A methodology for the simulation based Assessment of Coordination Strategies using Particle Swarm Optimization

The Problem

- Signal coordination can aim at very different objectives.
- Can be realised in different ways.
- How can we compare strategies and determine the best solution for a given set of objectives and traffic conditions?

The Objective

Provide a platform for a flexible and general assessment of signal coordination strategies, with reference to a benchmark solution.

Research questions

- How is “best” (in best coordination strategy) defined?
- How sensitive are strategies to changed demand?
- What if the data supply is unreliable or insufficient?
- What happens, if priorities change?

The Solution

Calculates performance for given signal programs and traffic situation

Signal Program Optimisation Tool

Optimises signal programs according to performance indicators

Example evaluation

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Cycle time</th>
<th>Offset 1</th>
<th>Offset 2</th>
<th>Offset 3</th>
<th>Offset 4</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual →</td>
<td>28 s</td>
<td>55 s</td>
<td>0 s</td>
<td>55 s</td>
<td>25.5 s</td>
<td></td>
</tr>
<tr>
<td>Manual ←</td>
<td>110 s</td>
<td>82 s</td>
<td>55 s</td>
<td>0 s</td>
<td>26.1 s</td>
<td></td>
</tr>
<tr>
<td>Optimum</td>
<td>56 s</td>
<td>56 s</td>
<td>109 s</td>
<td>51 s</td>
<td>25.5 s</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion and Outlook

- PSO is a suitable tool for optimisation problems in the context of signal control.
- The developed framework promises valuable insight into the performance of signal coordination strategies.
- The modular structure of the software (C++) facilitates adaption to different simulation tools.
- The assessment platform still has to be applied to different scenarios (network layout, traffic demand, strategies, …).

Contact

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Average performance

Performance of individual particles

Particle Swarm Optimisation

Convergence PSO

\[ v_i(t+1) = \chi \left[ v_j(t) + \phi_1 (y_j(t) - x_i(t)) + \phi_2 (\bar{y}(t) - x_i(t)) \right] \]

Constriction Factor

\[ \chi = \frac{2c}{c + \sqrt{c^2 - 4}} \]

Cognitive and social factors

\[ \phi_i = c_i r_i \]

Cognitive factor: cognitive factor (particle best)
Social factor: social factor (swarm best)
Random: random influence

Delay

Intersection 1
Intersection 2
Intersection 3
Intersection 4

Offset (s)

Iteration

Total Delay (s)

Min
Quartile 1
Mean
Median
Quartile 3
StdDev

Average performance

Performance of individual particles