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Optimizing the Shopping Center Mix: A GIS based Analysis

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Motivation

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'Ironically, real estate as a discipline espouses the supremacy of location while employing economic tools designed for a spaceless world.'

Source: Dubin, Pace and Thibodeau (1999)

- Shopping centers 'suggest' the GIS-use – due to monitoring customers' behavior
- two of the main problems of Shopping Center management: The optimization of the tenant mix at all and the arrangement of shops by a given optimal tenant mix

Central scope of this study is

'to solve the problem of the ideal tenant placement within the shopping centers by using GIS analysis'

Agenda

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1 Literature Review

2 Research Design and Results

3 Discussion

4 Conclusions

Category Concentration (Carter/Haloupek 2002; Yuo 2010)

- Non-anchor stores of the same retail category tend to be dispersed

  ⇒ GIS can identify a concentration of retail categories within the shopping center

Pass Ratio (Brown 1992, Carter/Haloupek 2000)

- The pass ratio declines from the center of a shopping center

  ⇒ GIS can identify 'dead spots' within the shopping center

Coupling Potential (Brown 1992, Yuo 2004)

- Shops of the same retail category have a higher coupling potential than those of different
- Proximity of shops suggests a higher coupling potential

  ⇒ GIS can identify coupling potentials within the shopping center

Attribute Data

- German Shopping Center with about 60.000 m² selling space and about 140 shops
- Customer survey: N= 1.163
  - Survey of the coupling potenial: Customer had to draw their routes
    ⇒ n x n coupling matrix (customer shopping sequence is not regarded)

Geometric Data

- Polyline network ⇒ ArcGIS ‚Network Dataset‘

Integration of costumer survey data into GIS (spatial dabase)

⇒ A GIS connects non-spatial database information with a matching geometry

2 Research Design and Results: Category Concentration

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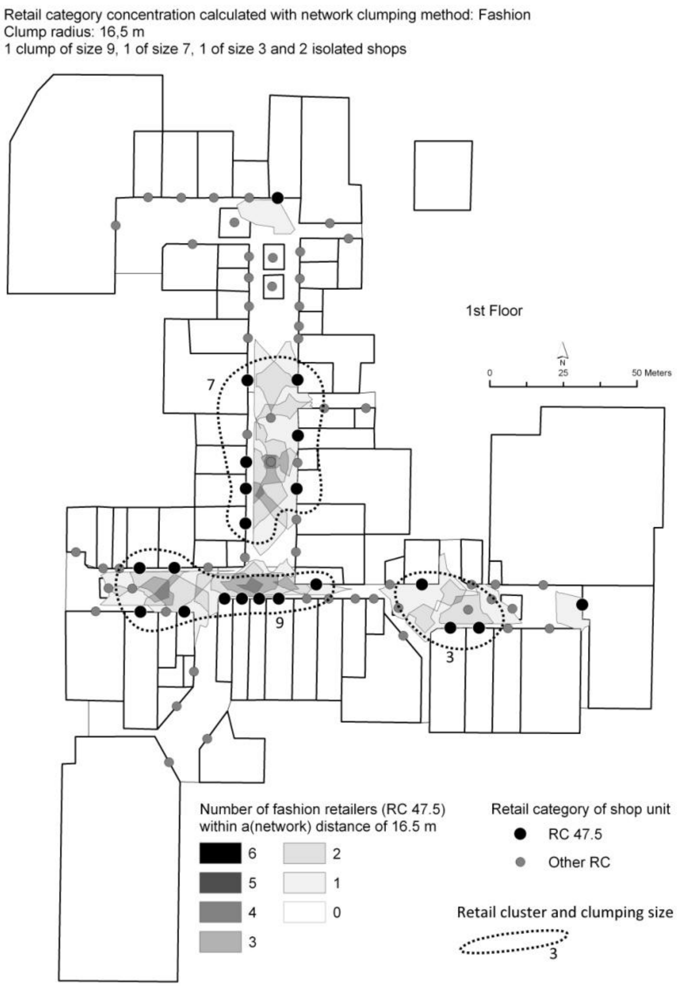
'Non-anchor stores of the same retail category tend to be dispersed'



Clumping method (OKABE/FUNAMOTO 2000)

- Radius: 16,5 m
- Overlapping of Buffer as decision criterion
- Min. 3 shops of the same category
- NACE classification (47)

⇒ Clump

Results

- Food-cluster (47.2)
- Fashion-cluster (47.5)
- Body & health-cluster (47.7)

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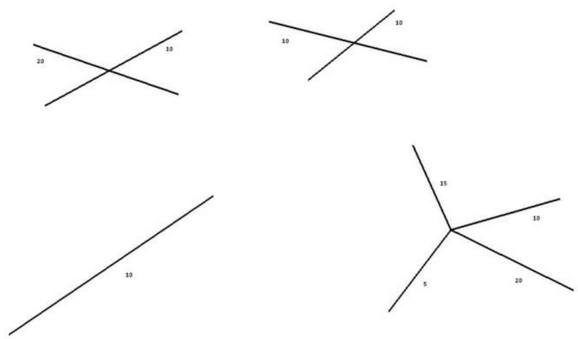
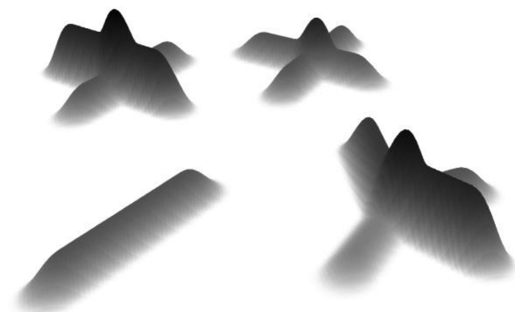
Kernel Density Estimator

- Integration over an area
- Volume above the area represents the probability of customer-presence





The higher the probability surface the higher the customer density

⇒ GIS-enables to detect 'dead spots'

2 Research Design and Results: Pass Ratio (2)

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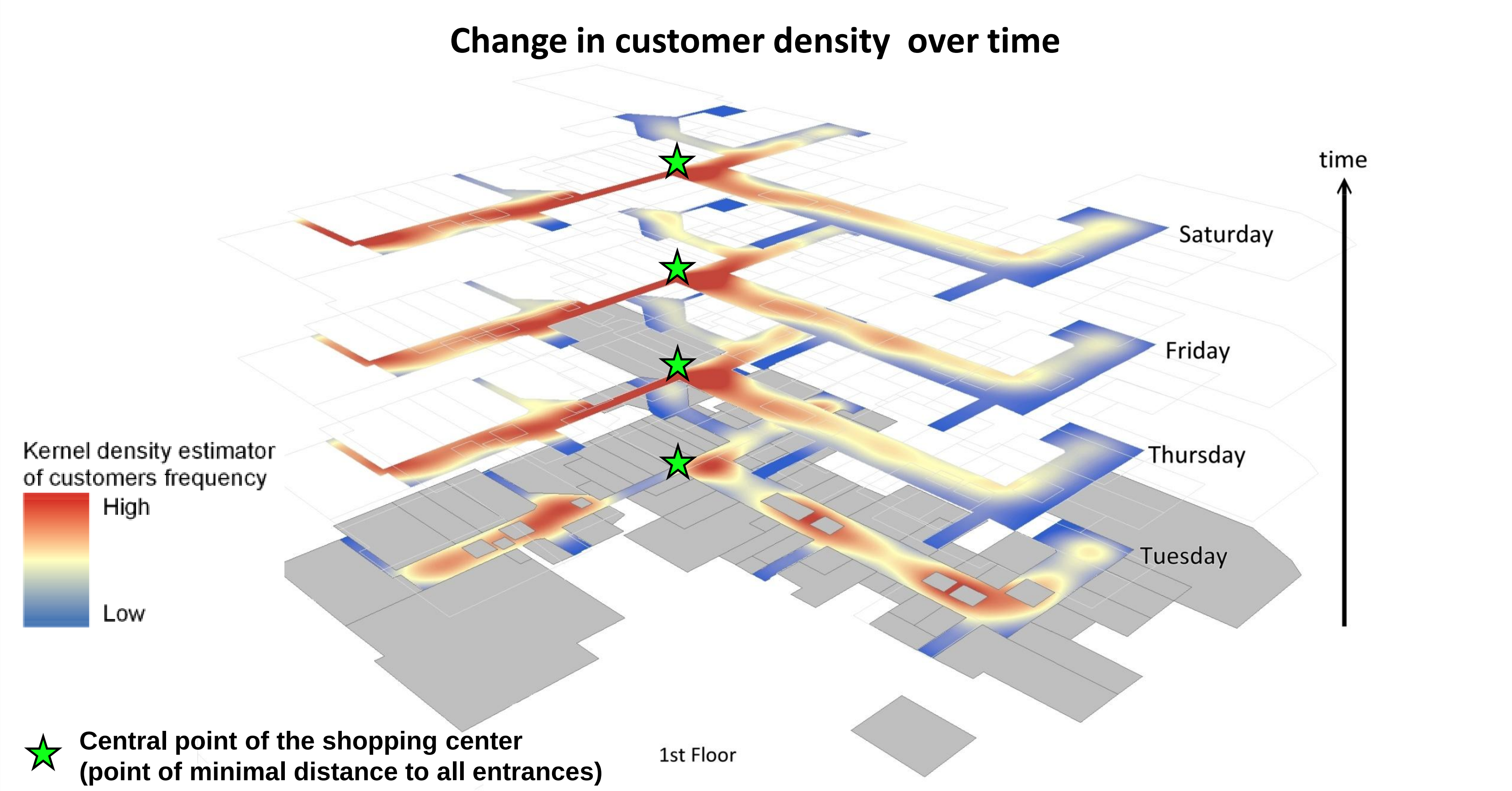
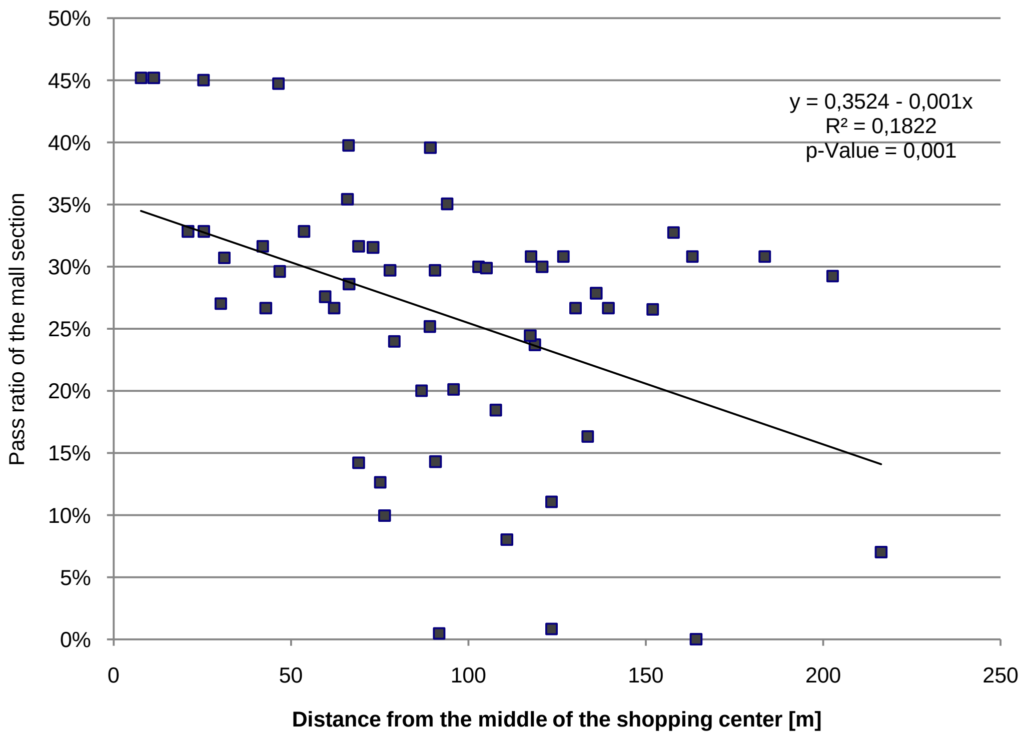
'The pass ratio declines from the center of a shopping center'

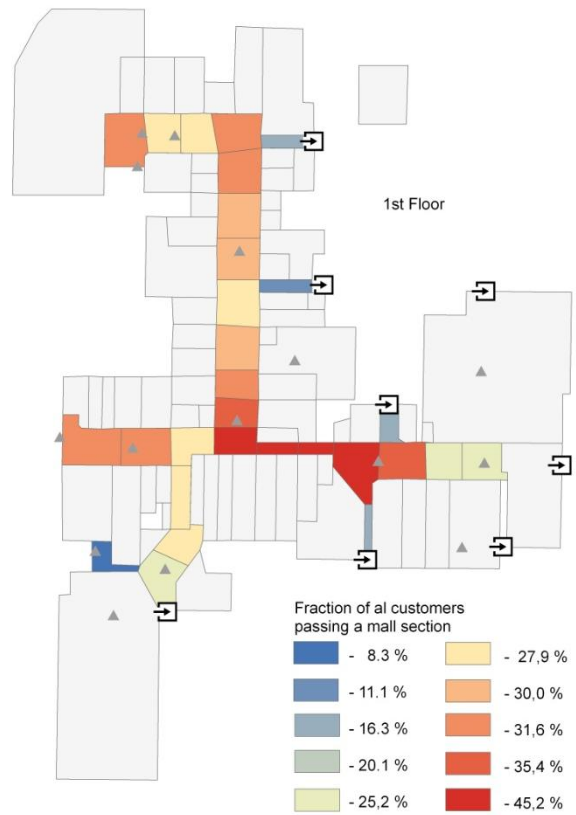


2 Research Design and Results: Pass Ratio (3)

'The pass ratio declines from the center of a shopping center'

Passersby frequency and distance from mall-center (mall sections)





2 Research Design and Results: Coupling Potential

'Shops of the same retail category have a higher coupling potential than those of different'
'Spatially proximate shops have a higher coupling potential than spatially separate shops'

All Retailers

	Similar Shop Type	*Dissimilar Shop Type*
Spatially Proximate	132,0	83,7
Spatially Seperate	143,2	105,2

Retailers with other goods

	Similar Shop Type	*Dissimilar Shop Type*
Spatially Proximate	30,8	66,2
Spatially Seperate	66,7	84,9

Food

	Similar Shop Type	*Dissimilar Shop Type*
Spatially Proximate	69,1	75,6
Spatially Seperate	36,5	71,4

Fashion

	Similar Shop Type	*Dissimilar Shop Type*
Spatially Proximate	198,4	94,4
Spatially Seperate	217,8	122,5

Cutting value for proximate: Mean value of shop-to-shop distance = 127.6 m

Value standardization: Mean value of coupling potential = 100

▪ Non-anchor stores of the same **retail category** tend to be dispersed ⇒ based on the clumping approach food, fashion and body & health stores tend to be clustered – due to the complex SC floorplan (c.f. Yuo 2010)	✗
▪ The **pass ratio** declines from the center of a shopping center ⇒ Regression, kernel density estimation and visual analysis of the pass ratio confirm a decline of the pass ratio from the mall-center	✓
▪ Shops of the same **retail category** have a higher coupling potential than those of different ⇒ The results of Brown 1992 cannot be confirmed for all retail categories (e.g. food)	–
▪ Proximity of shops suggests a higher coupling potential ⇒ The results of Brown 1992 can only be for the examined category food	–

Methodic perspective:

- GIS-use simplifies sophisticated (spatial) SC analyses, like clumping method or kernel density estimator
  - ⇒ GIS-use is the basic tool to automate the SC research and thus ideal tenant arrangement
- An integration of the dimension ‚time' is neccessary

Content perspective:

- **Data Survey**: Automated survey of passersby frequency
- **Sample:** Number of assessed Shopping Centers has to be extended
- **Target Variable:** The results have to be confirmed by focusing rental data

GIS can be assessed as a fundamental application to analyze and optimize the shopping center mix within the shopping center research

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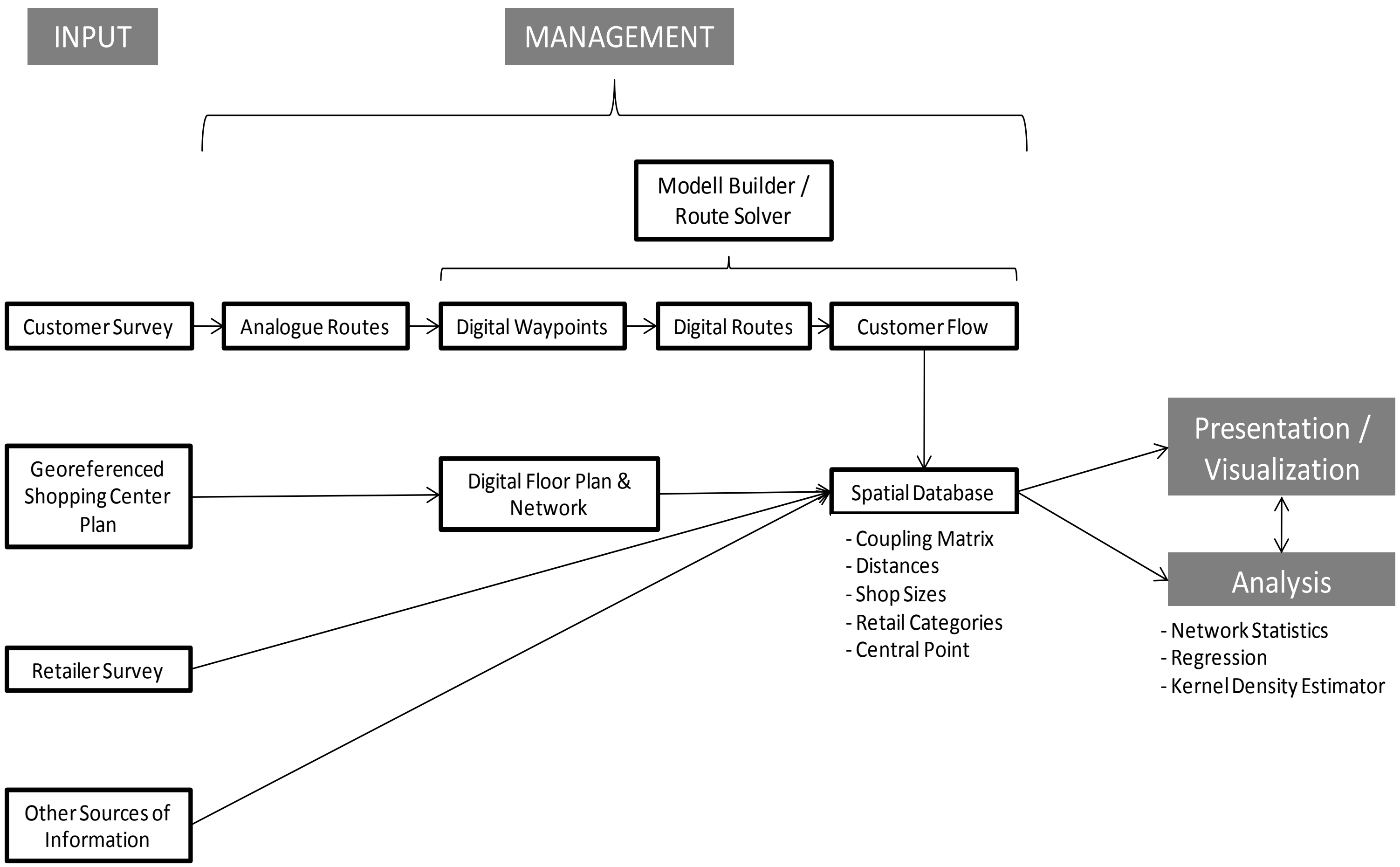
Back Up


INPUT
MANAGEMENT
Modell Builder / Route Solver
Customer Survey
Analogue Routes
Digital Waypoints
Digital Routes
Customer Flow
Georeferenced Shopping Center Plan
Digital Floor Plan & Network
Spatial Database
- Coupling Matrix
- Distances
- Shop Sizes
- Retail Categories
- Central Point
Presentation / Visualization
Analysis
- Network Statistics
- Regression
- Kernel Density Estimator
Retailer Survey
Other Sources of Information

$$\hat{f}_{K,h}(x) = \frac{1}{nh}\sum_{i=1}^{n} K_i(x)$$

K: Kernel function *n: Sample size* *h: Bandwidth*

The kernel function is:

$$K_i(x) = 3\pi^{-1}\left(1 - \left(\frac{x-x_i}{h}\right)^2\right)^2 \quad \text{if } \left(\frac{x-x_i}{h}\right)^2 < 1$$

$$K_i(x) = 0 \quad \text{otherwise}$$

x_i*: Location of ith observation*

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$$\hat{C}_{ij} = \beta_{0j} + \beta_j \cdot C_{i+}$$

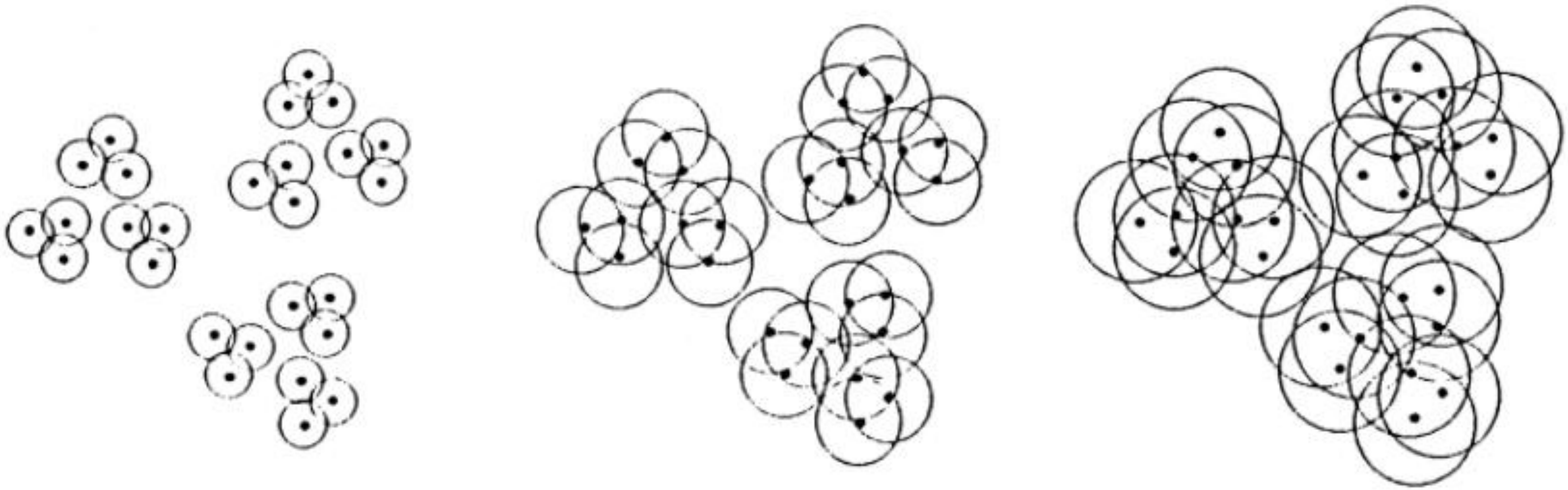
$\hat{C}_{ij} =$ *estimated coupling between shops i and j*
and i ≠ j

The residuals of this regression provide information about the relative coupling behavior.

$$\varepsilon_{ij} = C_{ij} - \hat{\hat{C}}_{ij}$$

$\hat{C}_{ij} =$ *estimated coupling between shops i and j*
$C_{ij} =$ *observed coupling between shops i and j*
$\varepsilon_{ij} =$ *Residual value*
and i ≠ j

Back Up



Source: Okabe/Funamoto 2000

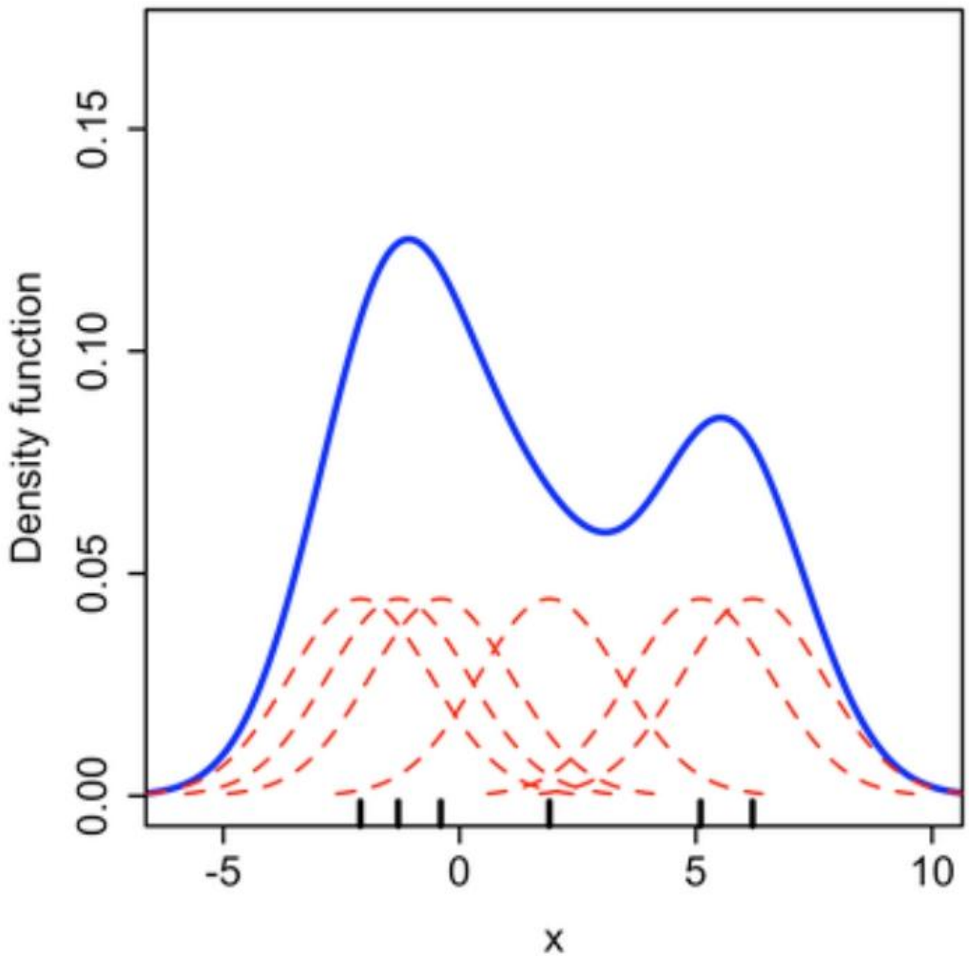

Density function
0.00
0.05
0.10
0.15
-5
0
5
10
x

Table 1. Critical numbers $n_i^*(r_j)$ of clumps with respect to a clump size $i = 1, \ldots, 10$ and a clump raidus r_j, $j = 1, \ldots, 16$ in a 1000m by 1000m square

r_j	$i = 2$	3	4	5	6	7	8	9	10
0.00	0	0	0	0	0	0	0	0	0
28.02	0	0	0	0	0	0	0	0	0
56.05	2	1	0	0	0	0	0	0	0
84.07	3	1	1	0	0	0	0	0	0
112.10	3	1	1	1	0	0	0	0	0
140.12	3	2	1	1	1	0	0	0	0
168.15	3	2	1	1	1	1	1	0	0
196.17	2	1	1	1	1	1	1	1	0
224.20	2	1	1	1	1	1	1	1	1
252.22	1	1	1	1	1	1	1	1	1
280.24	1	1	0	0	1	1	1	1	1
308.27	1	0	0	0	0	1	1	1	1
336.29	1	0	0	0	0	0	1	1	1
364.32	0	0	0	0	0	0	1	1	1
392.34	0	0	0	0	0	0	0	1	1
$\geq$420.37	0	0	0	0	0	0	0	0	1

Source: Okabe/Funamoto 2000