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ASSESSMENT OF TRAFFIC NETWORK RESILIENCE AND ROBUSTNESS WITH ADAPTIVE SIGNAL CONTROL

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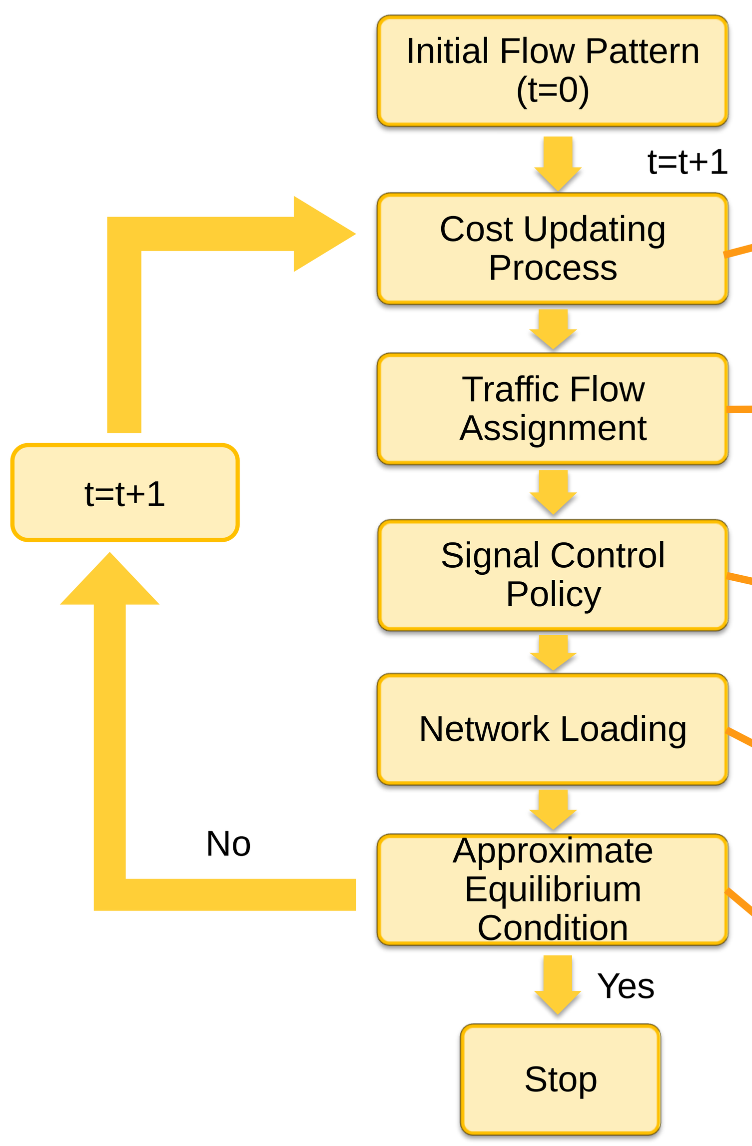
INTRODUCTION

Traffic network is important to daily mobility and transportation, however it may suffer different kinds of disruptions during its life time. Resilience and robustness are two key notions to characterize the performance of the traffic network to withstand stress. This research investigates network resilience and robustness under local capacity reduction from the perspective of day-to-day traffic evolution influenced by adaptive traffic signal control.

MODEL FORMULATION

The traffic evolution process after disruption is simulated with the logit-based day-to-day model under stochastic user equilibrium (SUE) condition. The influence of signal control is represented as extra flow which is a function of red time and saturation flow.



The perceived cost (P) is a function of the measured cost (C) and perceived cost of the previous day

$$P^t = \beta C(f^{t-1}) + (1-\beta)P^{t-1}$$

The probability of choosing route r is:

$$p_r = \frac{1}{1+\sum_{s\in R_w, s\neq r} e^{\theta(P_r^t - P_s^t)}}$$

The green time is assigned to each link to balance the red time cost, the aggregated link cost of link a is:

$$x_a + r_a s_a$$

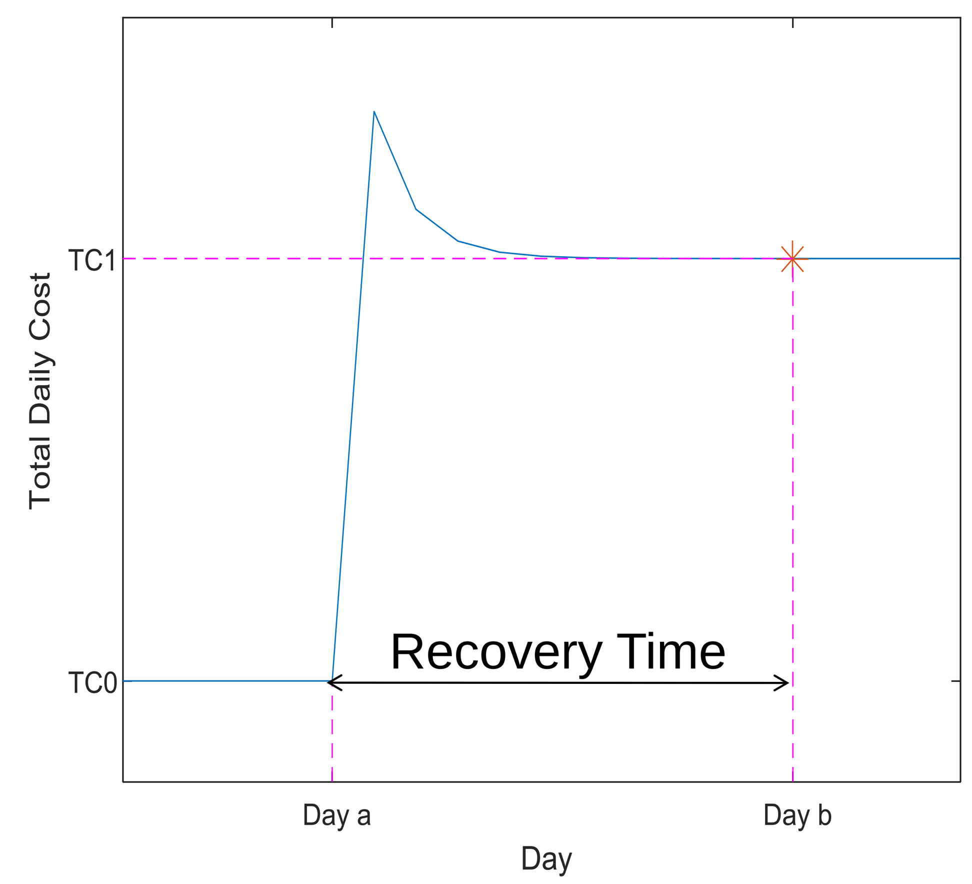
The link cost is calculated with the BPR formula:

$$c_a(x_a) = t_a\left[1 + b\left(\frac{x_a}{K_a}\right)^{\eta}\right]$$

The approximate equilibrium condition is dependent on path flow (f):

$$\frac{\| f^t - f^{t-1} \|}{\| f^{t-1} \|} \le \varepsilon$$

RESILIENCE AND ROBUSTNESS



Resilience – Recovery Time

The resilience is defined as the recovery time since the disruption occurs till the traffic network reaches the approximate equilibrium state.

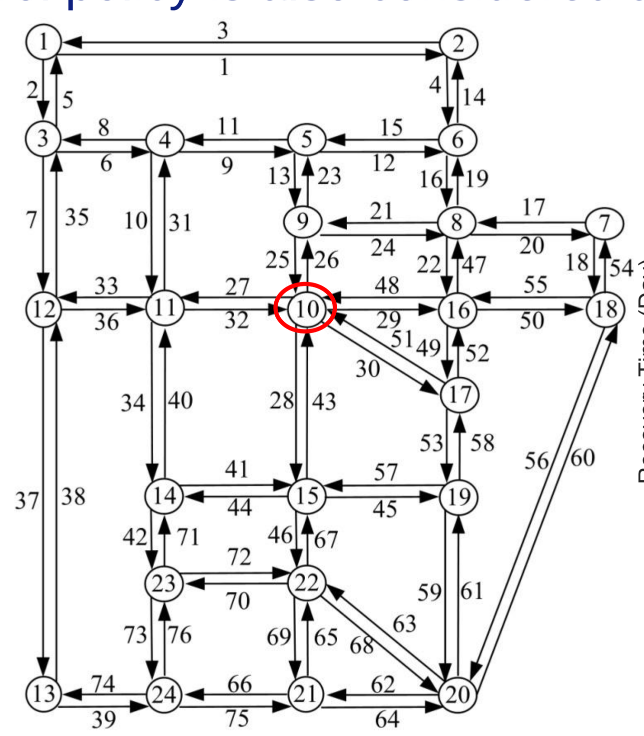
Robustness – Relative Total Cost Index (I)

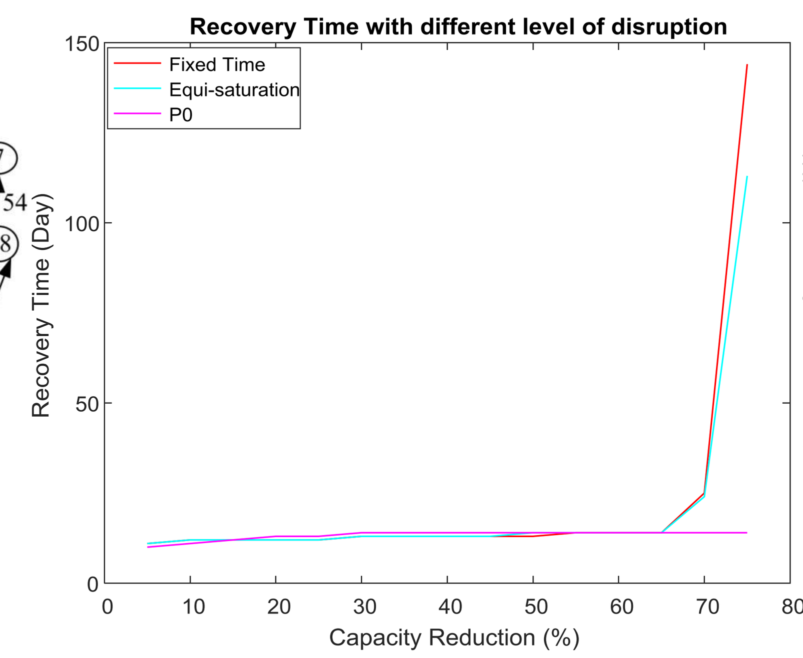
The robustness is represented as relative total cost index, which is the relative difference between the total costs before and after the disruption. The network with large relative total cost index is less robust.

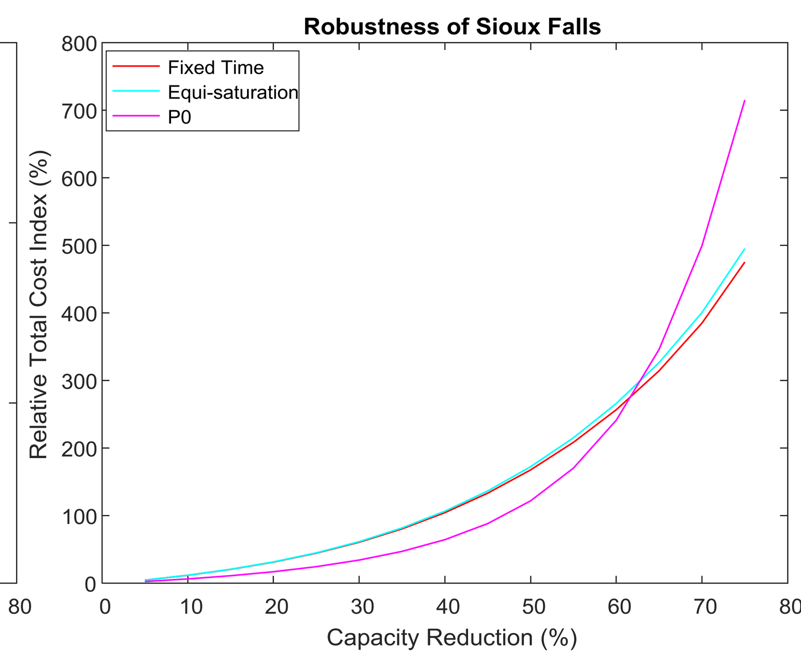
$$I = \frac{TC1 - TC0}{TC0} \times 100\%$$

RESULTS AND CONCLUSIONS

The numerical test is carried out with the Sioux Falls Network. Node 10 is assumed to be disrupted. Two adaptive signal control policies: equi-saturation policy and P0 policy are considered. The fixed signal control policy is also considered as a benchmark.







The results show that the adaptive signal control can reduce the recovery time effectively especially when the disruption is severe. P0 has nearly constant recovery time no matter how sever the disruption is. However, equi-saturation policy makes the network to be less robust compared with the fixed time signal control. P0 policy has smallest value of relative total cost index when the capacity reduction is below 60%, while the steep increase indicates that the system may have robustness problem when the disruption is serious.

REFERENCES

Watling, D. (1999) Stability of the stochastic equilibrium assignment problem: a dynamical systems approach. *Transportation Research Part B.* 33(4), 281-312.

Liu, R. & Smith, M. (2015) Route choice and traffic signal control: A study of the stability and instability of a new dynamical model of route choice and traffic signal control. *Transportation research Part B.* 77, 123-145.

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