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## Using GIS for setting up an urban simulation environment

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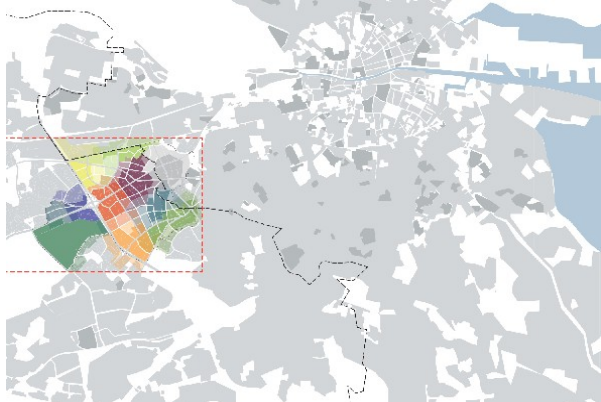
# Introduction

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## Scale of urban planning projects

- S - the neighborhood (1:1000 – 1:200)
- M - the quarter (1:2000 – 1:500)
- L - the city (1:10000 – 1:2000)
- XL?

### Examples of projects from KCAP Architects&Planners



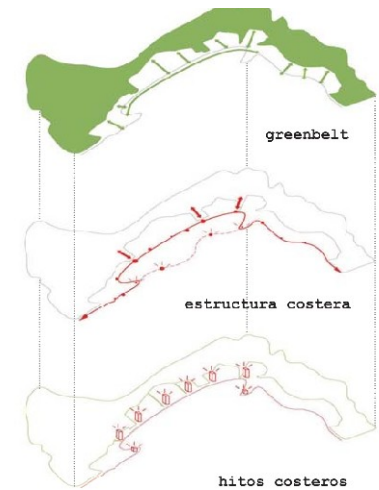
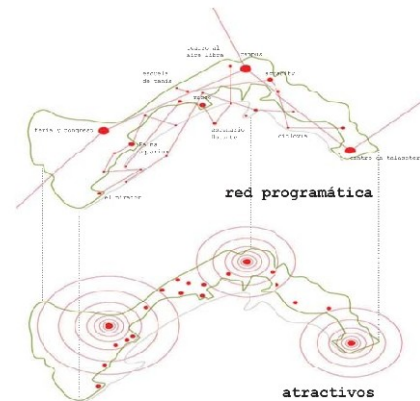
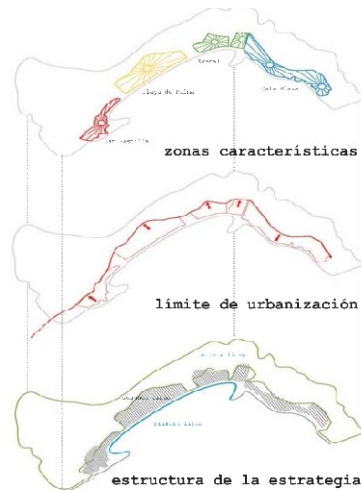
# Introduction

## Layers

- network (public transport, streets, cycling, pedestrians, ...)
- build space (volumes, use, density, ...)
- open-space (artificial, natural, public, semi-public, private, ...)
- urban cores (urban center, subcenter, neighborhood, ...)
- functions (points of interest, zonal definitions, ...)
- social structure (segregation, age, income, lifestyle, ...)
- policies (ownership, investors, constraints, ...)
- ....

Design-proposal for  
Platja del Palma

KCAP Architects&Planners



# Introduction

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## Process and dynamics

What happens if we create

... a new highway

... a new urban center

... a new station/airport

... or if we have a structural change of the economy?

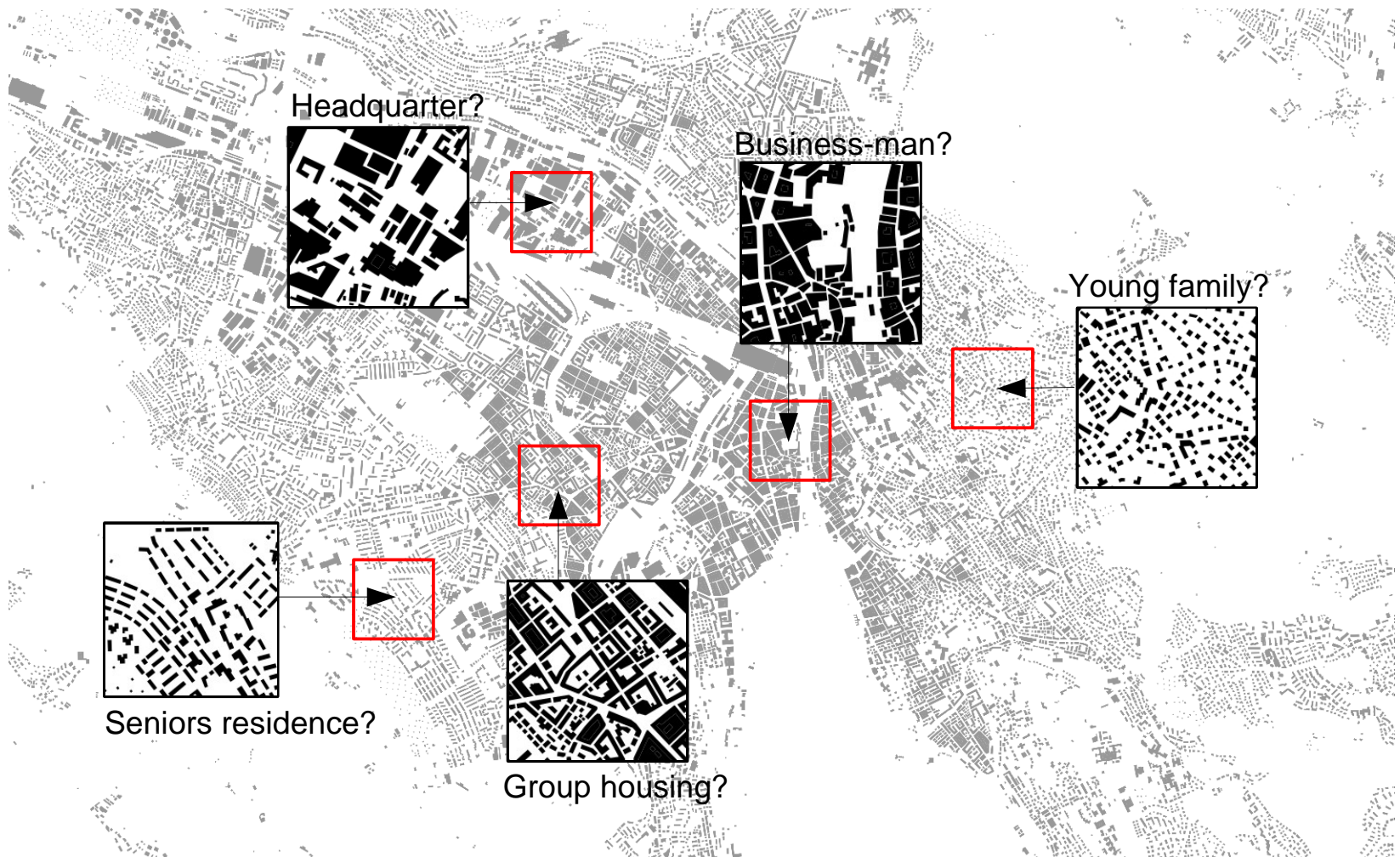
Can we simulate effects of urban planning decisions?

Design-proposal for  
Dublin

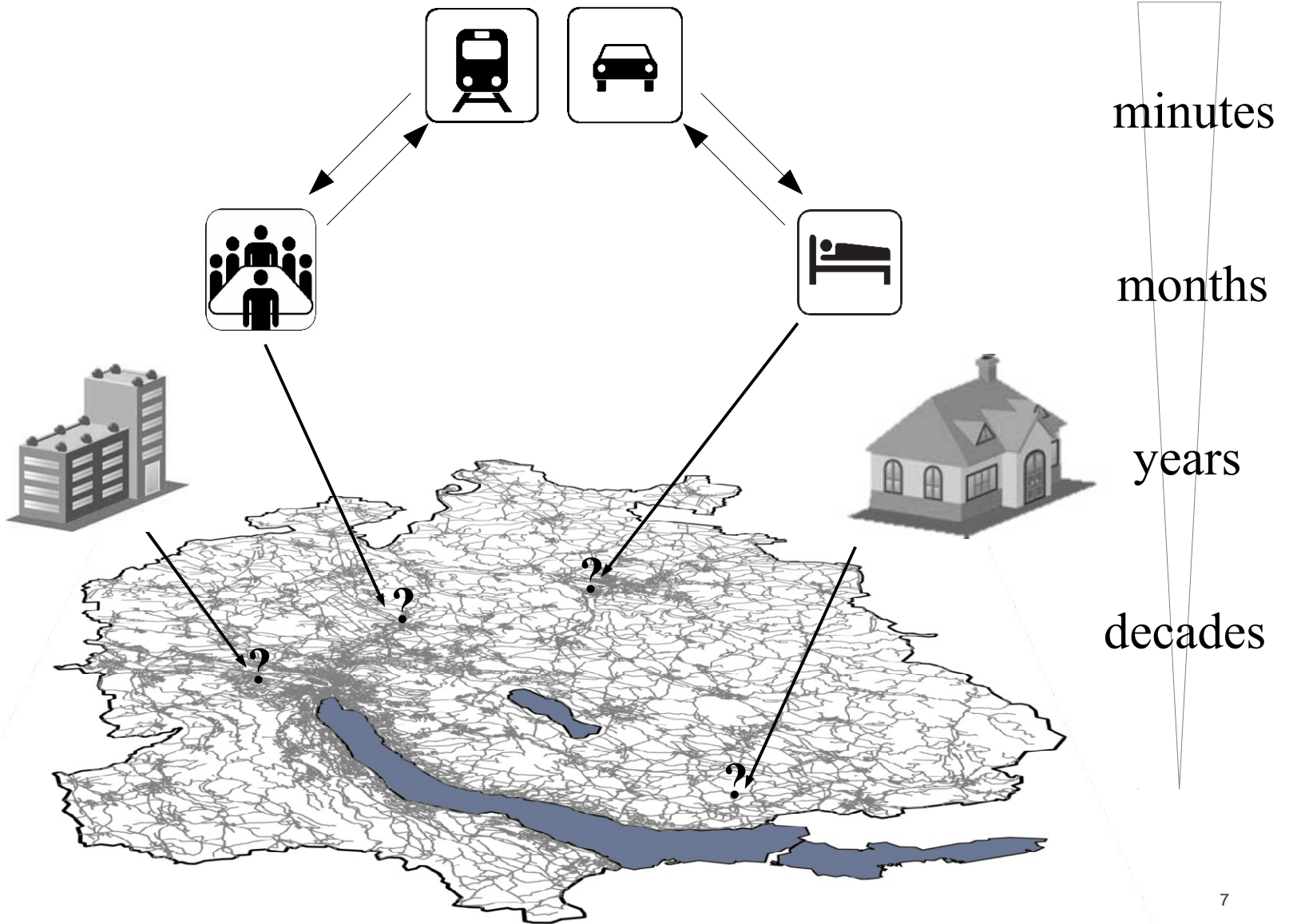
KCAP Architects&Planners



# Introduction



# Urban Simulation

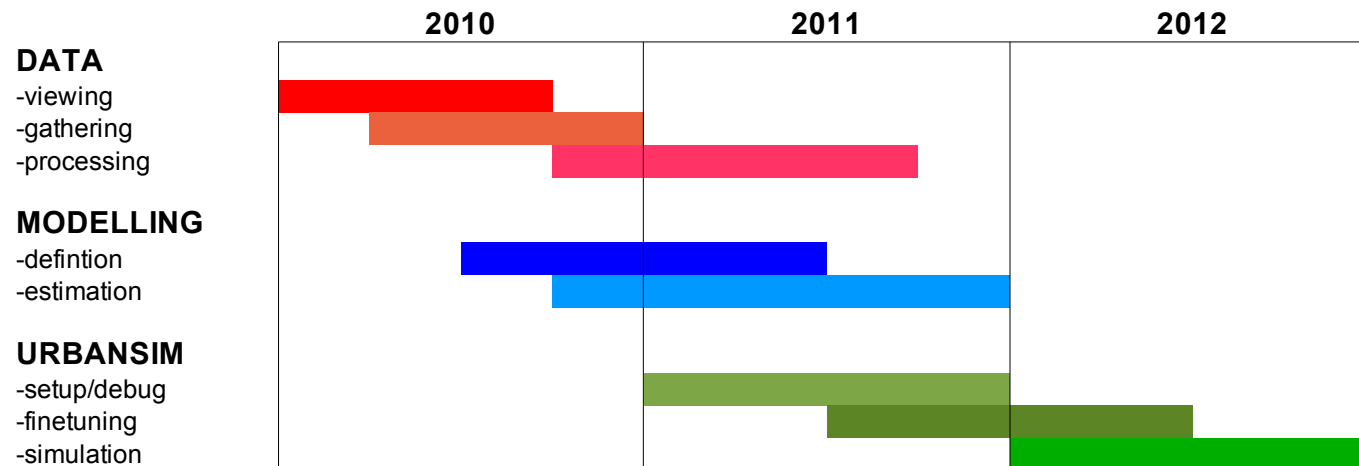


# SustainCity

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## SustainCity

- Introduction SustainCity
- The Zurich case study of UrbanSim
- Basis data
- Data processing
- Modelling
- Conclusions and Outlook





# SustainCity

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## SustainCity

- EU-funded research-project (2010-2012)
- 12 research institutions participating
- 3 case-studies of UrbanSim: Brussels, Paris, Zurich
- Previous UrbanSim-experience in all cities (Zurich: Zukunft Urbaner Kulturlandschaften, 2007)
- Aim of Project:
  - adapt 'UrbanSim' to European conditions => version 'UrbanSimE'
  - include additional models (demographics, developers, MatSim-exchange,...)
  - evaluate and compare results of case-studies

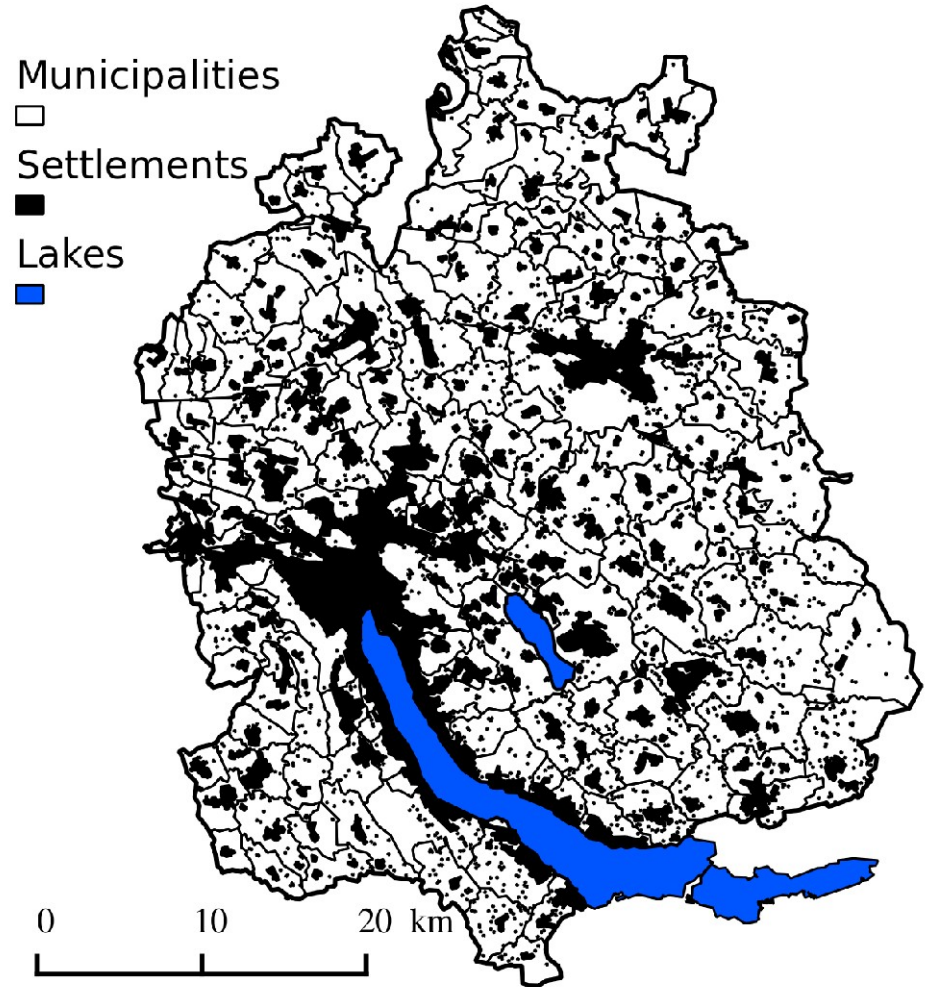
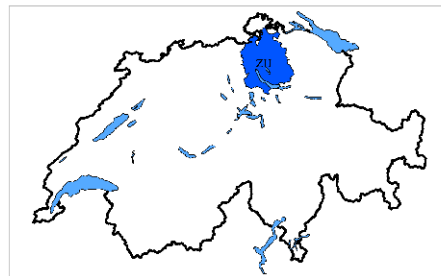


# Urban Simulation

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## Simulation area and time period

- Simulation start: 2000
- Evaluation period: 2000-2010
- Simulation period: 2010-2030



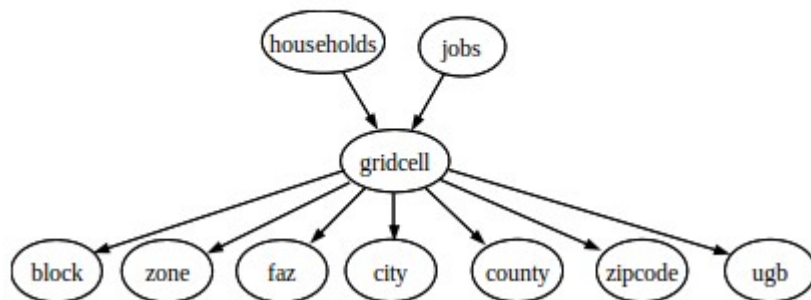
# Urban Simulation

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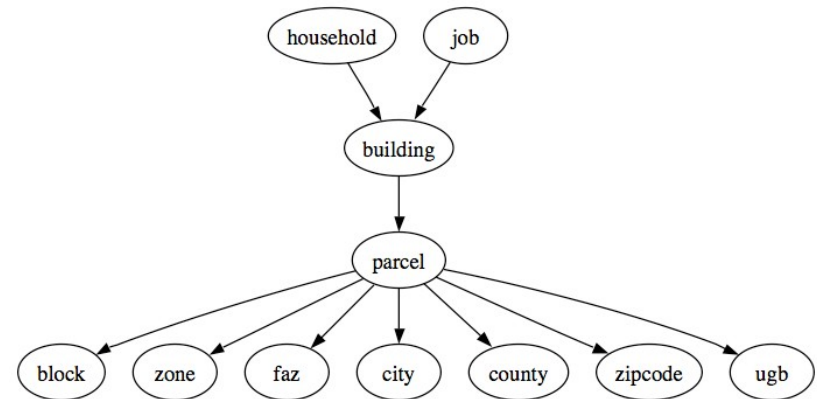
## UrbanSim

- Opensource software developed by P. Waddell and colleagues ([www.UrbanSim.org](http://www.UrbanSim.org))
- Simulation of land use development with interaction to traffic and accessibility
- Microsimulation representing the choice of households, businesses and landowners
- Previously gridcell-based approach, now geometries (zoning and parcel) as reference objects
- Various case studies world wide (in Zurich: Zukunft Urbaner Kulturlandschaften, 2007)

(a) Basic model structure of grid cell version



(b) Basic model structure of parcel version



Source: Waddell, P. A. (2010) Overview of UrbanSim and the Open Platform for Urban Simulation, presentation, UrbanSim Tutorial, Zurich

# Urban Simulation

## Basisdata (extract)

- Vectormaps

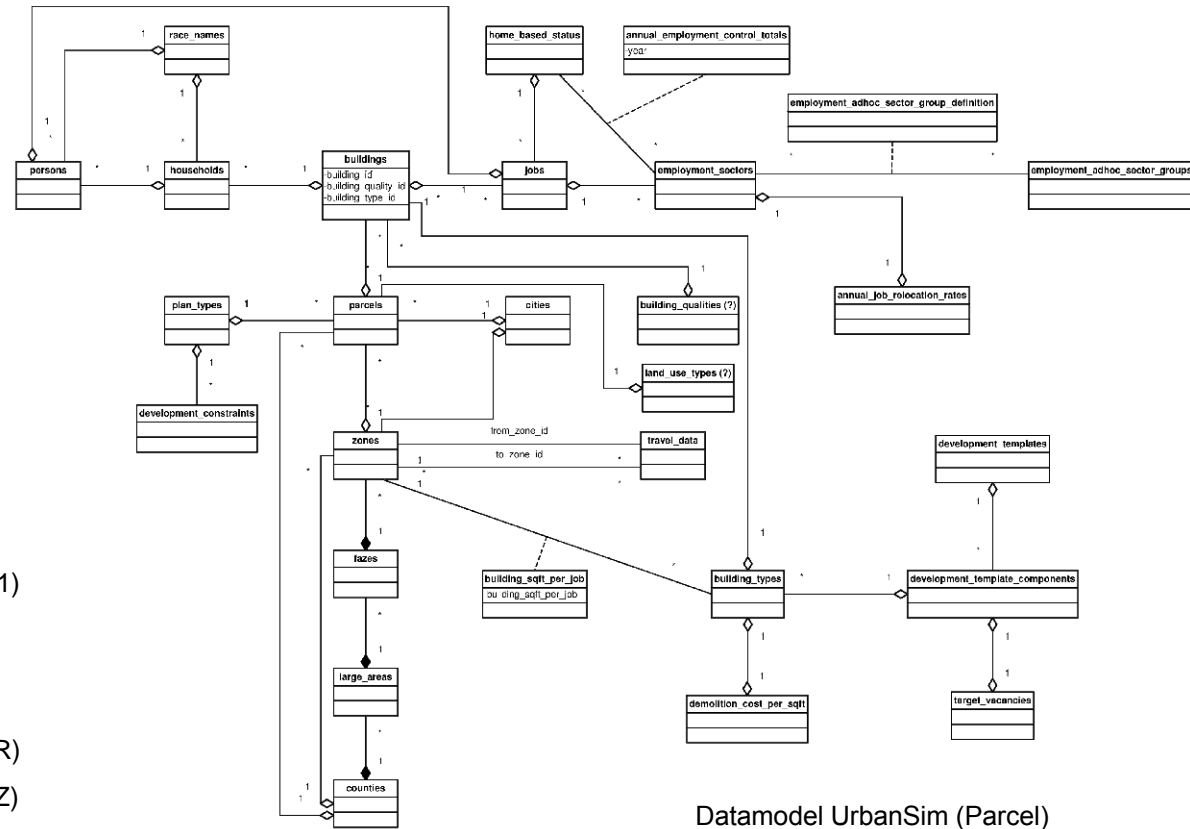
- Parcels & Buildings
- Soil coverage zones
- Landuse zones
- Traffic-zones (KVM & OeVM)
- Networks & stops
- Topography
- Noisemaps

- Agent information

- Population census (2000)
- Micro census (2005)
- Enterprise census (2001)
- Various surveys of IVT (2000-2011)

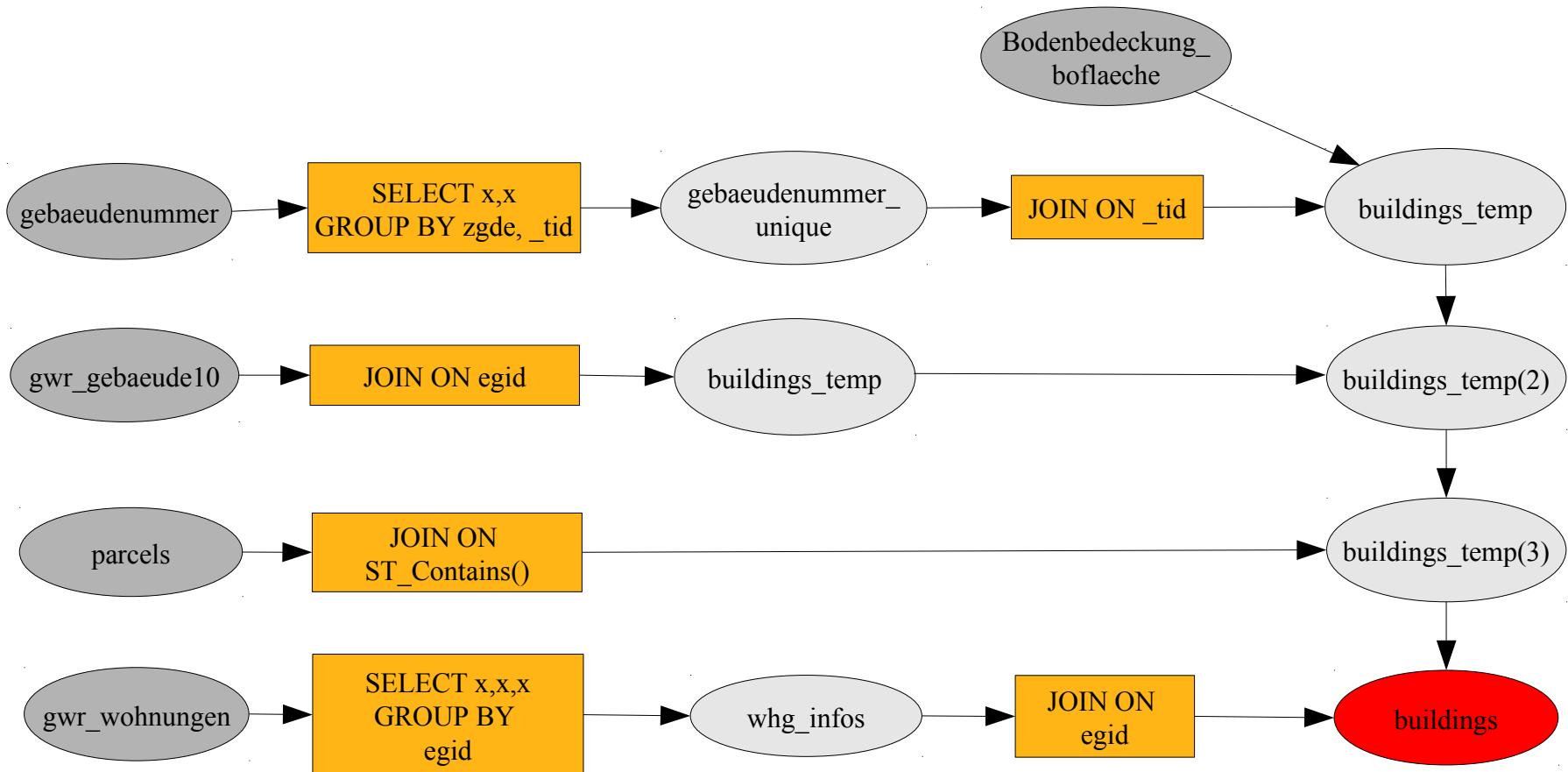
- Object information

- Residential building register (GWR)
- Cantonal building assurance (GVZ)
- Landprices (internet)



# Data Processing

## Assembling building information



# Data Processing

Entity described	Number of objects	Data set	Data owner	Spatial resolution	Date
Buildings	255801 (2010)	GWR-BFS	Federal Statistic Department	Addresses and coordinates [m]	2004-2010
	212497 (2010)	GWR-ARV	Canton Zürich	Coordinates [m]	2010
	286468 (2000)	GVZ	Cantonal Building Assurances	Addresses	2010
	534594 (2010)	Vector 25	Swisstopo	Polygon in projected coordinate system	2010
Appartments	671169 (2010)	GWR-BFS	Federal Statistic Department	Building (via EGID)	2004-2010
	478378 (2010)	GWR-ARV	Canton Zürich	Building (via EGID)	2010
Entrances	261650 (2010)	GWR-BFS	Federal Statistic Department	Addresses and coordinates [m]	2004-2010
	237481 (2010)	GWR-ARV	Canton Zürich	Coordinates [m] (and addresses)	2010
New buildings	40849 (2000-2010)	GVZ	Cantonal Building Assurances	Addresses	2001-2010
Development projects	57734 (2010)	GWR-ARV	Canton Zürich	Building (via EPROID)	1967-2015
	60056 (1998-2012)	Documedia	DOCUMEDIA (Baublatt)	Addresses	1998-2012
Parcels	367314 (2010)	Cadastral plans	Canton Zürich	Polygon in projected	2005, 2007-2010

# Data Processing

## Calculation-routines: example plan\_types

- **GWR/GVZ**
  - Housing units
  - Construction year
  - Value
  - ...
- **Soil coverage zones (AV)**
  - surface information
  - buildings footprints
  - .....
- **Parcel**
  - size
  - FAR covered
  - ...
- ▭ **Land-use zone**
  - planning-constraints



# Data Processing

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## Challenges

- Combination of various joins
    - Attribute based (EGID)
    - Spatial join (within, closest?)
    - Address-matching

=> Conditional joins

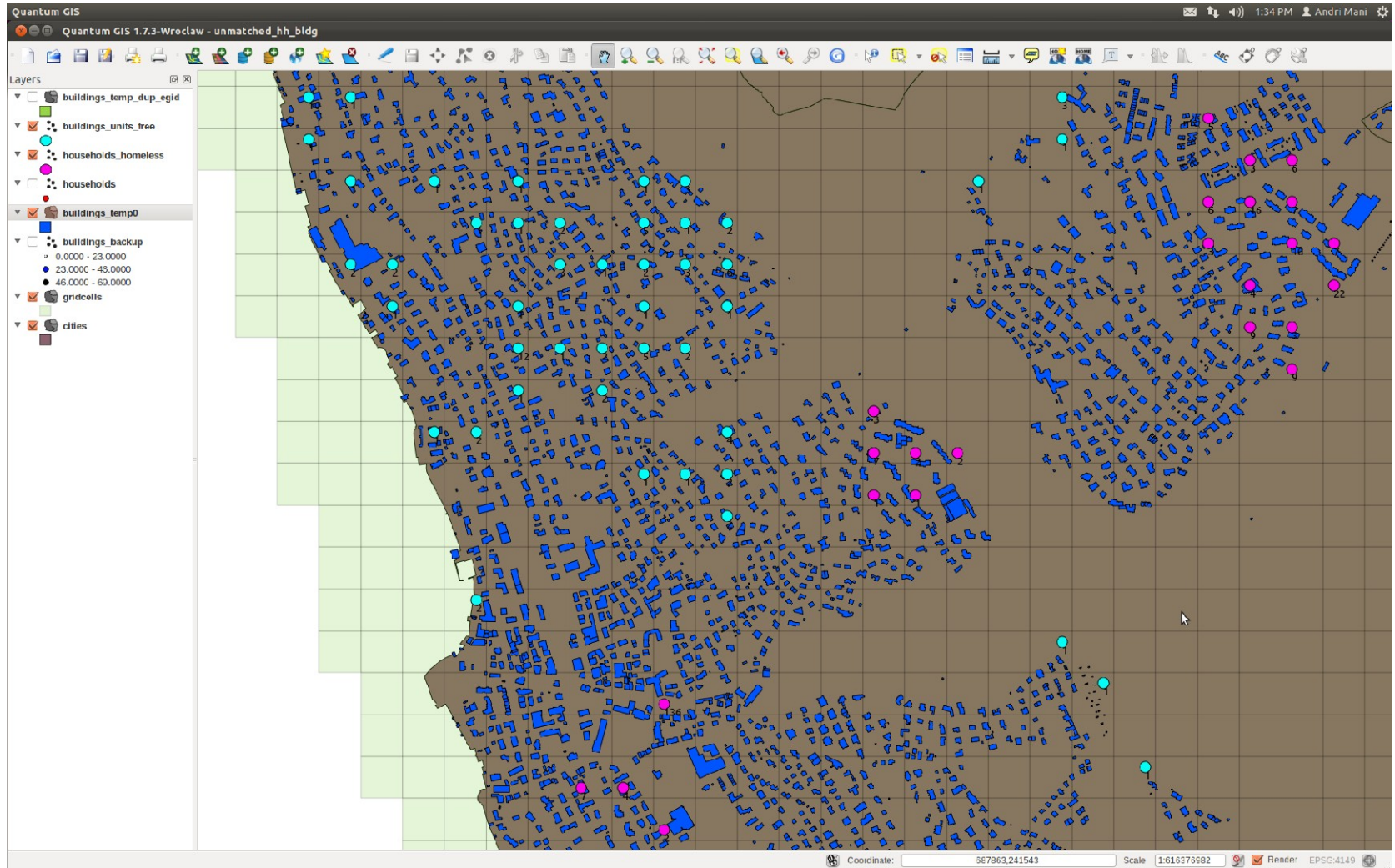
=> Iterations

=> Quality and plausibility checks

=> “Datamanipulation”, e.g. string
  - Very Large datasets
  - Scripted procedures for workprocess
  - LINUX running on servers
- => Use of PostgreSQL, PostGIS

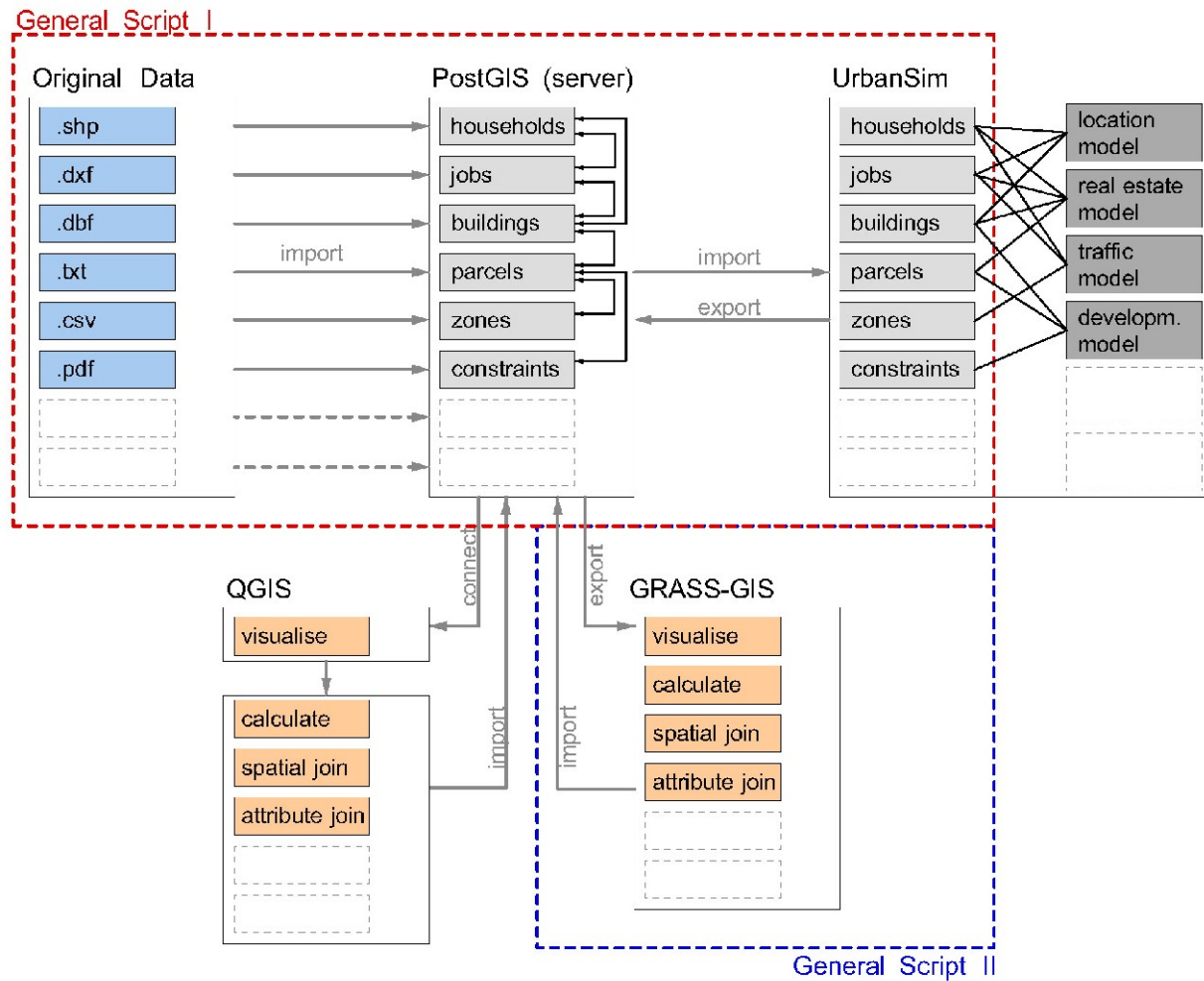


# Data Processing



# Data Processing

## Framework SustainCity



# Data Processing

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## The need of GIS functionality in UrbanSim

- 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

# Data Processing

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## Conclusion on the use of PostGIS

- + Very stable and scriptable
- + Fast on big datasets
- + Use of schemas
- + QGIS as Viewer
- + Direct import to UrbanSim
  
- Limited amount of tools
- Missing raster procedures
- Not “intuitive” for modelling
- Control of results
- No topological information

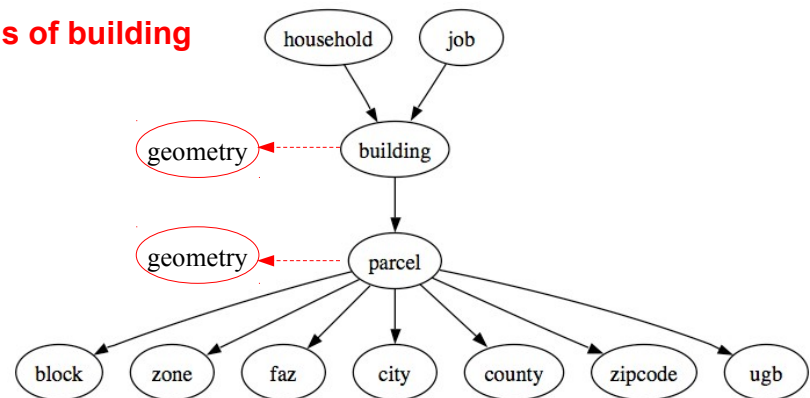
=> combine with ArcGIS for further work?

# Modelling

## Urban Shape

### building (extract)

building_id	integer	unique identifier
building_quality_id	integer	(optional) identified for building quality
building_type_id	integer	identifier for building type; valid id in the building_types table
improvement_value	long	value of building (replacement cost)
land_area	long	land area (usually in sqft) associated with building, includes footprint plus associated area such as landscaping and parking.
parcel_id	integer	identifier of parcel in which building is located
residential_units	integer	number of residential units in the building
sqft_per_unit	float	number of residential square feet per unit in the building
stories	integer	(optional) number of stories in the building
year_built	integer	year of construction of the building
<b>building-typology</b>	<b>integer</b>	<b>typological class of building</b>



# Modelling

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## Examples of geometric and spatial attributes

### building (extract)

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building_kind	integer	code for kind of building e.g 1= EFH, 2=MFH open structure, 3=MFH closed structure, 4=....
main_orientation	integer	Max of sum of all orientation parts
building_depth	float	Mean building depth of building
distance_to_neighbor	float	Minimum distance on side of building
distance_to_street	float	Minimum distance on front of building

### parcel (extract)float

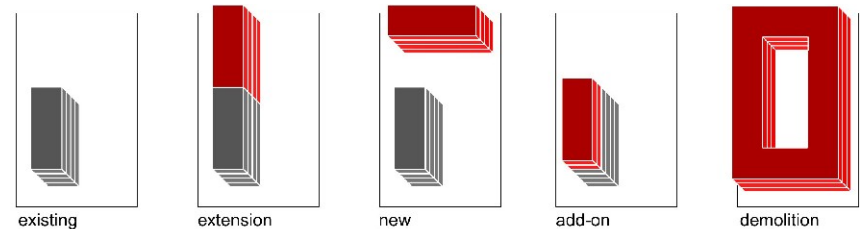
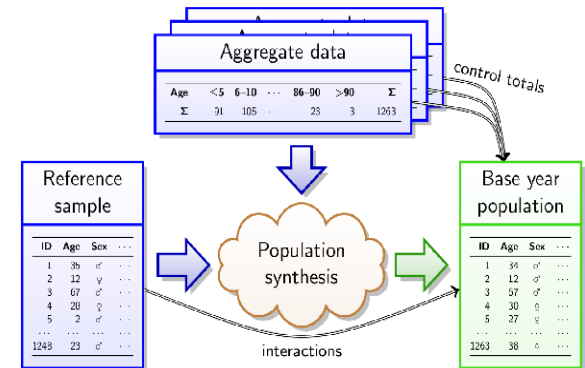
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density_per_parcel	float	ratio of building_sqm and parcel_sqm
homogeneity_per_block	float	variance of different typologies
development_options	integer	extension, demolition, new construction, additional construction
streetaccess_per_parcel	integer	number of streets accessing parcel
public_space_ratio	float	ratio of public space on parcel
private_space_ratio	float	ratio of private space on parcel

# Urban Simulation

## Ongoing work

- Extend models
  - Model for firmographics
  - Model for developers
  - Hedonic pricing
  - Implementing shape information
    - behaviour of agents
    - options for objects
    - visual output?
- Simplify setup
  - Population synthesis
  - Initial setup?
  - Implement Design Proposals?



# Location choice

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## Literature

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# Questions?