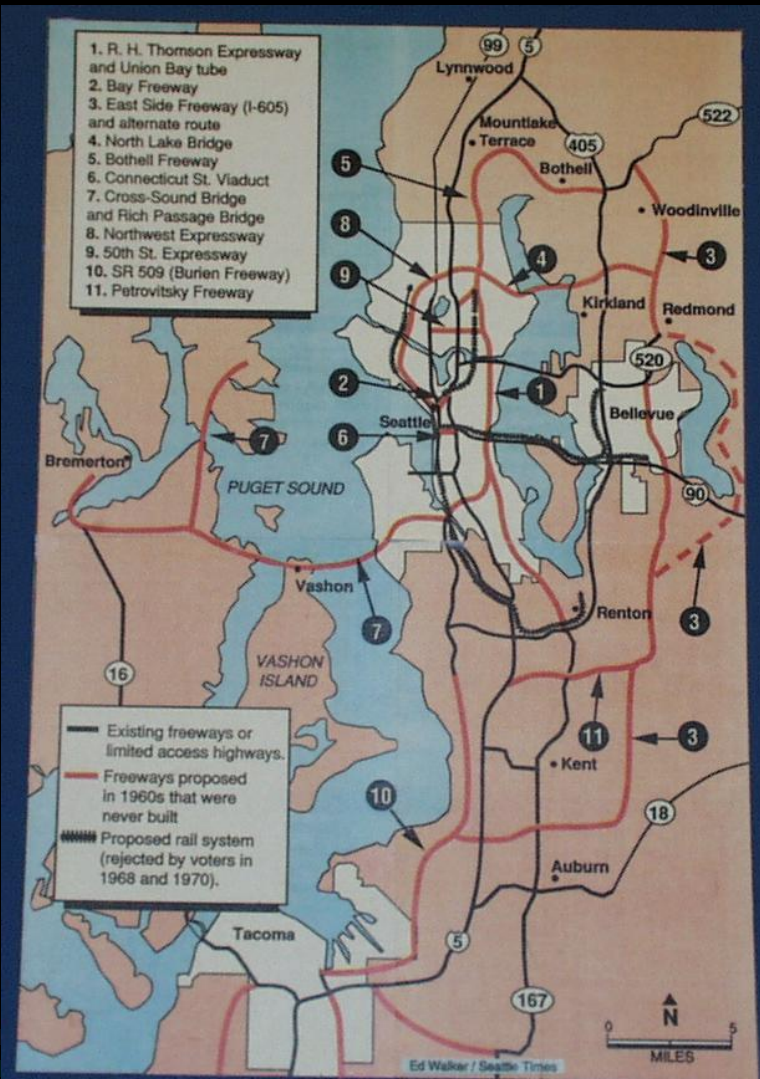# UrbanSim: Informing Public Deliberation about Land Use and Transportation Decisions using Urban Simulations

Alan Borning
Dept of Computer Science & Engineering

Using Models in Urban Planning

- What if …?
  - We built a new light rail line, or a new bypass freeway?
  - We established an urban growth boundary to contain development around the urban fringe?
  - We adopted congestion pricing for the city center?
- Decisions regarding such questions are often highly controversial and politically charged
- Important to consider:
  - Long-term effects (not just short-term)
  - Land use and transportation interactions and environmental impacts, not just transportation in isolation

Puget Sound Freeway Plans from early 60s

Light Rail System voted down in 1968 and 1970

1. R. H. Thomson Expressway and Union Bay tube
2. Bay Freeway
3. East Side Freeway (I-605) and alternate route
4. North Lake Bridge
5. Bothell Freeway
6. Connecticut St. Viaduct
7. Cross-Sound Bridge and Rich Passage Bridge
8. Northwest Expressway
9. 50th St. Expressway
10. SR 509 (Burien Freeway)
11. Petrovitsky Freeway

Existing freeways or limited access highways.

Freeways proposed in 1960s that were never built

Proposed rail system (rejected by voters in 1968 and 1970).

Ed Walker / Seattle Times

1985 SYSTEM
SEATTLE METROPOLITAN AREA
RECOMMENDED PUBLIC TRANSPORTATION PLAN

The UrbanSim System

- A simulation system for modeling the development of urban areas over periods of 20-30 years
- Written in Python; heavy use of efficient libraries for numerical computations, mapping, and so forth
  - Previous versions were in Java
- Open source (GNU Public License)
- In operational use in Houston, Detroit; being transitioned to operational use in Puget Sound, Salt Lake City, Phoenix, Honolulu
- Research and pilot applications (in various stages) elsewhere in the U.S., Europe, and Australia

UrbanSim geographic data:
150 square meter grid cells
& parcel data - Green Lake
neighborhood, Seattle
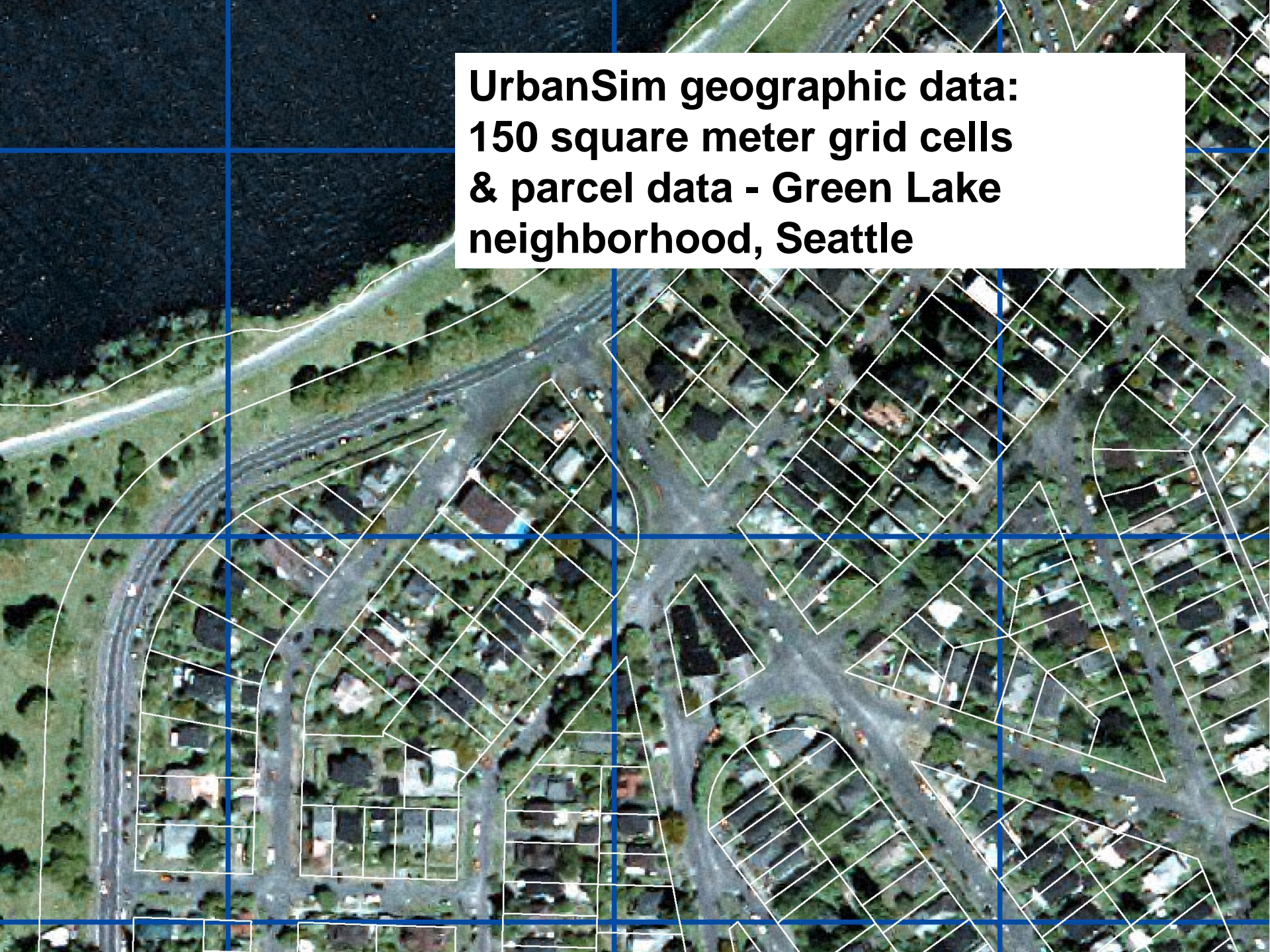
UrbanSim – System Design

- Modeling:
  - Provide interacting component models that represent different agents and processes in the urban environment
  - Dynamically simulate annual time steps
- Component models include:
  - Household Location Choice Model
  - Employment Location Choice Model
  - Real Estate Price Model
  - Building Construction Model
  - Travel (external model)

Example Model - Household Location

- Households that need to be placed in new locations in a given simulated year:
  - Existing household predicted to move by Household Relocation Mode
  - New households from Demographic Transition Model
- Available housing to move into:
  - Units vacated by households that moved out
  - New housing from the Real Estate Developer Model
- Household Location Choice is a probabilistic model – outcome is where household moves to.

Household Location Model (2)

- UrbanSim computes the probability of a unplaced household moving to different possible locations

- Then use a random number generator to choose a specific location

- Variables used in computing these probabilities: characteristics both of the household and of the potential housing

- Estimated using observed data for the region being simulated
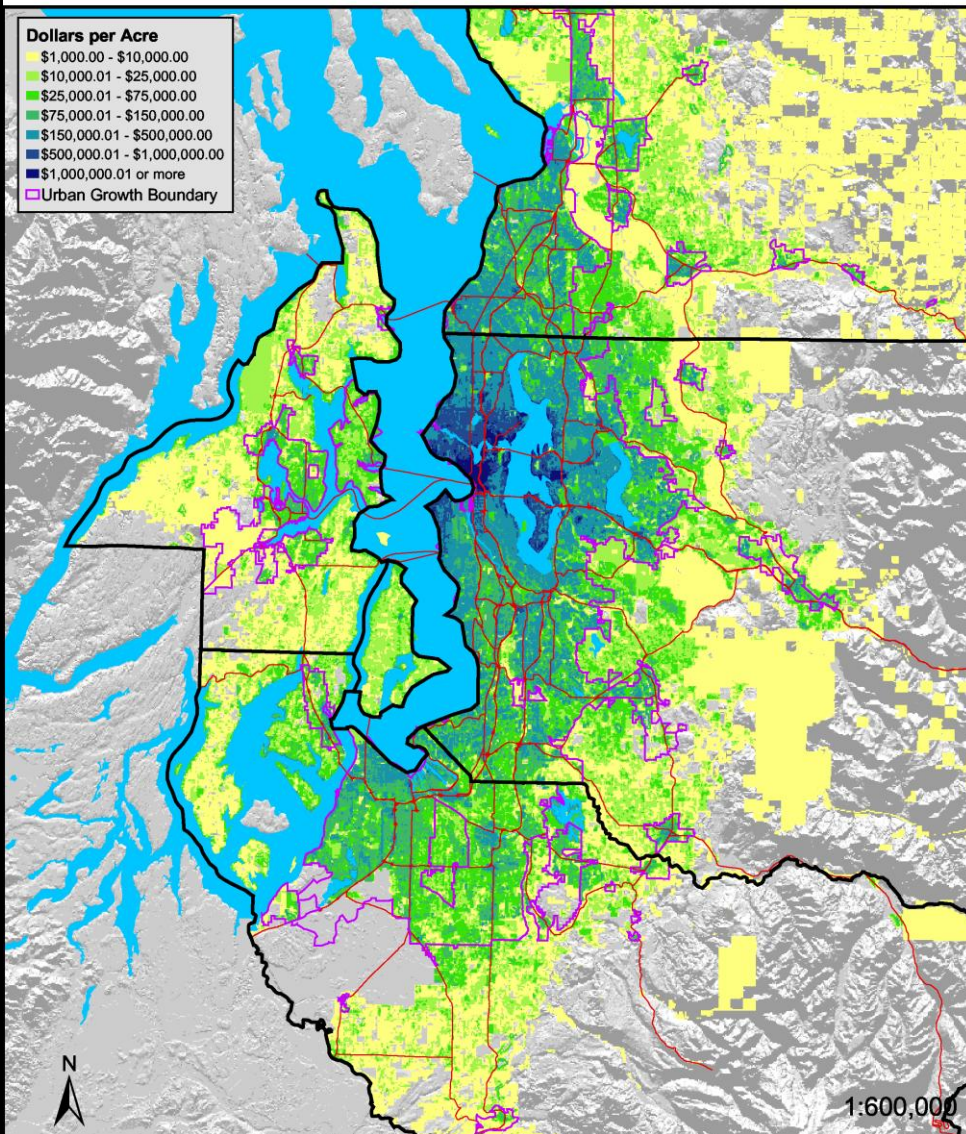
Some Software Engineering Issues

- Extensive testing essential!
- We use tests that can be run automatically (called unit tests)
- Tools to help different programmers integrate their work (source code repository)
- Tests are run automatically whenever someone "checks in" code to the repository
- Traffic light shows results of running these tests

UrbanSim Indicators

- Indicators provide the principal mechanism for summarizing results from the simulation. Examples:
  - Population density
  - Average household income
  - Acres of buildable land
  - Greenhouse gas emissions from transportation
- At stake:
  - Quantities that are modeled and presented using indicators have a privileged place in the deliberation

PSRC Region
2000 Total Land Value per Acre by Gridcell

Dollars per Acre
- $1,000.00 - $10,000.00
- $10,000.01 - $25,000.00
- $25,000.01 - $75,000.00
- $75,000.01 - $150,000.00
- $150,000.01 - $500,000.00
- $500,000.01 - $1,000,000.00
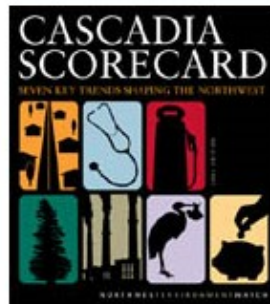- $1,000,000.01 or more
- Urban Growth Boundary

1:600,000

Example simulation output: Map-based indicator display for Puget Sound region

Indicator Perspectives (1)

NORTHWEST ENVIRONMENT WATCH

Cascadia Scorecard perspective on UrbanSim indicators

The ⊕Cascadia Scorecard is Northwest Environment Watch's new gauge of regional progress. The Scorecard puts a spotlight on the long view and the questions that most matter over time: Are we living longer, healthier lives? Are we building strong human communities? Are we handing down to our children a place whose ecosystems are regenerating?

In modeling sprawl, one of the seven key trends monitored by the Cascadia Scorecard, UrbanSim helps us to evaluate possible futures for our cities in comparison to historical trends and where we stand today. By better understanding the impact of public policy on sprawl, we can make better choices for a sustainable future.

Why Is Sprawl an Issue?

Sprawl—dispersed, automobile-oriented urban development—figures into the Scorecard because it contributes to a distressing array of ills. Sprawl locks northwesterners into an auto-dependent

Indicator Perspectives (2)

King County

King County Benchmarks

Perspective on UrbanSim Indicators

Since 1996, the 🌐King County Benchmark Program has published annual reports on progress in meeting the goals outlined in the 🌐Countywide Planning Policies (CPPs). As a complement to these progress reports, we provide links to indicators produced by UrbanSim, a tool for modeling the future impacts regional land use and transportation decisions. UrbanSim helps us to evaluate possible futures for our cities in comparison to historical trends and where we stand today.

Follow this link to learn more about Benchmark Indicators produced by UrbanSim in key areas of King County's growth management policy.

- Land Use

The King County Benchmark Program also includes indicators in the following additional categories. We plan to add information about these as well, as new indicators are implemented in UrbanSim.

- Economics
- Affordable Housing
- Transportation
- Environment

Benchmarking as a Strategy for Change

As one of the first and most durable efforts at monitoring outcomes in the public sector, the King County Benchmark Program demonstrates how measurement of broad quality-of-life outcomes can help determine if public policy and programs are making a difference. The purpose of King County's Benchmark Program is to provide the King County Growth Management Council and other users with a method for:

- Evaluating the progress of the County and its jurisdiction in managing growth, and
- Encouraging and measuring the implemention of the goals outlined in the Countywide Planning Policies

Public outcome monitoring is a strategy for a change: it alerts us to what we are doing well, and to where we need to do better. It is closely connected to both the policy goals that it monitors, and to the strategic planning, programs, and services

Indicator Perspectives (3)

Washington REALTORS®

last modified 2005-10-20 03:35 AM

REALTORS® recognize the need to sustain and enhance the quality of life enjoyed by Washington's citizens. We believe we can build better communities by supporting quality growth and seeking sustainable economies and housing opportunities that embrace the environmental qualities we cherish, while protecting a property owner's ability to own, use, buy, and sell property.

The Washington REALTORS®' Quality of Life Program is based on the principles that Washington residents have told us are important for building better communities. REALTORS®, like other residents who live and work in the community, want a strong economy, plenty of housing opportunities, good schools and parks, safe neighborhoods and great transportation choices.

The Quality of Life Project is about creating communities where everyone thrives. Quality of life starts with a good job. It means having a roof over your head – and a range of choices in housing design, style, and price. It means the opportunity to live in communities with clean, safe neighborhoods, good schools, and efficient transportation. Our Quality of Life Project is designed to impact public policy in order to ensure economic vitality, provide housing opportunities, and preserve the environment that we cherish here.

REALTORS® are taking the lead in developing policy proposals that reflect our Quality of Life Principles.

In the Puget Sound region, UrbanSim is being used to simulate the long term effects of different transportation and land use plans in order to provide useful information for the discussion of the proposals. Below we explain how UrbanSim can help evaluate such alternatives with respect to one of the Quality of Life principles: *Providing Housing Opportunities*.

Providing Housing Opportunities

REALTORS® understand that home ownership is the cornerstone of the American Dream and deserves consideration as a top priority when it comes to quality of life. Home ownership contributes to community responsibility; civic, economic, business and employment stability; family security and well being.

Every citizen should have the opportunity to purchase an affordable, safe, and decent home near where they work, shop and play. Choice in style, price and location is critical to increasing home ownership. These objectives should be met through market-driven approaches that foster a wide-range of urban, suburban and rural housing choices at all prices.

> *When there is sufficient housing to accommodate growth in a community, it relieves pressures on housing prices and provides the opportunities of home ownership for all.*

Home prices skyrocket when housing is not available where jobs are located – that causes people to buy homes further away from where they work, exacerbating traffic problems. Providing affordable housing choices close to where people work, live and play prevents long commutes and increased traffic on our roads. A community should
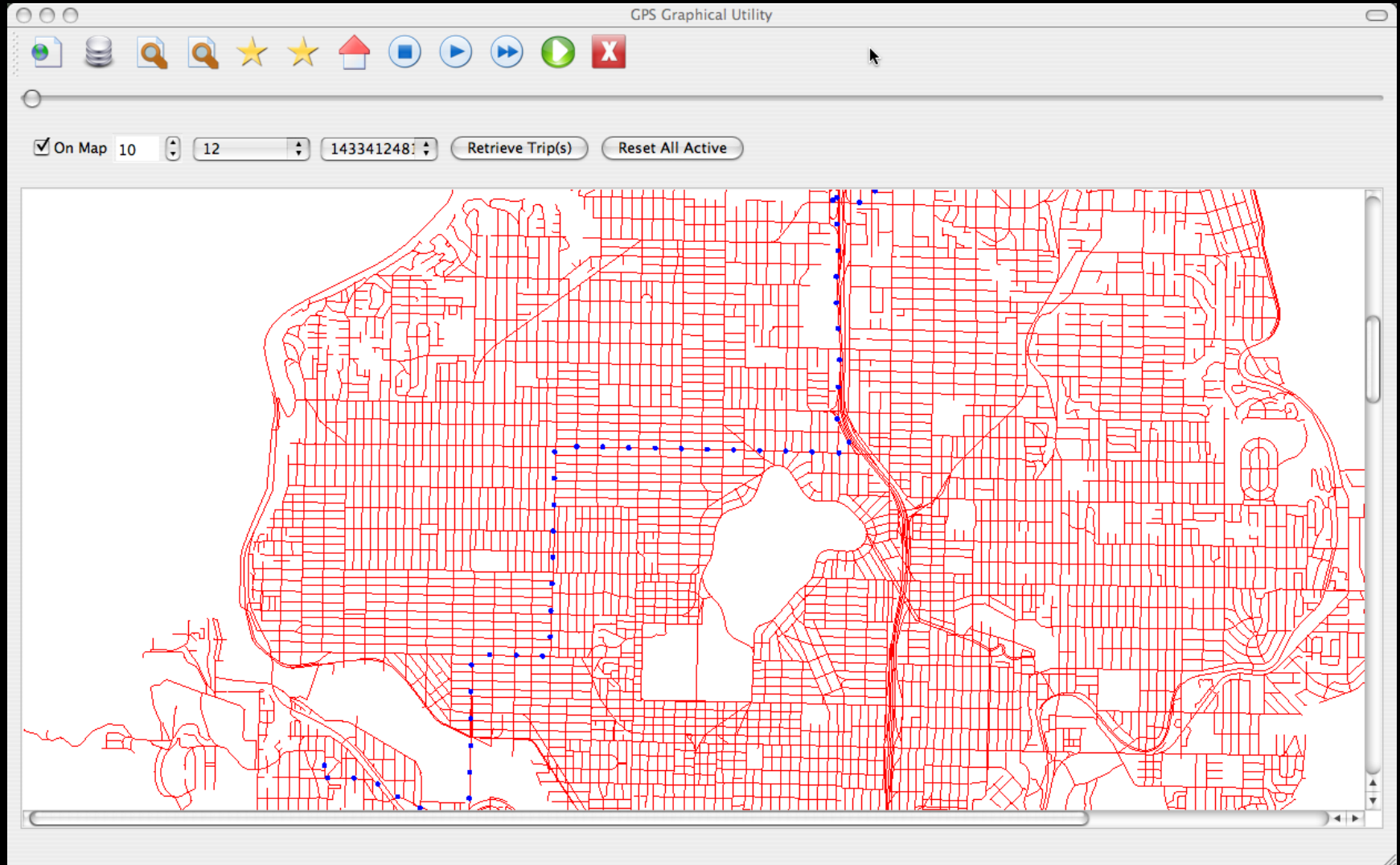
Some Current Projects

- Modeling and presenting uncertainty in simulation results
- Using data from a congestion pricing study in the Seattle area to build better travel models
- Using OneBusAway data to build better travel models
- Indicator Perspectives meets Wikipedia

Tolling Scheme
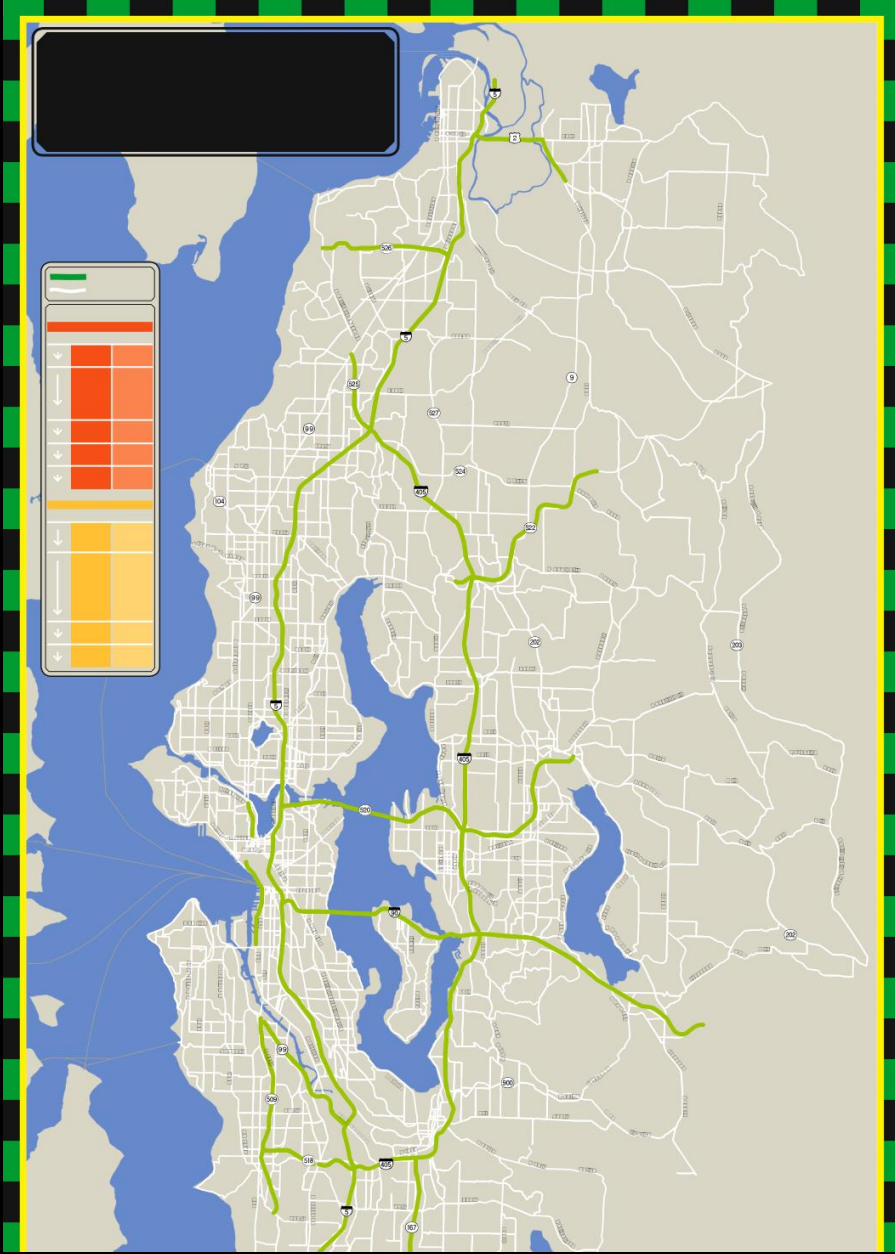
Analyzing GPS Traces from Congestion Pricing Study

WikiCommons: Wikipedia-meets-UrbanSim

- Extend Indicator Perspectives idea to allow participation by editing Wikipedia-style articles
  - Proposals for alternatives
  - Perspectives on alternatives
  - Links to simulation results to inform the discussion
- Some key aspects:
  - Unlike Indicator Perspectives, individual citizens can also form ad-hoc groups around a perspective
  - Unlike Wikipedia, encourage multiple perspectives in the form of separate "position papers"
  - Separate actions from reasons to support or oppose them
  - Unlike current public comment process, goal is to have more cogent, useful positions that decision makers can use