



Innovations in UrbanSim & UrbanCanvas: SustainCity and Related Initiatives

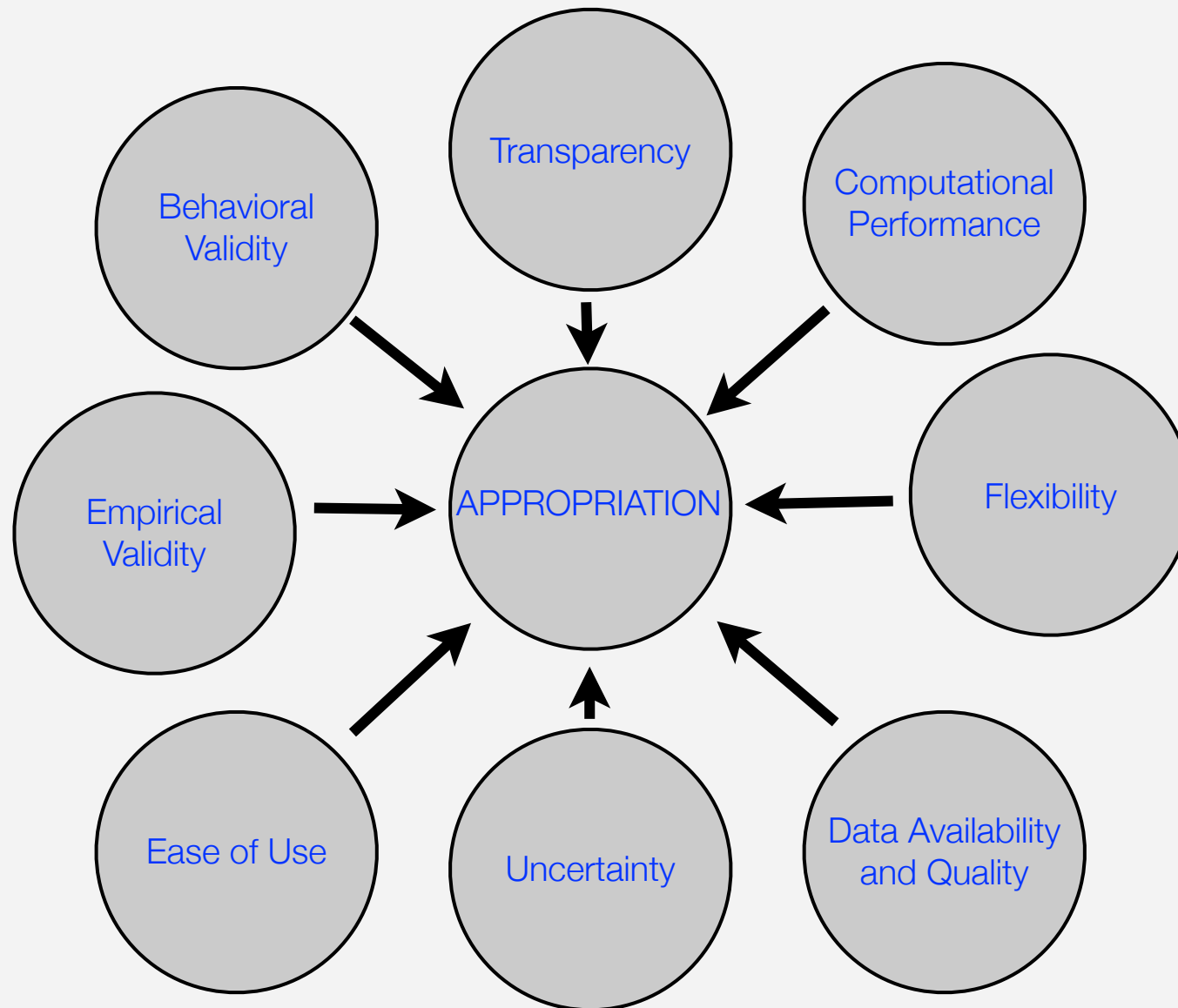
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Department of City and Regional Planning
University of California, Berkeley;
Chief Executive Officer, Synthicity

- 1. Creation of Synthicity**
- 2. Recent Developments in UrbanSim**
- 3. Development of UrbanCanvas**

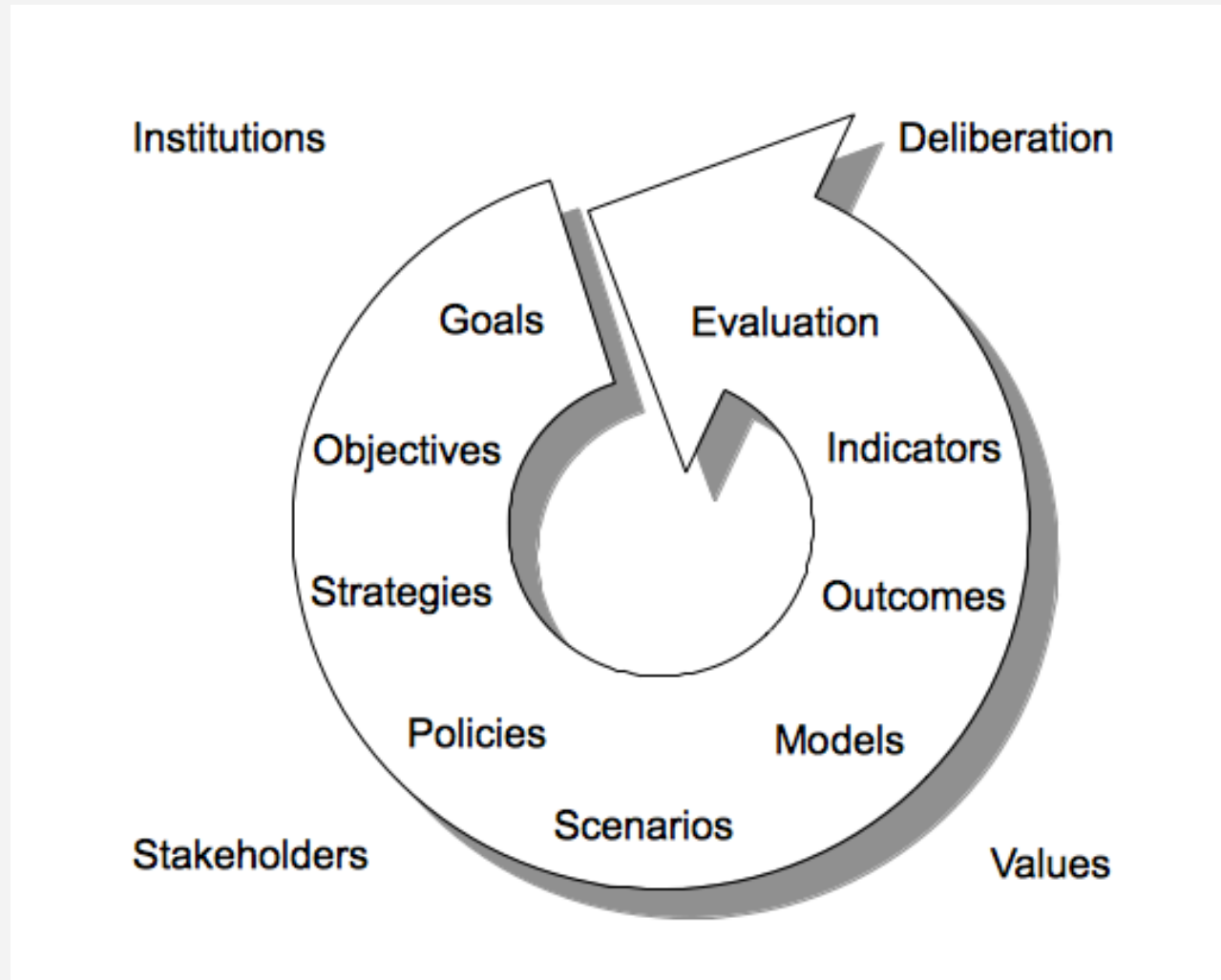
Syntheticity (www.syntheticity.com)

- Berkeley spinoff firm started by Paul Waddell with partners
- Highly skilled mix of software engineers, civil engineers, land use and transportation planners, urban designers
- Goals: robust and sustainable software and research platform, useful globally, with more coherent and efficient management of the evolution of the platform; maintenance of shared data and code infrastructure
- Offices in San Francisco, Seattle, Buenos Aires; proposed expansion in Europe, Asia
- Created to provide professional quality models and software to support operational decision making in public agencies
- Moving from open source to mixed licensing model
 - Open source is subject to free-rider problem associated with public goods
 - Crisis-mode requests for free assistance from researchers and consultants
 - Difficult to ensure quality control in software and model applications
- Soon to release major platform: UrbanCanvas
 - Major advances in ease of use, productivity, and 3D visualization
 - Commercial license

Challenges to Integrated Modeling

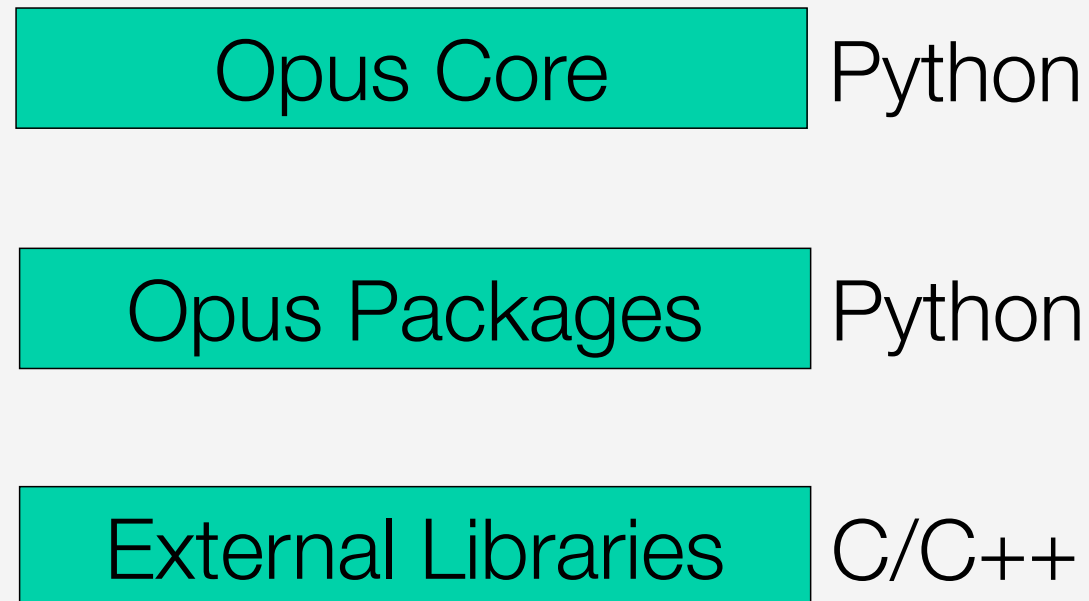


UrbanSim: Political Context



1. Creation of Synthicity
- 2. Recent Developments in UrbanSim**
 - a. Adaptations for SustainCity**
 - b. Behavioral Developer Model**
 - c. Other UrbanSim Innovations**
3. Development of UrbanCanvas

Software Architecture for UrbanSim: The Open Platform for Urban Simulation (OPUS)



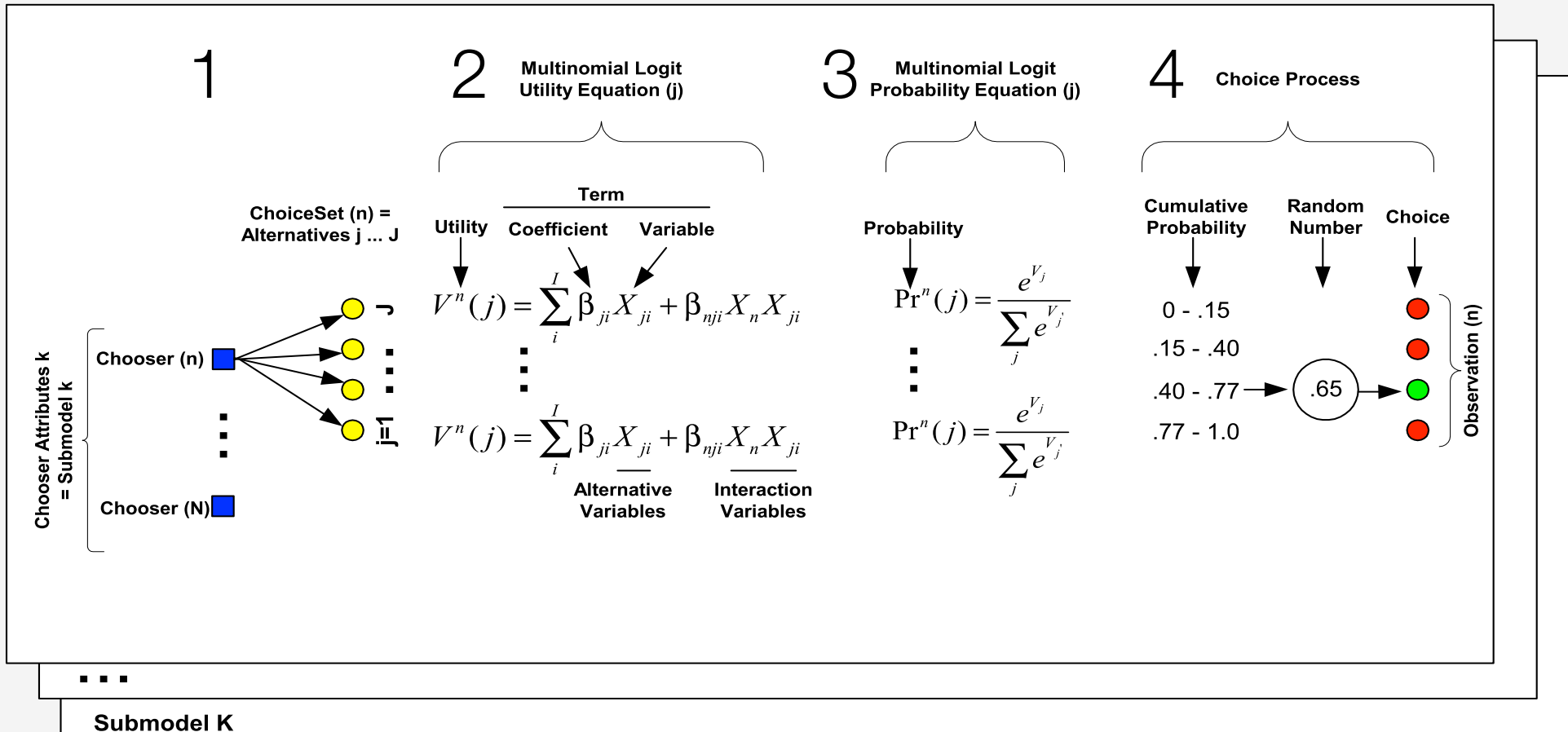
All UrbanSim code and packages are maintained in a Version Control System and monitored with an automated build and testing system

Opus External Libraries (C/C++ with Python Interface)

Statistical and Numeric	Data Management and GIS	Travel Models
Biogeme	MySQL	Emme
R	Postgres	Transcad
Numpy	PostGIS	VISUM
Scipy	ArcGIS	MATSIM
BLAS	QGIS	METROPOLIS
Lapack	GDAL	AMOS

Software Architecture for UrbanSim: Modular Choice Models

Model Specification



Implementation of a choice model involves selecting options for each step in the model process, and setting its configuration. In most cases, this can be done in the GUI, without the need to edit program code. New models can be created from templates, specified, and estimated, all in the GUI.

Recommended UrbanSim Development Approach: Start Simple, Then Add Details

- **Experience has demonstrated that an incremental development path may be most productive:**
 - Begin with a very simple zone model configuration
 - Begin using and assessing the model
 - Add detail to the model incrementally, targeting most pressing needs
- **Incremental development using a single platform**
 - Open Platform for Urban Simulation (OPUS) and UrbanSim
 - Use microsimulation of agents and explicit representation of time, just vary geographic detail
 - Modular configuration and estimation of models
 - Zonal model configurations
 - Synthesizing parcel details
 - Parcel model configurations
 - Exploiting parcels and local streets

UrbanSim: Start From the Simplest Zonal Configuration

Household Location Models

Household Transition Model

Household Location Choice Model

Employment Location Models

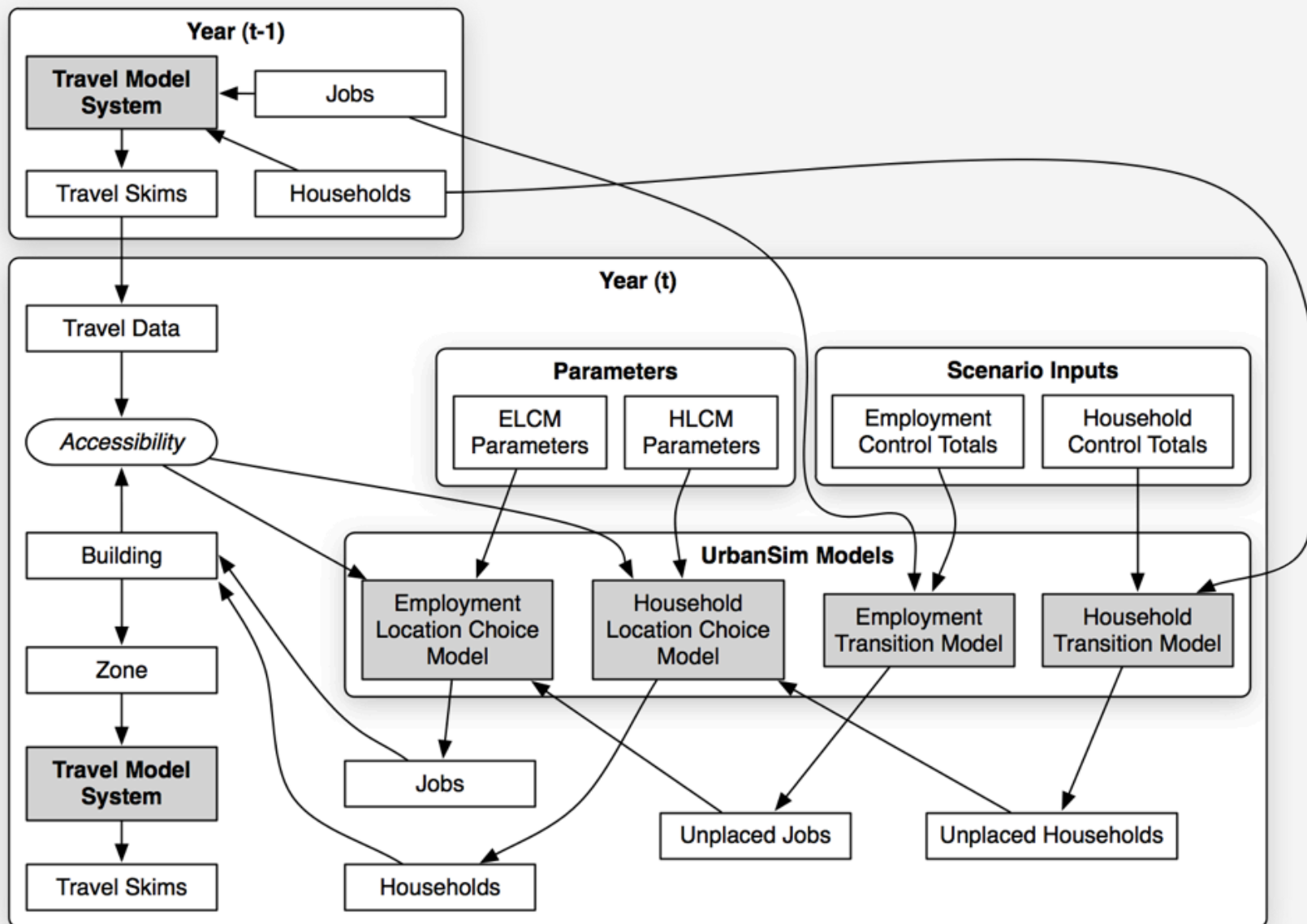
Employment Transition Model

Employment Location Choice Model

No representation of supply side of real estate market, or prices. No relocation of agents once placed. Becomes an 'incremental' model, allocating growth.

Assessment: probably too simple to be very realistic, but improves over many prior models

The Simple Zone Configuration of UrbanSim: In Detail



UrbanSim: Add Relocation Dynamics

Household Location Models

Household Transition Model

Household Relocation Model

Household Location Choice Model

Employment Location Models

Employment Transition Model

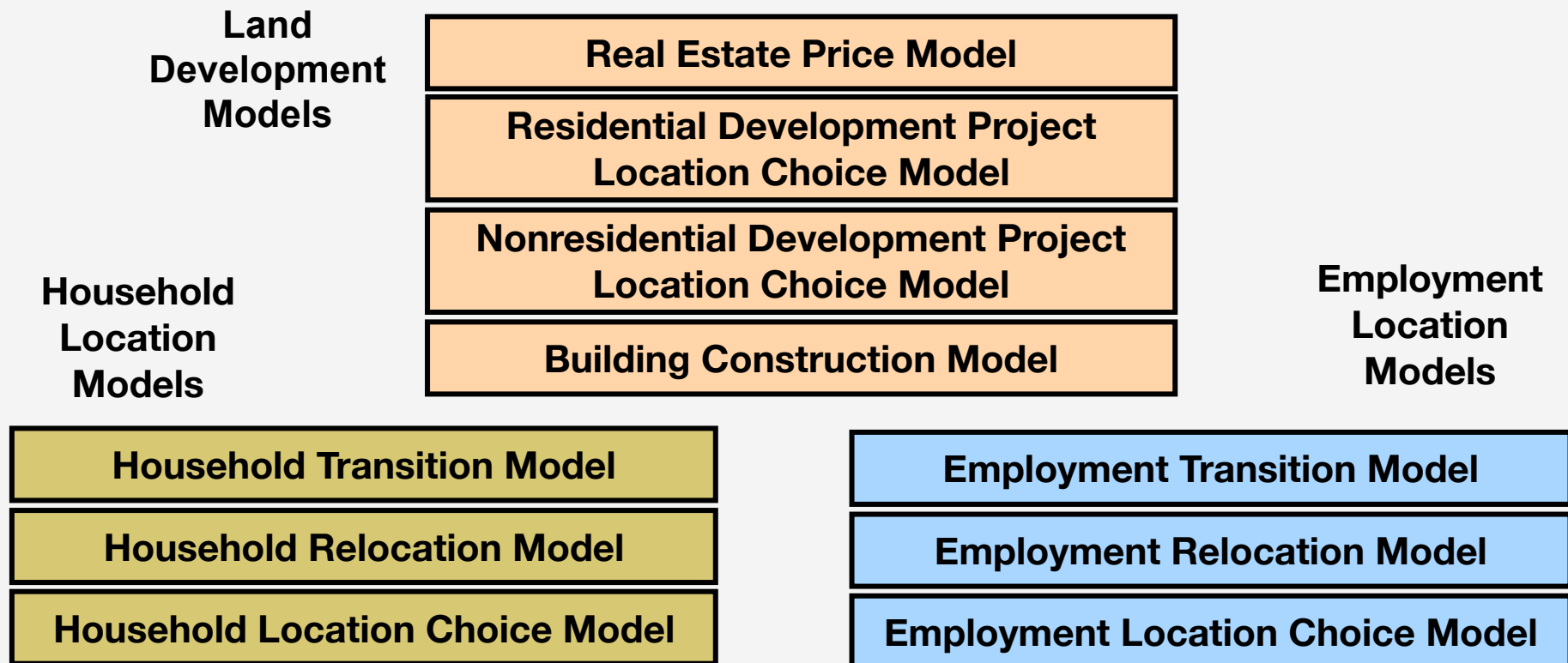
Employment Relocation Model

Employment Location Choice Model

Being used in Durham, North Carolina. No representation of supply side of real estate market, or prices. Last resort when there is no data on supply.

Note that this allows decline to occur, not just growth.

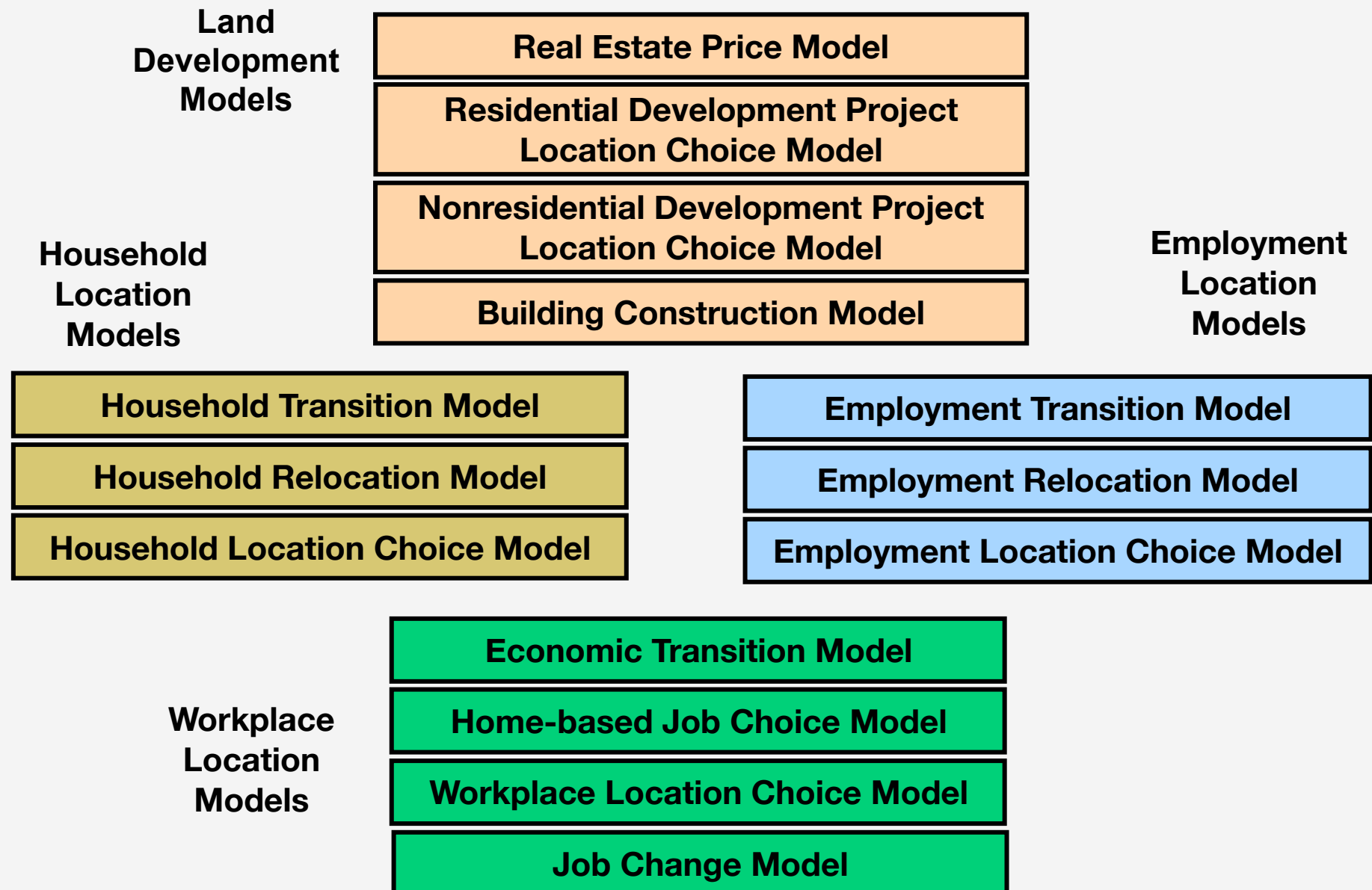
UrbanSim: Add Real Estate Supply and Price



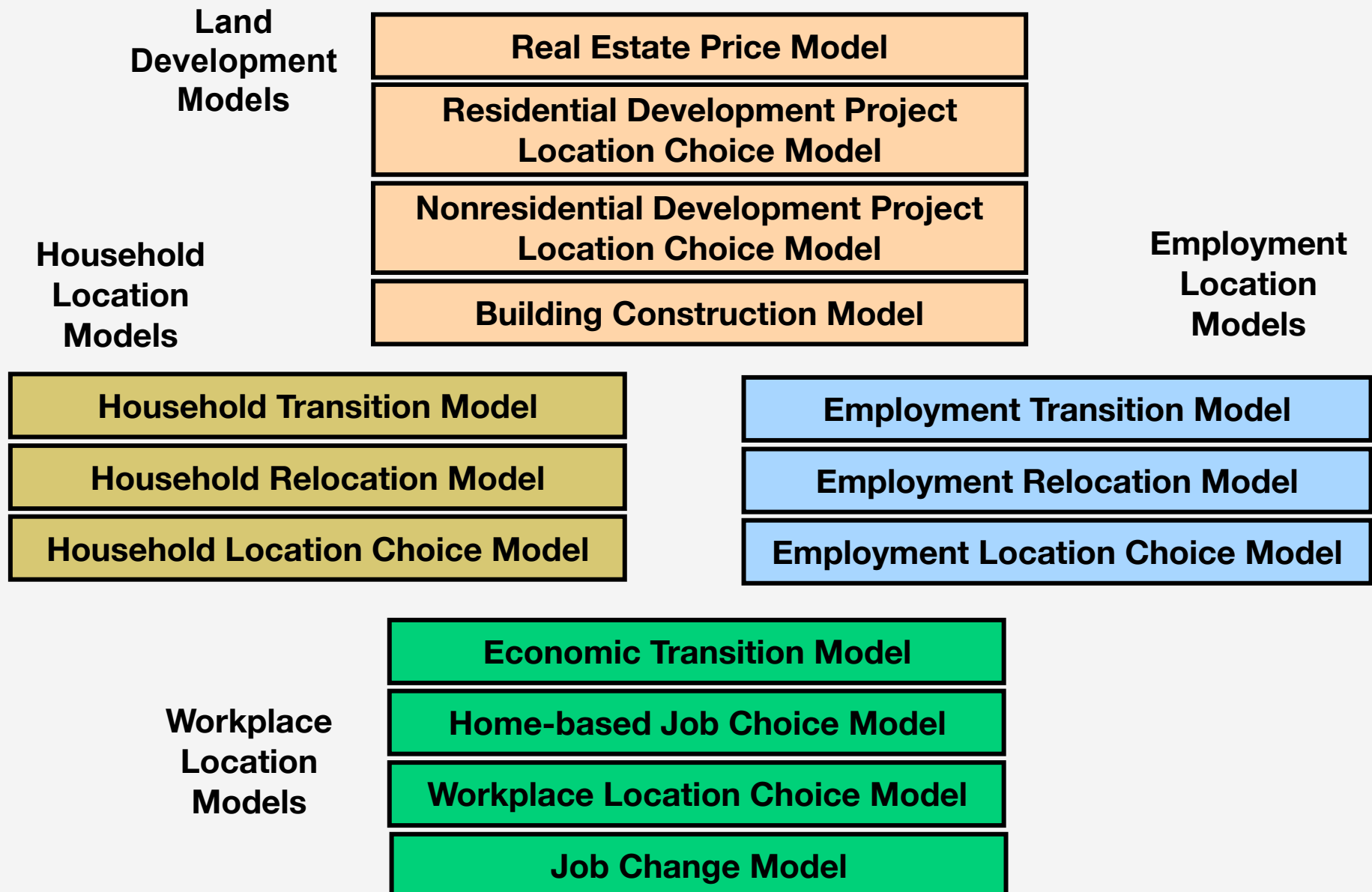
Being used in Maricopa County (MAG). Two different levels of geography being tested: travel model zones, and 'super-parcels' or aggregated parcels by land use/block.

More on this a bit later...

UrbanSim: Add Labor Market & Workplace



UrbanSim: Shift From Zones to Parcels as Locations

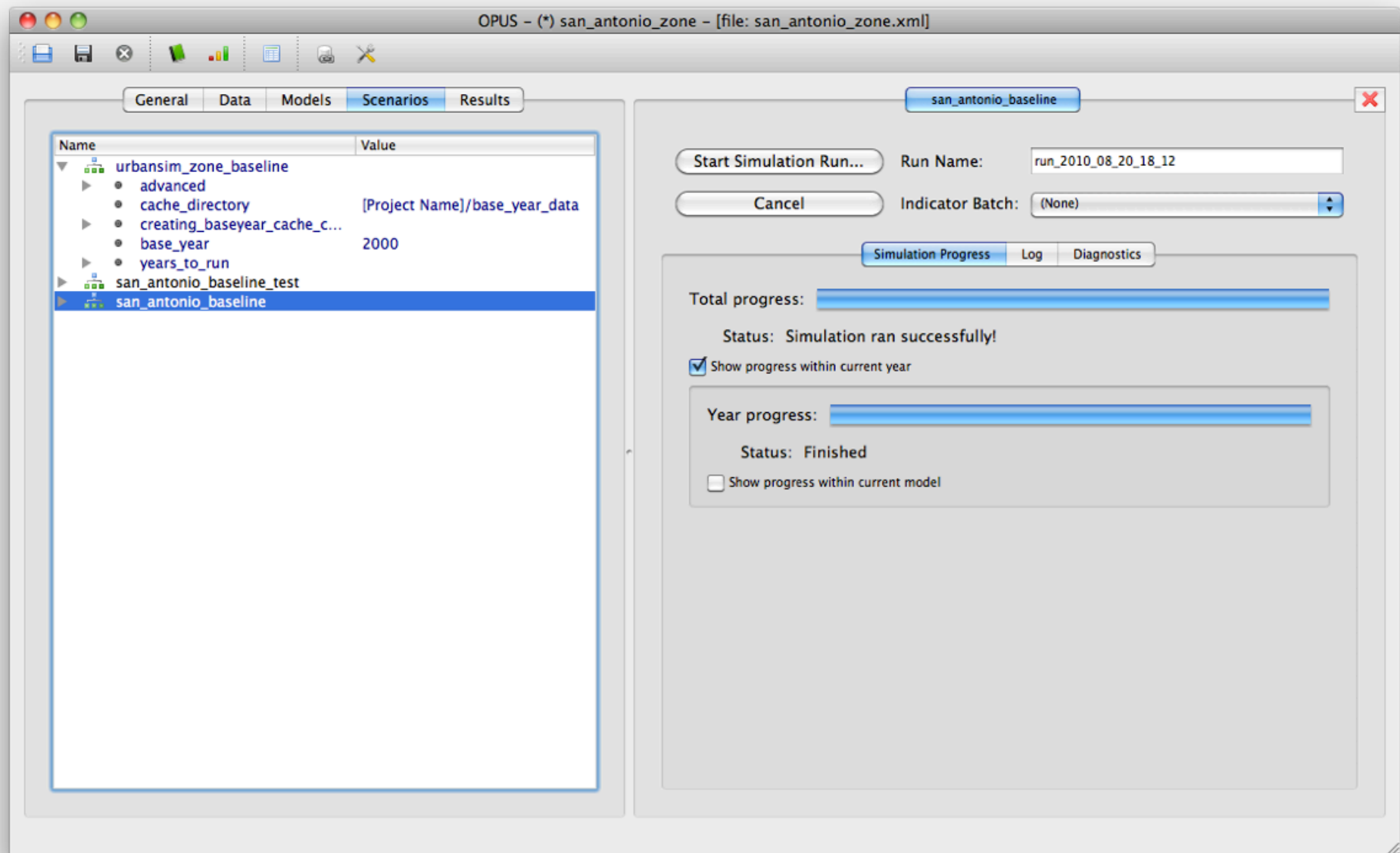


Synthesizing Detail with Procedural Geometric Models



As a test, we created Monterey Peninsula streets, parcels, buildings in 3D using only 5 minutes of user input of the highways, coastline, undevelopable areas, center of jobs, total population and jobs.

Interface for Developing, Estimating, Running Models



Measuring Progress: Benefits and Costs

- **Incremental model development ideally will monitor and evaluate progress:**
 - How much better is a new innovation compared to the best available version?
 - How much more costly is it in terms of computational expense or data effort?
- **How to measure progress**
 - Model estimation results
 - Model sensitivities
 - Calibration of model uncertainty over time

Estimation of Workplace Choice Model in GUI

OPUS - psrc_parcel - [file: psrc_parcel_test.xml]

General Data **Models** Scenarios Results

workplace_choice_model_for_resident estimation

Start Estimation...

Estimation finished successfully

Estimation result log

```
psrc_parcel.person_x_job.logsum_hbw_am_from_home_to_work... completed...0.4 sec
psrc_parcel.person_x_job.network_distance_from_home_to_work....0.8 sec
Choice set size: 30
submodel: -2
Convergence achieved.
Akaike's Information Criterion (AIC): 18936.3528676
Bayesian Information Criterion (BIC): 18999.9652765
Number of Iterations: 10
*****
Log-likelihood is: -9458.17643382
Null Log-likelihood is: -14550.3223987
Likelihood ratio index: 0.349967913107
Adj. likelihood ratio index: 0.349280643113
Number of observations: 4278
Suggested |t-value| > 2.89158103633
Convergence statistic is: 0.000305533799711
-----
Coeff_names      estimate      std err      t-values
edu_x_job_is_in_employment_sector_group_basic -0.177369    0.0127099    -13.9552
edu_x_job_is_in_employment_sector_group_edu 0.224213    0.0155413    14.4269
edu_x_job_is_in_employment_sector_group_fires 0.144304    0.010768     13.4012
edu_x_job_is_in_employment_sector_group_retail -0.191668   0.014026    -13.6651
home_dist_19_workplace_dist_19 0.466456    0.205951     2.26489
home_area_type_1_workplace_area_type_2 0.0125937   0.0681605    0.184766
home_area_type_4_workplace_area_type_2 -0.123488   0.113273    -1.09018
home_district_is_same_as_workplace_district 0.569024    0.0499707    11.3871
logsum_hbw_am_from_home_to_work 1.28446     0.0639487    20.0858
network_distance_from_home_to_work -0.0381675  0.0037057    -10.2997
*****
Elapsed time: 1.55 seconds
Estimating Non-home-based Workplace Choice Model for residents (from
urbansim_parcel.models.workplace_choice_model): completed...2 min, 3.1 sec
Simulate year 2000: completed.....2 min, 14.1 sec
```

Adaptations of UrbanSim for SustainCity

- Original proposal emphasized need to customize UrbanSim for Europe, ergo: UrbanSim**E**
- However, in reality, software platform did not require extensive modifications:
 - Brussels model required ZERO changes to software. Only a configuration file. Built on the already developed zone configuration of UrbanSim.
 - Zurich model was based on the parcel configuration of UrbanSim. Mostly configuration changes to implement model application. Created a zurich_parcel package for localized changes
 - Paris model required configuring new models such as firmography. Some localized changes in paris package
 - Added a Matsim interface for Brussels and Zurich
 - Adding a Metropolis interface for Paris application - in progress
 - Created a suite of demographic models internal to UrbanSim, in addition to a method to load data from INED demographic models

Development Types Evaluated in Model

Paul Waddell, 2013

Single-Family Builder

Single-Family One-off

Multi-Family

Condo

Office

Manufacturing Industrial

Warehouse Industrial

Neighborhood-retail

Auto-oriented Retail

Big-Box Retail

MXD-MultiFam

MXD-Condo

MXD-Office



Suburban – Large Lot



Suburban – Small Lot



Modern Urban

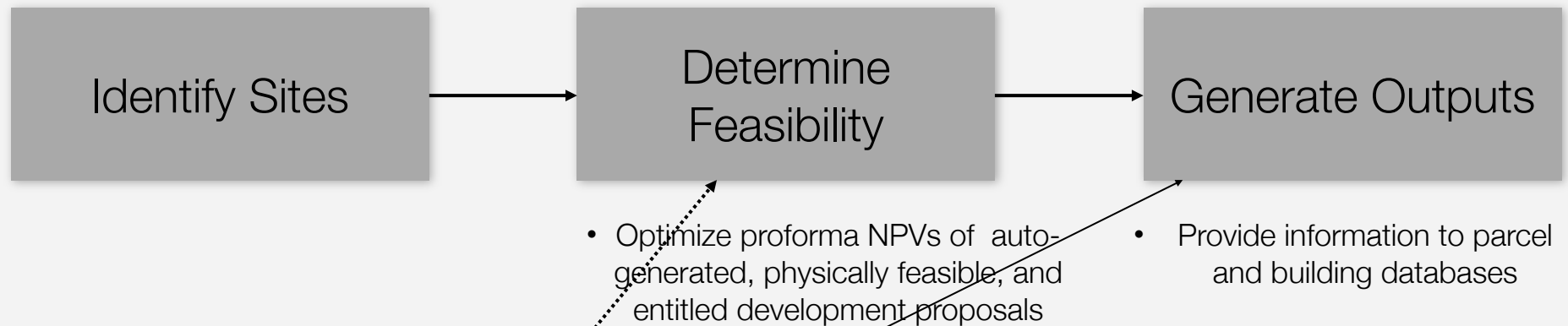
Represents Different Types of Development

Type of Development Opportunity	Predetermined Aspects of Deal	Associated Developer Behavior
Build to Suit	Land, tenant	Fee developer*
Government sponsored	Land, entitlements	Fee developer
Listed land	N/A	Spec developer*
Hot market	N/A	Spec developer

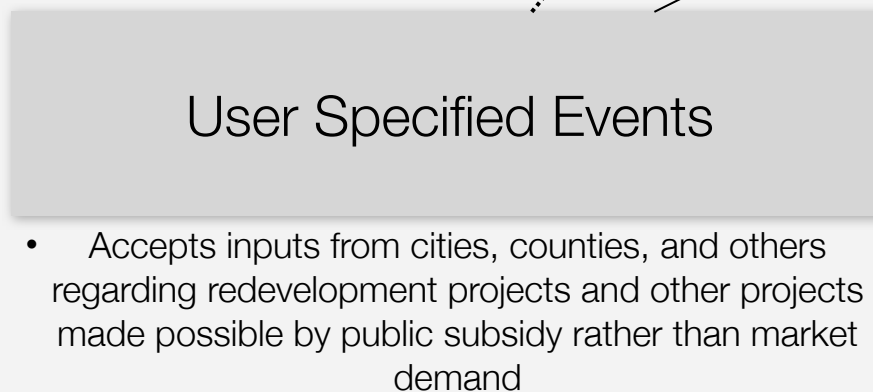
(*) Note: Firms involved with fee-based developments may also act as speculative developers and vice versa, but behavior varies depending on the type of activity in which they are engaged

Developer Model

Spec Development Model



Fee Development Model



Contributions of the Developer Model

- Incorporates of local regulatory and market conditions
- Being further developed to deal with public (social) and subsidized housing, and rent control and anti-displacement policies
- User-interface allows inclusion of “fee developments” into endogenously generated market conditions
- Calculates profitability based on NPV / IRR
- Allows ‘market-testing’ of alternative land use regulations and market policies, e.g. Sustainable Communities Strategies in

Other Recent UrbanSim Enhancements

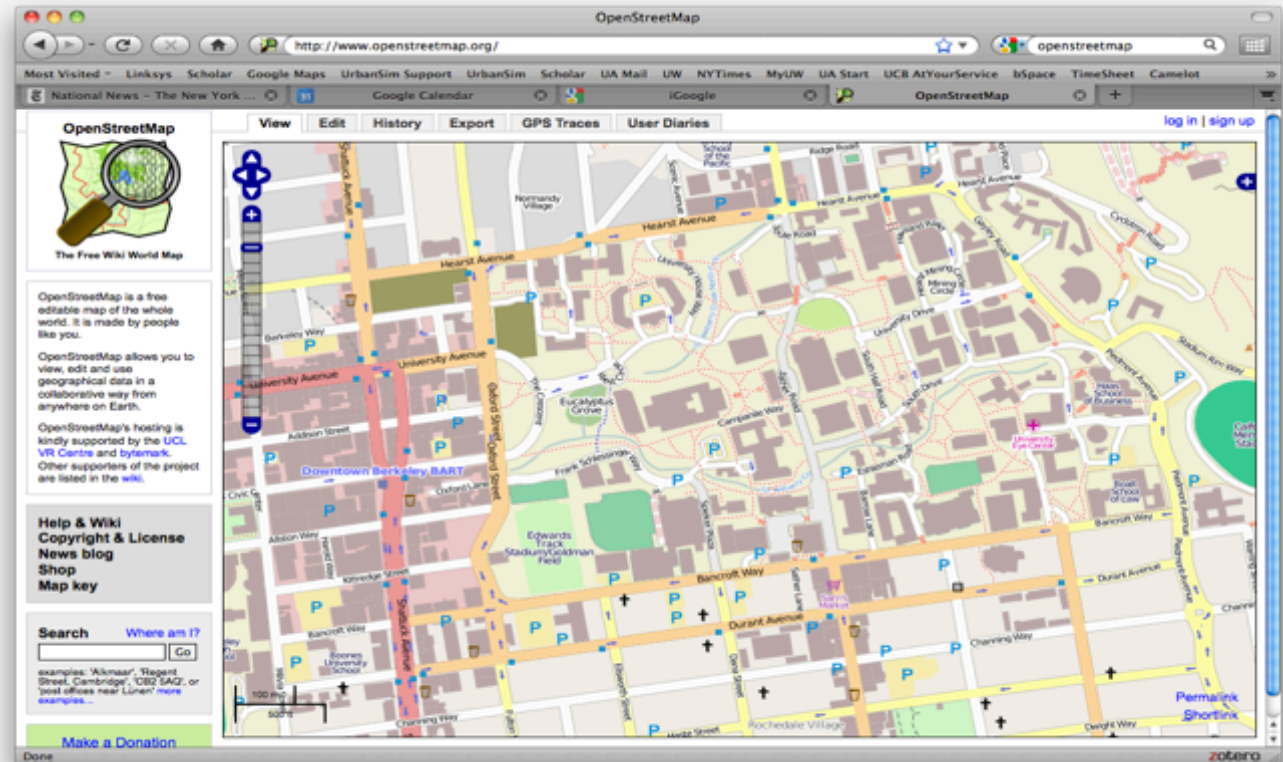
- **Implementation of Demographic Microsimulation**
 - Births, Deaths, Household Restructuring, Labor Force Participation, Workplace Location Choice
- **Implementation of Firm Dynamic Microsimulation**
 - Births, Deaths, Expansion, Contraction
- **Nested Logit with Sampling of Alternatives**
- **Dampened Market Equilibrium**
 - Compute full equilibrium price adjustments that clear the market under normal equilibrium assumptions
 - Calibrate price adjustment dampening to reflect observed dynamics

UrbanCanvas

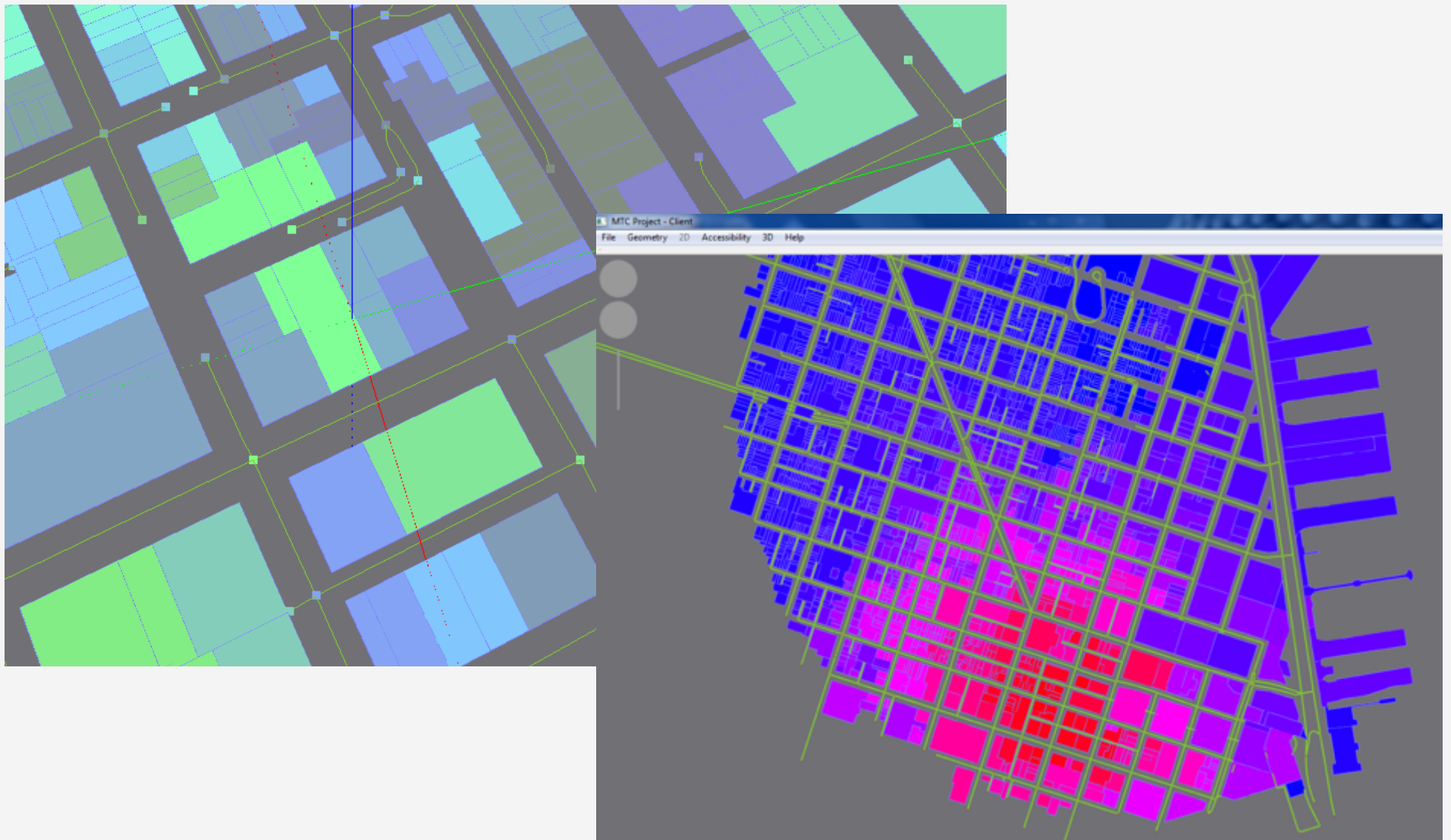
- **Prototype Funded by Metropolitan Transportation Commission, NSF**
 - MTC Plan Bay Area, a Sustainable Communities Strategies Planning Process
 - Involves visioning, modeling, and visualization for community engagement
- **Commercial Version Being Used by Albuquerque and Denver**, with more soon after initial release in 2013
- **Summary:**
 - Develop an extension to UrbanSim to visualize simulation results in 3D
 - Adds flexible indicator and accessibility framework
 - Adds intuitive scenario editing/creation interface in 3D environment
 - Shared metropolitan data infrastructure for coordination of planning and evaluation
 - Dramatically increases productivity of creating input data and using UrbanSim

Data Sources

- Digital terrain models
- Digital orthophotos
- Street Network
 - openstreetmap.org
- Parcels
- Building attributes
- Google buildings where available and of good quality
- Zoning
- General Plans
- Planned Developments
- Business establishments
- Synthesized population
- Planning boundaries



Connecting Urban Geometry, Computing Accessibilities



Summary and Status

- Developed an integrated UrbanVision platform for
 - **Visioning**: engaging communities in designing their future
 - **Modeling**: analyzing alternative land use and transportation policy/design scenarios
 - **Evaluating**: Computing Return on Investment (ROI) of development projects
 - **Visualizing**: 3D representation of alternative scenarios, with indicators
- Developed fast pedestrian-scale accessibility and urban design calculator
- Implementing a realistic real estate development simulator
- Expanding to support operational planning, project evaluation, and design in North America, Latin America, Europe, Asia, Africa
- Synthicity proposal to provide professional support for application of UrbanSim in Society of Grand Paris project; preliminary plan for creation of an office in Europe
- `Advanced research directions: dynamic general equilibrium, hierarchical models, more direct integration of travel modeling components, consistent evaluation

Thank you

www.synthicity.com

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