Preferred citation style for this presentation

Advancing land use transport interaction models

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IVT
ETH
Zürich

May 2011
Outline

The SustainCity project
Data aquisition
Data organisation and processing
Create base year
Base year data
Set up the UrbanSim project
Lessons learned
Outlook
The SustainCity project
Case study Zurich

Existing gridcell operationalisation (project ZUK)
Changing from gridcell to parcel version
Changing from Windows to Ubuntu
New base year (2000), more detailed data structure (schema pw)
  • Considering new and detailed data, new contracts
  • Adapting and improving ZUK models

[Diagram of data structure]

SustainCity
Scheduling of work

Data acquisition
Data organisation and processing
Create base year
Initial first run with dummy models and Zurich data
First run with reimplemented ZUK models and Zurich data
Second run with new data structures
Data needs - US parcel entity relationship model
Data acquisition

Data for:
- Base year
- Model estimation
- Control totals
- Geographies
- Scenarios

Basic sources:
- Data providers
- Survey (Household location choice)
- Synthesise (Population synthesis)
## Data acquisition – data providers

<table>
<thead>
<tr>
<th>Hierarchy of dataowner</th>
<th>Data owner</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>Swisstopo, the Federal Geo-Information center</td>
<td>Topographical maps (pixel)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital height model</td>
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<tr>
<td></td>
<td></td>
<td>Topographical maps (vector)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Municipal boundaries</td>
</tr>
<tr>
<td></td>
<td>BfS, Federal Statistical Office</td>
<td>Population census</td>
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<tr>
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<td>Enterprise census (3 sectors)</td>
</tr>
<tr>
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<td></td>
<td>Micorcensus of travel behaviour</td>
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<td></td>
<td></td>
<td>Building- and dwelling register</td>
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<tr>
<td>Cantonal</td>
<td>Cantonal building insurance</td>
<td>Building data</td>
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<td>Building- and dwelling register</td>
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<td>Vacancy rates for dwelling sizes</td>
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<td>Zoning and building status</td>
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<td></td>
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<td>Cadastre</td>
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<td></td>
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<td>Cantonale Richtpläne</td>
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<td></td>
<td>Orthophotos</td>
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<tr>
<td></td>
<td>Cantonal civil engineering department</td>
<td>Cantonal travel model</td>
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<td></td>
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<td>Public transport stations</td>
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<tr>
<td></td>
<td></td>
<td>Noise maps (Transport and shooting)</td>
</tr>
<tr>
<td></td>
<td>Cantonal statistical office</td>
<td>Population growth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land prices per zone and region</td>
</tr>
<tr>
<td>Municipal</td>
<td>Statistical office of the city of Zurich</td>
<td>Building- and dwelling register</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building projects</td>
</tr>
<tr>
<td>Private institution</td>
<td>DOCUMEDIA (Baublatt)</td>
<td>Building projects</td>
</tr>
</tbody>
</table>
Survey of household location choice

• Recently moved households in canton Zurich (~5000 persons contacted, 1000 answers)
• Addresses from address dealer
• Observed attributes:
  • **socio demographic variables**
    • Workplace, education, place of all household members
    • Social contacts
  • **characteristics and location**
    • characteristics of house/apartment
    • location of previous residence
    • search mode for residence (internet, newspaper, contacts,...)
  • **lifestyle**
    • lifestyle-typologies of G.Otte (2005)
    • new items / scope of B.Belart (2011)

• Two models estimated (renter, owner)
Population synthesis

• Base year: 2000
• Use national census (2000) for population
• Missing attributes: Income, car ownership and job
• Impute from travel microcensus (2005)
  • Probabilistic selection with replacement, based on the attributes available in both census and microcensus
• Using census data is tied to heavy restrictions
  • Sensitive data, no sharing
  • Using a synthetic population would be preferable
• Next steps: Generate a synthetic population using PopGen
  • Upcoming beta version of PopGen usable for non-US contexts should be available soon
Data organisation and processing

shp2pg

pg2urbansim

Original Data

PostGIS (server)

UrbanSim

QGIS

GRASS-GIS

General Script

General Script

Data organisation and processing

11th STRC Swiss Transprot Research Conference, May 2011
Create base year - GIS

Missing GIS functionality relevant for work with UrbanSim:

- Combine datasets through spatial joins and attribute-joins
- Convert data, e.g. polygon to centroid or intersections
- Queries and visualisation of data
- Interpolations and density-calculation (use of raster procedures)

=> Geometry and shape essential for dataprocessing
=> As OPUS can not handle geometry, (external) processing is necessary
Creat base year – sample script for assembling building data

#!/bin/sh
psql $PSQL_OPTIONS << END_SQL
SET search_path TO sc261,public;

-- Create table buildings with SQL queries.
INSERT INTO buildings
(building_id, building_quality_id, building_type_id, improvement_value, land_area, parcel_id, residential_units, sqft_per_unit, stories, year_built)

WITH

gvz AS (SELECT DISTINCT ON (egid) egid AS egid_gvz, wert FROM sc261.gwr_gebaeude10 JOIN sc.gvz_geb2000 ON
    gvz.geb2000.plz=sc261.gwr_gebaeude10.dplz4),
av_geb_grundrisse AS (SELECT gid AS gid_av_bod, art_code, flaeche_m2, the_geom FROM sc261.av_bodenbed_f WHERE art_code < 8),
geb_whg_infos AS (SELECT egid AS egid_whg, avg(warea) AS avg_whga FROM sc261.gwr_wohnungen10 GROUP BY egid),
parcel AS (SELECT gid AS parz_id, the_geom FROM sc261.av_liegensch)

SELECT
    egid AS building_id, gklas AS building_quality_id, art_code AS building_type_id, wert AS improvement_value, flaeche_m2 AS land_area, parz_id AS
        parcel_id,
ganzwhg AS residential_units, avg_whga AS sqft_per_unit, gastw AS stories, gbauj AS year_built
FROM sc261.gwr_gebaeude10
JOIN gvz ON egid=egid_gvz
JOIN av_geb_grundrisse ON ST_Contains(av_geb_grundrisse.the_geom, sc261.gwr_gebaeude10.the_geom)
JOIN parcel ON ST_Contains(parcel.the_geom, sc261.gwr_gebaeude10.the_geom)
JOIN geb_whg_infos ON egid=egid_whg;

UPDATE ONLY buildings SET non_residential_sqft=land_area * stories WHERE building_type_id<>1;
UPDATE ONLY buildings SET non_residential_sqft=0 WHERE building_type_id=1;
END_SQL
Create base year – bringing data sources together

\[
gvz\_buildings
\]
\[
\text{improvement\_value}
\]
\[
\text{arv\_soil\_coverage}
\]
\[
\text{building\_type\_id}
\]
\[
\text{land\_area}
\]
\[
gwr\_appartments
\]
\[
\text{residential\_units}
\]
\[
\text{m2\_per\_unit}
\]
\[
arv\_parcels
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\[
\text{parcel\_id}
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\[
\text{by address}
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\text{by coordinates}
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\text{by egid}
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\text{building\_id}
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\text{building\_quality\_id}
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\text{stories}
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\[
\text{year\_built}
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\[
\text{person}
\]
\[
\text{household}
\]
\[
\text{job}
\]
\[
\text{building}
\]
\[
\text{land development}
\]
\[
\text{parcel}
\]
Base year data

Main tables
- Parcels
- Buildings
- Households
- Jobs
- Persons

Definition tables

Data for estimation

Travel data

Geographies
### Base year data – main tables – parcels

<table>
<thead>
<tr>
<th>Column name</th>
<th>Type</th>
<th>Required</th>
<th>Status</th>
<th>PrimaryKey</th>
<th>ForeignKey</th>
<th>ForeignKey</th>
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<tr>
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<td>parcel_sqft</td>
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<td>av_liegensch.flm2</td>
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<tr>
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<td>Dummy 1001</td>
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<tr>
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<td>Y</td>
<td>sc261.av_liegensch.the_geom</td>
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<td></td>
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<tr>
<td>centroid_y</td>
<td>Integer</td>
<td>Y</td>
<td>sc261.av_liegensch.the_geom</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>tax_exempt_flag</td>
<td>Integer</td>
<td>N</td>
<td>Dummy 0</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>city_id</td>
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<td>av_liegensch.zgde</td>
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<td>county_id</td>
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<td>zone_id</td>
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<td>av_liegensch.zonennr1</td>
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<td></td>
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<tr>
<td>census_block_id</td>
<td>string</td>
<td>N</td>
<td>Dummy 0</td>
<td></td>
<td></td>
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</table>
## Base year data – main tables – buildings

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</thead>
<tbody>
<tr>
<td>building_id</td>
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<td>gwr_gebaude10.egid</td>
</tr>
<tr>
<td>building_quality_id</td>
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<td>Y</td>
<td>gwr_gebaude10.gklas</td>
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<tr>
<td>building_type_id</td>
<td>ForeignKey</td>
<td>Y</td>
<td>av_bodenbed_f.art_code</td>
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<tr>
<td>improvement_value</td>
<td>Integer</td>
<td>Y</td>
<td>gvwz_geb2000.wert</td>
</tr>
<tr>
<td>land_area</td>
<td>Integer</td>
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<td>av_bodenbed_f.flaeche_m2</td>
</tr>
<tr>
<td>non_residential_sqft</td>
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<td>Y</td>
<td>land_area * stories</td>
</tr>
<tr>
<td>parcel_id</td>
<td>ForeignKey</td>
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<td>av_liegensch.gid</td>
</tr>
<tr>
<td>residential_units</td>
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<td>Y</td>
<td>gwr_gebaeude10.ganzwhg</td>
</tr>
<tr>
<td>sqft_per_unit</td>
<td>Integer</td>
<td>Y</td>
<td>avg(gwr_wohnungen10.warea)</td>
</tr>
<tr>
<td>stories</td>
<td>Integer</td>
<td>N</td>
<td>gwr_gebaeude10.gastw</td>
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<tr>
<td>tax_exempt_flag</td>
<td>Integer</td>
<td>N</td>
<td>Dummy 0</td>
</tr>
<tr>
<td>year_built</td>
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<td>gwr_gebaeude10.gbauj</td>
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</table>
## Base year data – main tables - households

<table>
<thead>
<tr>
<th>Column name</th>
<th>Type</th>
<th>Required</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>household_id</td>
<td>PrimaryKey</td>
<td>Y</td>
<td>vz.hhnr</td>
</tr>
<tr>
<td>building_id</td>
<td>ForeignKey</td>
<td>Y</td>
<td>buildings.building_id</td>
</tr>
<tr>
<td>persons</td>
<td>Integer</td>
<td>Y</td>
<td>COUNT(vz.person_id)</td>
</tr>
<tr>
<td>income</td>
<td>Integer</td>
<td>Y</td>
<td>50000 * COUNT(person_id)</td>
</tr>
<tr>
<td>age_of_head</td>
<td>Integer</td>
<td>Y</td>
<td>vz.valtj</td>
</tr>
<tr>
<td>race_id</td>
<td>Integer</td>
<td>Y</td>
<td>vz.hmat</td>
</tr>
<tr>
<td>workers</td>
<td>Integer</td>
<td>Y</td>
<td>COUNT(person_id) when vz.ams BETWEEN 11 AND 14</td>
</tr>
<tr>
<td>children</td>
<td>Integer</td>
<td>Y</td>
<td>zkind &gt; 0</td>
</tr>
<tr>
<td>cars</td>
<td>Integer</td>
<td>Y</td>
<td>COUNT(person_id) when vz.apkwl = 1</td>
</tr>
</tbody>
</table>
## Base year data – main tables - jobs

<table>
<thead>
<tr>
<th>Column name</th>
<th>Type</th>
<th>Required</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>job_id</td>
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</tr>
<tr>
<td>building_id</td>
<td>ForeignKey</td>
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<td>buildings.building_id</td>
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<tr>
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<td>Default 0</td>
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<td>sectors ZUK</td>
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</table>
## Base year data – main tables – persons

<table>
<thead>
<tr>
<th>Column name</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>person_id</td>
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<td>vz.person_od</td>
</tr>
<tr>
<td>household_id</td>
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<td>N</td>
</tr>
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<td>relate</td>
<td>Integer</td>
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</tr>
<tr>
<td>age</td>
<td>Integer</td>
<td>N</td>
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<td>sex</td>
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<td>race_id</td>
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<td>worker</td>
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<td>edu</td>
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<td>N</td>
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<tr>
<td>earning</td>
<td>Integer</td>
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<td>N</td>
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<tr>
<td>job_id</td>
<td>ForeignKey</td>
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<td>N</td>
</tr>
</tbody>
</table>
Base year data – definition tables

annual_employment_control_totals → linear extrapolation
annual_household_control_totals → statistics canton Zurich
annual_relocation_rates_for_households → Beige (2008)
annual_job_relocation_rates → ZUK definitions (Löchl et al. 2007, p. 32)
building_types → 7, according to soil coverage information
employment_sectors → ZUK categories (Löchl et al. 2007, p. 32)
target_vacancies → 0.66% (housing), 4.0% (non-housing)
development_constraints → derived from zoning plans
land_use_types → 9 categories
plan_types → reduced to 146 categories
### Base year data – plan types, generic land uses, constraints

<table>
<thead>
<tr>
<th>PLAN TYPE (SC)</th>
<th>Generic_Use (SC)</th>
<th>SC</th>
<th>GIS AZ</th>
<th>GIS AZ via BZ</th>
<th>Densities</th>
<th>Max Fractions (%)</th>
<th>Min Fractions (%)</th>
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</thead>
<tbody>
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<tr>
<td>Residential</td>
<td>100% Residential</td>
<td>1000</td>
<td>1 Resi</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>90</td>
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<td>Residential dis</td>
<td>1100</td>
<td>1</td>
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<td>1</td>
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<td>residential&gt;</td>
<td>90%</td>
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<td>residential&lt;</td>
<td>90%</td>
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<td>Residential with</td>
<td>2000</td>
<td>2 Res</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>(lou) commerci</td>
<td>2100</td>
<td>2</td>
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<td>and industrial</td>
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<td>Residential with</td>
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<tr>
<td></td>
<td>Center</td>
<td>3000</td>
<td>3 Res</td>
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<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Central area;</td>
<td>3100</td>
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<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>mix of residen</td>
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Base year data – definition tables

urbansim_constants
building_sqft_per_job
demolition_cost_per_sqft
development_constraints
development_event_history/development templates
development_project_proposals
employment_adhoc_sector_groups
home_based_status
household_characteristics_for_ht
race_names
velocity_functions
Further base year data

Data for estimation
  • households_for_estimation
  • jobs_for_estimation

travel_data

Geographies
  • cities
  • zones
  • counties
  • fazes
  • large_areas
Set up the UrbanSim project – Approach

Two basic options:

• Start from default (urbansim_parcel)
• Reduce example model

Reasons:

• Target structure of pw-script (some times inconsistent with documentation)
• Example models contain “specials”
• Default project for the European context
• Understanding of model system
Set up the UrbanSim project

Creating new project from template (parent urbansim_parcel)
Import base year data into US cache (sometimes tricky)

Specifying models
  • Starting from templates or copied parent models
  • Define variables as expressions or python classes

Running estimations or providing model definition tables

Configure scenarios

Running scenarios and checking errors
Lessons learned

Import tool wants database with project name
Not all steps supported in GUI (yet)
  • Set scenario as executable (fixed)
  • Adding new specification nodes
  • Adding datasets to preload
Via editor it is possible
There are no default location choice specifications
For debugging
  • Same process
  • All in same thread
Outlook – first run – data structure and models

- Job change model
  - Home-based job choice model
  - Workplace location choice model
- Demographic events model
  - Household transition model
  - Household relocation model
  - Sub-model: dwelling cooperatives
  - Household location choice model
- Parcel transition model
- Recalculation accessibility
- Transition planning zones

Geographical aggregations
- Plan types (development constraints)
- Accessibility
- Other parcel characteristics

Economic Transition Model
- Process pipeline events
- Real estate price model
- Expected sale price model
- Sub-model: Urban shape options
- Sub-model: dwelling cooperatives
- Development proposal choice model
- Building construction Model
Outlook – Definitions of table-contents and dependency
Outlook – Definitions of table-contents and dependency
Outlook – Extension of table-contents and dependency
Outlook – Open questions

First run with MATSim integration (WP6)
First run with demography integration (WP4)
Indicators (WP8)

Usage of vector and raster data
Handling of geometries

UrbanSimE basic default model specifications
  • LCM of data sources
  • LCM of variables
References


