

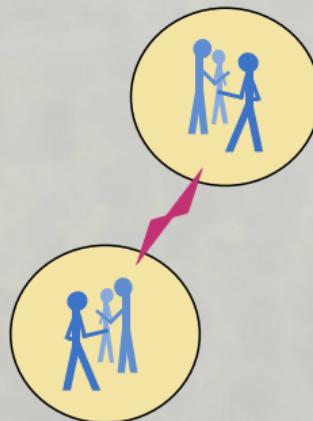
# Modelling archaeological interaction based on cultural distances

Oliver Nakoinz

Interaction  
Models

Theoretical Interaction Models  
Empirical Interaction Models  
Conclusions and Perspectives

Kiel, 2018-08-20





Paintings from S. Bening, E. Hünten, C. Monet

source: Wikipedia

# Defining Interaction

## Definition 1

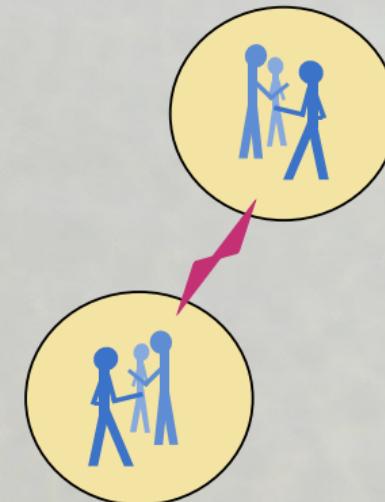
**Interaction** is the joint action of at least two interaction partners.

## Definition 2

**Spatial Interaction** connects different locations by the means of moving people, goods or knowledge between the locations.

## Definition 3

**Communication** is the exchange of information



- ▶ allows to join forces to reach certain targets
- ▶ changes (extends/reduces) the individual capability

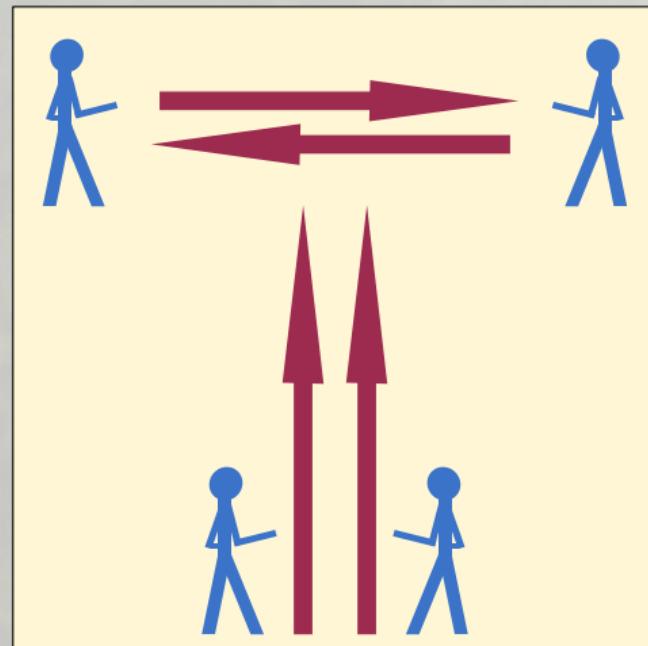
# Conflict and Cooperation

## Conflict

- ▶ contradicting goals of the two interaction partners
- ▶ limitation of the other's capability
- ▶ hamper the other's efforts

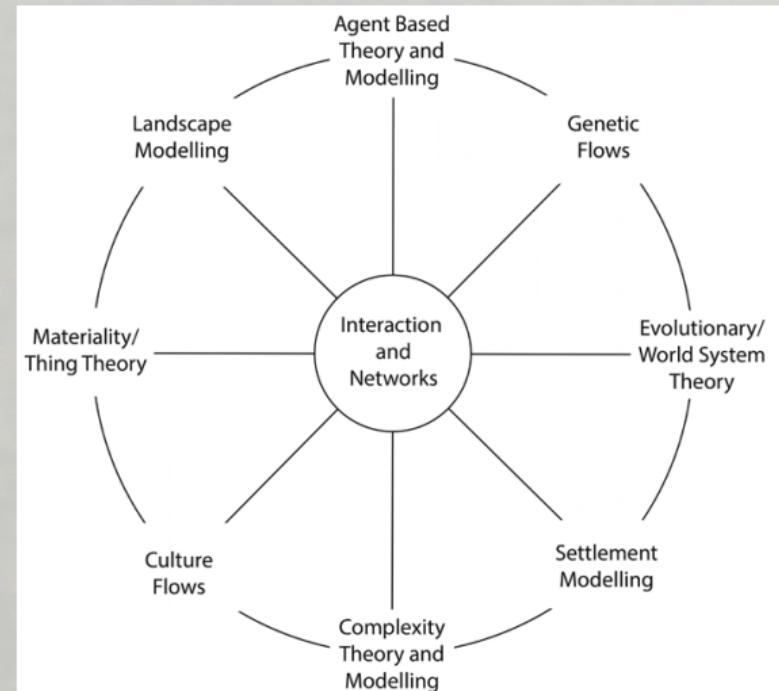
## Cooperation

- ▶ similar goals of the two interaction partners
- ▶ extension of the other's capability
- ▶ supporting the other's efforts



# Advantages of Interaction as Concept

- ▶ interaction is the **driving force** of social, economic, cultural and historical processes
- ▶ interaction is very **abstract** and is able to cover different aspects of human behaviour
- ▶ **there is no need for an interaction typology** as starting point for investigations
- ▶ interaction allows to **integrate** concepts from different disciplines



The theoretical wheel, suggesting new axes of theorizing (Kristiansen 2014).

# Models

## Definition 4

A **model** is characterised by:

- ▶ mapping
- ▶ reduction
- ▶ pragmatism

Herbert Stachowiak 1973

## Definition 5

A **model** is characterized by:

- ▶ comprehensiveness;
- ▶ predictivness;
- ▶ efficiency; and
- ▶ accuracy.

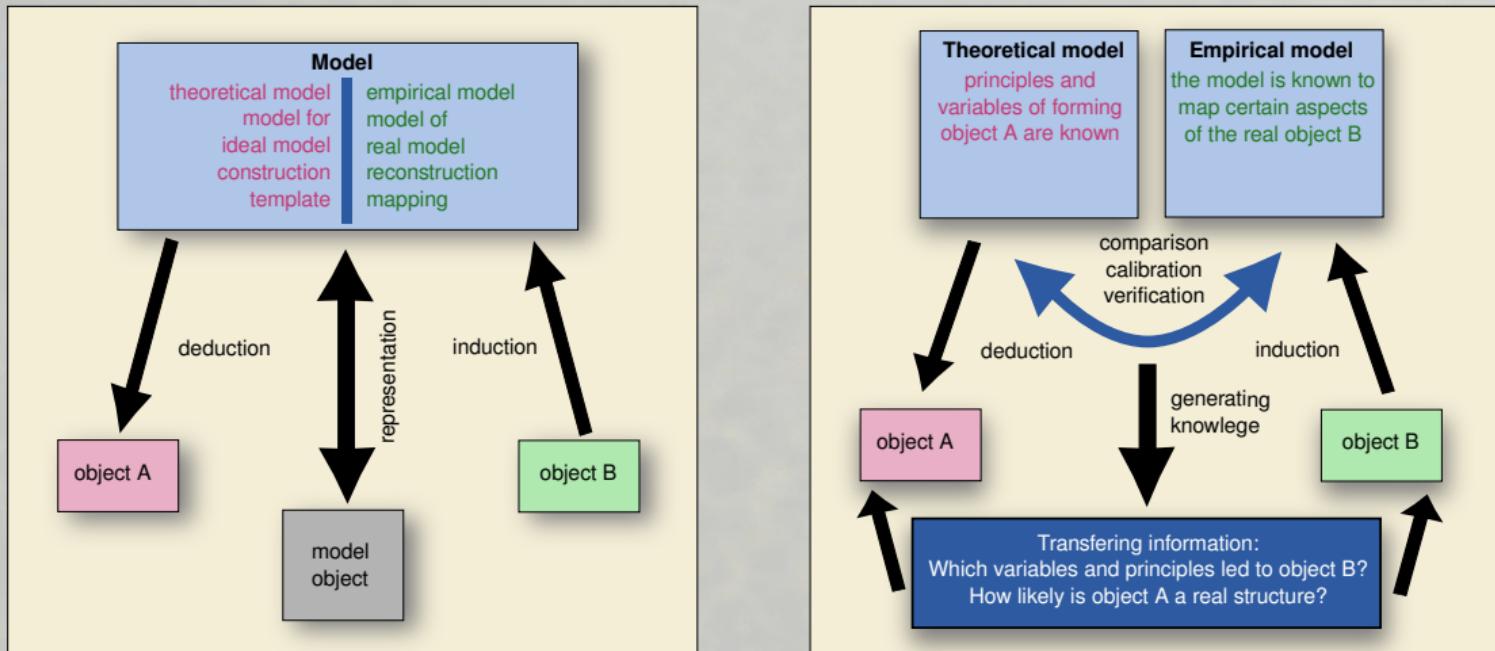
David L. Clarke 1972

## Definition 6

A **model** is defined as an artefact, representing a part of the world. There is an analogy between model and original. A model is used in a certain community of practice as tools for a certain purpose. The community of practice shares some assumptions of the models, methods for developing and using models and ideas for validating models.

Thalheim/Nissen 2015

# Theoretical and Empirical Models



# First Law of Geography

- ▶ distance and interaction are positively correlated
- ▶ the function of interaction in dependence of distance is monotone (at least in a statistical sense)
- ▶ no quantification of the kind of relationship

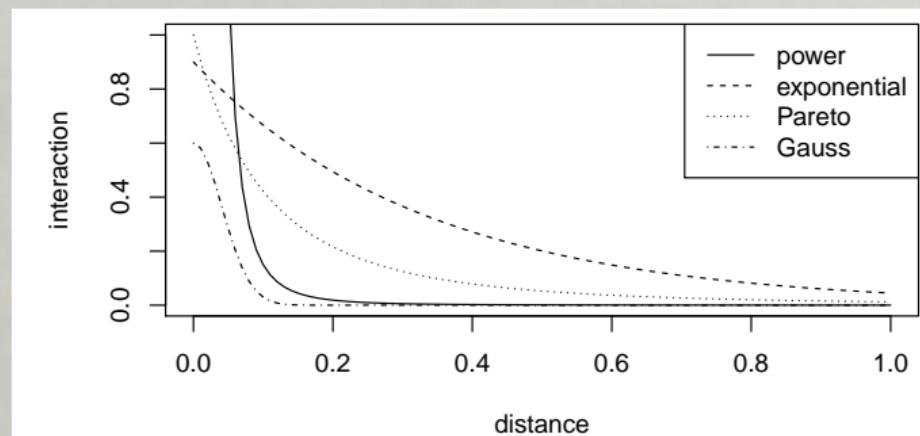
*Everything is related to everything else, but near things are more related than distant things.*

W. Tobler 1970

$$I_{(d)} \approx f_{(d)}$$

# Distance Decay Functions

Distance decay functions define the dependency of interaction on distance.

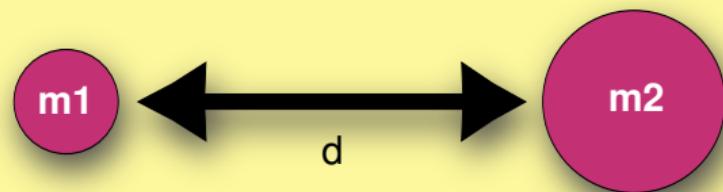


2016

Nak

# Gravity

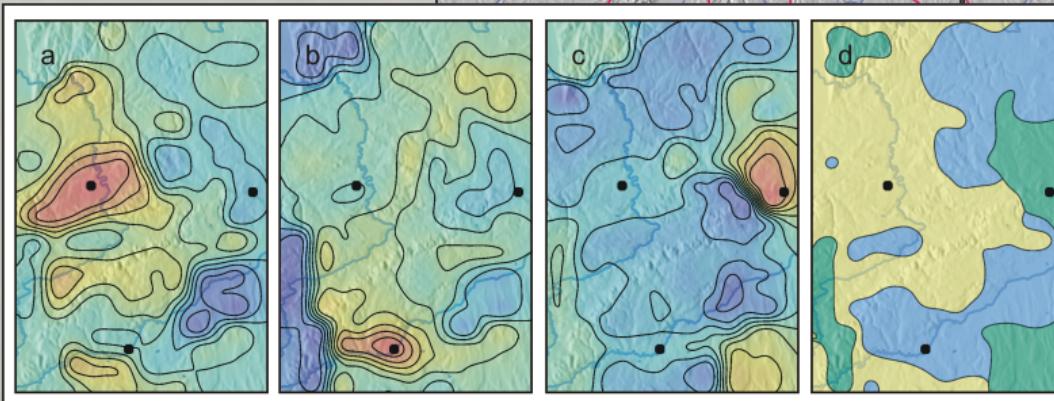
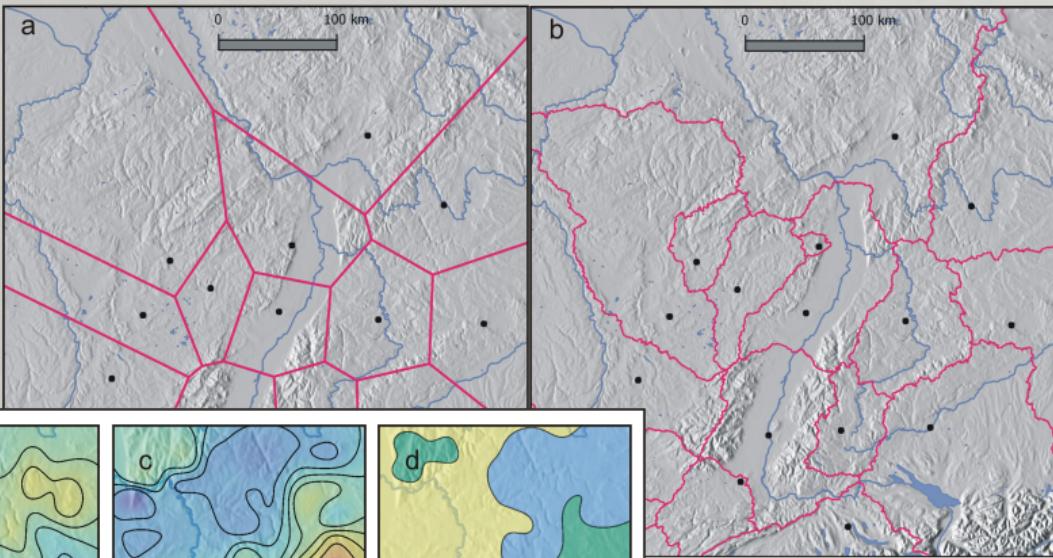
Gravity models introduce the size (or importance) of the interaction partners into the interaction model.



$$I = \frac{m_1 m_2}{d^k}$$

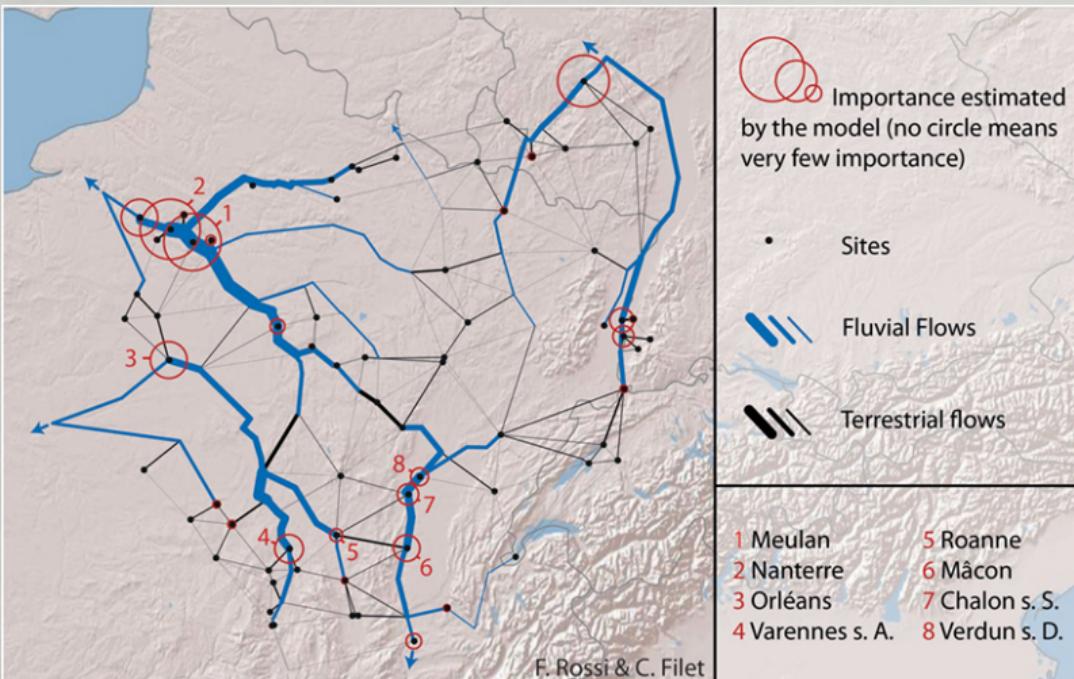
# Voronoi Graph

- ▶ geometrical space
- ▶ economical space  
(least cost distance)
- ▶ cultural space



# Wilsons Entropy

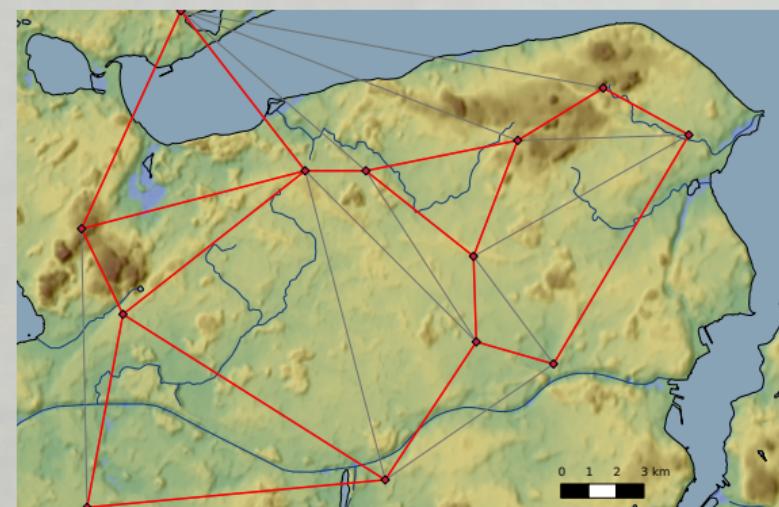
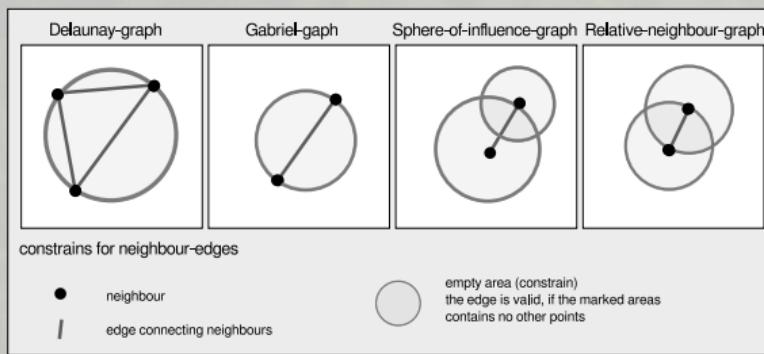
Entropy models calculate a statistical estimation of the flow between sites based on the location of the sites.



Filet 2017

# Neighbourhood Graphs

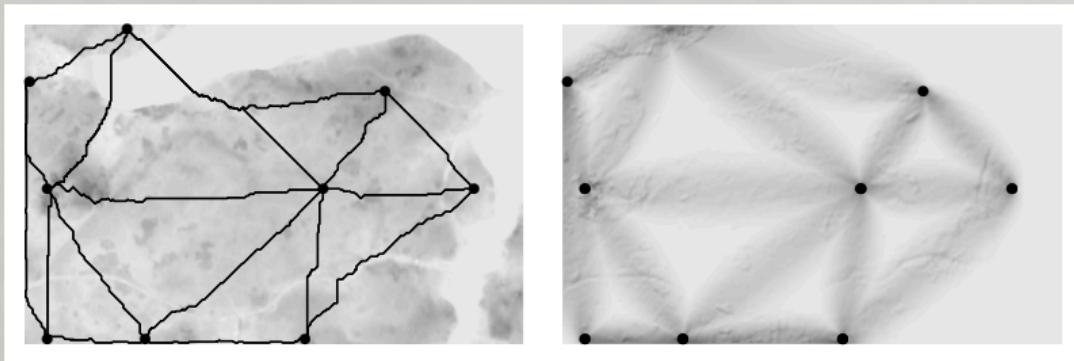
Neighbourhood graphs establish connections due to certain geometrical rules



Gabriel Graph (red) and Delaunay Graph (grey)

# Least cost path analysis (LCP)

- ▶ routes of minimal effort (Dijkstra algorithm)
- ▶ altitude, slope, soil, bogs, view as parameters
- ▶ random walk is possible



# Data

## Available Data

- ▶ archaeological finds
- ▶ archaeological structures
- ▶ site locations
- ▶ composition and provenance analysis
- ▶ typological connections

## Not Available Data

- ▶ written sources and oral statements
- ▶ measurements of interaction
- ▶ observation of mobility

# Measures

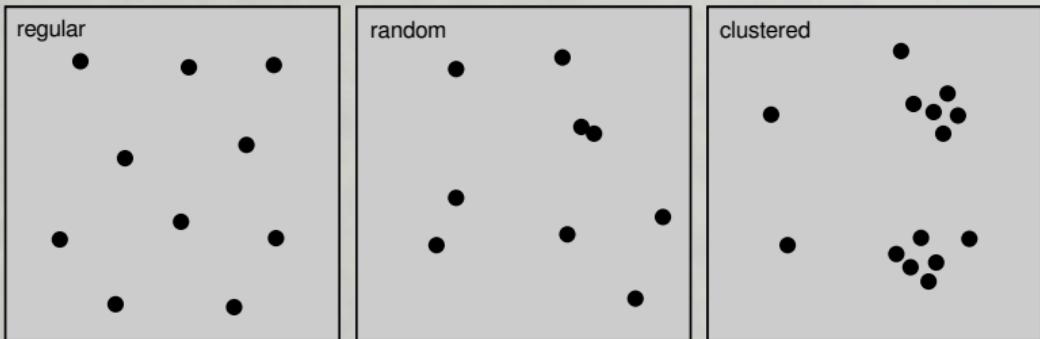
- ▶ number of exchanged objects
  - ▶ small data
  - ▶ can deal with individual interactions
- ▶ point distribution
  - ▶ minimal requirements
  - ▶ measures general degree of interaction in a region
- ▶ inverse cultural distance
  - ▶ robust because of extensive data
  - ▶ can deal with short range interaction
  - ▶ can measure different types of interaction



Mediterranean import from Ipif (Krause 2015)

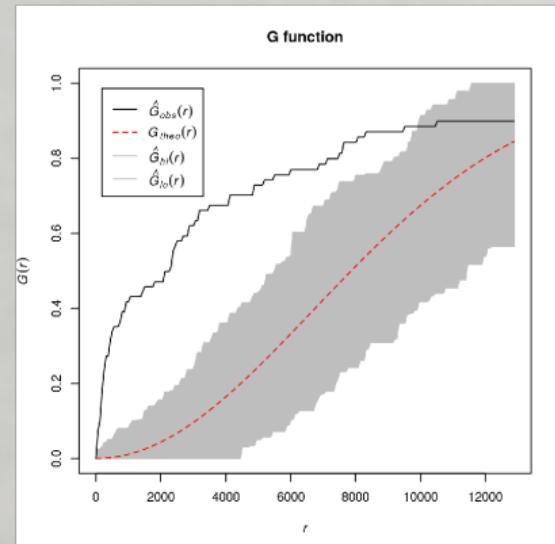
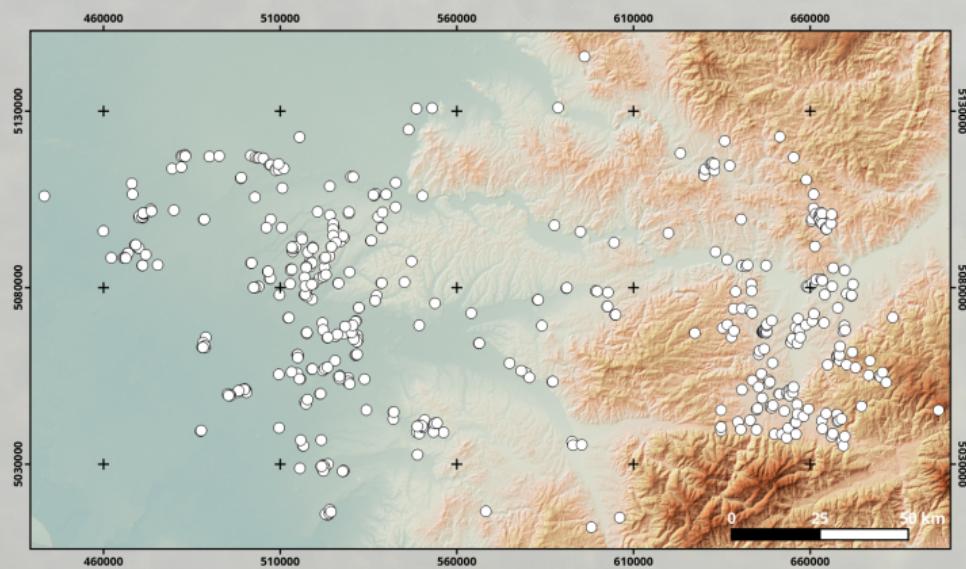
# NN-Distance

- ▶ Is there interaction between the points?
- ▶ Test on complete spatial randomness
- ▶ regular - random - clustered



# Point Pattern

- ▶ Iron Age Sites in Banat
- ▶ G-Funktion

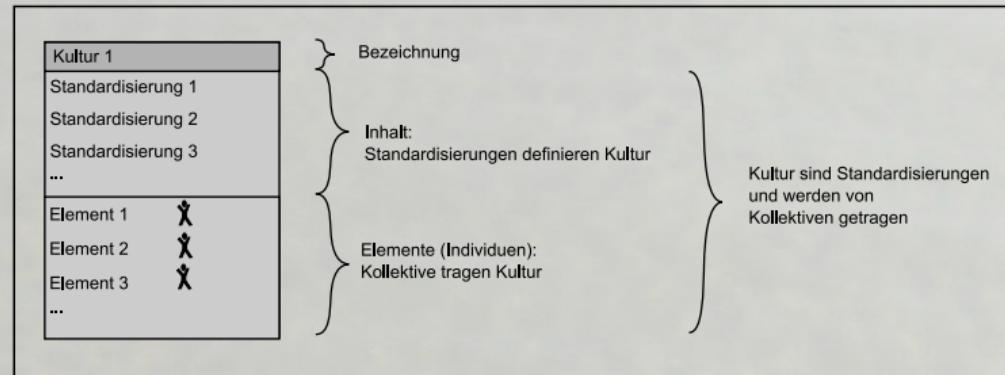


# Culture

## Definition 7

**Culture covers standardisations which are valid in collectives.**

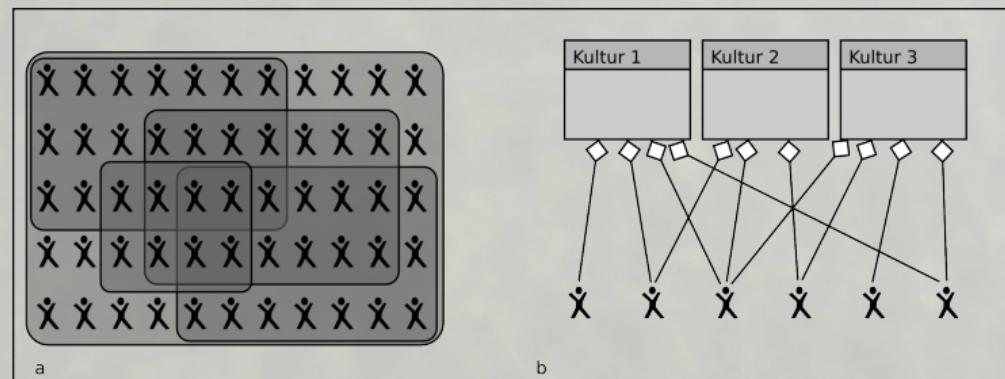
Hansen 2003, 39



Cultures are mapping interaction structures!

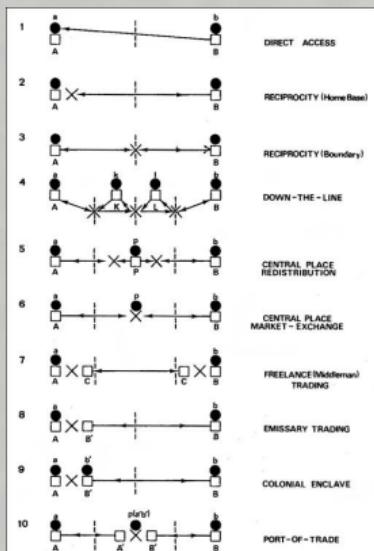
Similarities can be caused by

- ▶ natural and social conditions (convergence)
- ▶ accident
- ▶ interaction (force, spy and adaption)

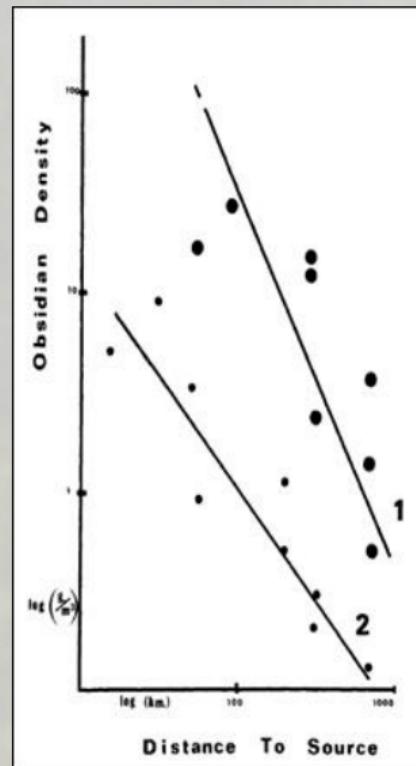


# Fall Off Curves

Fall off curves map the density of finds at a different distances from the source



Renfrew 1977



Renfrew 1977

# Distance Diagrams

## Definition 8

### ***Interaction models***

*plot intensity of interaction over distance.*

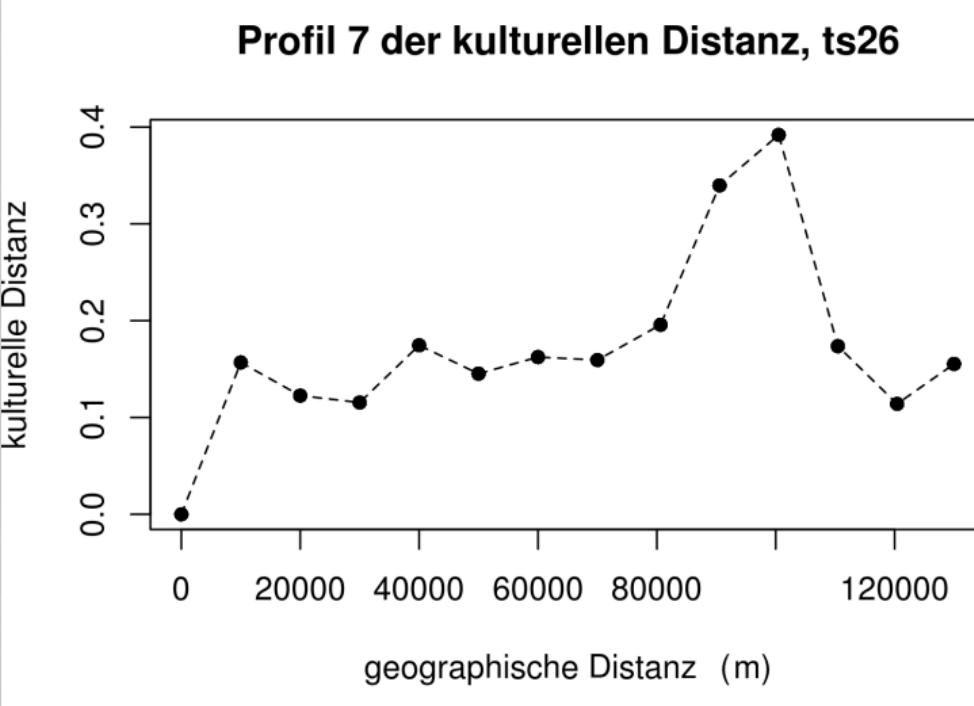
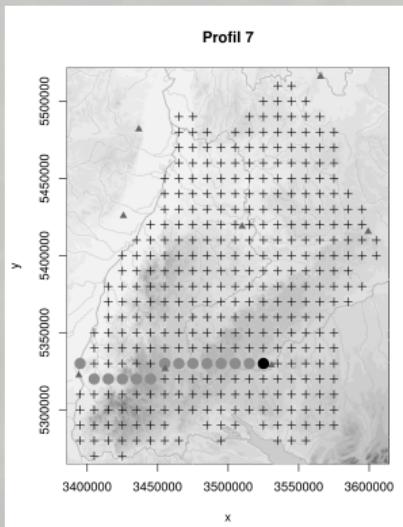
### Distance diagram (dd):

- ▶ different view-points
- ▶ different focus-points
- ▶ cultural distance as an inverse interaction proxy

		fixed focus	selected focus	all focused
	fixed view-point	dd1 fixed profile dd, similarity profiles	dd2 fixed sector dd	dd3 fixed multi-focal dd, fall-off curve
	selected viewpoints	dd4 selected profiles dd	dd5 selected sector dd	dd6 selected multi- focal dd
	all view-points	dd7 aggregated pro- file dd	dd8 aggregated sec- tor dd	dd9 aggregated multi-focal dd, variogram

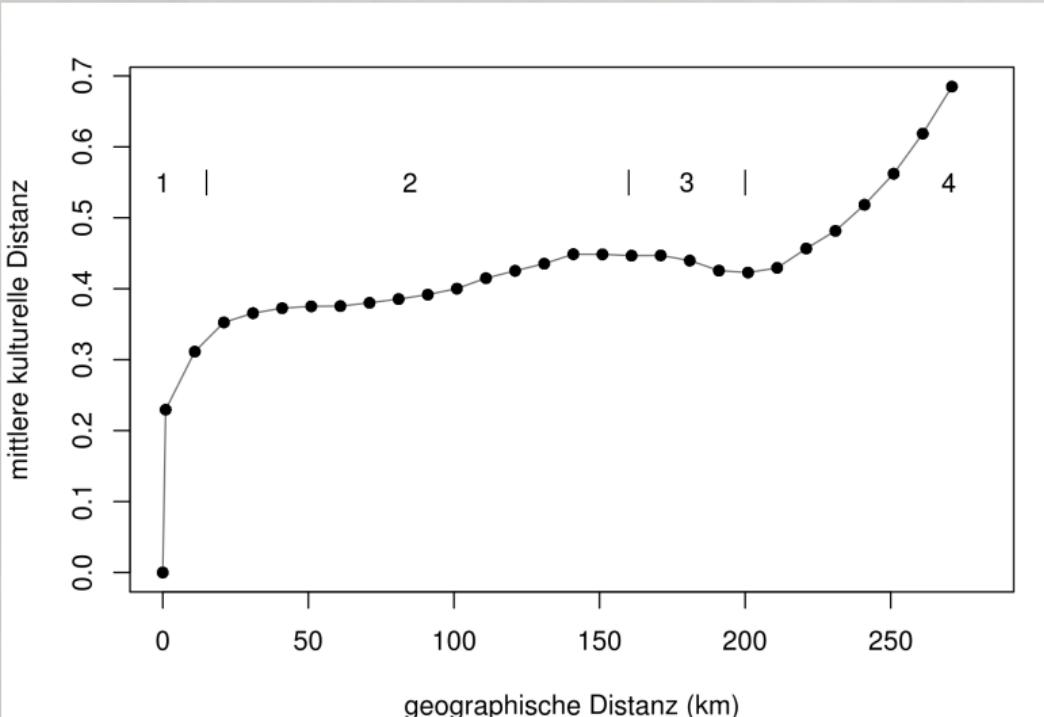
# Interaction Model dd1

- ▶ fixed starting point
- ▶ fixed profile
- ▶ ceramics

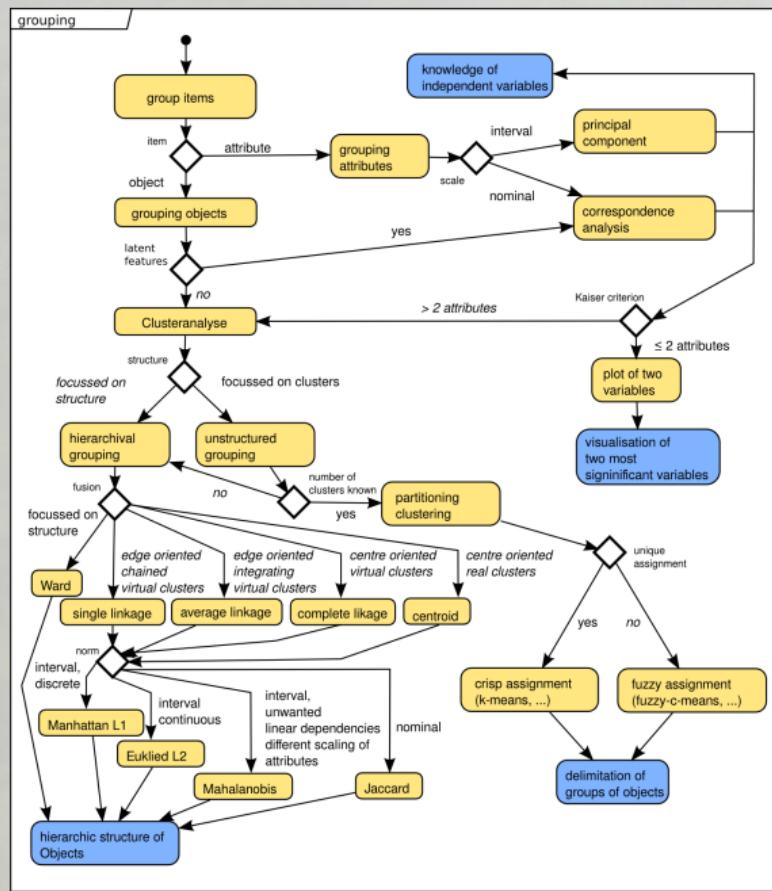
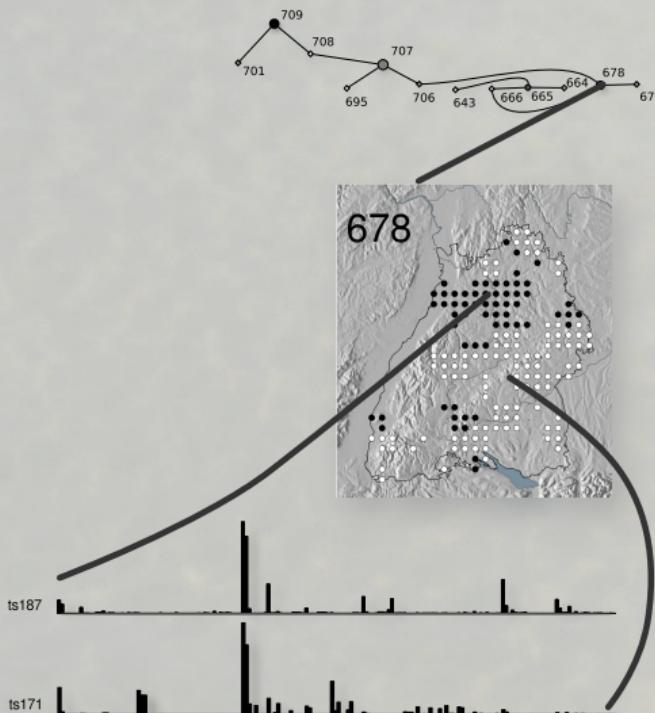


# Interaction Model dd9

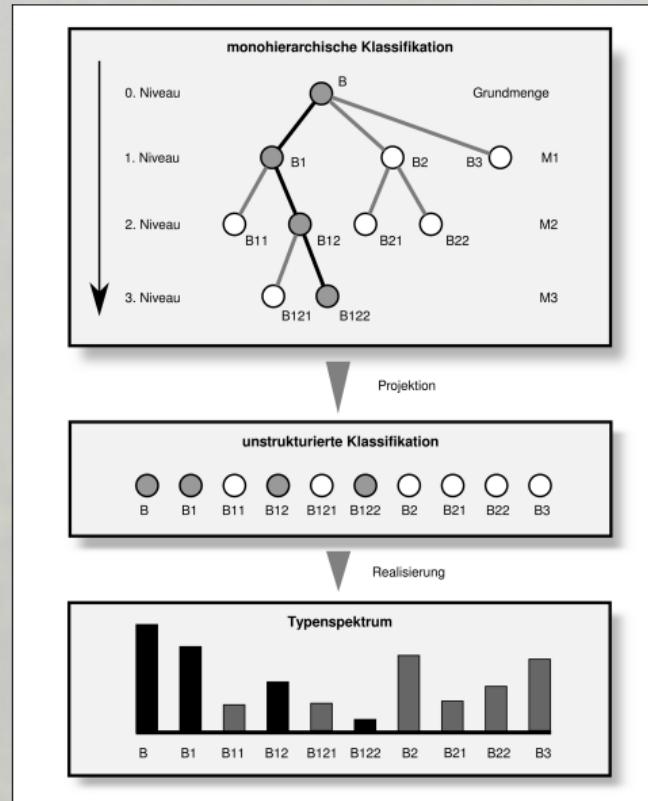
- ▶ from all points
- ▶ to all points
- ▶ fibulae and adornment

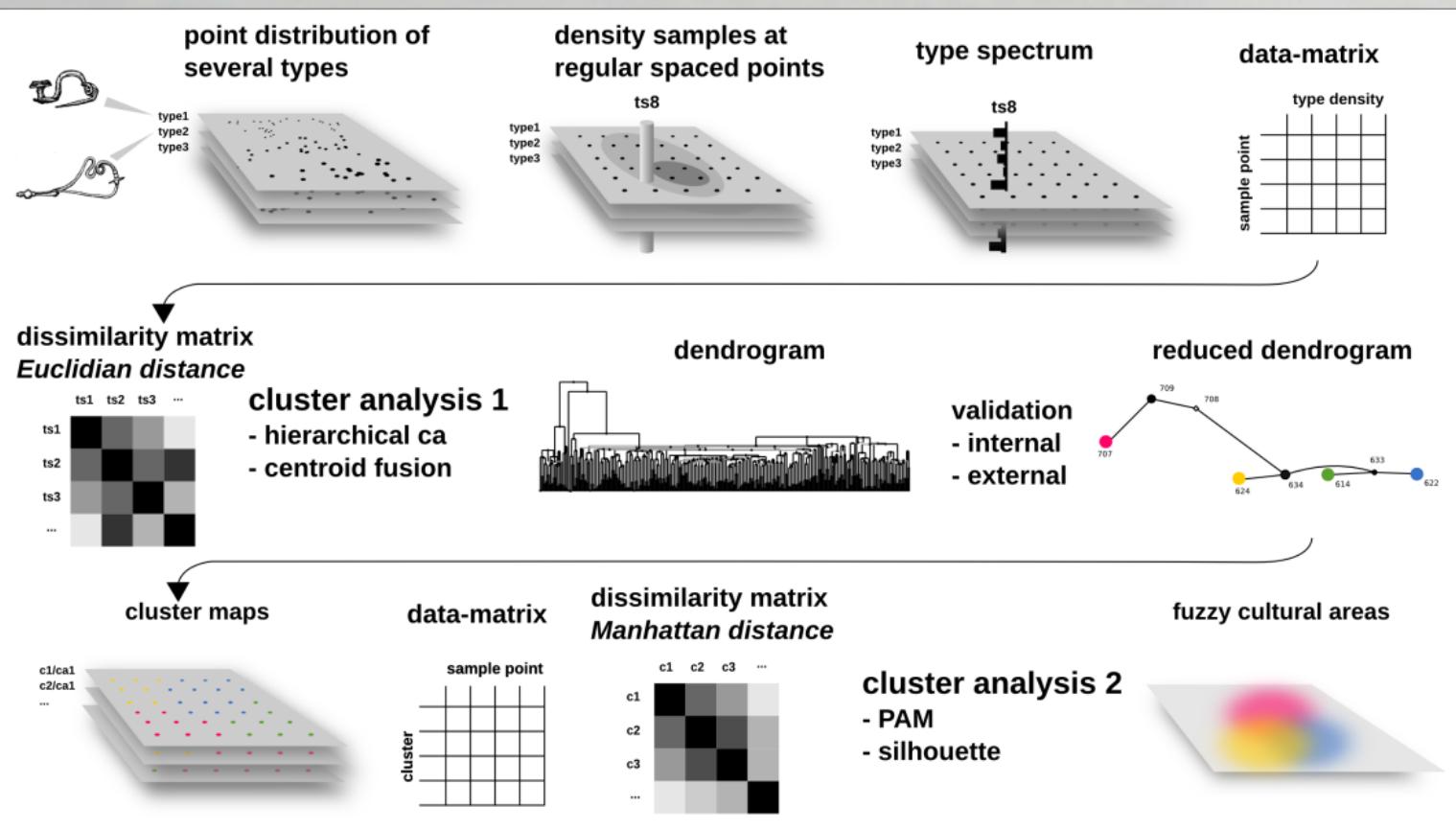


# Decision Tree



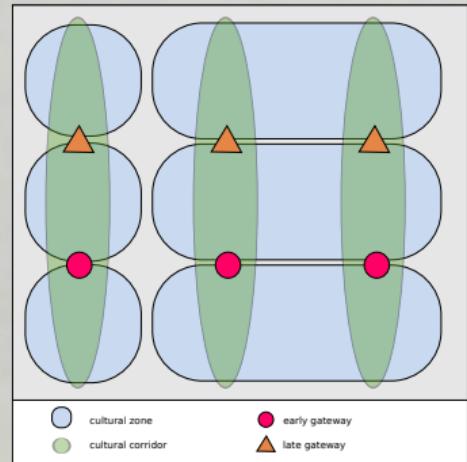
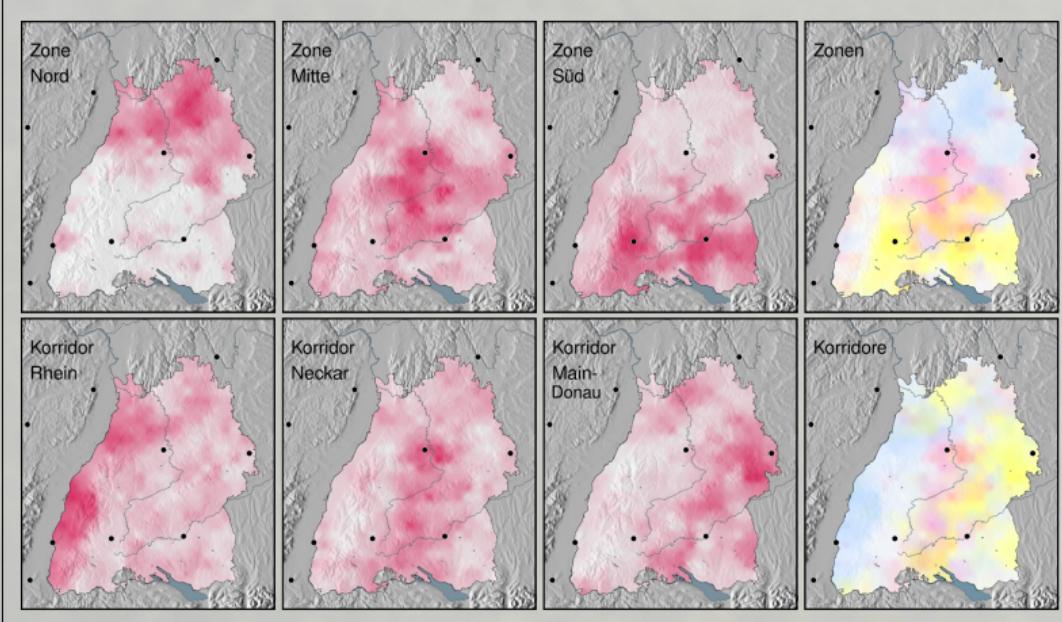
# Weighting





# SHKR Results

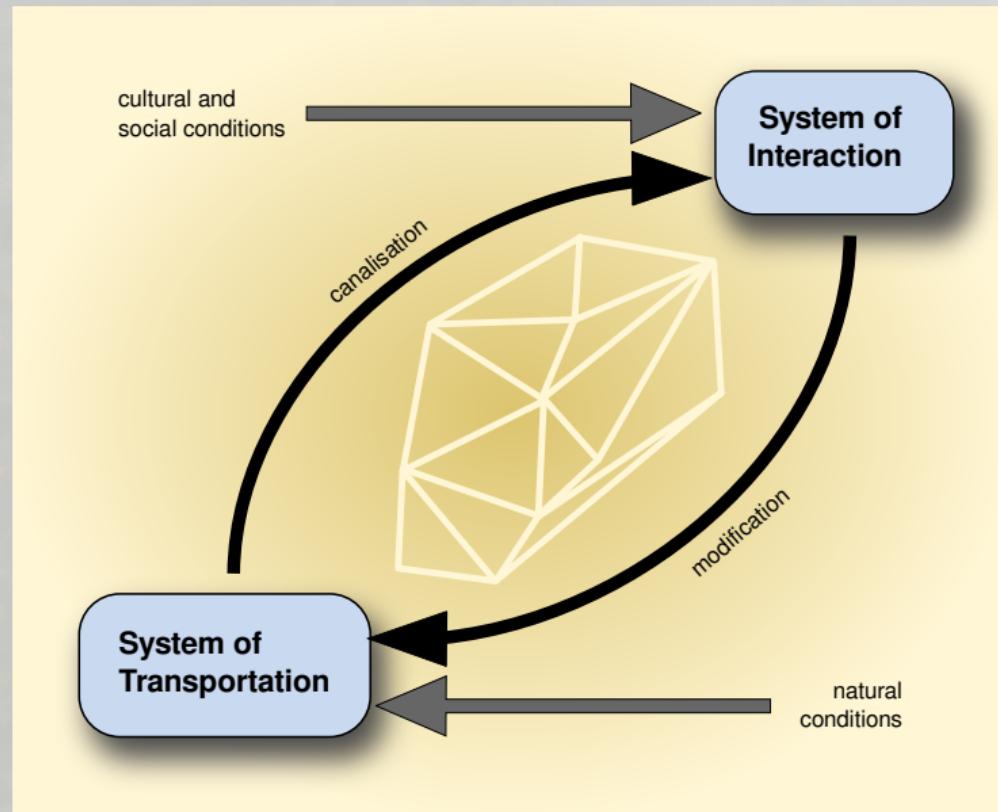
- centres at the border of cultural areas
- network centres rather than Christaller centres
- gateways



# Transportation

## Modelling systems of transportation

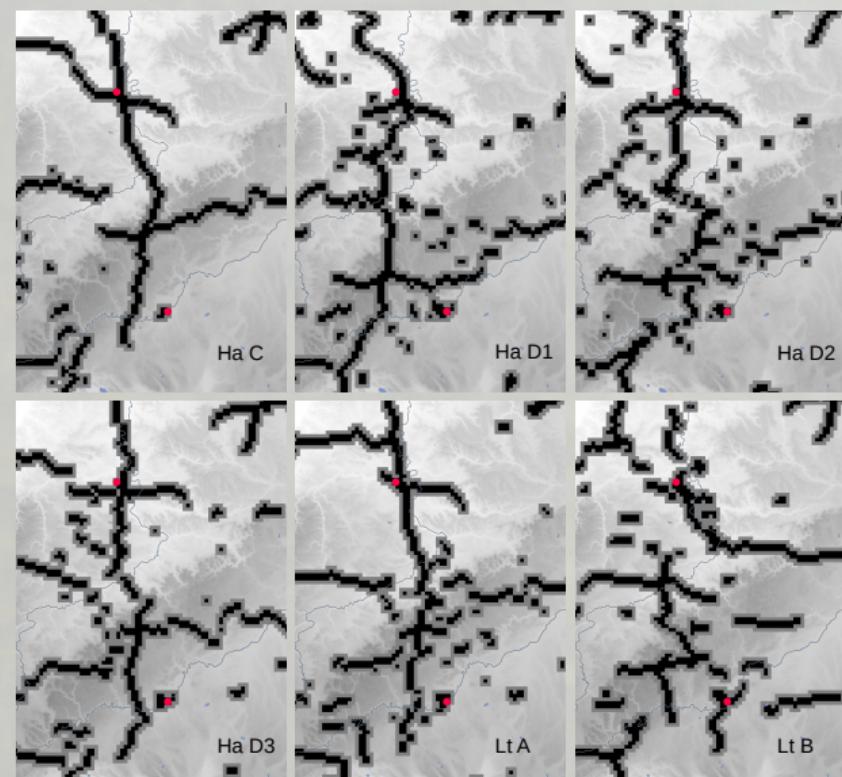
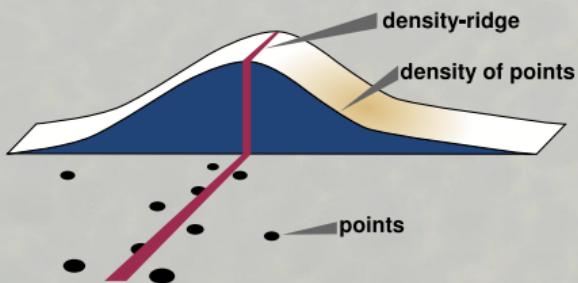
- ▶ is essential for modelling interaction
- ▶ produces knowledge of significant parameters



# Transportation

## Road system

- ▶ Ridges of sites density
- ▶ KDE with additive Gaussian Kernel

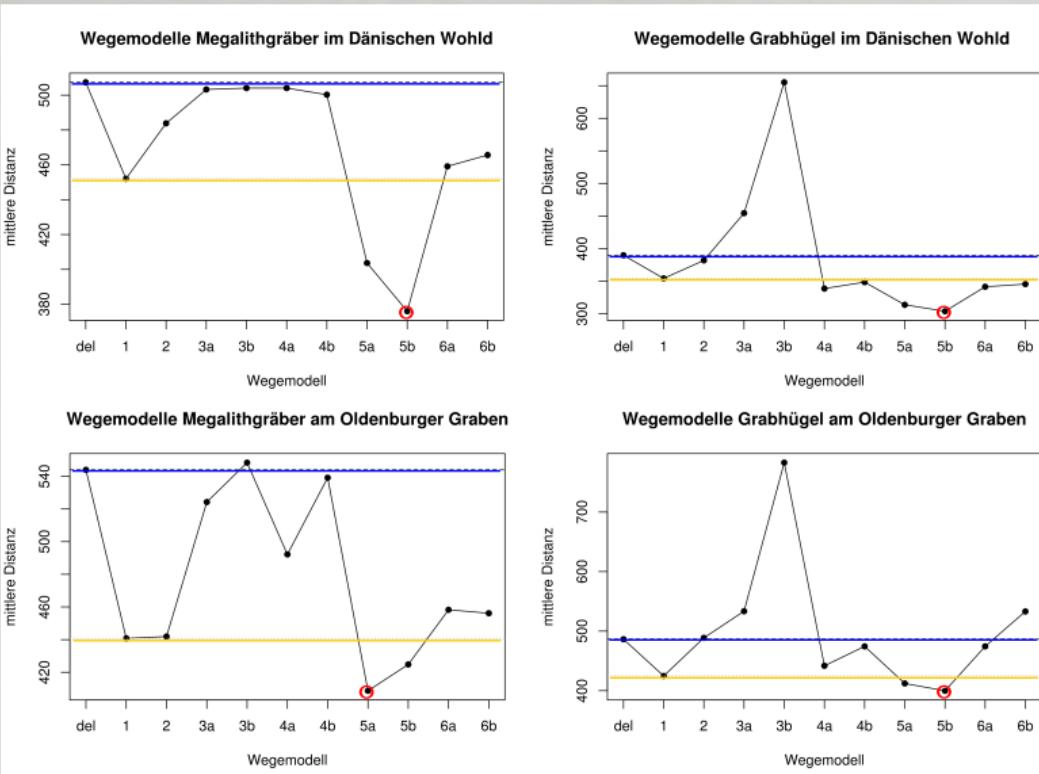


# LCP Evaluation

Model 5b appears to fit best to the empirical data.

- ▶ del = Delaunay
- ▶ 1 = DEM only, cost function for walking
- ▶ 2 = DEM only, cost function for driving
- ▶ 3 = DEM and hiding view
- ▶ 4 = DEM and preferring view
- ▶ 5 = DEM and preferring high altitude
- ▶ 6 = DEM and avoiding bogs

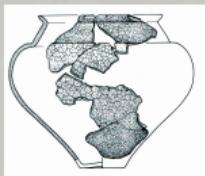
⇒ Security matters



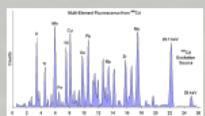
## Data



Sites

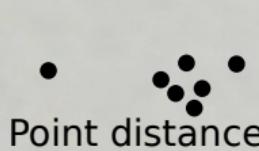


Artefacts

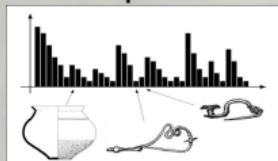


Chemical  
components

## Measures

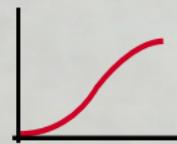


"Imports"

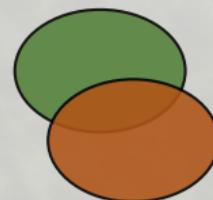


Cultural distance

## Models



Quantification

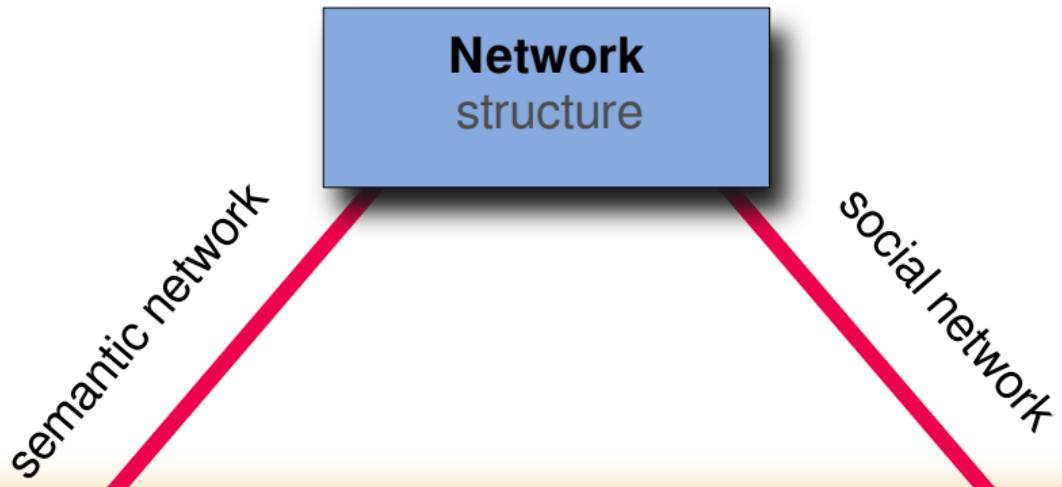


Regionalization



Connection

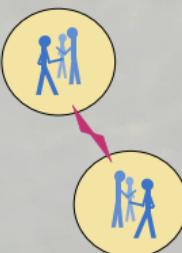
# Integration



# European Perspective: SIMB

SIMB: Spheres of  
Interaction between the  
Baltic and the  
Mediterranean in the  
first Millennium BC

[https://a-simb.  
gitlab.io/home/](https://a-simb.gitlab.io/home/)



- ▶ Internal Workshops, Nordic Chapter
  - ▶ Strasbourg 2015
  - ▶ Kiel 2015
  - ▶ Odense 2016
  - ▶ Kiel 2017
  - ▶ Lublin 2017
- ▶ Conferences and Conference Sessions
  - ▶ Session A2 on LAC 4 in Uppsala 2016
  - ▶ Session 6 at Workshop in Kiel 2017
  - ▶ Session on the 18th UISPP Conference in Paris 2018
- ▶ Courses
  - ▶ Summer School MOSAIC Kiel 2016
  - ▶ École thématique MOSAICnet Bibracte 2018
- ▶ Projects
  - ▶ Modellierung und Rekonstruktion ältereisenzeitlicher Interaktions- und Distributionssysteme in Südwest- und Westdeutschland sowie im Elsass
  - ▶ Pathes through Europe - Transportation Time of Goods in the La Tène Period