Where Simulation meets Reality

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Motivation
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STREET: Simulating Transportation for Realistic Engineering Education and Training
Funding

National Science Foundation's Division of Undergraduate Education
Match support from the ITS Institute at UMN
Seed grants from the Digital Media Center at UMN

Principal Investigators

Professors Henry Liu and David Levinson
Modules

ROAD (Roadway Online Application for Design)

OASIS (Online Application for Signalized Intersection Simulation)

ADAM (Agent-based Demand and Assignment Model)

SONG (Simulation of Network Growth)

SAND (Simulation and Analysis of Network Design)

SOFT (Simulation of Freeway Traffic)

CLUSTER (Clustered Locations of Urban Services, Transport, and Economic Resources)

ABODE (Agent Based Model of Origin Destination Estimation)

ANGIE (Agent-based Network Growth with Incremental Evolution)
ROAD

Roadway Online Application for Design
**SO FT**

Freeway traffic simulator

<table>
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<tr>
<th>Start</th>
<th>1: Ring Road</th>
<th>3: Lane Closing</th>
<th>5: Traffic Lights</th>
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<tr>
<td>Stop</td>
<td>2: On-Ramp</td>
<td>4: Uphill Grade</td>
<td>6: Lane Changes</td>
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Time 5:37

- **Main Inflow**: 3300 Vehicles/h
- **Ramp Inflow**: 400 Vehicles/h
- **Ramp p_Factor**: 0.0
- **a_bias_onramp**: -2.0 m/s²
- **Time Warp Factor**: 6.9 times
OASIS

Actuated Signal Control Module
ADAM

Agent-based model of travel patterns
SONG

Simulating transportation network growth
CLUSTER

Retail location choice on supply chains
ABODE

Matching trips’ origins and destinations

ABODE (Agent Based Model of Origin Destination Estimation)
ANGIE: Agent-based Network Growth model with Incremental Evolution
Developed by the Nexus Research Group at the University of Minnesota

Scenario setting:
- Scenario: Single-center grid-like city

Parameters:
- Distance decay parameter: delta
- Number of rounds: 10
- Parameters in the Grid-like City:
  - Number of rows/columns: 5
  - Distance between rows/columns: 4.0
  - Cost of an edge: movecost: 4.0
  - Cost per unit length of an edge: undedgetcost: 4.62
  - Value of a central location (red): x_center: 2.815
  - Value of accessing an employee: unitbenefit: 1.65

Parameters in the Minneapolis skyways:
- Show downtown streets (Google Map)
- Show actual skyways

Network topological measures:
- Num of connected nodes
- Average degree of connections
- Meshedness: (m-n+3)/(2n-5)
  - m: number of links
  - n: number of vertices
  - Greater meshedness indicates more grid-like
How to apply them in teaching?

Students fill out background survey

Students finish the assignment and submit a report summarizing the results

Students fill out the evaluation survey

Instructors evaluate the tool’s effectiveness
Fundamentals of Transportation

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- Route Choice
- Evaluation

**Transit**

Hypotheses

STREET will improve students’ understanding of critical concepts in Transportation Engineering and enhance students’ learning outcomes.

STREET will improve students’ motivation toward transportation engineering and improve students’ retention.
Effectiveness (ADAM as an example)

Class: CE 3201 (Introduction to transportation engineering)

Subjects: 37 students in spring 2006
            38 students in fall 2006

Method: ADAM in Spring 2006
        Traditional teaching in Fall 2006

Data: pre-simulation survey + post-simulation survey of self-evaluation of effectiveness + Students’ scores in Quiz I

Findings:
(1) ADAM effectively improves students’ learning outcomes;
(2) Visual and active learners benefit more from ADAM.

Ref: Zhu and Levinson (2011)
Dissemination

Web-based and open-sourced

Presented at the Minnesota State Fair and UMN Academic Technology Showcase

Faculty members from 17 universities have agreed to incorporate STREET into their curricula

6 research papers have been published or presented at TRB Annual Meetings
List of publications


Future plans

Continue to develop online simulation modules related with ongoing research projects.

Apply the modules or derivatives for other educational purposes, such as educating the general public on traffic and planning and integrating modules into high school extracurricular activities to attract students into the transportation field.
Thank you!
Questions?

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