2017 Philomathia Forum
Urban Data Science and Simulation
For Metropolitan Sustainability

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Sustainability Research Framework
Urban Data Science Toolkit – Open Source Python Data Science Stack

Urban Data Science Toolkit:

- **UrbanSim**
  A platform for simulating urban real estate markets and their interaction with transportation.

- **ORCA**
  A generalized framework for data processing and orchestration to support UrbanSim, ActivitySim, and other types of modeling.

- **ActivitySim**
  A platform for simulating Activity-Based Travel.

- **Pandana**
  A fast network accessibility engine for computing accessibility metrics.

- **Spandex**
  Spatial Analysis and Data Extraction.

- **Synthpop**
  A Population Synthesizer.

- **ChoiceModels**
  A library of flexible discrete choice models, including Multinomial Logit, Nested Logit, Mixed Logit, and Latent Class Models.

- **UrbanAccess**
  A library to obtain, clean, merge and analyze GTFS Transit Networks and OSM networks for pedestrian and transit accessibility.
Open Data for Sustainability Planning

Open Street Map

UrbanCanvas
Vizicities
A framework for 3D geospatial visualization in the browser.
Open Source Tools for Sustainability Planning

Pandana
A fast network accessibility engine for computing accessibility metrics.
UrbanAccess
Quickly compute transit and pedestrian networks for accessibility analyses.

Travel time
integrated network

Job accessibility
Harnessing Urban Data Streams: Scraping Rental Listings Nationally
Integrating the Tools to Develop and Evaluate Sustainability Plans

UrbanSim:
A simulation platform for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment.
Simulating individual choices such as household location, for entire populations, at an agent level.
UrbanSim in operational use

- Seattle, WA
- Eugene-Springfield, OR
- San Francisco, CA
- Salt Lake City, UT
- Denver, CO
- Tucson, AZ
- Phoenix, AZ
- San Antonio, TX
- San Diego, CA
- Albuquerque, NM
- Honolulu, HI
- Detroit, MI
- Houston, TX
- Colorado Springs, CO

Global locations:
- Paris, FR
Reconciling Data From Many Sources

- Parcels
- Buildings
- Households
- Persons
- Jobs
First regional plan to integrate transportation, land use, and housing (Sustainable Communities Strategy)

Initiated by California Senate Bill 375
UrbanSim Application
UrbanSim Application: Plan Bay Area

Policy Inputs to Model System

• **Transportation**
  – Transit investments (Rail, Bus)
  – Roadway investments (GP, HOV, HOT, Bike, Pedestrian)
  – Pricing (Tolls, Congestion)

• **Land Use Regulations**
  – City comprehensive Plans
  – Transit Oriented Development, Urban Villages & Centers
  – Subsidies, Impact Fees
  – Urban Growth Boundaries
  – Protection of Environmentally-sensitive Areas
UrbanSim Application: Plan Bay Area

Outputs from Model System

- **Land and Development**
  - Housing units by type, density, price (affordability)
  - Non-residential buildings by type, density, price
  - Acreage in agricultural land, forest, open space

- **Demographics**: households by income, size, life cycle

- **Economics**: employment by sector and building type

- **Transportation**
  - Accessibility, Mode Shares, Vehicle Miles Traveled, Congestion Delay

- **Environment**
  - Greenhouse Gas Emissions
  - Pollution
UrbanSim Application: Plan Bay Area

**ECONOMY**
- Increase gross regional product
- Increase non-auto mode share
- Reduce VMT per capita
- Maintain the transportation system

**ENVIRONMENT**
- Reduce per-capita greenhouse gas emissions from cars and light-duty trucks
- Reduce premature deaths from exposure to particulate emissions
- Reduce injuries and fatalities from collisions
- Increase average daily time spent walking or biking
- Direct all non-agricultural development within the urban footprint
- Increase non-auto mode share
- Reduce VMT per capita
- Maintain the transportation system

**EQUITY**
- House all of the region’s projected housing growth
- Decrease housing and transportation costs as a share of low-income household budgets

**ECONOMIC VITALITY**
- Increase gross regional product

**CLIMATE PROTECTION**
- Reduce per-capita greenhouse gas emissions from cars and light-duty trucks
- Reduce premature deaths from exposure to particulate emissions
- Reduce injuries and fatalities from collisions
- Increase average daily time spent walking or biking

**OPEN SPACE AND AGRICULTURAL PRESERVATION**
- Direct all non-agricultural development within the urban footprint
- Increase non-auto mode share
- Reduce VMT per capita
- Maintain the transportation system

**HEALTHY AND SAFE COMMUNITIES**
- Increase average daily time spent walking or biking

**EQUITABLE ACCESS**
- Decrease housing and transportation costs as a share of low-income household budgets
## UrbanSim Application: Plan Bay Area

<table>
<thead>
<tr>
<th>Target</th>
<th>Goal</th>
<th>No Project</th>
<th>Preferred</th>
<th>Transit Priority Focus</th>
<th>Network of Communities</th>
<th>Equity, Environment &amp; Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Reduce per-capita CO₂ emissions from cars and light-duty trucks</td>
<td>−15%</td>
<td>−8%</td>
<td>−18%</td>
<td>−16%</td>
<td>−16%</td>
<td>−17%</td>
</tr>
<tr>
<td>2 House the region’s projected growth</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>118%</td>
<td>100%</td>
</tr>
<tr>
<td>3a Reduce premature deaths from exposure to fine particulates (PM₂.₅)</td>
<td>−10%</td>
<td>−71%</td>
<td>−71%</td>
<td>−72%</td>
<td>−69%</td>
<td>−72%</td>
</tr>
<tr>
<td>3b Reduce coarse particulate emissions (PM₁₀)</td>
<td>−30%</td>
<td>−16%</td>
<td>−17%</td>
<td>−17%</td>
<td>−14%</td>
<td>−18%</td>
</tr>
<tr>
<td>3c Achieve greater particulate emission reductions in highly impacted areas</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4 Reduce the number of injuries and fatalities from all collisions</td>
<td>−50%</td>
<td>+18%</td>
<td>+18%</td>
<td>+17%</td>
<td>+23%</td>
<td>+16%</td>
</tr>
<tr>
<td>5 Increase the average daily time walking or biking per person for transportation</td>
<td>+70%</td>
<td>+12%</td>
<td>+17%</td>
<td>+18%</td>
<td>+13%</td>
<td>+20%</td>
</tr>
</tbody>
</table>
UrbanSim Application: Plan Bay Area

Project Performance Assessment:
Results by Project Type

Bubble size represents the total annual benefits for all projects of that type.

- Road Project
- Transit Project
- Regional Program

- Freeway Performance Initiative
- Road Efficiency
- BRT and Infill Transit Stations
- Transit Frequency Improvements (Central Bay Area)
- Transit Frequency Improvements (North Bay Area)
- Rail Expansion
- Transportation for Livable Communities
- Bike Network
- Maintenance
- Climate Program
- Lifeline and New Freedom
- Express Lane Network
- Highway Expansion
- Congestion Pricing
UrbanSim Cloud Platform, UrbanSim Inc.
The census block models are pre-built from public data for most metropolitan areas in the United States. This is the fastest way to begin using UrbanSim.

Users are required to upload zonal data whereby they will be able to build and calibrate an UrbanSim model. For metropolitan areas outside the United States, this is the fastest way to build an UrbanSim model.

Users of the block or zone versions can convert to the parcel version easily when uploading local parcel data.
UrbanSim Cloud Platform: Making the methodology accessible

Pre-built UrbanSim model with lower entry requirements

Comes with supporting tools needed for an operational forecast

MPO jurisdictions with pre-built census block level UrbanSim models
Questions?

Further reading: