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Dynamic Origin-Destination Estimation in TRANSIMS using Parallel Semi-Heuristic Algorithms

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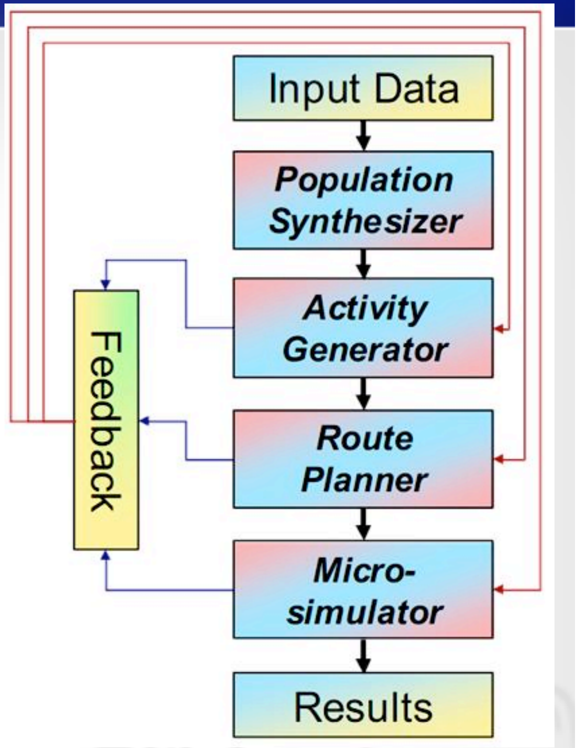
Motivation



- Increased resolution requires:
  - Dynamic Demand
  - Fine-grained network

- Objective:
  - The ability of Heuristic search techniques (e.g. Genetic Algorithms) to aid in the adjustment and/or calibration of dynamic demand

Motivation

- The goal is:
  - Given a priori known Origin-Destination (O-D) matrices, and hourly field traffic counts, how can we estimate (or calibrate) the time dependent O-D matrices

Dynamic O-D Estimation (DODE)

- From an analytical standpoint, DODE is typically formulated as a bi-level programming problem
- The problem is very difficult to solve, and several approaches have been proposed
- A fine-grained network and a simulation-based approach introduces more complexity, and precludes an analytical, closed-form solution

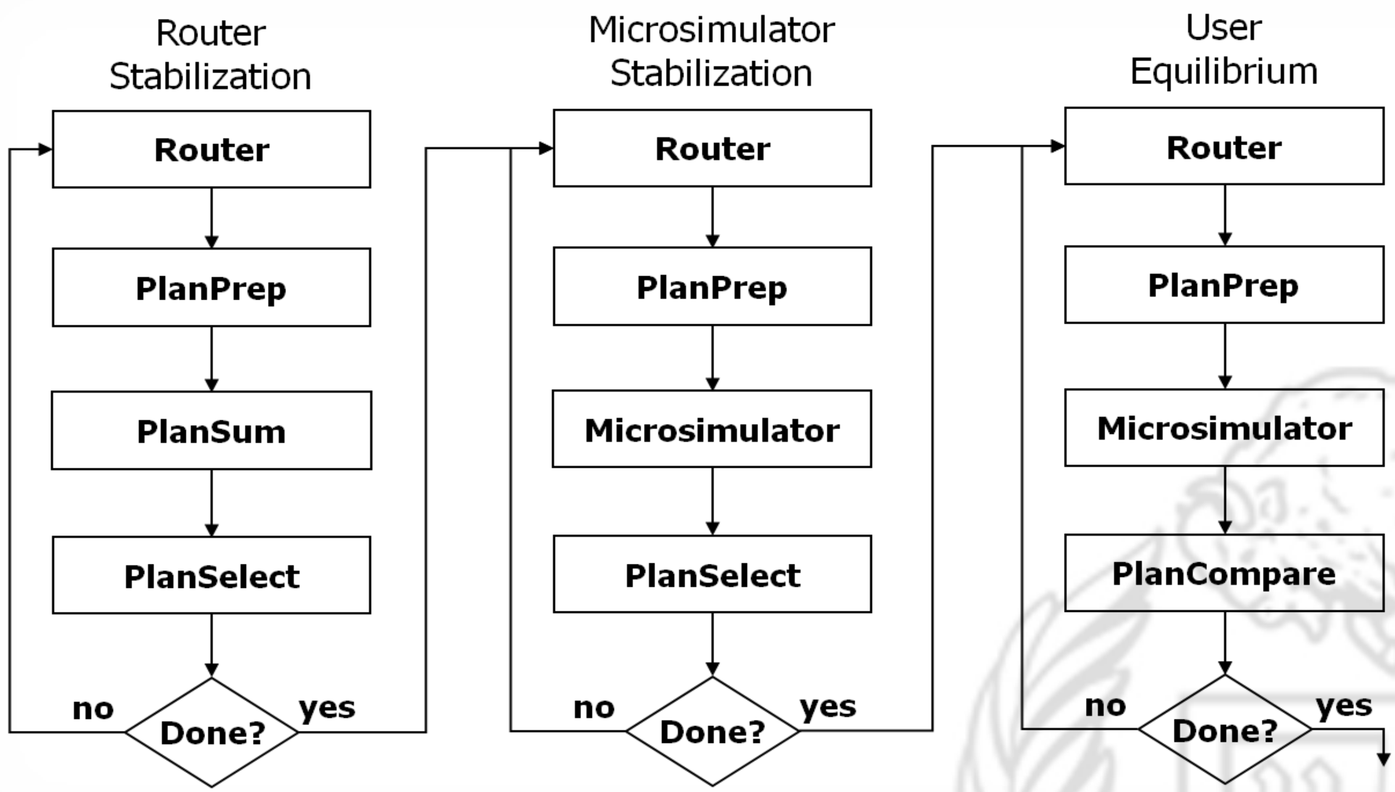
DODE in the context of TRANSIMS

- Challenges:
  - Detailed modeling of traffic dynamics
  - More than one O-D matrix
  - Randomness within the traffic assignment process
  - Run-time is quite long

Traffic Assignment in TRANSIMS

- TRANSIMS separates traffic assignment and micro-simulation into two stages
- Router performs all-or-nothing assignment using a time-dependent minimum impedance path algorithm based on the travel time on each link
- Micro-simulator then purely loads the plans given by Router (i.e. vehicles are not dynamically re-routed).

Approximating User Equilibrium in TRANSIMS

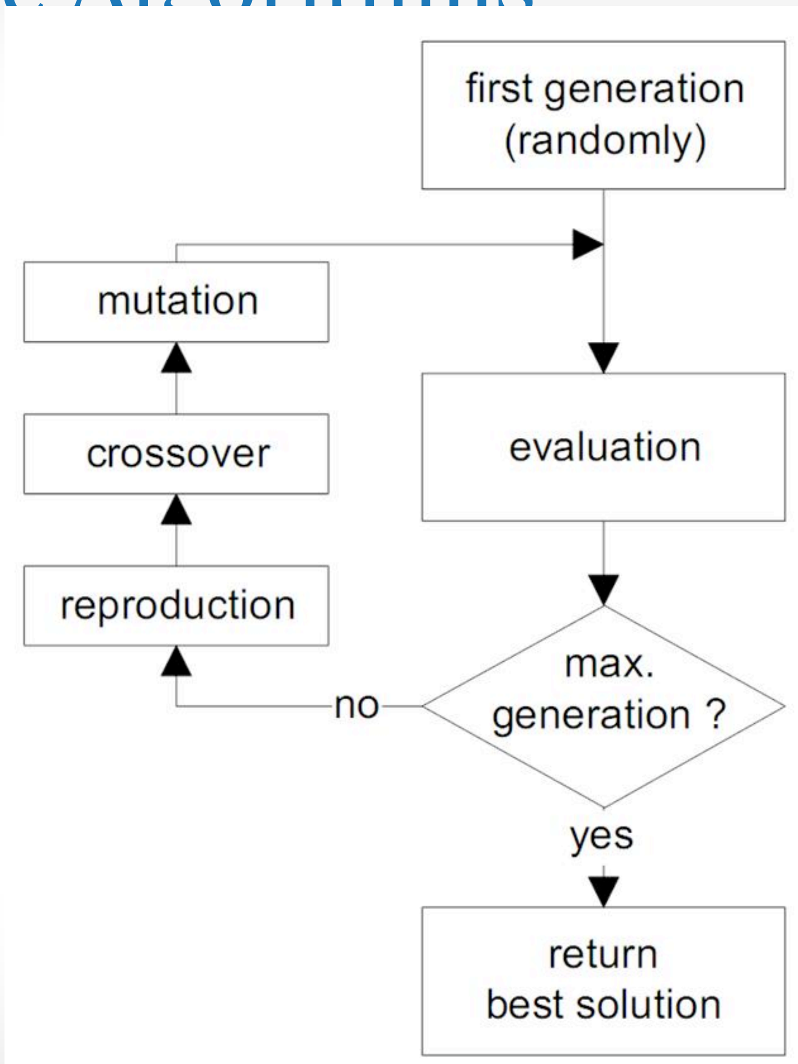


Heuristic Search Algorithms (HSA)

- Used when an optimal solution cannot be mathematically found, and an exhaustive search cannot satisfy the given time / space constraint

- Examples:
  - Tabu Search, Simulated Annealing, Genetic Algorithms, Smarm Intelligence, …etc.

Genetic Algorithms



GA and Micro-simulation

- Advantages:
  - Do not require gradient information
  - Rather robust
  - Can overcome combinatorial explosive problems

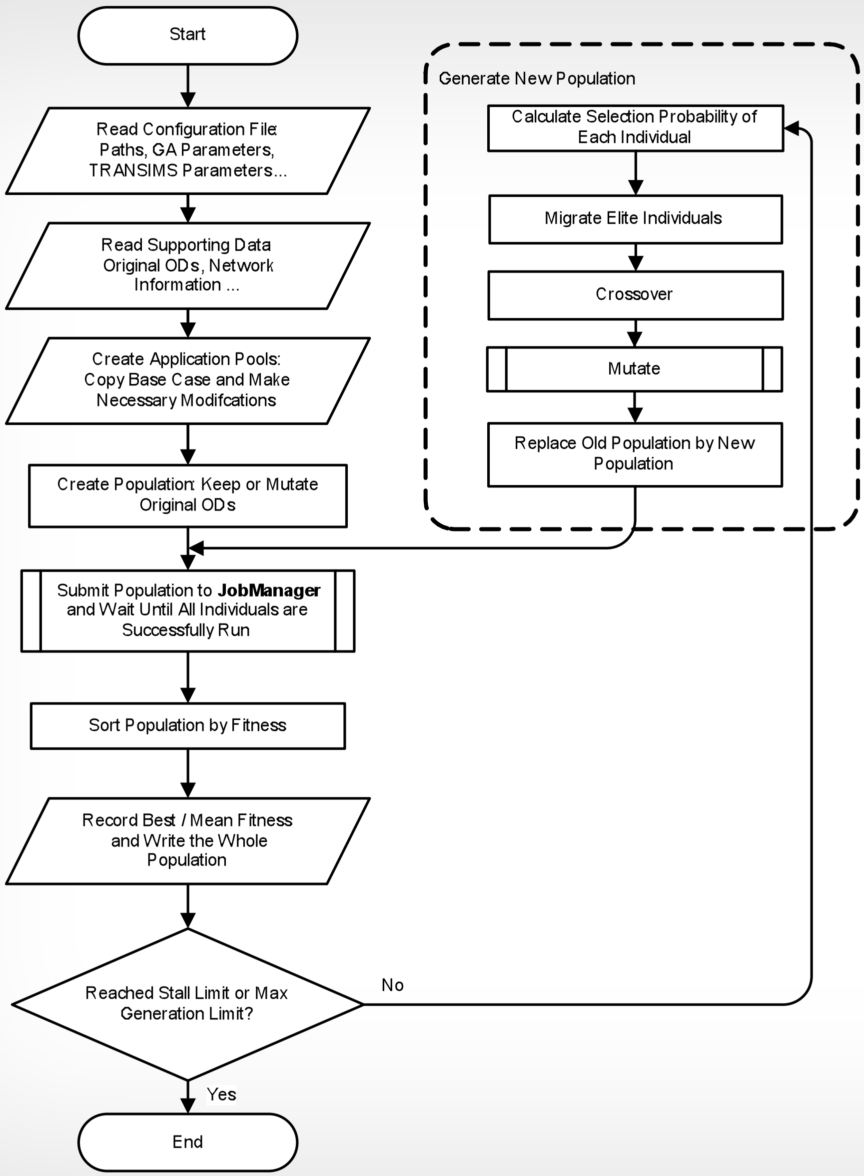
- Several examples in the literature regarding simulation model parameter calibration, where the search space is relatively small

UB-GA for TRANSIMS

- Challenges include:
  - Very large search space of the problem
  - Computational requirements of running TRANSIMS
  - Memory usage

- A new software named UB-GA for TRANSIMS, is being developed in Java

UB-GA for TRANSIMS



UB-GA Highlights

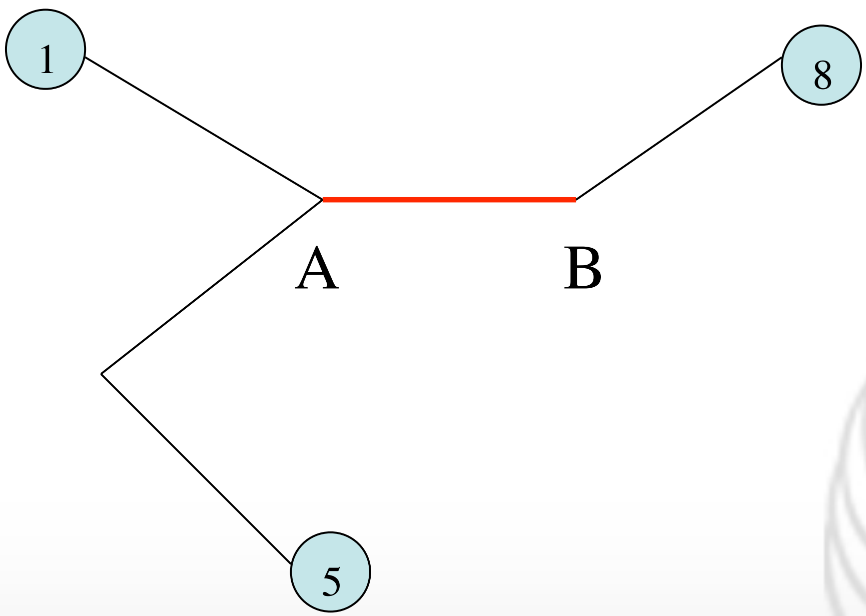
- For evaluation, candidate solutions are translated from a memory data structure into TRANSIMS text-based input format
- After the TRANSIMS run is completed, UB-GA detects the “finished” event and reads TRANSIMS output text
- Simulated volumes are then extracted from the output files and compared against the field counts.
- Genetic operators are custom-designed.

UB-GA Highlights (cont.)

- HashMap for storing sparse matrices
- A “hibernation” ability added so that when a GA individual is not active, it would be written to the hard-disk and released from memory
- Parallel implementation of the GA

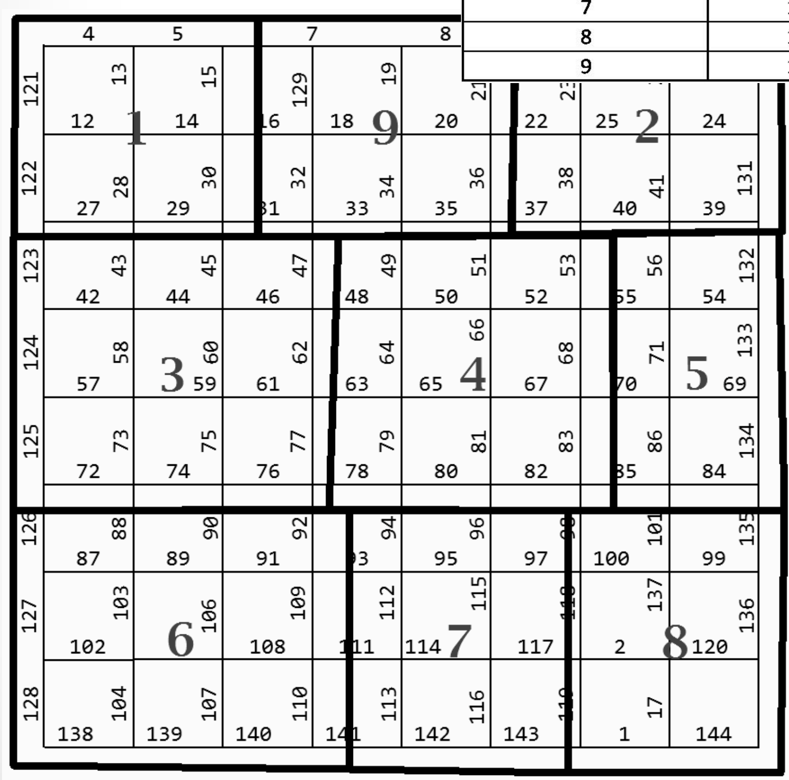
UB-GA Plan Analyzer

- Plan Analyzer analyzes the TRANSIMS plan file to identify the origin and destination pairs that contribute to the links where field counts are available

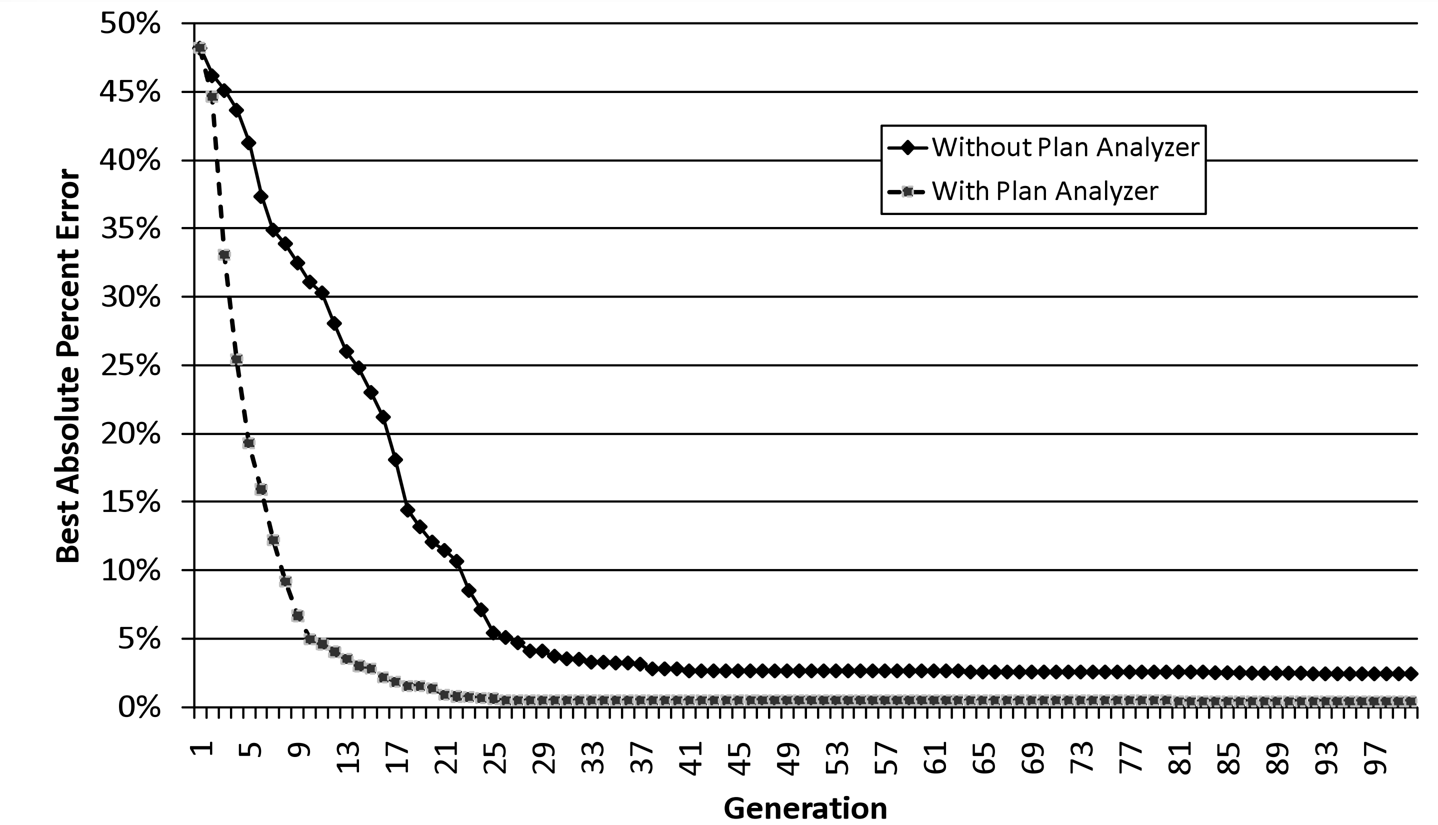


Experimental Results

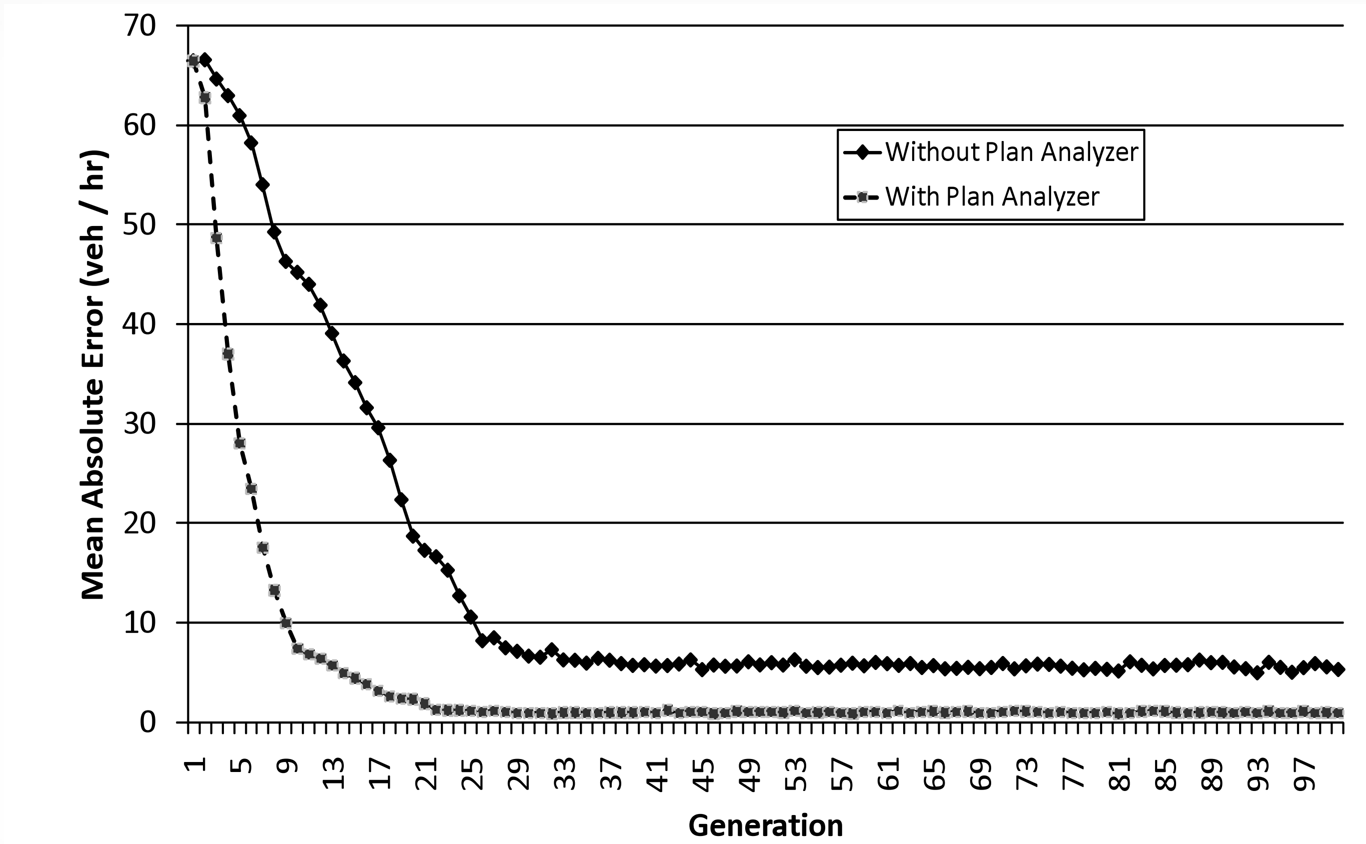
Origin \ Destination	1	2	3	4	5	6	7	8	9
1	*0*	10	10	**100**	10	10	10	10	10
2	10	*0*	10	**100**	10	10	10	10	10
3	10	10	*0*	**100**	10	10	10	10	10
4	10	10	10	*0*	10	10	10	10	10
5	10	10	10	**100**	*0*	10	10	10	10
6	10	10	10	**100**	10	*0*	10	10	10
7	10	10	10	**100**	10	10	*0*	10	10
8	10	10	10	**100**	10	10	10	*0*	10
9	10	10	10	**100**	10	10	10	10	*0*



Results


50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Best Absolute Percent Error
Without Plan Analyzer
With Plan Analyzer
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
Generation

Results



70
60
50
40
30
20
10
0
Mean Absolute Error (veh / hr)
Without Plan Analyzer
With Plan Analyzer
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
Generation

Next Steps

- Test UB-GA for TRANSIMS on realistic, large-scale networks:
  - A TRANSIMS model of the UB north campus
  - A TRANSIMS model of Chittenden County, VT
  - A TRANSIMS model of the Buffalo-Niagara region

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