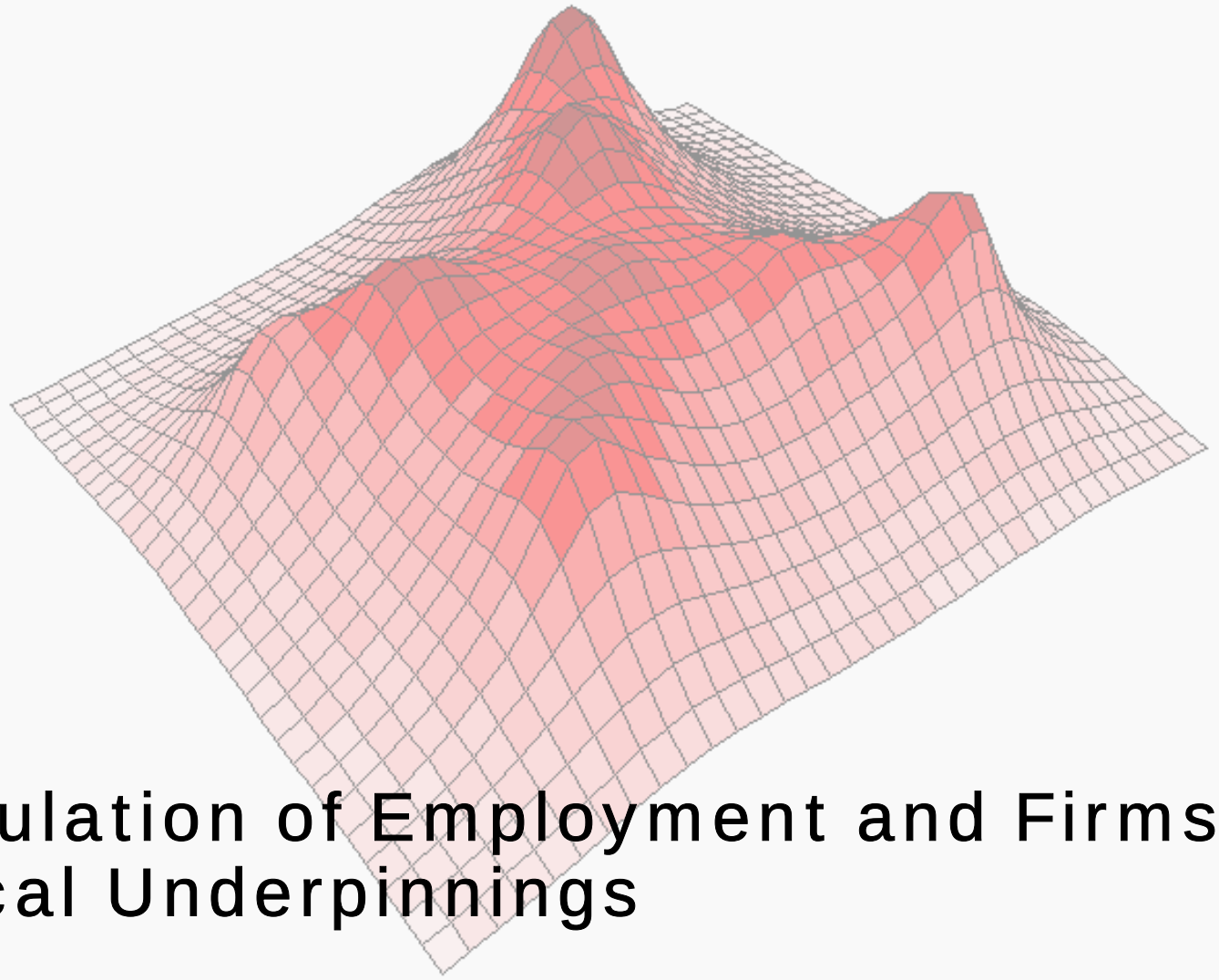
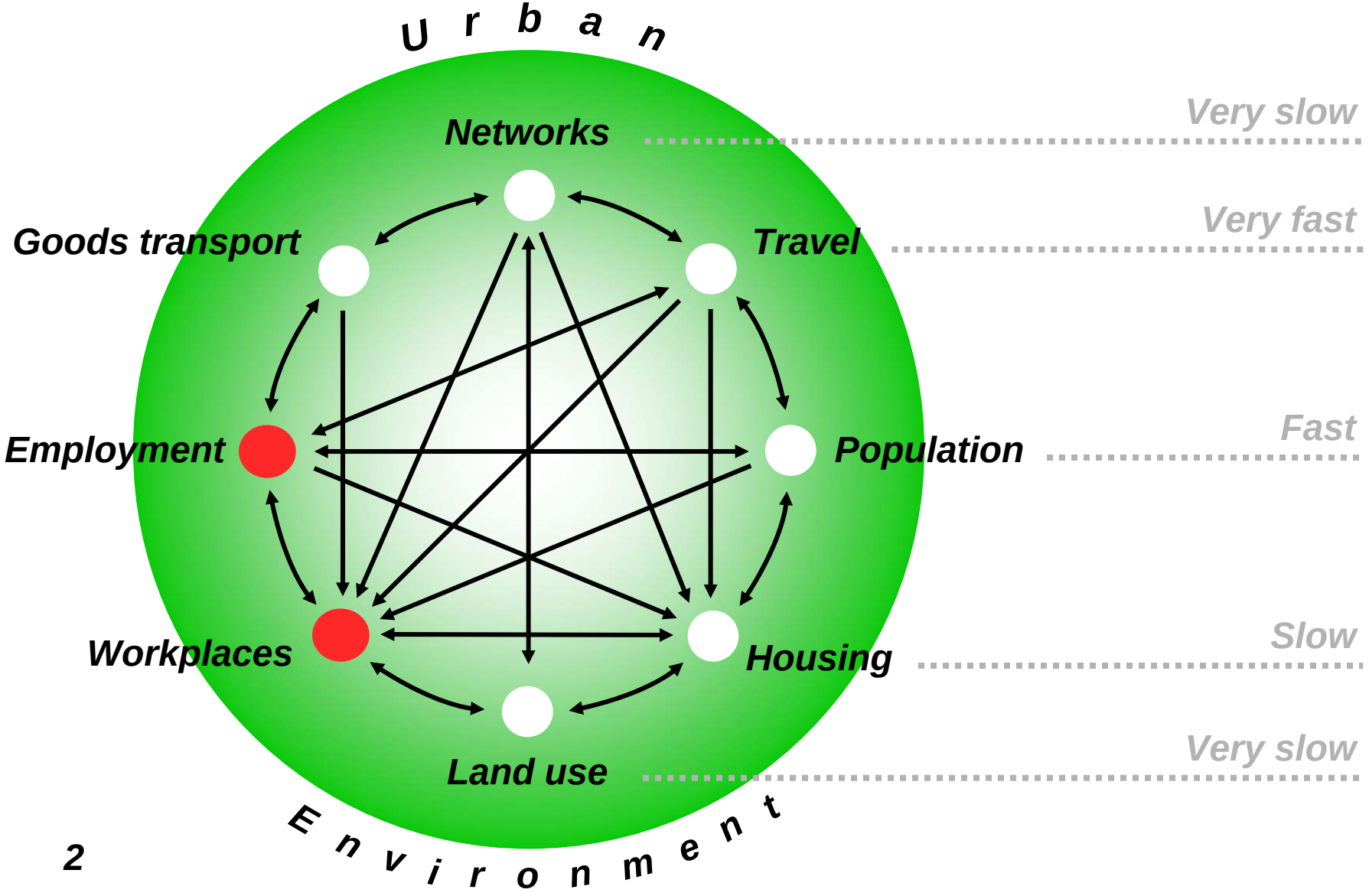


Microsimulation of Employment and Firms Theoretical Underpinnings

Michael Wegener, Spiekermann & Wegener, Dortmund

Fourth Oregon Symposium on Integrated Land-Use Transport Models
Portland, Oregon, 15-17 November 2005

Urban systems **Employment & Firms** **Speed of change**



Firmography

Growth and decline of employment

Growth and decline of industries cannot be modelled endogenously in urban models because they are co-determined by the competition with industries in other regions.

Therefore exogenous assumptions about sectoral growth or decline are needed based on

- national economic forecasts
- national input-output models
- extrapolation of past trends

Typically, these forecasts take the form of forecasts of GDP by sector, which are converted to employment by exogenous assumptions about future labour productivity.

Growth and decline of households

There is a long tradition of collecting information on household formation:

- Households are generated through separation of persons from existing household, marriage or cohabitation.
- Households grow in age by ageing of its households members.
- Households grow in size by birth of a child or joining of another person.
- Households decline in size by death or separation of a person.
- Households disappear by death or separation.

Growth and decline of firms

There is only little information on firm formation:

- Firms are generated through foundation of a new firm or separation of owners or workers from existing firms or merger of two or more existing firms.
- Firms grow in age by ageing of its workers.
- Firms grow in size by expanding its production and hiring new workers.
- Firms decline in size by reduction of its production and releasing workers.
- Firms disappear by going out of business.

Growth and decline of firms

There is a high degree of variation in growth and decline of firms:

- Firms may perform better (or worse) than the average development of their industry because they have a superior (inferior) management or better (or worse) products.
- Firms may be under control of other firms and subject to decisions taken outside the study region.
- There is a greater variation in size of firms than in size of households. Decisions about large firms are singular events that cannot be forecast in probabilistic models.

Firm Location

Firm location

There is a large body of theory and empirical evidence on the location and relocation of firms:

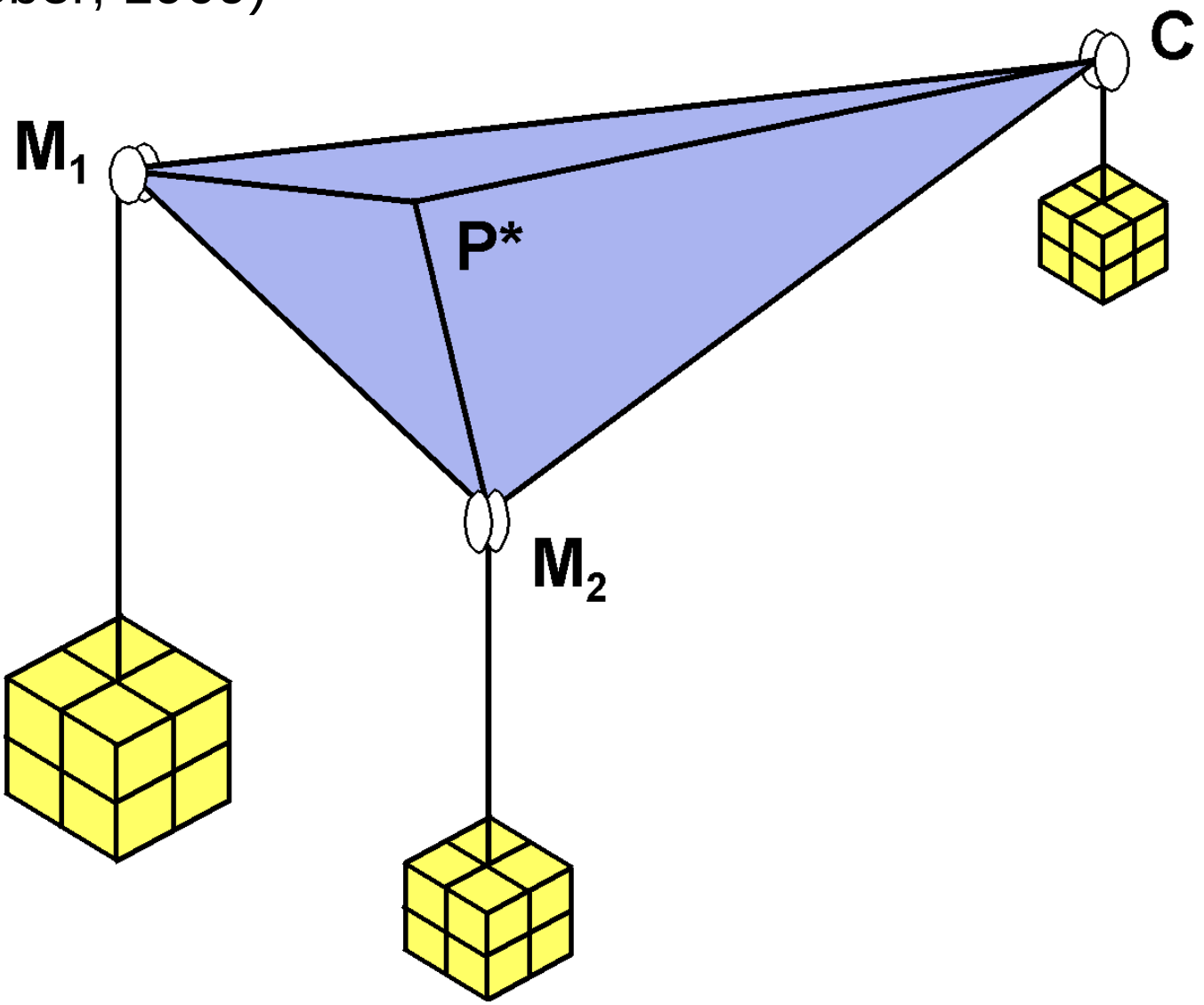
- New firms choose a location close to their suppliers and markets.
- Growing firms move to another location if they cannot expand in their present location.
- Declining firms move to another location if their present location is becoming unaffordable.
- Firms move to another location to follow the movement of their suppliers and markets.

"Weber Triangle"
(A. Weber, 1909)

The model of firm location by Weber assumes that firms choose locations at which the costs of transporting inputs from locations *M* and the costs of transporting outputs to markets *C* are minimised.

In the case of two inputs and one output this results in the "Weber triangle". As usually inputs are heavier than outputs, optimal locations tend to be close to input.

"Weber Triangle"
(A. Weber, 1909)

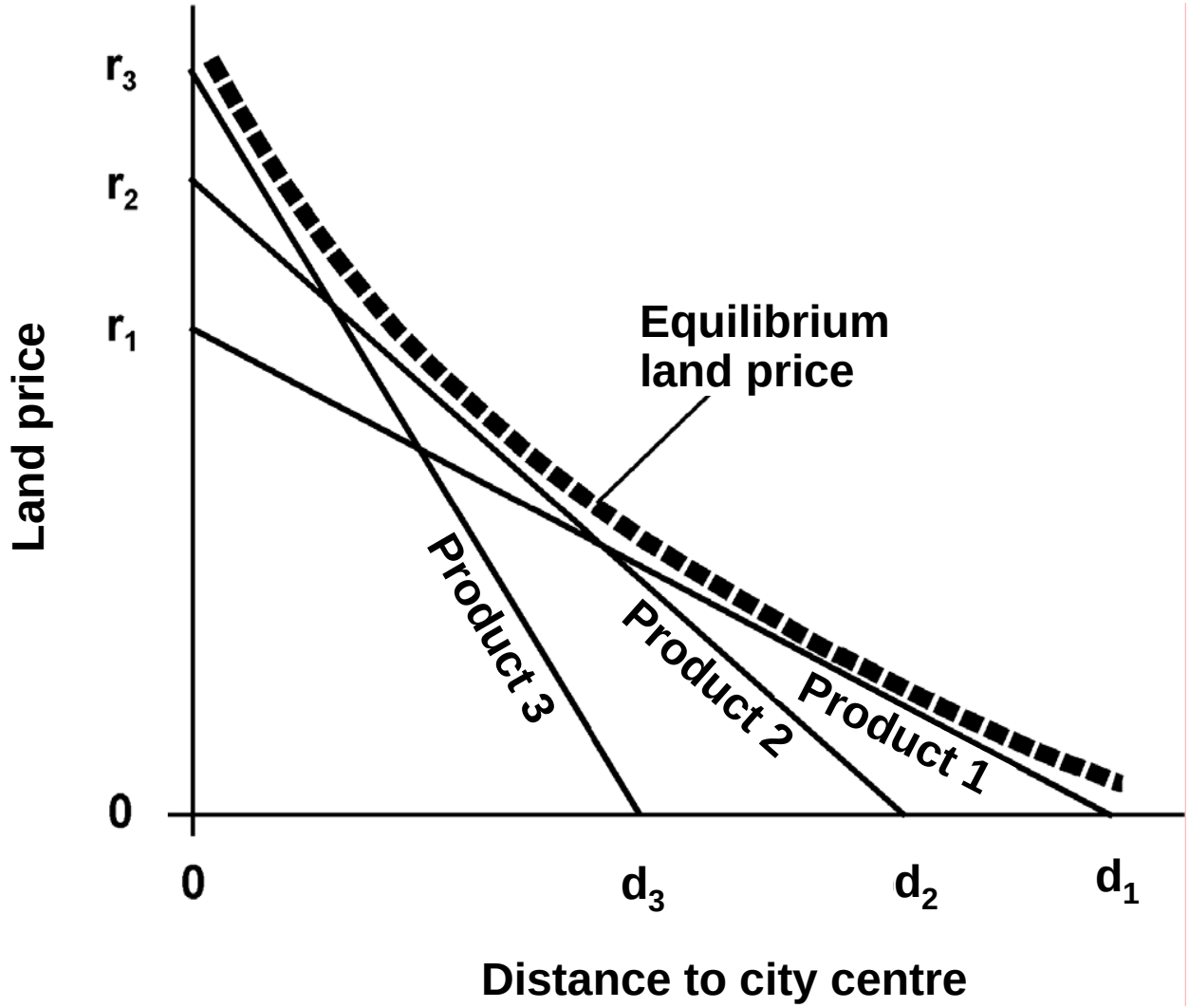


Bid-rent theory
Alonso (1964)

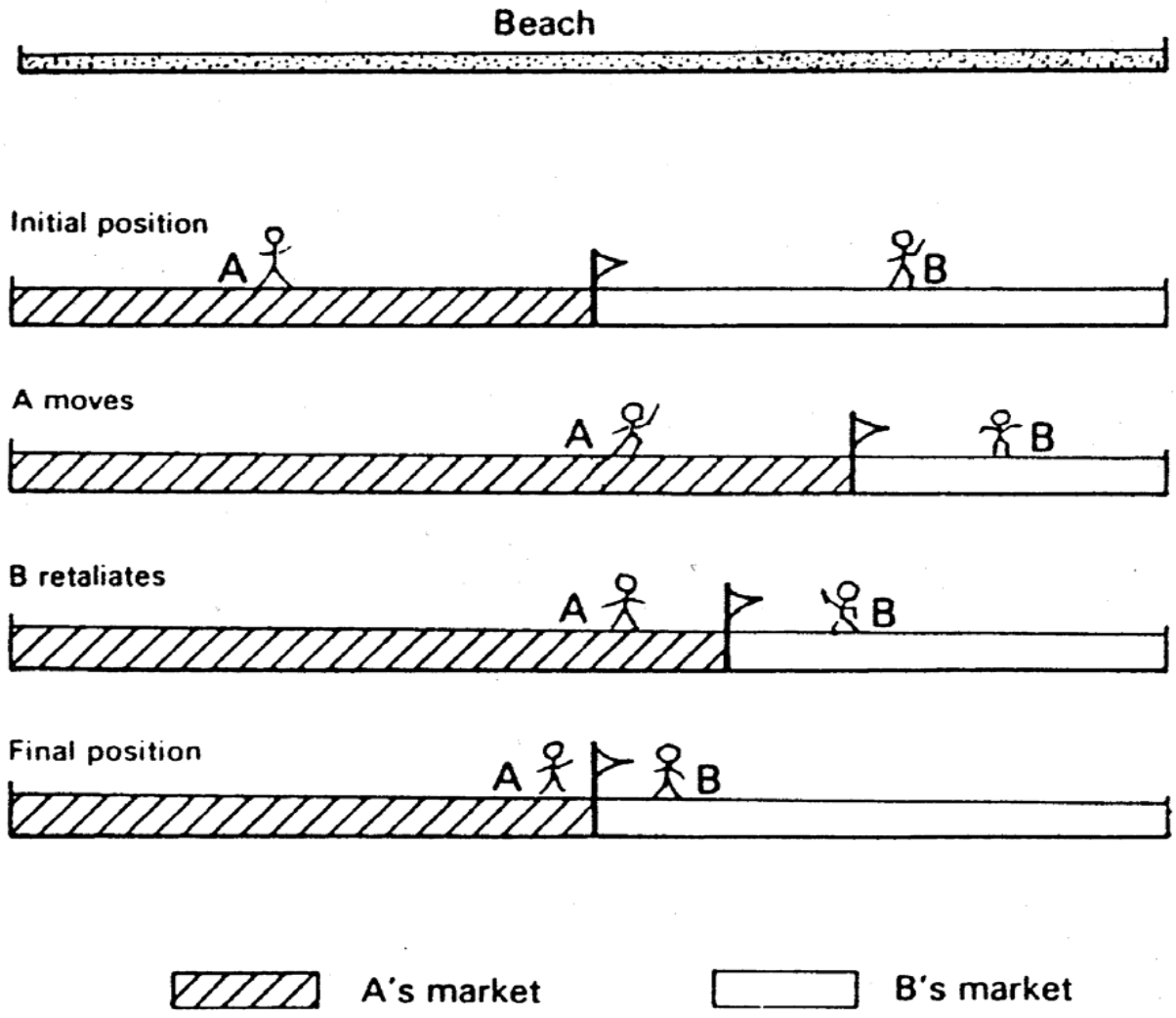
Alonso's model of the urban land market assumes that at market equilibrium firms are willing to pay for land as much as land owners are asking for (***bid rent*** = ***asking rent***).

A firm with high profitability per unit of land can pay more for land than a firm with low profitability. This explains why jewellers tend to locate in city centres and logistics firms are found at the urban periphery.

Bid-rent theory
(Alonso, 1964)

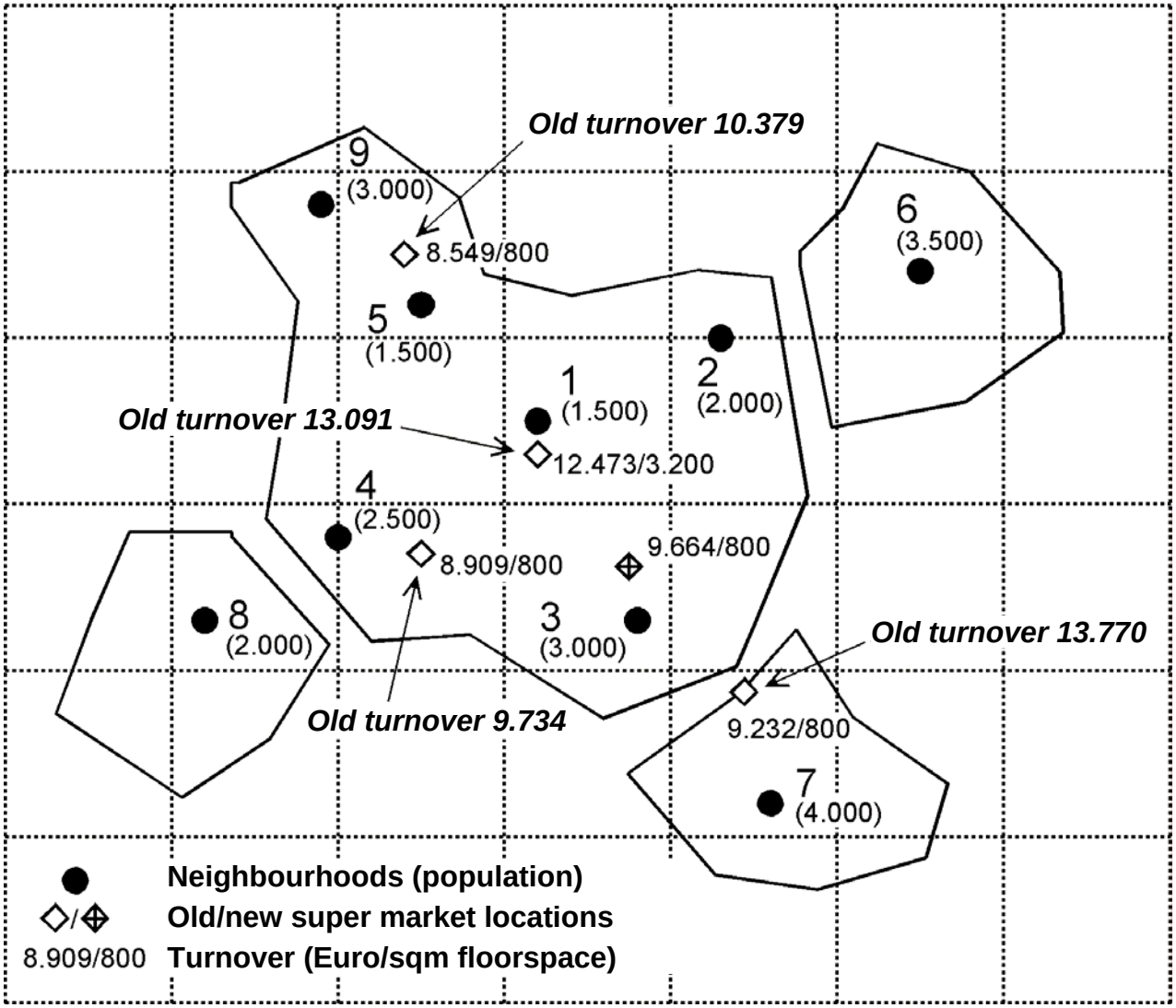


Location of competing firms
(Hotelling, 1929)



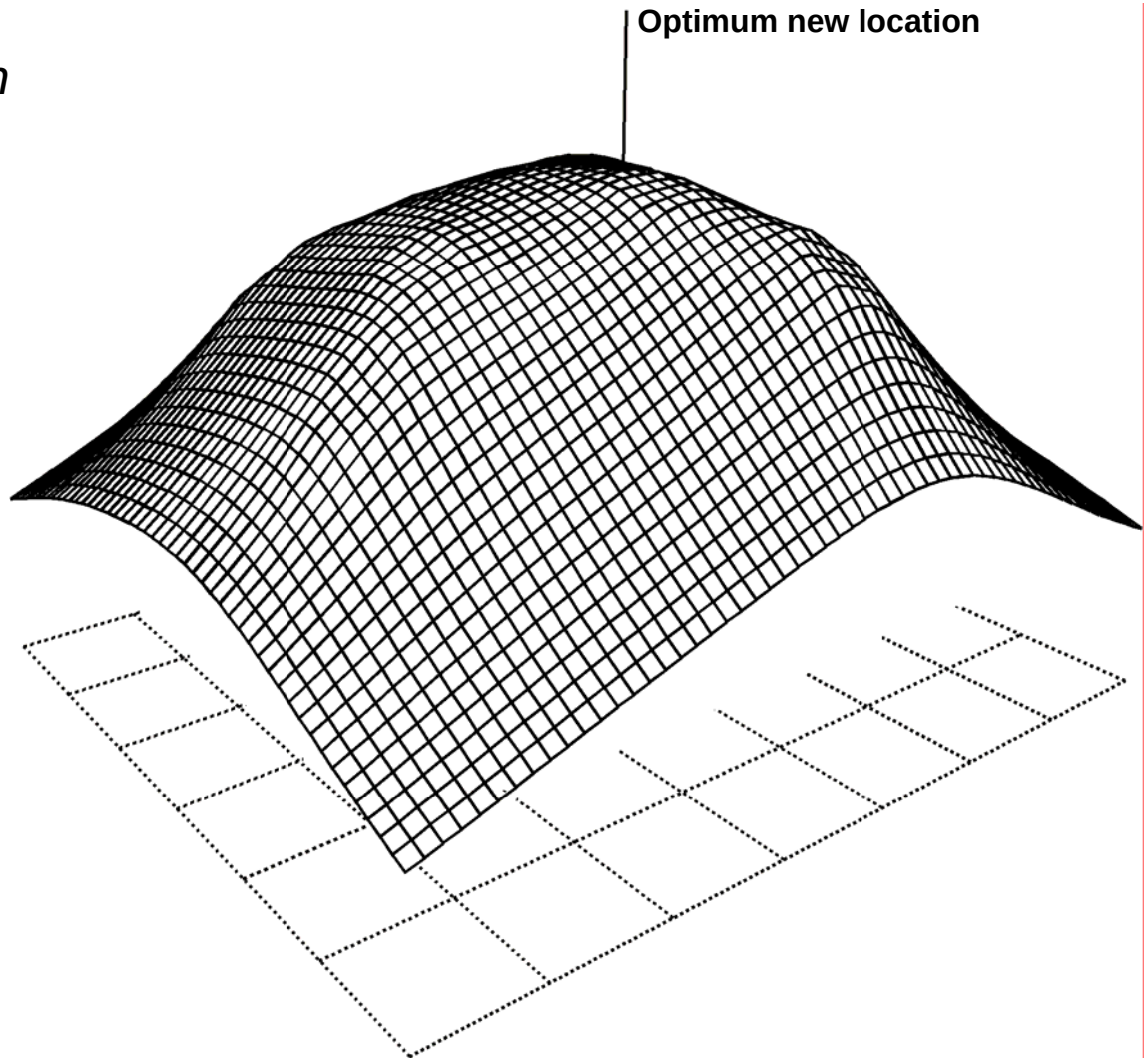
Retail location
(Huff, 1963)

In this typical town there are four existing super markets. A fifth super market wants to open in the town. Where will it locate?



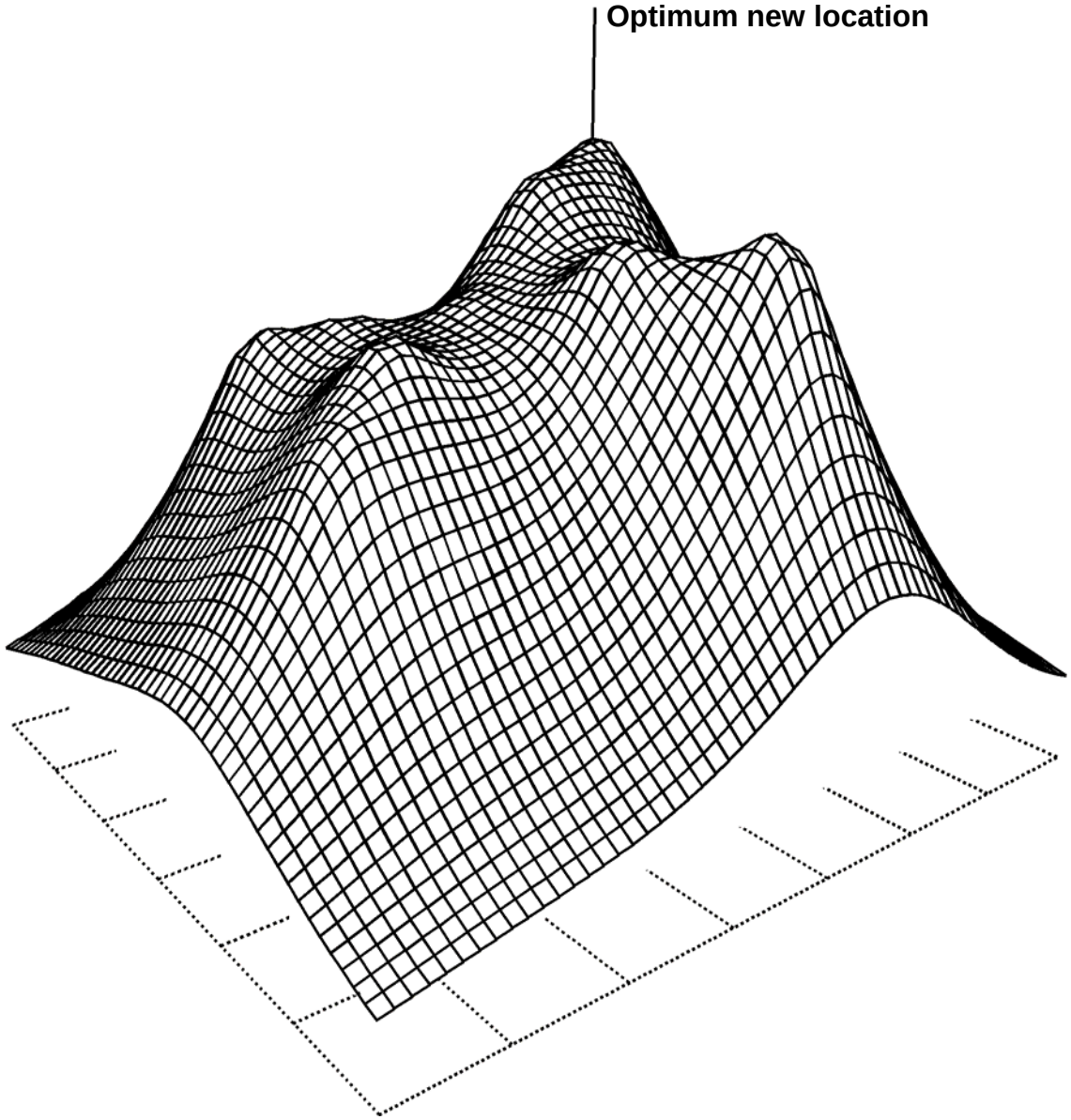
Retail location
(Huff, 1963)

The optimum new location



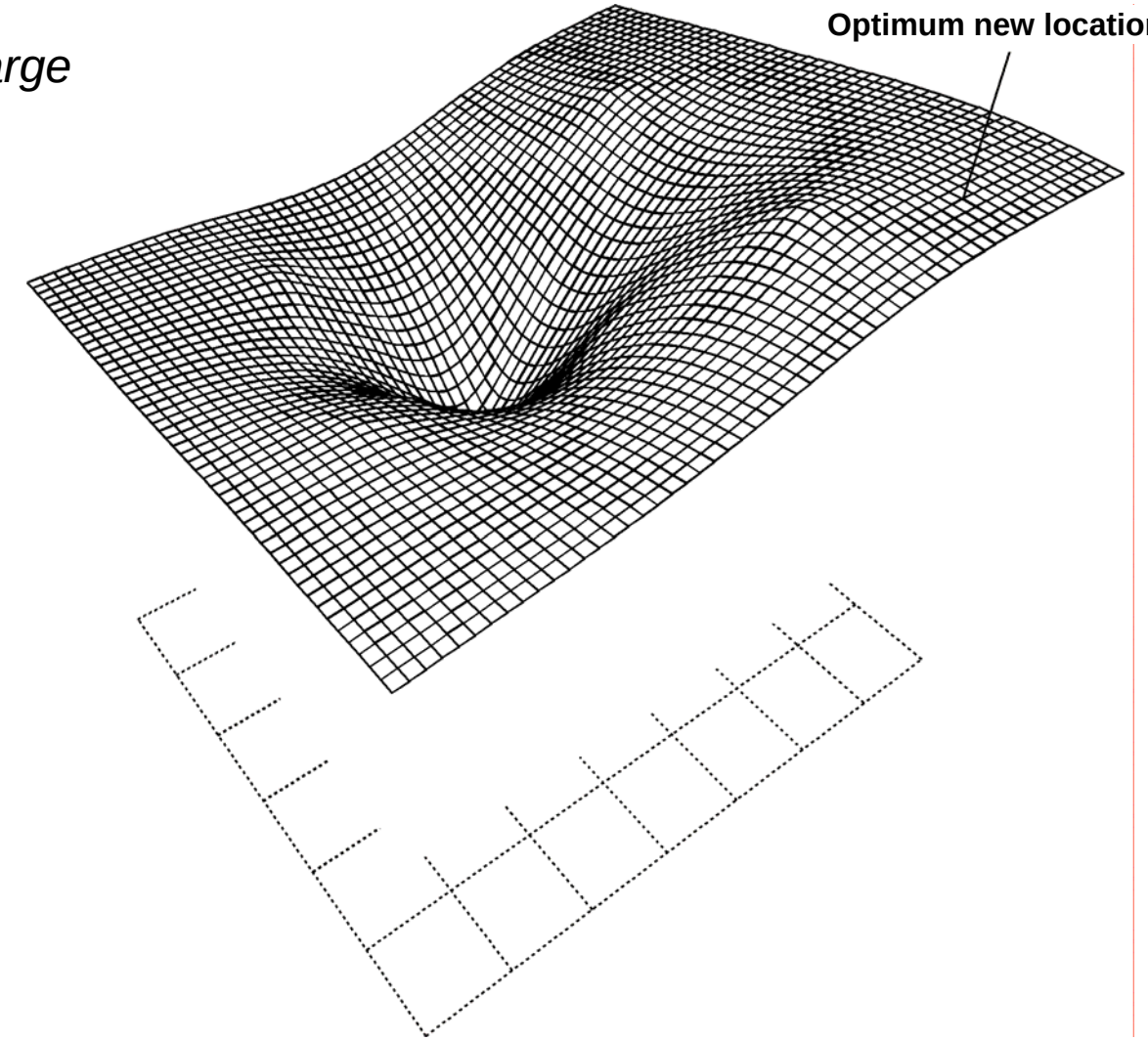
Retail location
(Huff, 1963)

Transport cost doubled



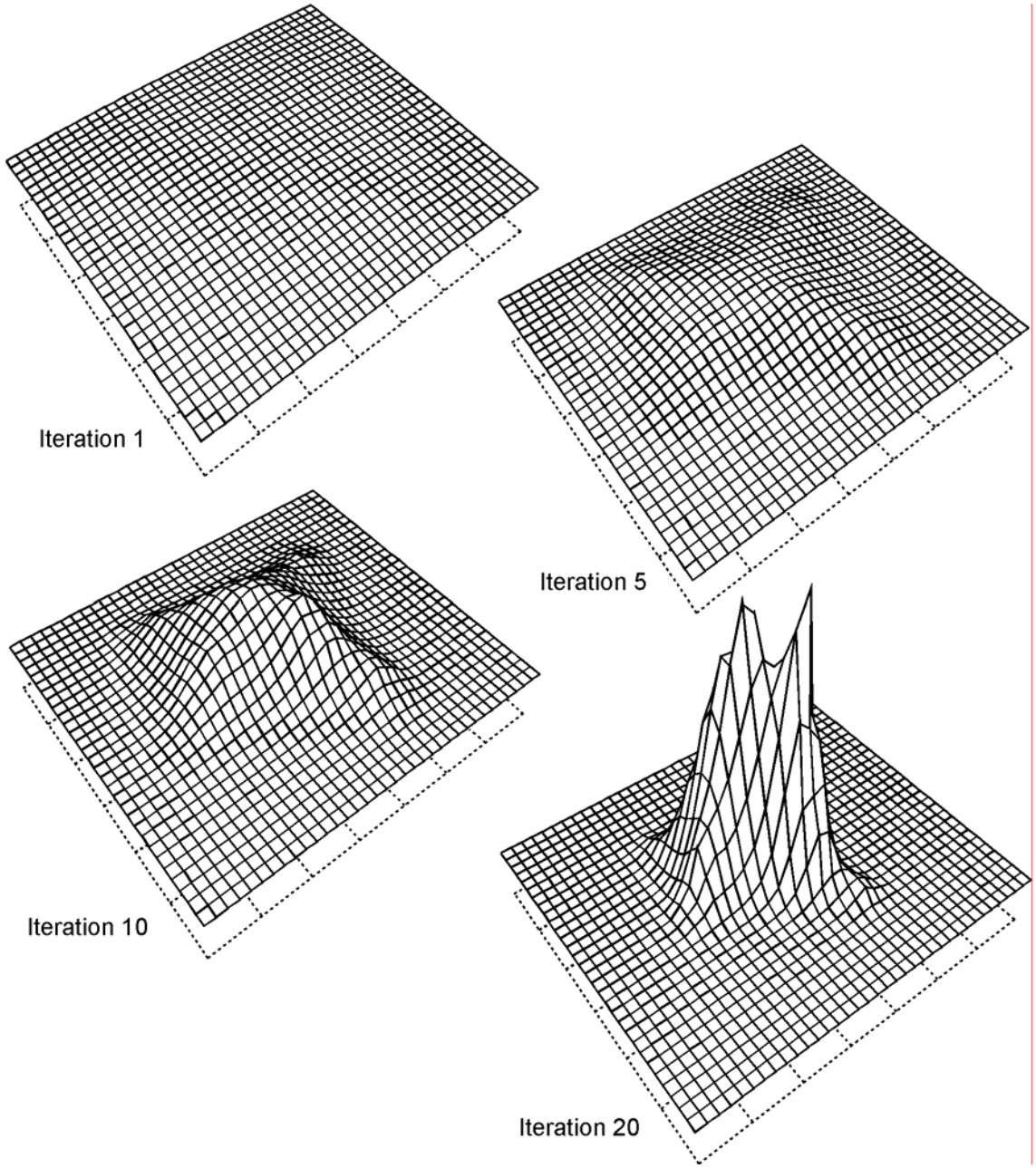
Retail location
(Huff, 1963)

Inner-city congestion charge



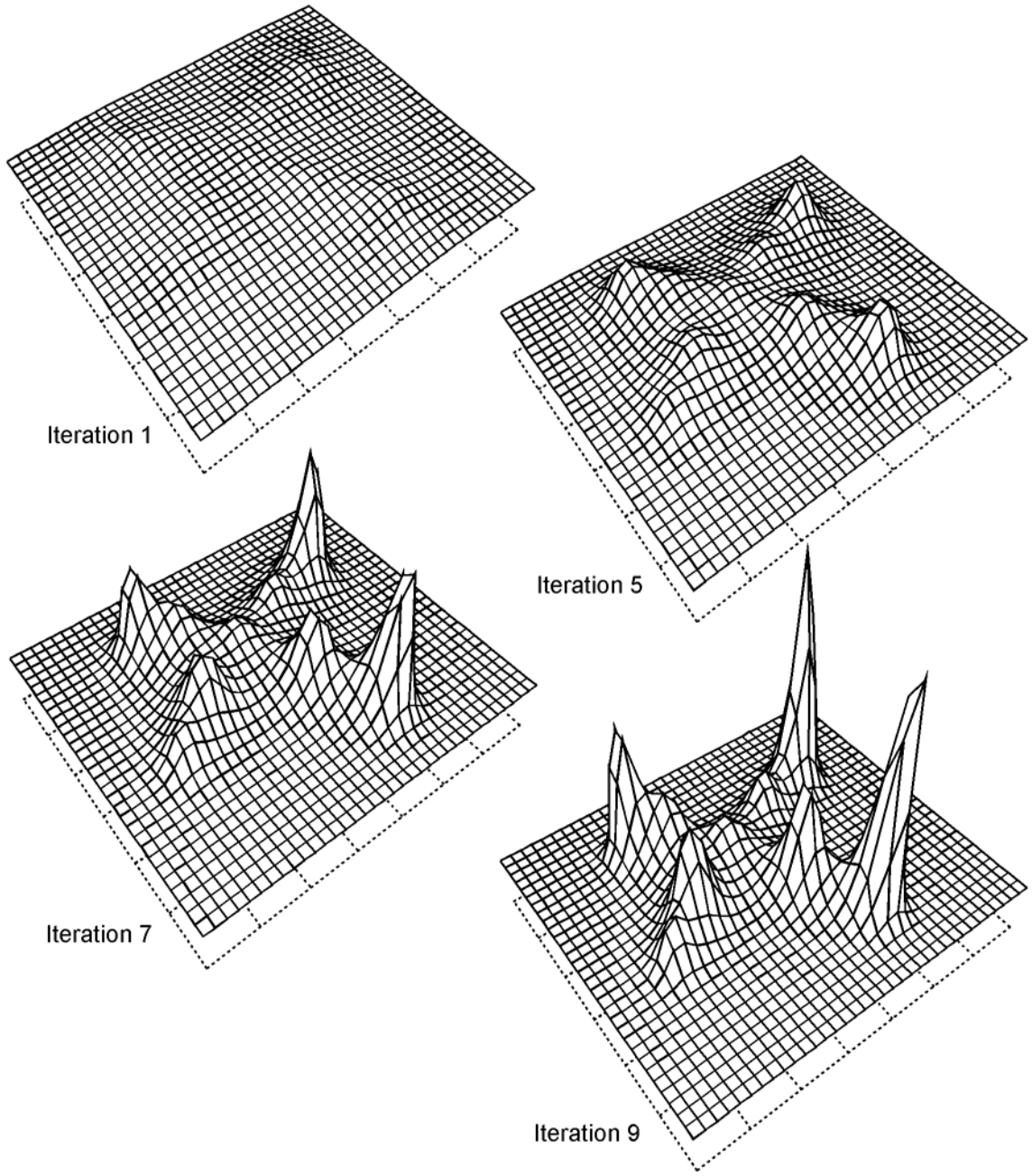
Retail location
(Harris & Wilson, 1978)

Retail locations



Retail location
(Harris & Wilson, 1978)

Retail locations with transport cost doubled



New Developments

"Hard" location factors

The requirements with respect to the "hard" location factors are changing:

- *Capital*:	Financial aid Tax discounts
- Labour:	Availability Skill
- *Land*:	Accessibility Environmental quality
- *Transport*:	Travel time Reliability

"Soft" location factors

New "soft" location factors gain in importance:

- Quality of life:	Housing/leisure
	Local services
	Environment, climate
	Culture, education
- Economic climate:	Innovative mileus
	Clusters of related industries
	Business services
- Political climate:	Flexibility of administration
	Business orientation
- Others	Image of location

New technologies

New technologies transform production processes:

- Flexibility, universal applicability
- Substitution of labour
- Formalisation of work processes
- Less division of labour
- Less simple work, more complex work
- Shorter product cycles
- Product variety
- Global sourcing, global marketing
- Logistic chains
- Outsourcing, just-in time delivery

New technologies

New technologies create new location factors for manufacturing firms:

- Peripheral locations with good access to motorways and airports
- Extensive, one-story facilities with loading ramps access on all sides
- Large centrally located warehousing facilities

Telecommunications

Telecommunications create new location factors for service firms:

- The division between high-level and back office functions becomes more pronounced.
- Inner-city locations are no longer indispensable except for high-level management and services.
- Accessibility to services and skilled labour becomes less important.
- Environmental quality of office locations becomes more important.

Microsimulation

Microsimulation (1)

Theory

Microsimulation is the reproduction of a ***macro process*** by many ***micro events***.

Events:

The basic building block of microsimulation is the ***event***.

No ***deterministic*** assertions (that are valid with certainty) can be made about events, only ***probabilistic*** assertions (that are valid with probability) are possible.

Microsimulation (2)

There are two types of events:

- ***Transitions*** are changes of an individual or object from one state to another subject to ***transition probabilities*** (e.g. ageing of persons or buildings) .
- ***Choices*** are selections between alternatives by an individual as a function of their ***perceived utility*** (e.g. modal choice, residential location).

If the causal chain behind choices is of no interest, also choices may be modelled as transitions (e.g. birth, marriage, divorce).

Microsimulation (3)

Method

The method of microsimulation consists of generating a sequence of **events** according to their frequency of occurrence.

To generate an event, a ***lottery*** is drawn the result of which is one of the possible outcomes of the event and subject to their probability.

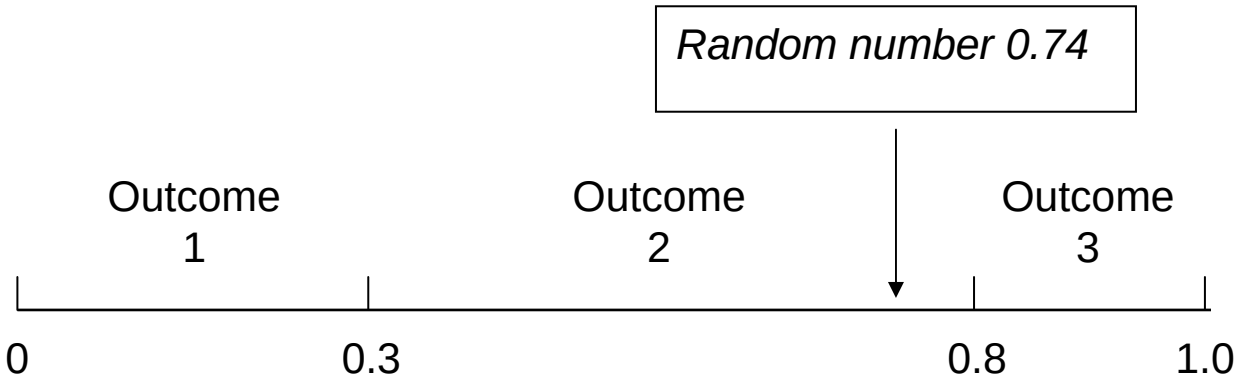
This is why microsimulation is also called Monte-Carlo simulation.

Microsimulation (4)

The ***lottery*** consists of the mapping of a random number between 0 and 1 to the vector of cumulated probabilities of pos- sible outcomes of the event.

Example:

An event has three possible outcomes with probabilities 0.3, 0.5 and 0.2. If the random number 0.74 is drawn, Outcome 2 is the event.



Microdatabase (1)

Microsimulation models require ***micro data***.

In reality micro data are rarely available or where available cannot be used because of privacy concerns.

Synthetic micro data are micro data generated from available spatially aggregate data with which they are consistent in all known attribute distributions.

Microsimulation models can be operated with synthetic micro data instead of real micro data.

Microdatabase (2)

Buildings

Residential buildings (micro location)
- Dwellings (type, size, quality)

Nonresidential buildings (micro location)
- floorspace (industrial, retail, offices)

Households/Businesses

Households (micro location)
- Households (size, income,cars)
- Persons (age, sex, education, job)

Businesses (micro location)
- Firms (industry, size, vehicles)
- Employment (skill)

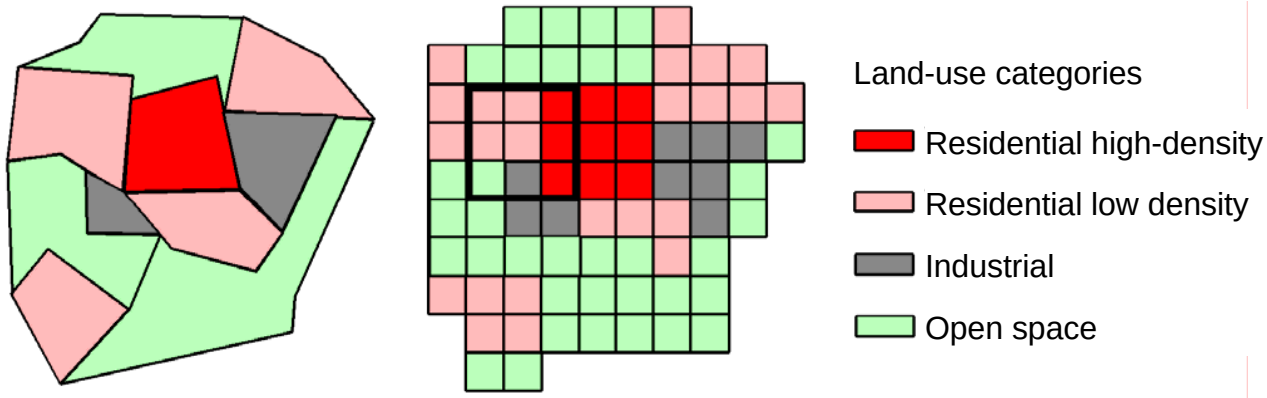
Microdatabase (3)

For the synthetic microdatabase zonal data are allocated to raster cells.

Two steps are performed:

(1) Conversion of polygons to raster cells

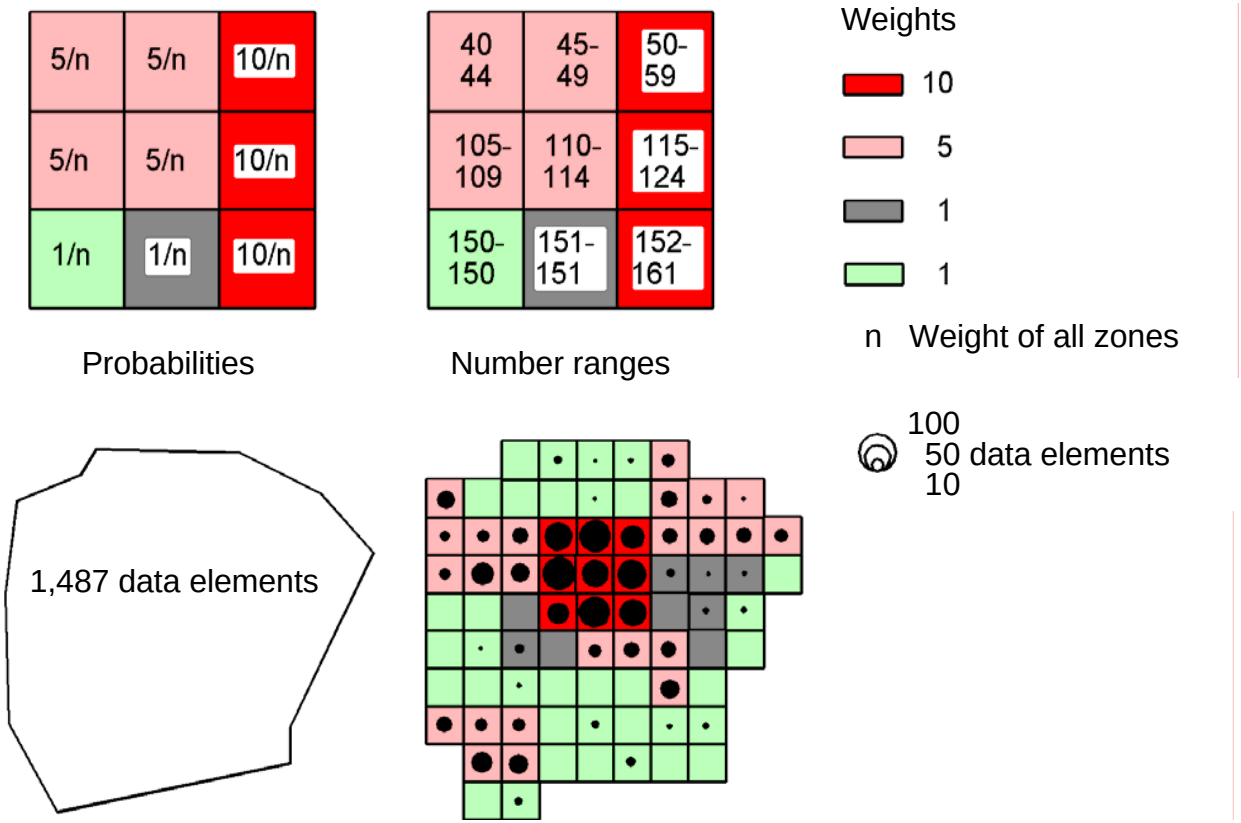
The polygons of a land use map are converted to raster cells and each raster cell is assigned a land use category.



Microdatabase (4)

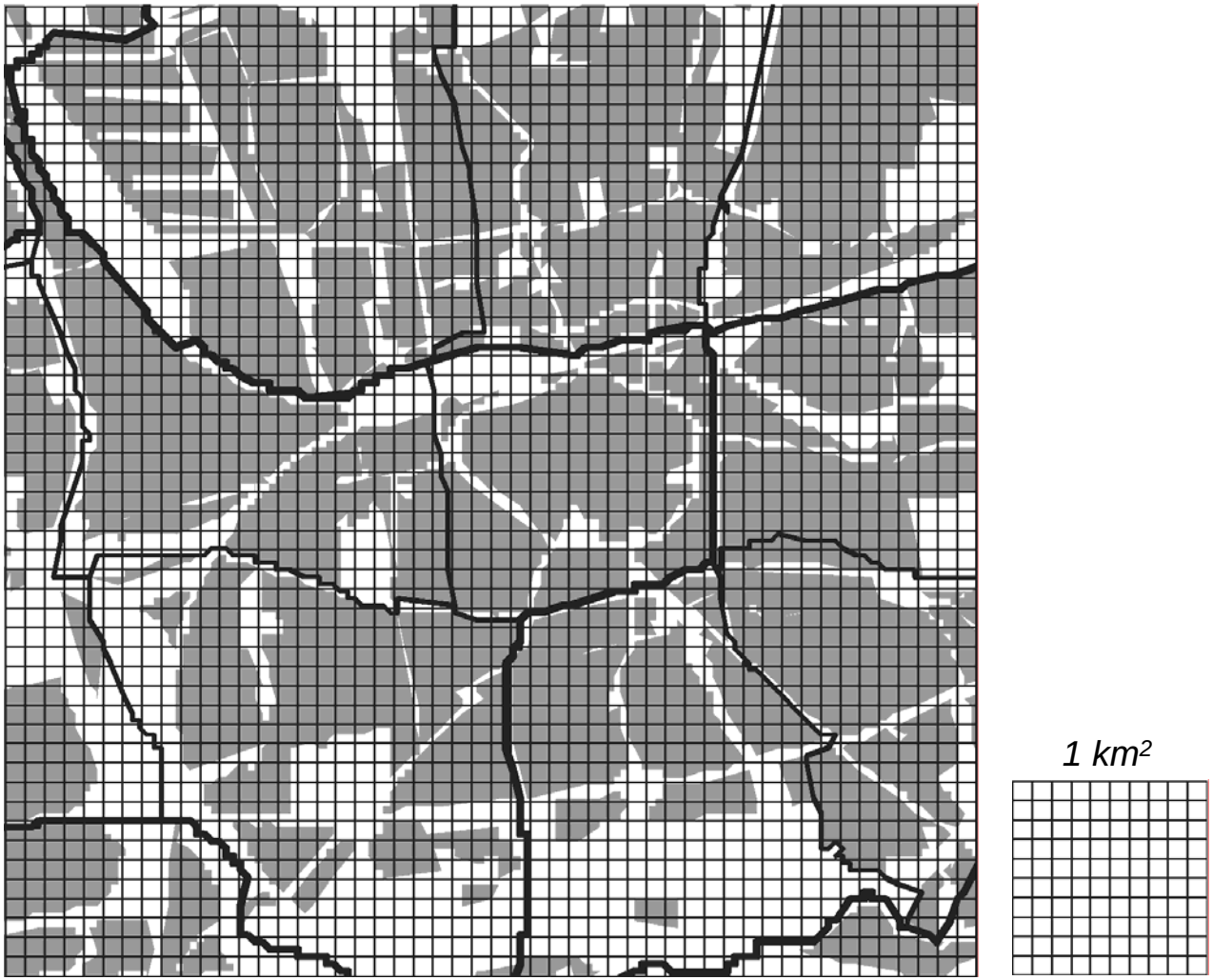
(2) Allocation of zonal data to raster cells

The data elements are allocated to raster cells by Monte-Carlo simulation according to their density.



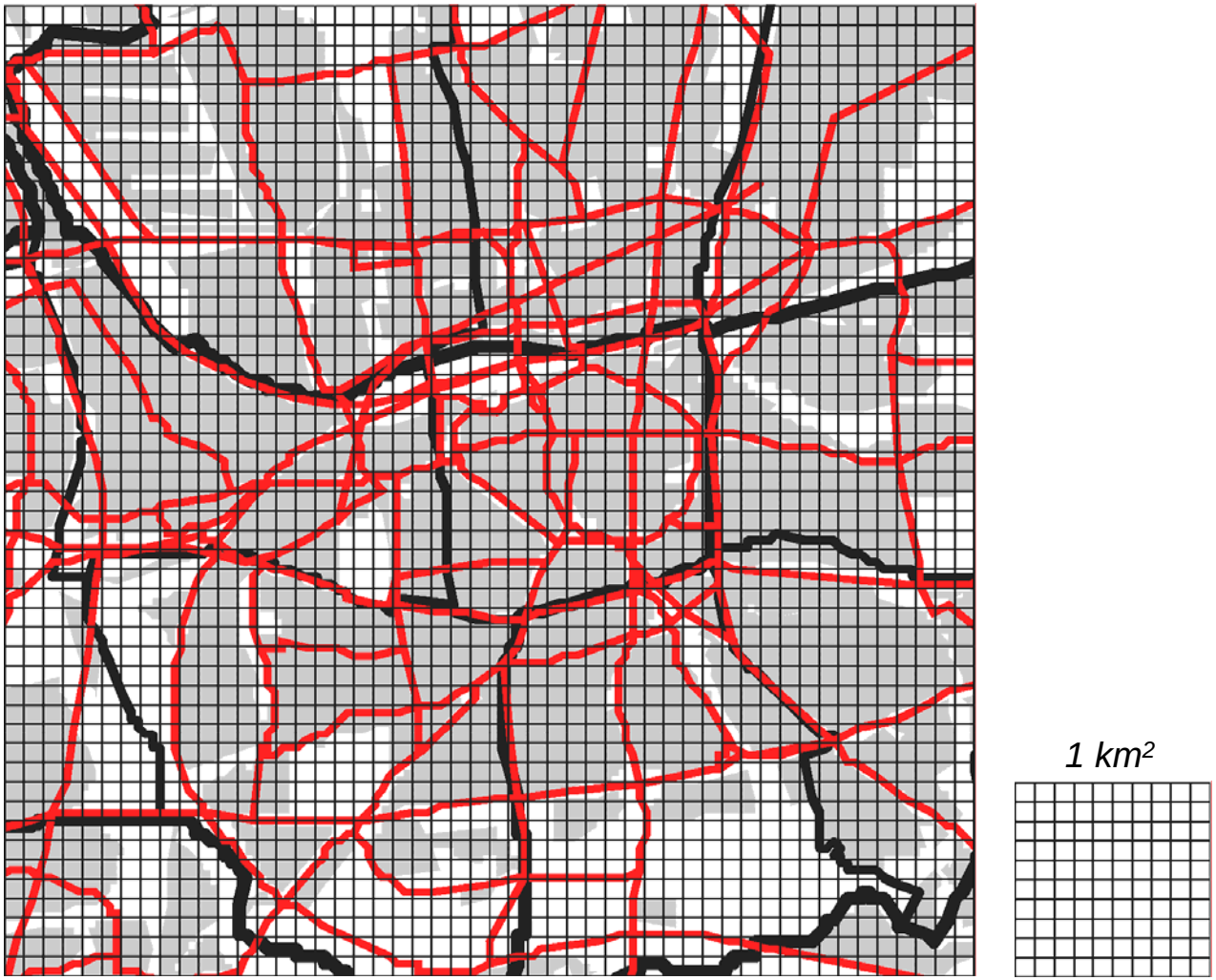
Spatial Disaggregation

100 x 100 m raster cells

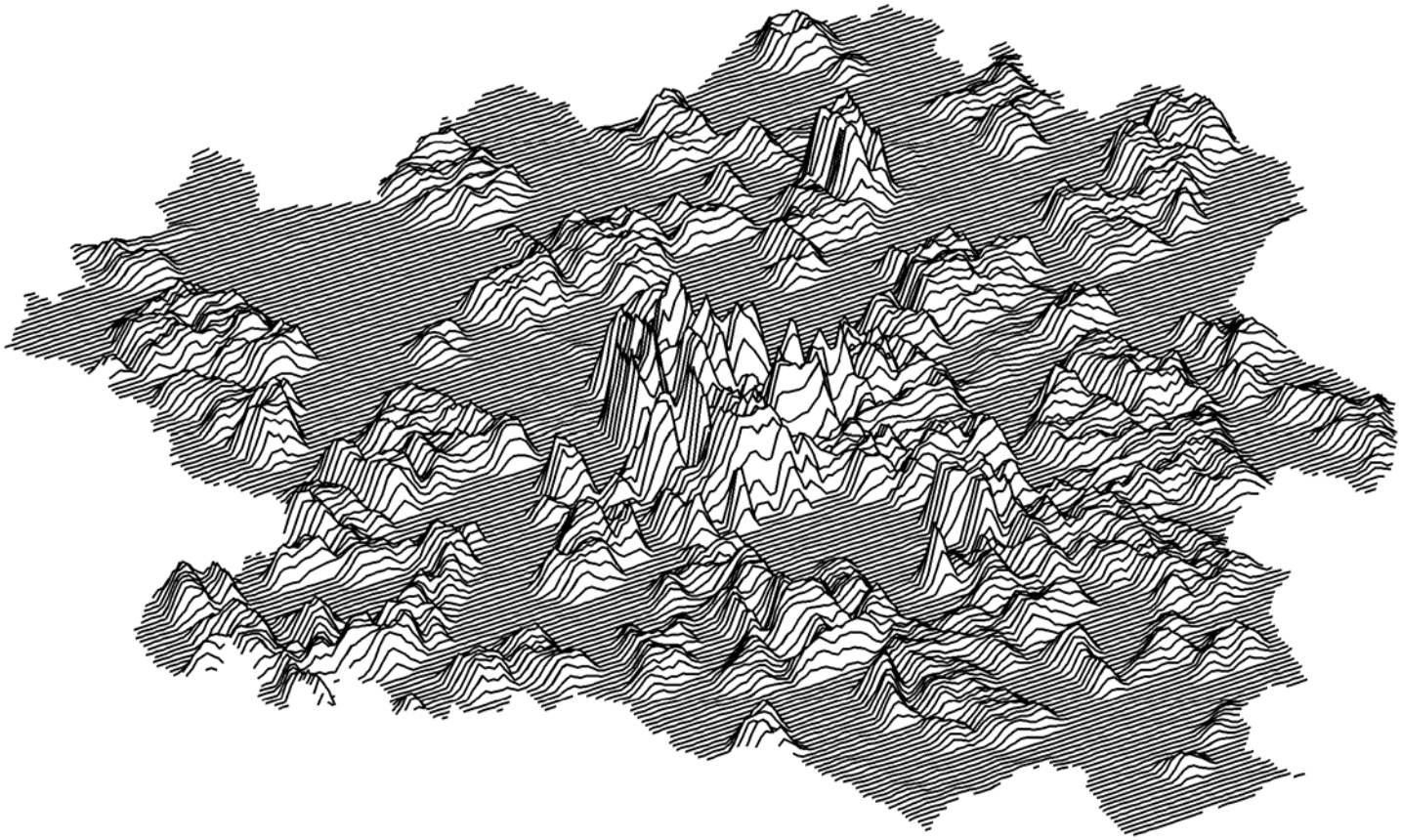


Spatial Disaggregation

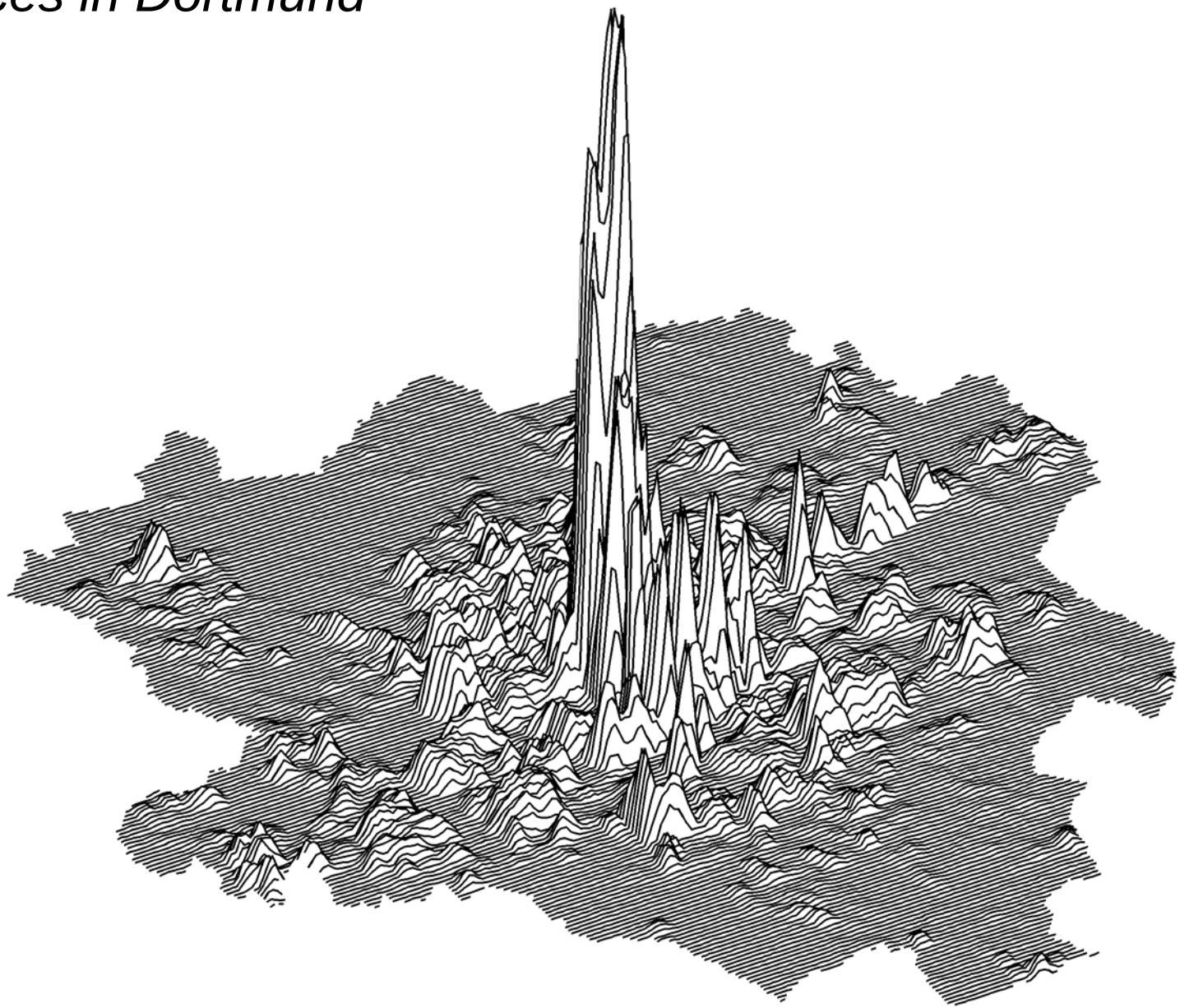
100 x 100 m raster cells



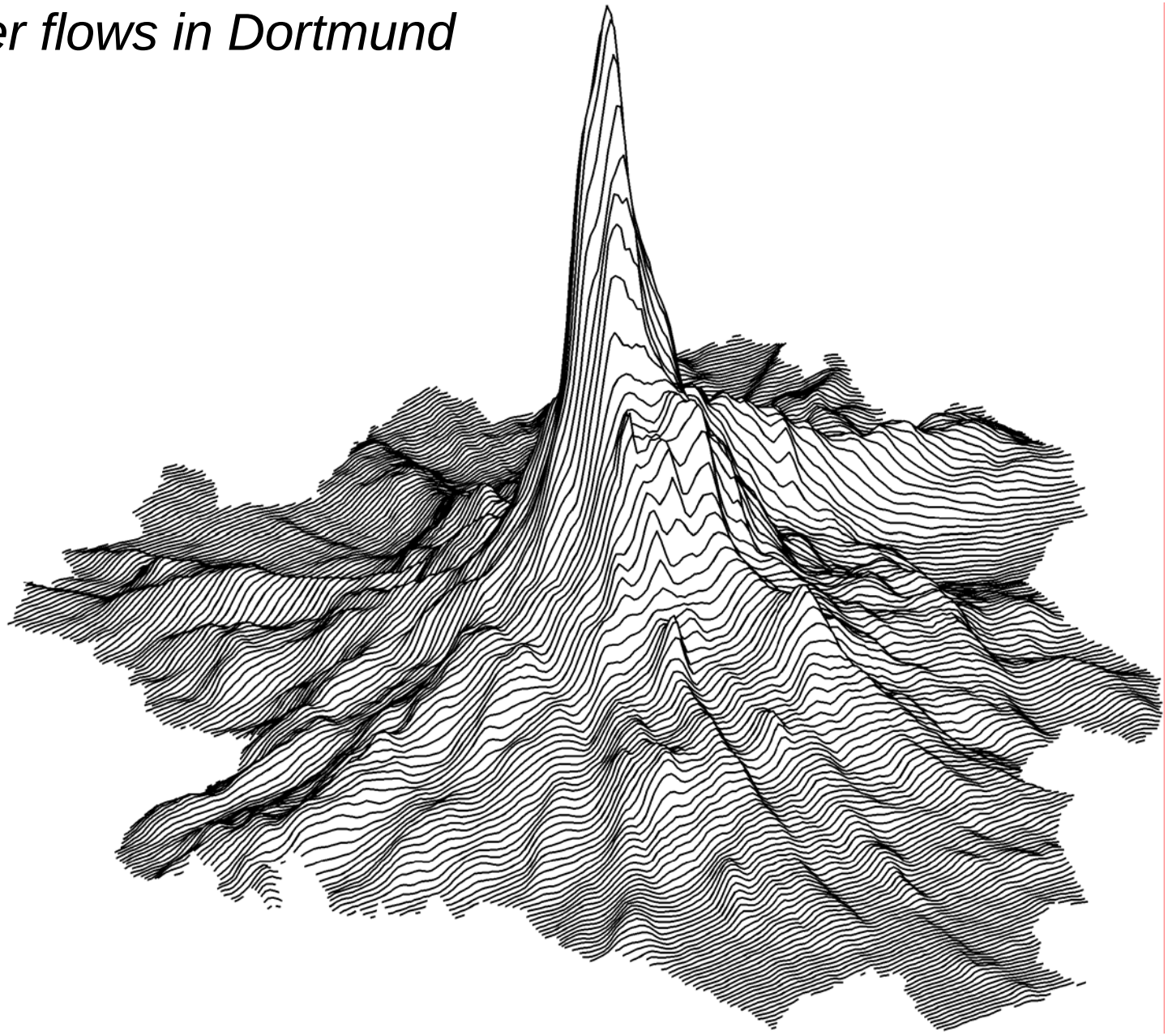
Residences in Dortmund



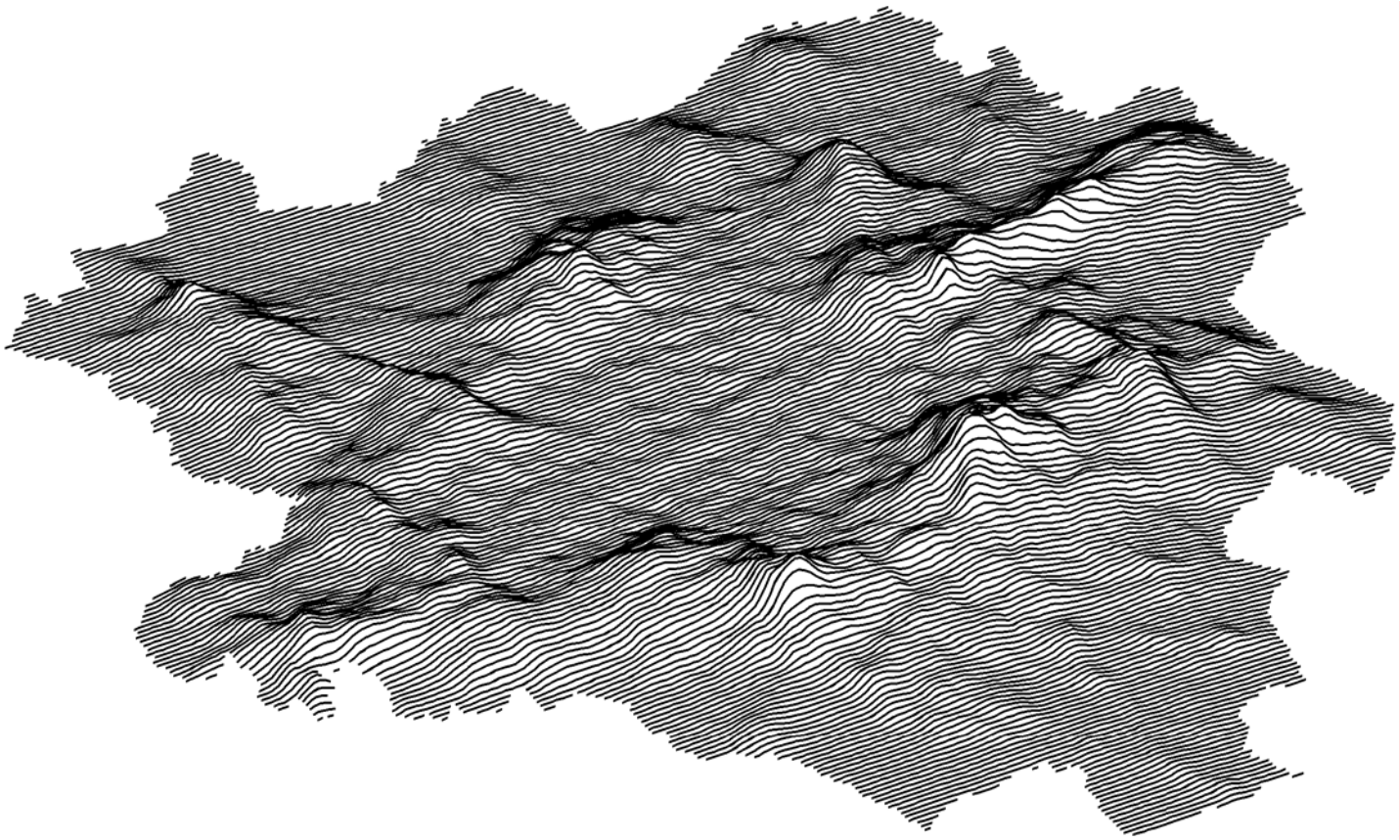
Work places in Dortmund



Commuter flows in Dortmund

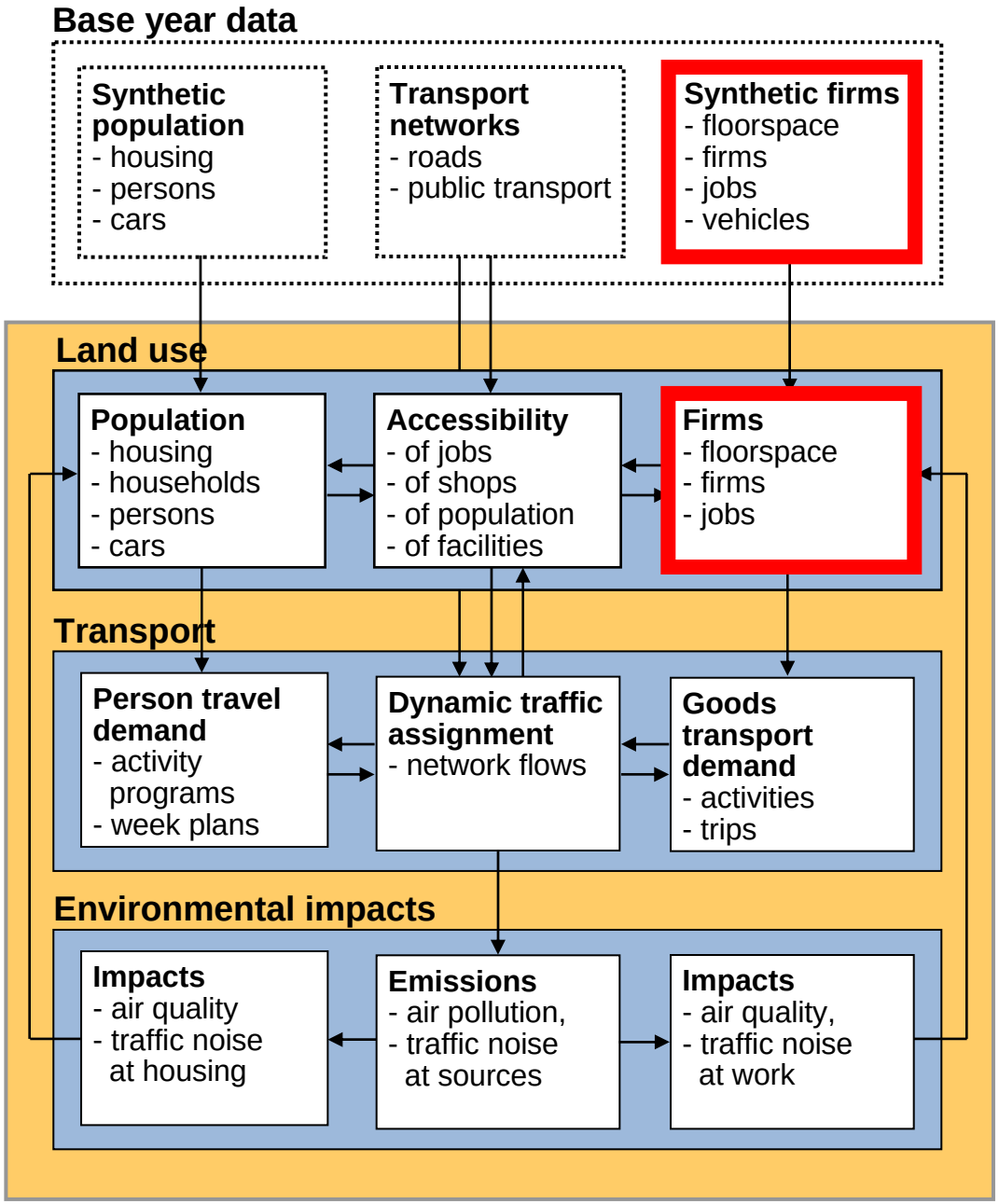


Suburb-to-suburb commuter flows

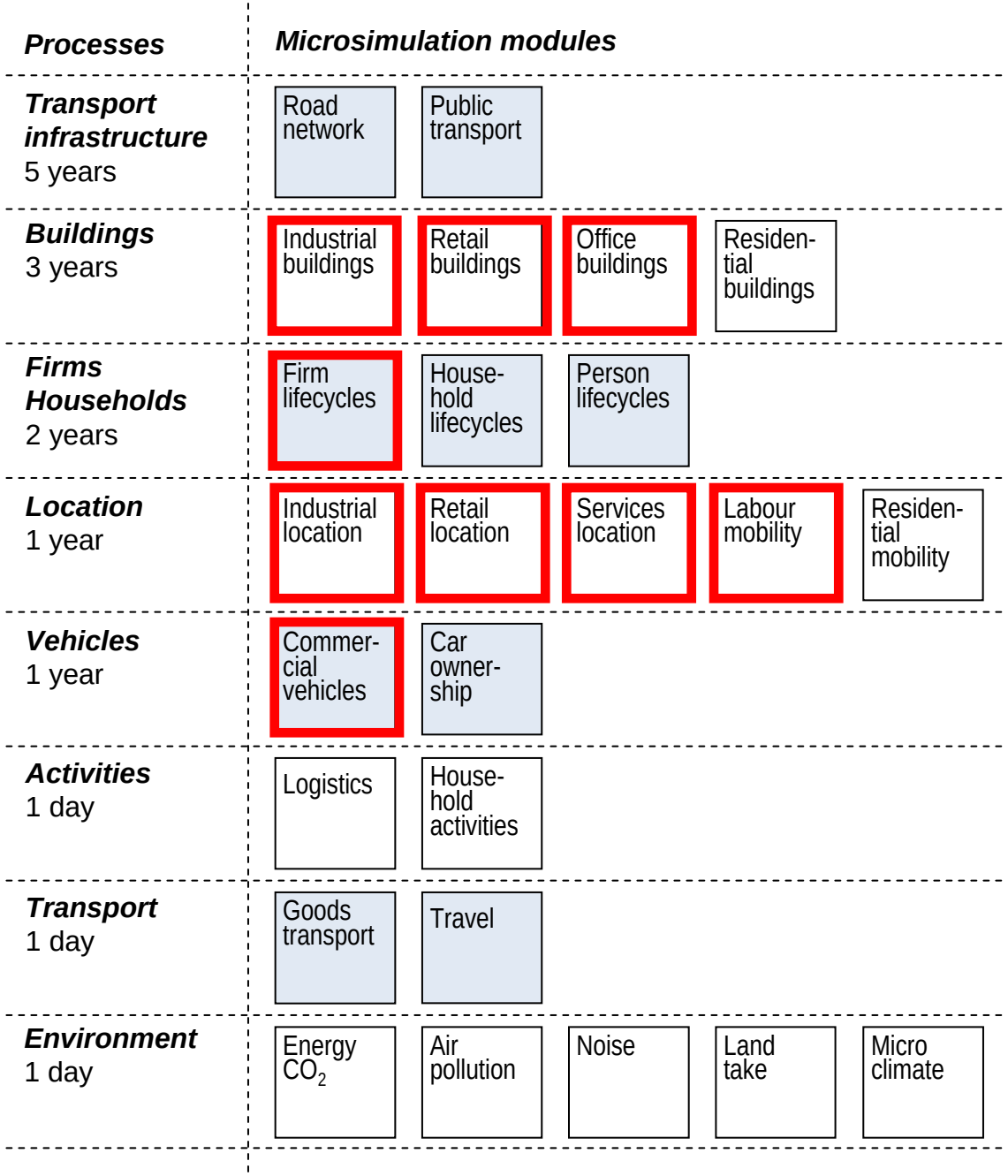


ILUMASS

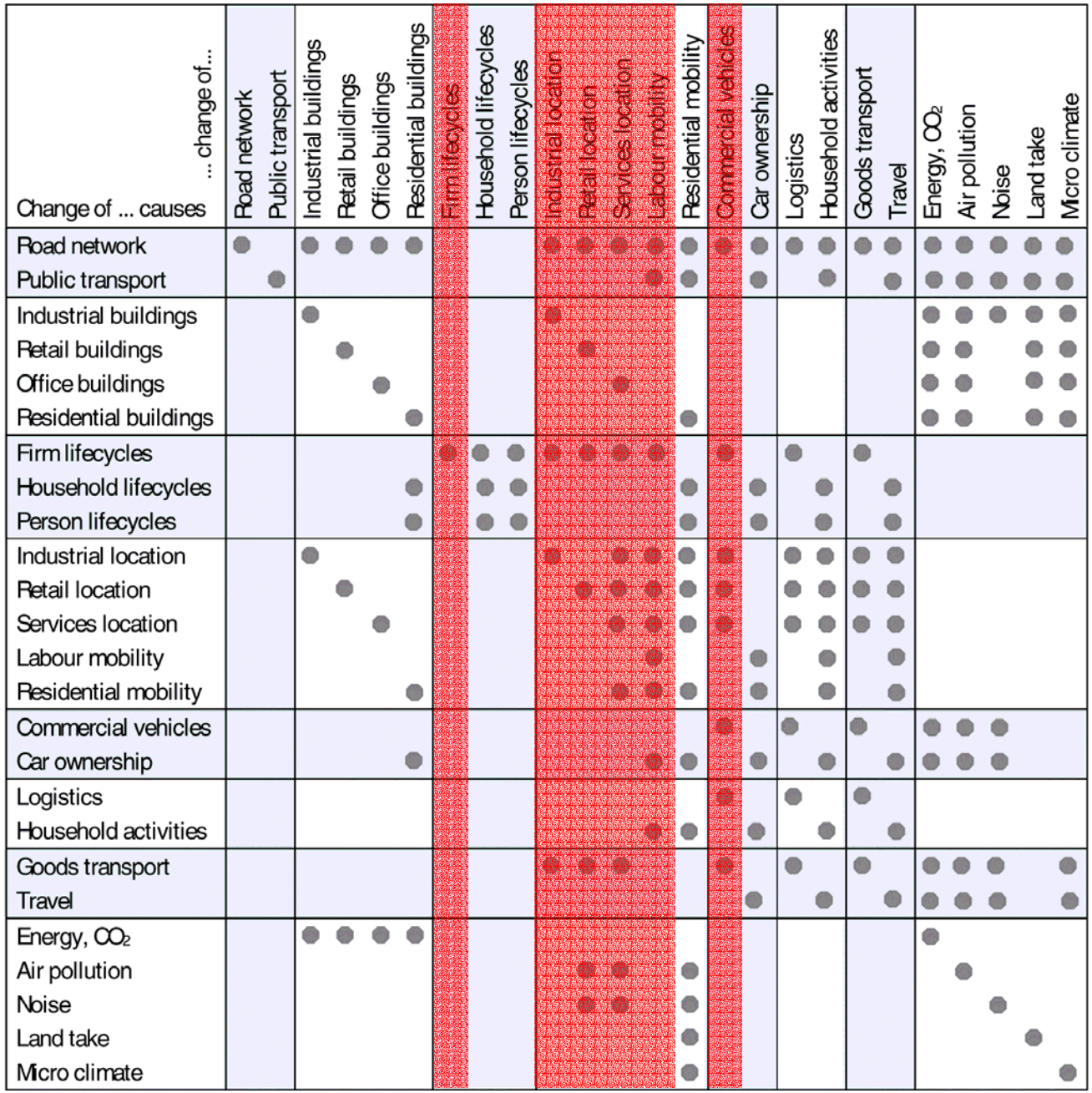
Model Overview



Micro-simulation modules



Interactions between microsim-ulation modules



How Much Micro is Enough?

Microsimulation of employment and firms

Microsimulation of employment and firms allows feedback between firms and between firms and customers in more detail.

Examples:

- Firms choose locations close to suppliers, competitors and customers.
- Firms grow or decline as a function of location to suppliers, competitors and customers.
- Growth and decline of firm employment is reflected in employment and income of households.
- Emerging trends in e-commerce and telework can be modelled

Microsimulation of employment and firms

However, there are limits and costs of microsimulation of employment and firms:

- Data on firm formation and firm location are much more difficult to obtain than data on household location and mobility.
- There is much more variability in the behaviour of firms than in the behaviour of households.
- Modelling search processes on the labour market is costly in terms of computing time.

How much micro is enough?

The common belief of microsimulation modellers seems to be: the ***more*** micro the ***better***.

This is the dream of the ***one-to-one Spitfire***.

The Spitfire

The one-to-one model of the Spitfire

The one-to-one Spitfire

"Simplifying assumptions are not an excrescence of model-building; they are its essence. Lewis Carroll once remarked that a map on the scale of one-to-one would serve no purpose. And the philosopher of science Russell Hanson noted that if you progressed from a five-inch balsa wood model of a Spitfire airplane to a 15-inch model without moving parts, to a half-scale model, to a full-size entirely accurate one, you would end up not with a model of a Spitfire but with a Spitfire".

Robert M. Solow (1973)

How much micro is enough?

There seems to be little consideration of the benefits and costs of microsimulation:

- Where is microsimulation really needed?

- What is the price for microsimulation?

- Would a more aggregate model do?

For spatial planning models, the answer to these questions depends on the planning task at hand.

Future evolution of land-use transport models?

Land-use model		T1 No public transport, no modal split	T2 Public trans-port, no logit, 24 h	T3 Public trans-port, logit, peak hour	T4 Multimodal, activity-based
L1	None				
L2	Activity and judgement				
L3	No market-based land allocation				
L4	Logit allocation with price signals				
L5	Market-based land-use model				
L6	Activity-based land-use model				??

Adapted from Miller et al., 1998.

Conclusions (1)

Microsimulation of employment and firms has to based on the same ***theoretical underpinnings*** as more aggregate models.

Microsimulation of employment and firms allows ***feedback*** between firms and between firms and customers in more detail.

However, there are ***limits*** and ***costs*** of microsimulation of employment and firms.

Conclusions (2)

Under constraints of ***data collection*** and ***computing time***, there is for each planning problem an optimum level of ***conceptual***, ***spatial*** and ***temporal*** resolution.

This suggests to work towards a ***theory*** of ***balanced multi-level models*** which are as ***complex*** as needed for the planning task at hand yet as ***simple*** as possible but no simpler.

Future urban models will be ***modular*** and ***multi-level*** in ***scope***, ***space*** and ***time***.