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21–25 October

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TRAFFIC SIGNAL CONTROL OPTIMIZATION UNDER SEVERE INCIDENT CONDITIONS USING GENETIC ALGORITHMS

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Overview

- Introduction
- Methodology
- GA optimization process
- Experiment design
- Results
- Conclusion and future works

Introduction

Traffic congestion is classified into two types: recurrent congestion (RC) which can appear due to daily travel patterns and non-recurrent congestion (NRC) which can be caused by unexpected events such as accidents/breakdowns/etc. The most problematic incidents can occur at random locations, at various moments in time and do not ever repeat themselves. It is a big challenge to model and handle the network optimization under these non-recurrent incidents because of its uncertainty of occurrence in both time and space.

Methodology

Problem

Optimizing the signal control plans when severe incidents occur.

Our approach

The approach relies on deploying genetic algorithms (GA) by considering the phase durations as decision variables and the objective function to minimize as the total travel time in the network.

Methodology

Data input

- O-D configuration,
- O-D demand table,
- Network configuration,
- Link detail table,
- Traffic signal configuration.

Data output

- Optimized traffic signal configuration.

GA optimization process

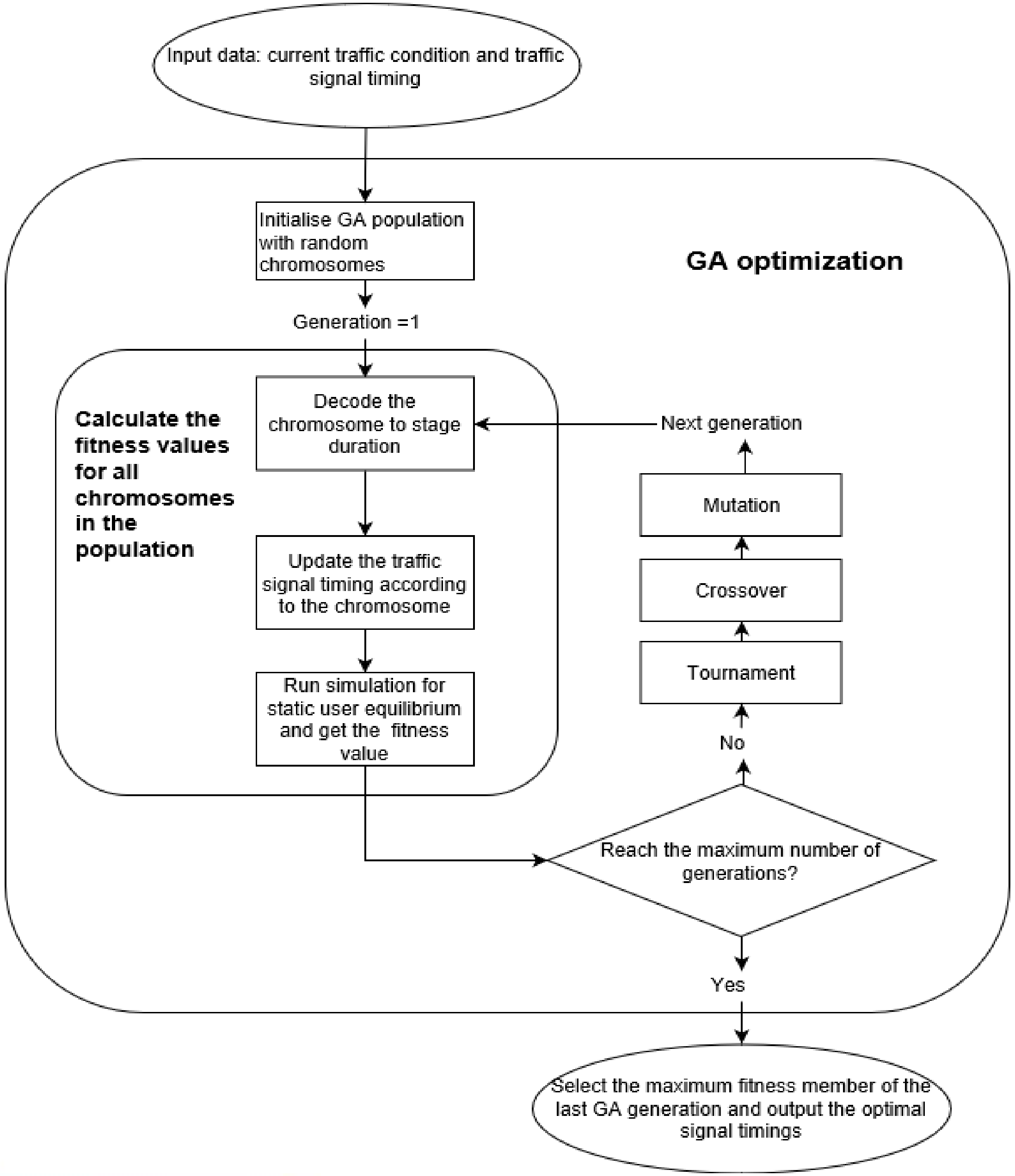
The target function is to minimize the total travel time of the network.

$$\text{Fitness} = -\sum_{a \in A} \int_0^{v_a} t_a(v_a, \lambda_a)dx$$

The decision variable is a vector of all phase durations within the network.

Chromosome (array) =

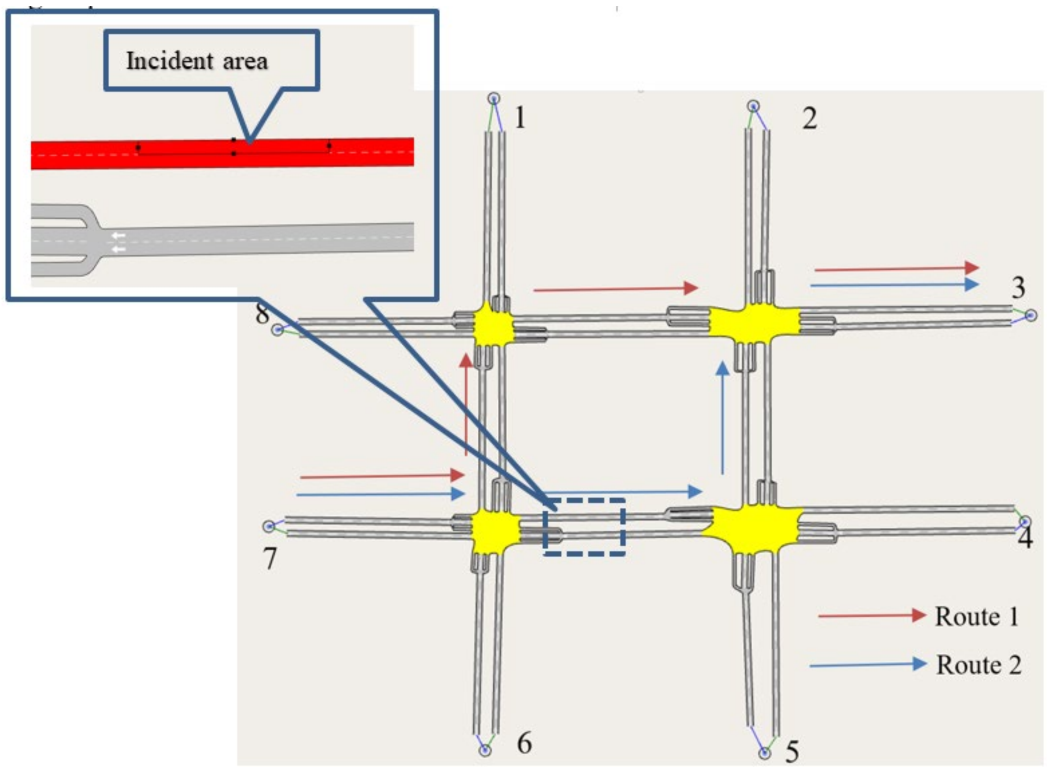
$$[\quad p11, p12, p13, p14,$$
$$p21, p22, p23, p24,$$



Experiment design

Scenarios

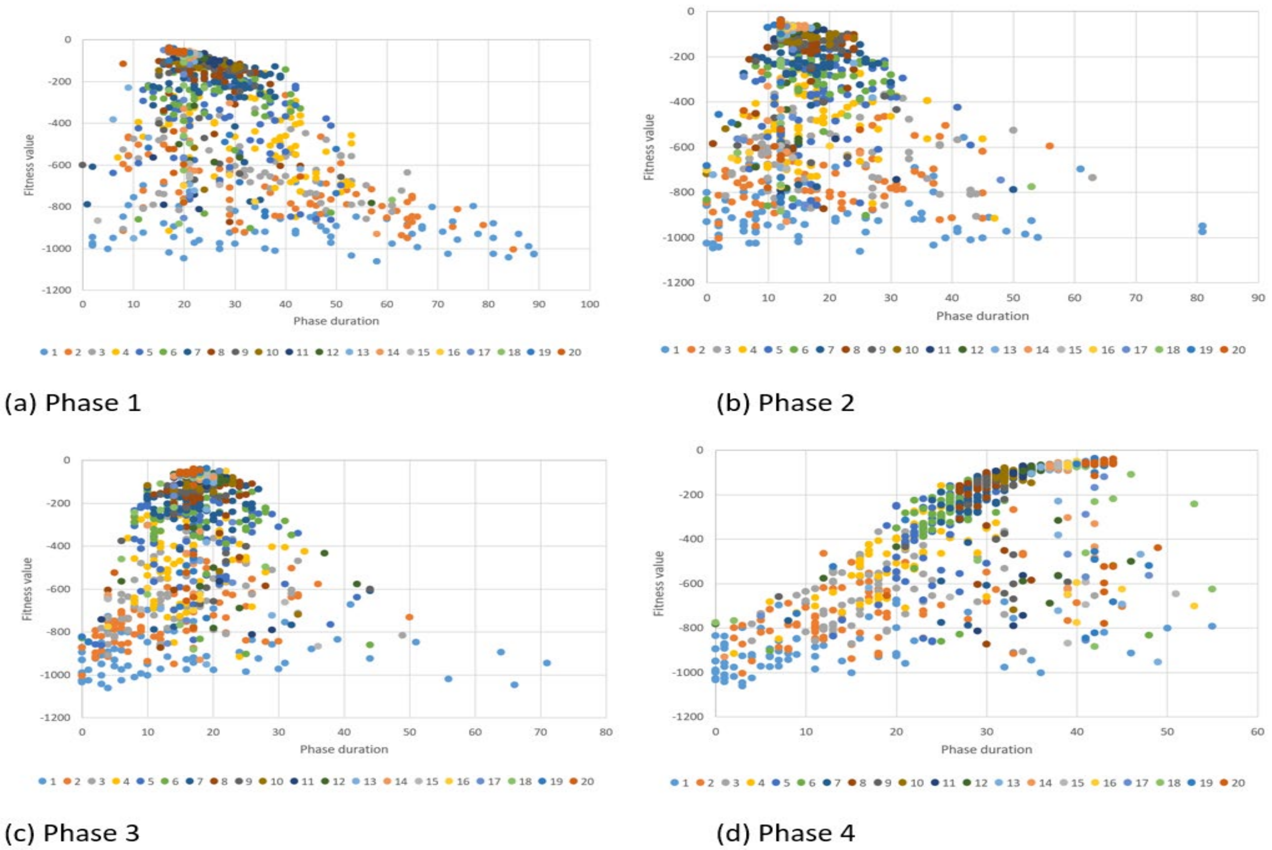
- No traffic incident scenario,
- Traffic incident scenario without GA traffic control optimization,
- Traffic incident scenario with the GA traffic control optimization.



Experiment network

Experiment results

GA optimization

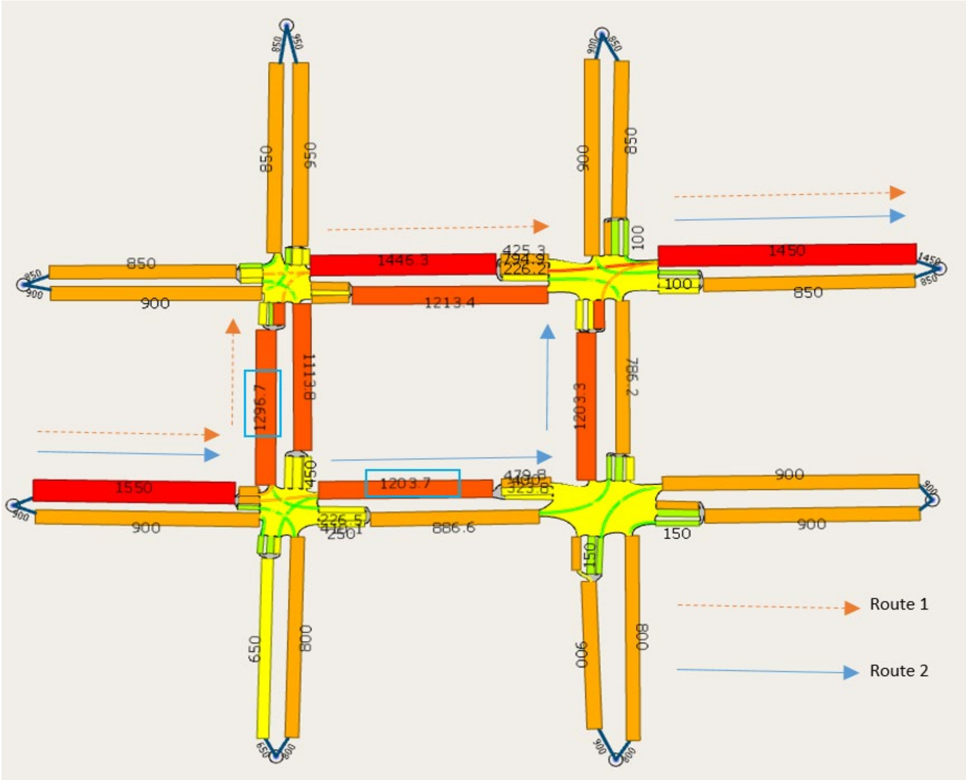


Phase duration convergence in intersection 3

Experiment results

Traffic flow

- No traffic incident scenario,
- Traffic incident scenario without GA traffic control optimization,
- Traffic incident scenario with the GA traffic control optimization.



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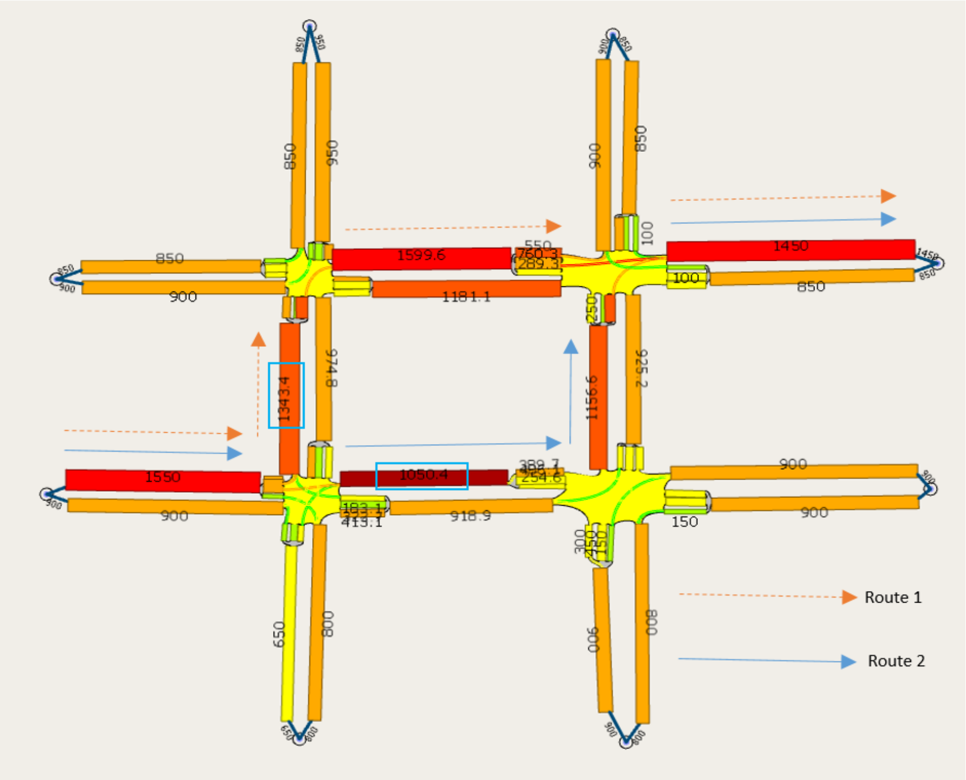

Experiment results

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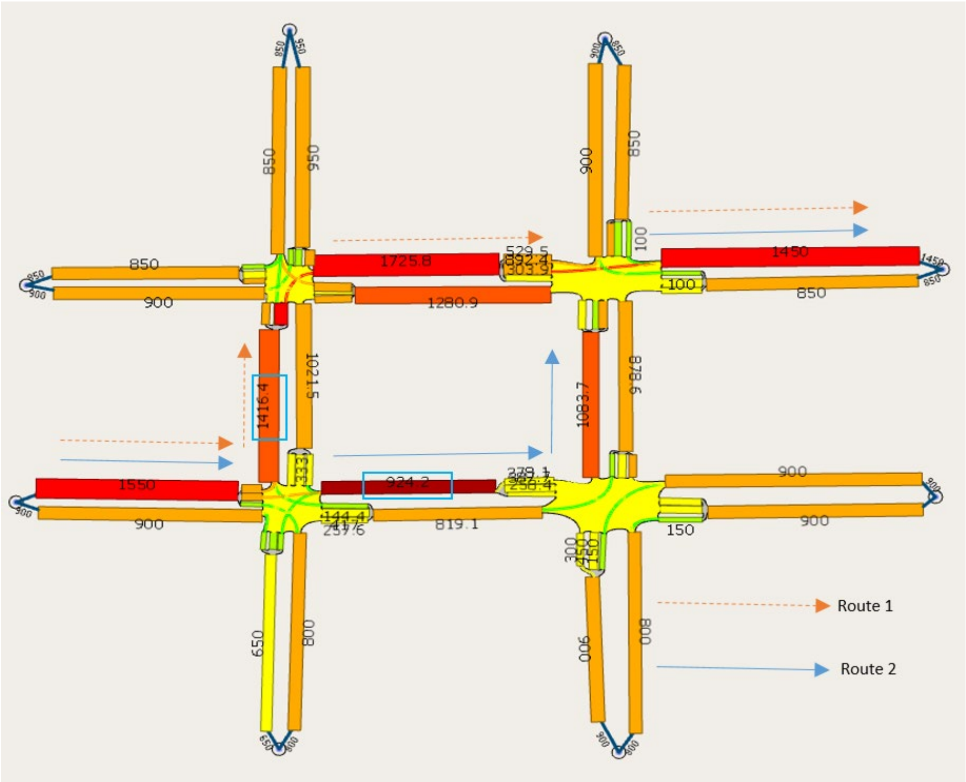

Experiment results

Simulation statistics

In our case study, a 40.76% of total travel time saving is achieved in our network after applying GA traffic signal optimization under traffic incidents comparing using default pre-optimized traffic signal plan.

Conclusion and future works

The experiment results show improvement of the total travel time if the TMC uses our proposed GA model to re-optimize the traffic control plan if an incident happens in a network.

- Future work can be done in investigating **more complicated network and even real-world network**.
- In order to fit the proposed model to real-world application, we are working on **enhancing the algorithm to parallel computing and increasing efficiency**.
- In addition, we are currently **deploying machine learning** to further scale up the approach for larger networks in Sydney.

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Thank you!

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