Building Shared Metropolitan Data, Modeling and Planning Frameworks

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Regional Transportation Plans (RTPs):

• Are multi-year efforts that often involve the collection of a massive amount of data on current and planned land uses from many local governments

• Are reliant on coordination with local jurisdictions that control land use decisions

• Land use forecasting and modeling efforts that inform the RTP are often started from scratch as each new RTP process begins

• The start-up process to collect local data and harmonize it within the region can be cumbersome and costly

Source: Plan Bay Area 2040, MTC & ABAG 2017
Challenges

Example: Metropolitan Transportation Commission MPO jurisdiction in the San Francisco Bay Area

9 counties

101 municipalities
Challenges

There is no persistent, collaboratively maintained repository for data on the built and planned environment.

Examples of crowdsourced initiatives of centralized open datasets:

- OpenStreetMap

Examples of datasets in a shared regional database:

- Street network
- Transit network (GTFS)
- Zoning
- Parcels (with attributes)
- Undevelopable land
- Land use
- Buildings

Standard data schema:

- Public
- City
- County
- Cross-jurisdictional agencies
- MPO

Permissions
Allocation of future development & land use:

- Political negotiation with local jurisdictions or committee of experts
- In-house spreadsheet models and custom software
- Sketch planning and visioning tools
- Behavioral models

The UrbanSim land use model:

- Substantial data requirements
- Requires significant staff resources for training and knowledge of computer programming
- Most practical for MPOs with large budgets, computing resources, and staff
What is UrbanSim?

UrbanSim is:

• A microsimulation land use model
• Designed to support the need of MPOs, cities and other organizations for analyzing the potential effects of land use policies and infrastructure investments on the development and character of cities and regions
• Developed as a Open Source model system initially funded by 6 NSF grants
• Based upon research led by Paul Waddell at the University of California, Berkeley
• Actively used by MPOs in: Albuquerque, Austin, Denver, Detroit, Honolulu, Phoenix, Salt Lake City, San Diego, San Francisco, and Seattle, among others

Geographic levels of analysis:
- Parcels
- Census Block
- Arbitrary Zone
How does UrbanSim work?

**UrbanSim:**

- Simulates the behavior of decision-making agents that participate in the real estate market (e.g. households, employers, and real estate developers)
- Simulates urban development as a dynamic process over time and space
- Simulates the land market as the interaction of demand and supply, with prices and rents adjusting to clear the market
- Housing markets are separated by tenure and building type
- Explicitly incorporates governmental policy assumptions and evaluates policy impacts by modeling market responses
- Is based on random utility theory and uses logit models for the implementation of demand components
How does UrbanSim work?

Annual time steps:
- travel times from skims
- indicators at the travel analysis zone (TAZ)

Travel model

1. Scheduled Development Events
2. Real Estate Price Model
3. Household Transition/Relocation
4. Job Transition/Relocation
5. Job Location Choice
6. Proforma Developer Model

Constraints

OLS Regression
Multinomial Logit
Multinomial Logit
Adjustments
UrbanSim Cloud Platform:

• Wraps the UrbanSim land use model within cloud infrastructure:
  – scalable cloud computing on demand
  – run as many simulations as needed without the need for local computing resources

• 2D/3D mapping web user interface to manage data inputs and visualize simulated results with integrated analytics

• Shared regional data repository enabling collaboration among cities, counties, transportation agencies and the MPO

• Rapid prototyping and management of scenarios

• Flexible geographic aggregation from the parcel level to arbitrary zonal geographies
UrbanSim Cloud Platform: UrbanCanvas
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UrbanSim Cloud Platform: UrbanCanvas
UrbanSim Cloud Platform: UrbanSim Census Block Model

- **350+ metropolitan areas:**
  - Synthetic population at census block level
  - Pre-built block level UrbanSim models

- **Lower barrier of entry to begin using UrbanSim:**
  - Meanwhile can build parcel level data needed to run more detailed parcel level model

- Leverage national data and modeling infrastructure for model specification and calibration
UrbanSim Cloud Platform: Shared regional database

Feedback
- Feedback on results (e.g. comments, additional data)
- Propose alternative scenarios
- Incorporate feedback

Stakeholders
- The greater public
- City 1, City 2, City 3
- County 1, County 2
- Cross-jurisdictional agencies (e.g. transit authority, air quality district)

Data
- standard data schema/versioning
- Zoning/land use
  - Parcels
  - Buildings
- Development project pipeline
- Development constraints
- Share maintenance of input data

MPO
- Initiates data & scenario inputs
- Run revised scenarios
- Adopt RTP
- Share model results
- Proposes alternative scenarios
- Incorporates feedback

Conceptual diagram of the UrbanSim shared regional database
Open Source tools for regional planning

**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.

UrbanSim’s public open source software repository at the Urban Data Science Toolkit
Open Source tools for regional planning

Vizicities
A framework for 3D geospatial visualization in the browser.

Example: Buildings in New York City categorized by height
Open Source tools for regional planning

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

Example: Street network accessibility at the street node level to points of interest in the San Francisco Bay Area.
Open Source tools for regional planning

UrbanAccess
Quickly compute transit and pedestrian networks for accessibility analyses.

Travel time integrated transit and pedestrian network from GTFS and OpenStreetMap

Job accessibility within 45 minute travel time at the street node level

Example: Oakland, CA transit and pedestrian network accessibility analysis using Pandana and UrbanAccess
UrbanSim Cloud Platform use cases:

Represents 13 municipalities and parts of two counties in Colorado’s North Front Range

Land Use and Travel Demand Modeling Efforts:

**Now – December 2017:**

- Gathering zoning and future land use data from 35 communities and two counties
- Adjusting TAZ boundaries for use in UrbanCanvas with staff from 16 communities, two counties, and the National Park Service

**2018 and Beyond:**

- Compose and run scenarios that integrate growth, land use, and water demand trends to aid the NFRMPO long-range planning process
- Integrate UrbanCanvas outputs into NFRMPO’s 2045 Regional Travel Demand Model

NFRMPO UrbanSim simulation results in UrbanCanvas
Thank you!
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UrbanSim can be used to:

- Predict land use information (e.g. real estate development and prices, and the location and types of households and businesses) for input to a travel model
- Predict the effects on land use patterns from alternative investments in transportation infrastructure, or in alternative levels of service or pricing.
- Predict the effects of changes in land use regulations on land use, including the effects of policies to relax or increase regulatory constraints on development of different types.
- Predict the effects of changes in the macroeconomic structure or growth rates on land use.
- Predict the possible effects of changes in demographic structure and composition of cities on land use, and on the spatial patterns of clustering of residents.
- Examine the potential impacts on land use and transportation of major development projects, whether actual or hypothetical.