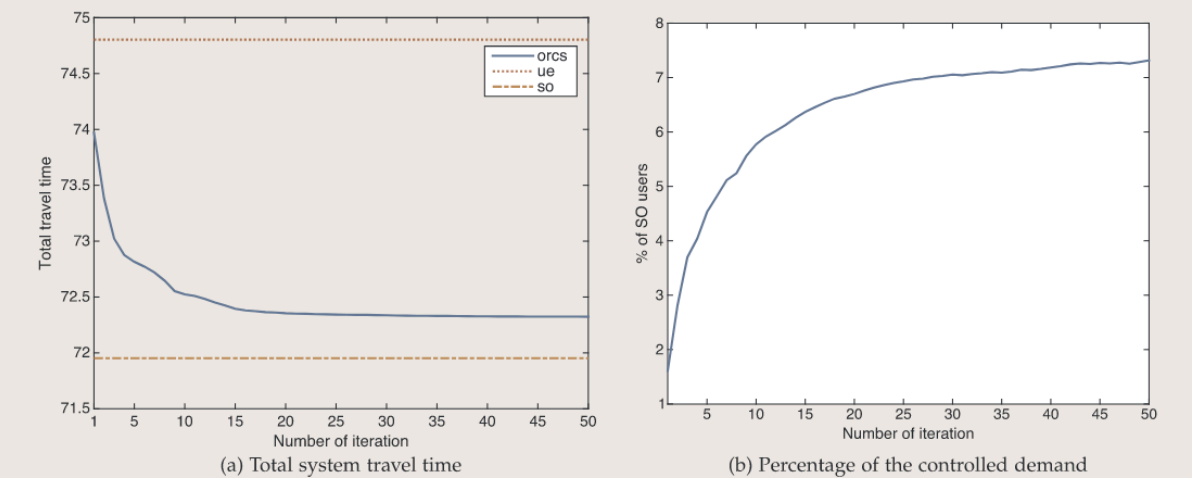
3 Questions

Q1:

Chapter 5.1.3(ORCS with full control potential) demonstrates that:

- Control potential $C_{max} = 1$, meaning that all travelers can be controlled.
- Control coefficient $\gamma = 0.1$.

As shown in Fig. 3a and b, the model converges quickly within 20 iterations and achieves almost 85% of the potential total travel time saving with less than 7.5% vehicles being controlled. Fig. 3c plots link volume-to-capacity (V/C) ratios at UE, SO and under



(a) Total system travel time (b) Percentage of the controlled demand

The results in this paper are:

- First part of the objective functions: $\gamma||\tilde{q}||_1 = 0.1 * 360600 * 0.07 = 2524$.

- Second part of the objective functions:
  $TSTT = 7480225 - (7480225 - 7194922) * 0.85 = 7237718.$
- Objective values: $7237718 + 2524 = 7240242$

However, if we assume that all travelers are controlled(which equals to the SO state). the results are:

- First part of the objective functions: $\gamma||\tilde{q_{so}}||_1 = 0.1 * 360600 = 36060.$
- Second part of the objective functions: $TSTT_{SO} = 7194922.$
- Objective values: $7194922 + 36060 = 7230982 < 7240242$

This means that the objective values of the bi-level program can be decreased, and the solution in this chapter is not optimal.

Solution in my demo:

- First part of the objective functions: $\gamma||\tilde{q_*}||_1 = 0.1 * 154461 = 15446.$
- Second part of the objective functions: $TSTT_* = 7195742.$
- Objective values: $7195742 + 15446 = 7211188 < 7230982.$

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D:\sci_software\miniconda\envs\myenv\python.exe D:\library\Programs\ORCS\ORCS.py
Iteration 1: cur_gap3 = 129700.00, TSTT = 7269329.41, controlled ratio = 0.35968, total controlled demand = 129700.00
Iteration 2: cur_gap3 = 19400.00, TSTT = 7207530.28, controlled ratio = 0.41348, total controlled demand = 149100.00
Iteration 3: cur_gap3 = 3261.41, TSTT = 7205796.70, controlled ratio = 0.42252, total controlled demand = 152361.41
Iteration 4: cur_gap3 = 2100.00, TSTT = 7195742.31, controlled ratio = 0.42835, total controlled demand = 154461.41
Iteration 5: cur_gap3 = 0.00, TSTT = 7195742.31, controlled ratio = 0.42835, total controlled demand = 154461.41
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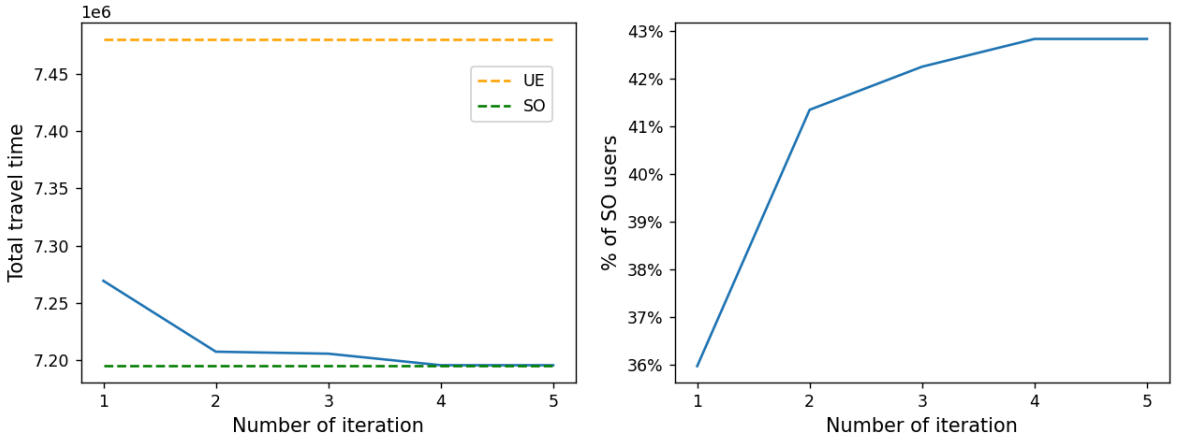
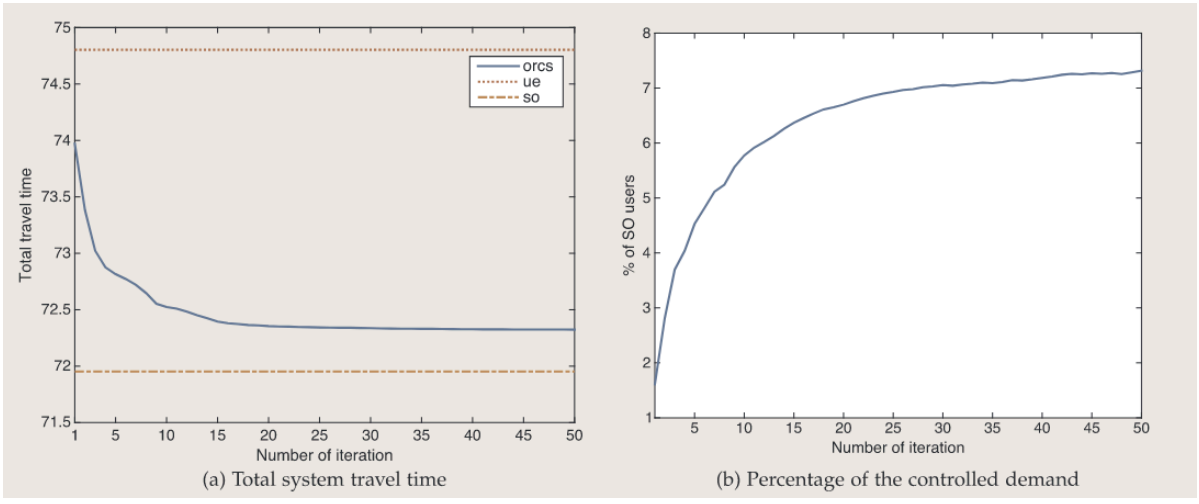
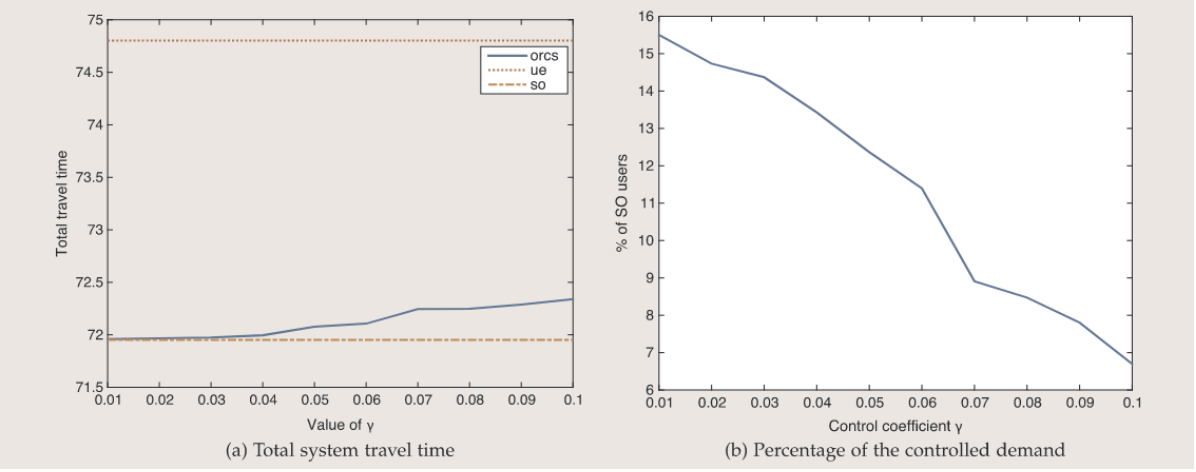


Q2:





(a) Total system travel time (b) Percentage of the controlled demand

In Fig 3, when $\gamma = 0.1$, the percent of SO users is around 7.3%. However, in Fig 4, it changes to around 6.8%.