

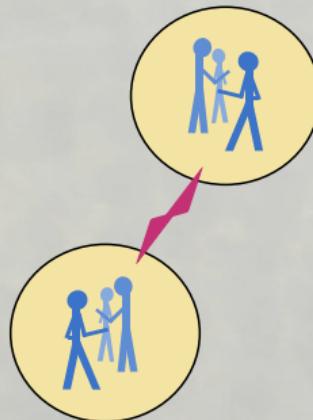
Modelling archaeological interaction based on cultural distances

Oliver Nakoinz

Interaction
Models

Theoretical Interaction Models
Empirical Interaction Models
Conclusions and Perspectives

October 2017





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

source: Wikipedia

Defining Interaction

Definition 1

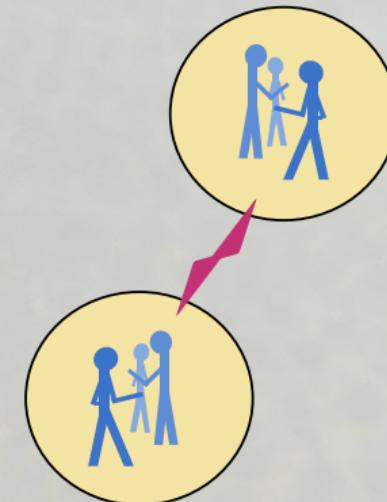
Interaction is the joint action of at least two interaction partners.

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

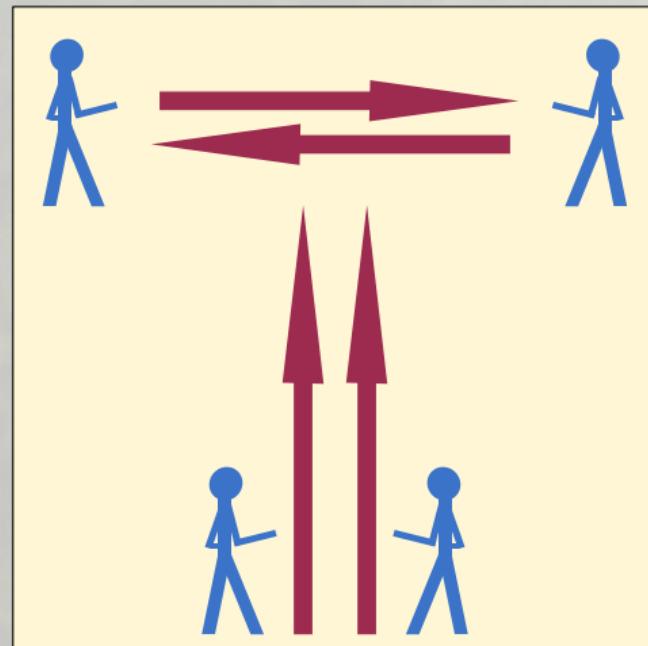
Conflict and Cooperation

Conflict

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

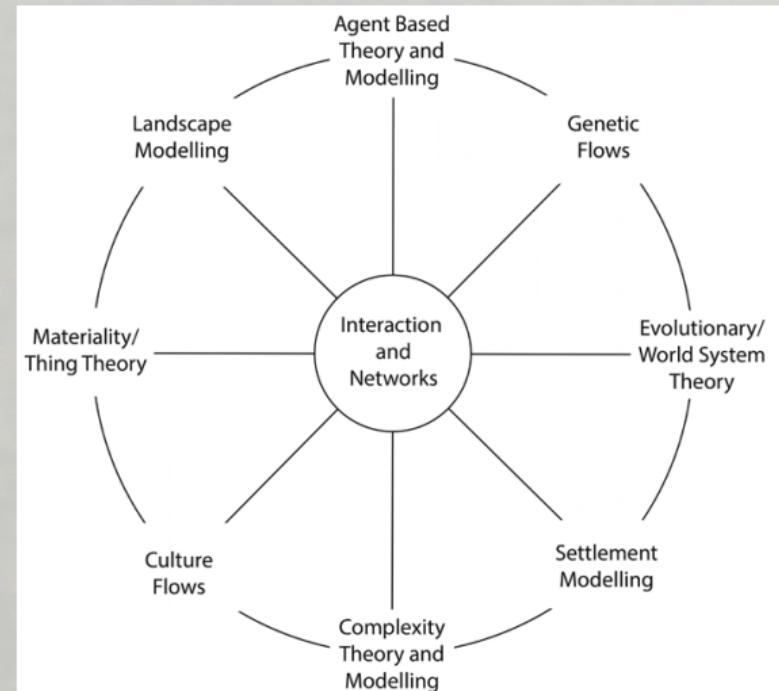
Cooperation

- ▶ 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.

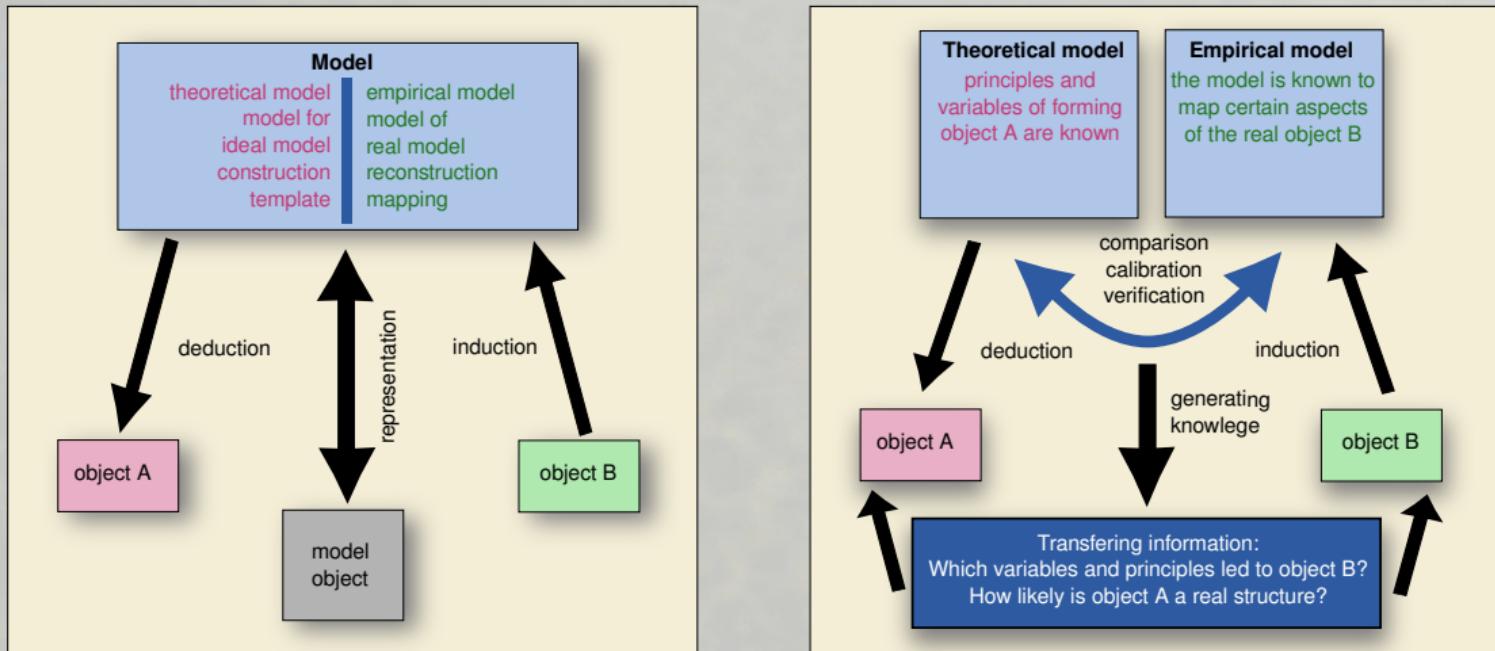
David L. Clarke 1972

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

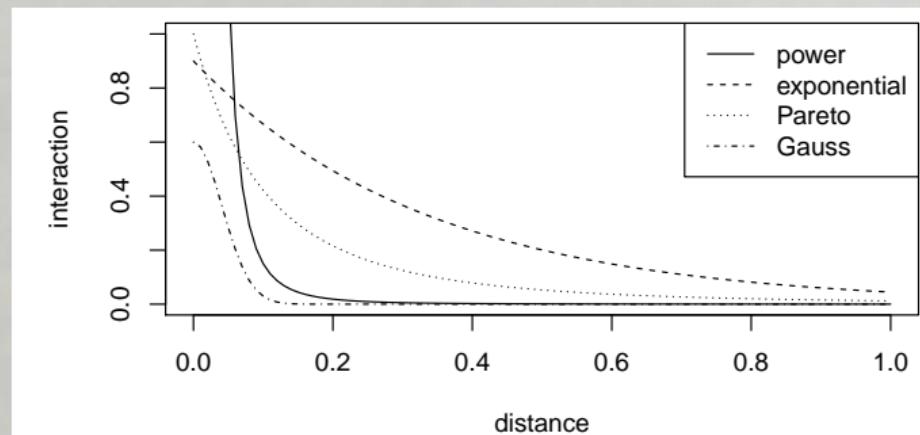
Everything is related to everything else, but near things are more related than distant things.

W. Tobler 1970

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

Distance Decay Functions

Distance decay functions define the dependency of interaction on distance.

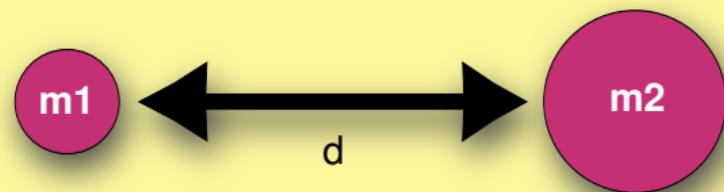


2016

Nak

Gravity

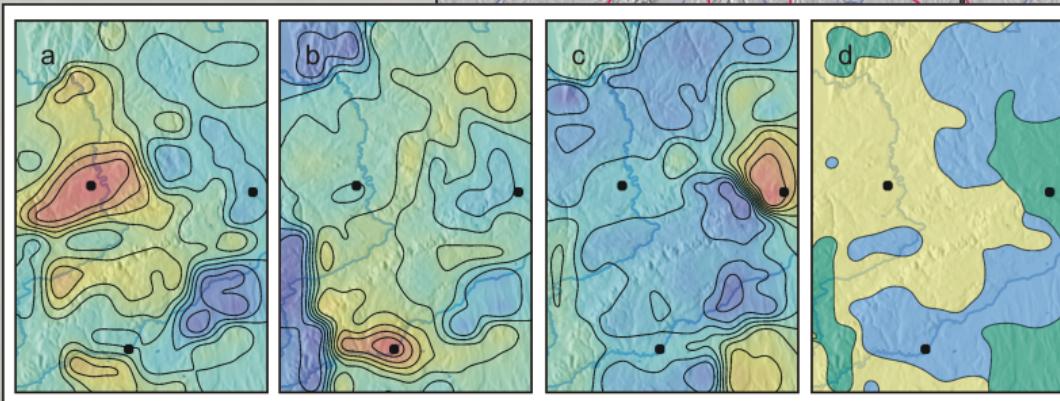
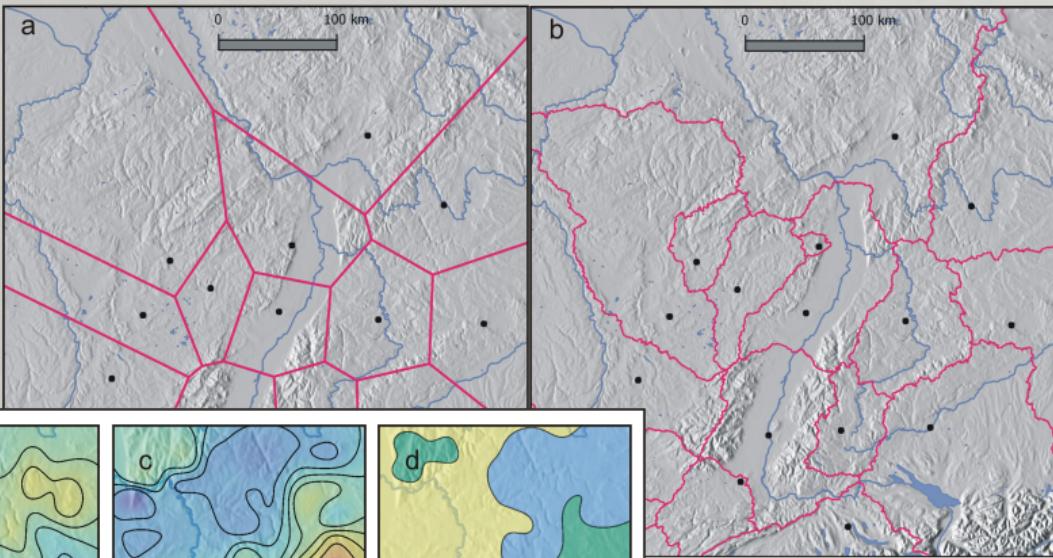
Gravity models introduce the size (or importance) of the interaction partners into the interaction model.



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

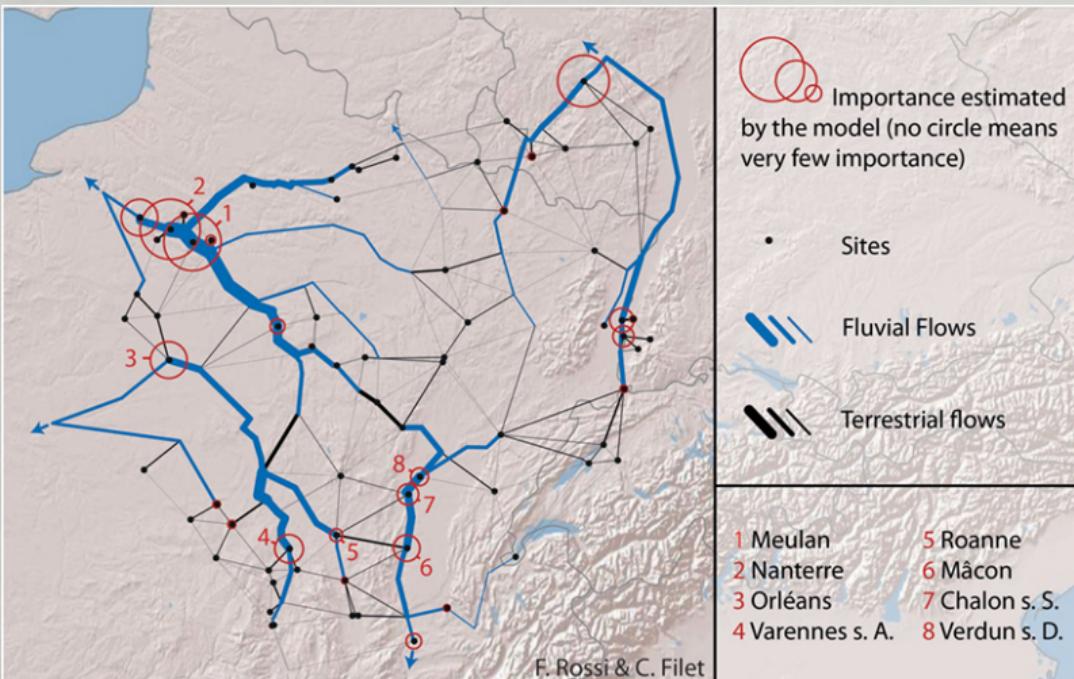
Voronoi Graph

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



Wilsons Entropy

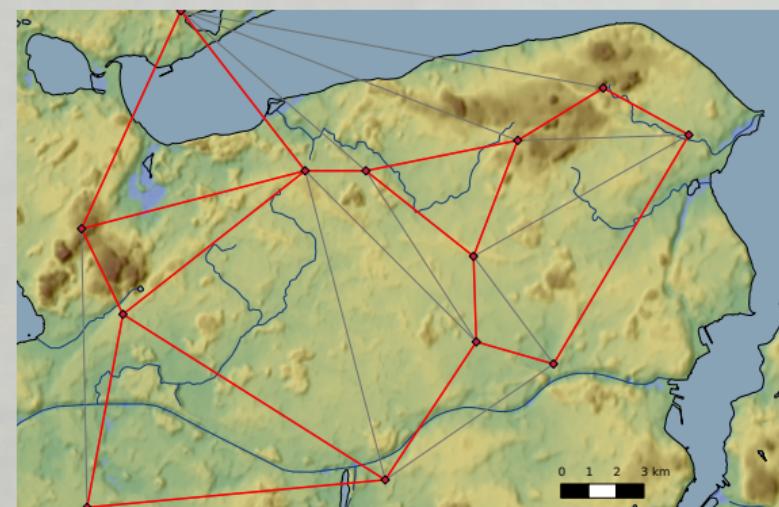
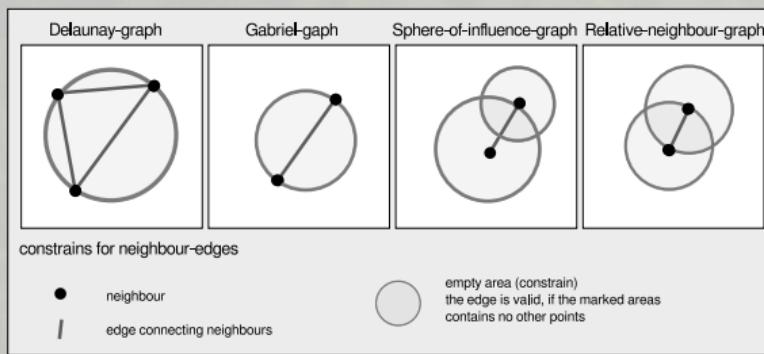
Entropy models calculate a statistical estimation of the flow between sites based on the location of the sites.



Filet 2017

Neighbourhood Graphs

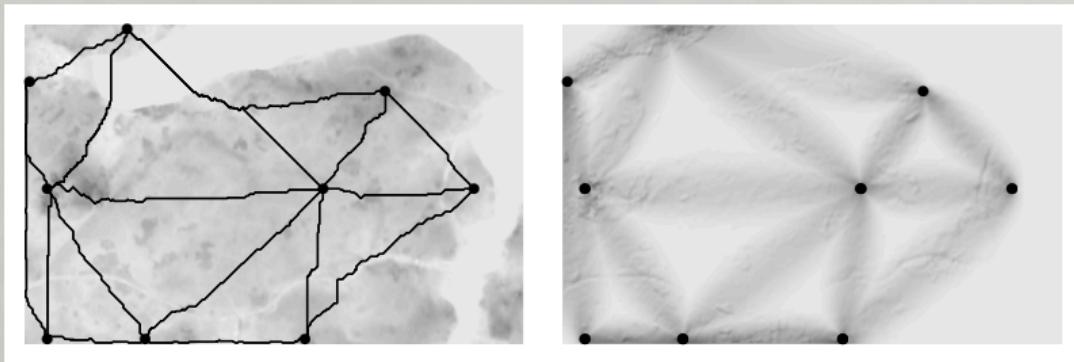
Neighbourhood graphs establish connections due to certain geometrical rules



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

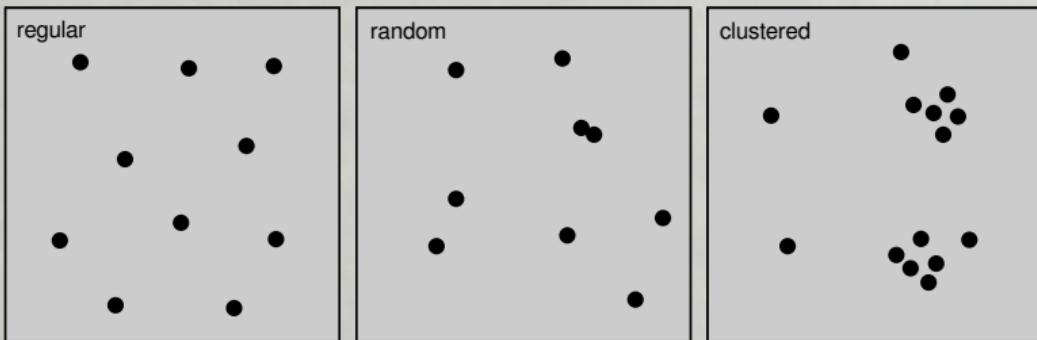
- ▶ number of exchanged objects
 - ▶ small data
 - ▶ can deal with individual interactions
- ▶ point distribution
 - ▶ minimal requirements
 - ▶ measures general degree of interaction in a region
- ▶ inverse cultural distance
 - ▶ robust because of extensive data
 - ▶ can deal with short range interaction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



Mediterranean import from Ipif (Krause 2015)

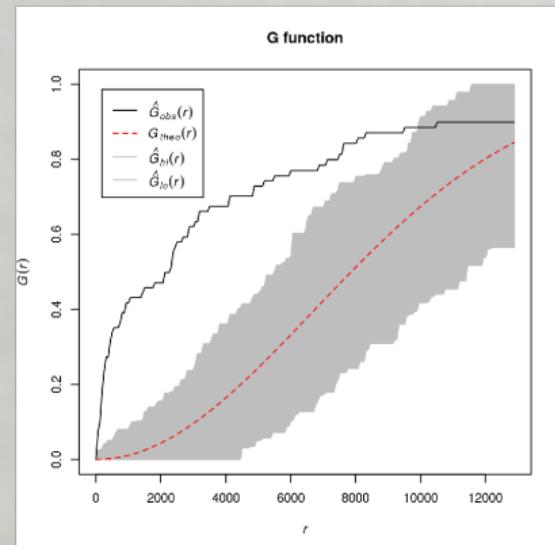
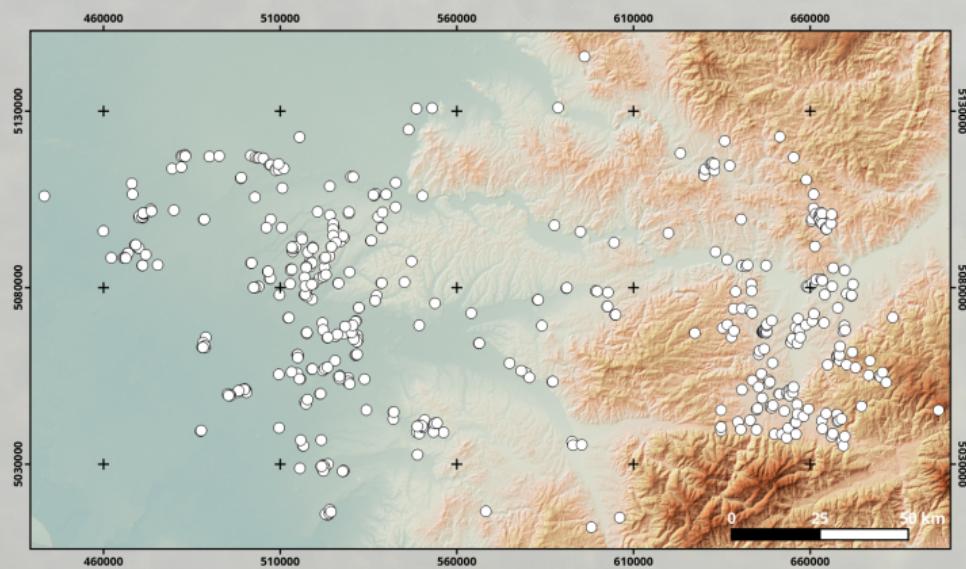
NN-Distance

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



Point Pattern

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

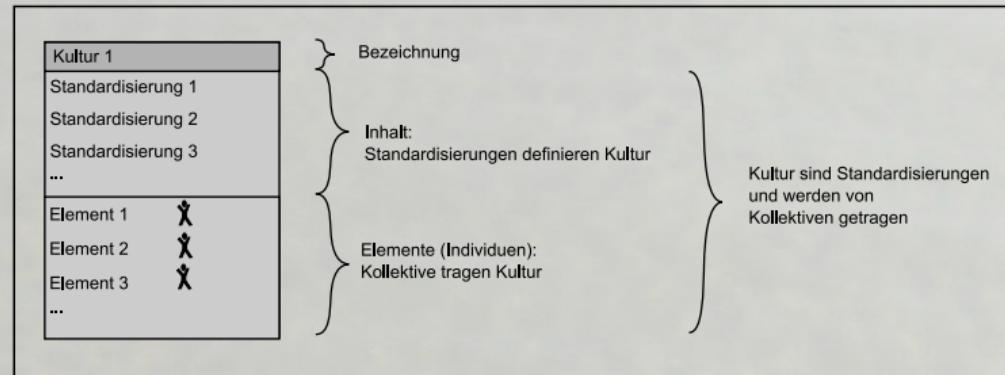


Culture

Definition 7

Culture covers standardisations which are valid in collectives.

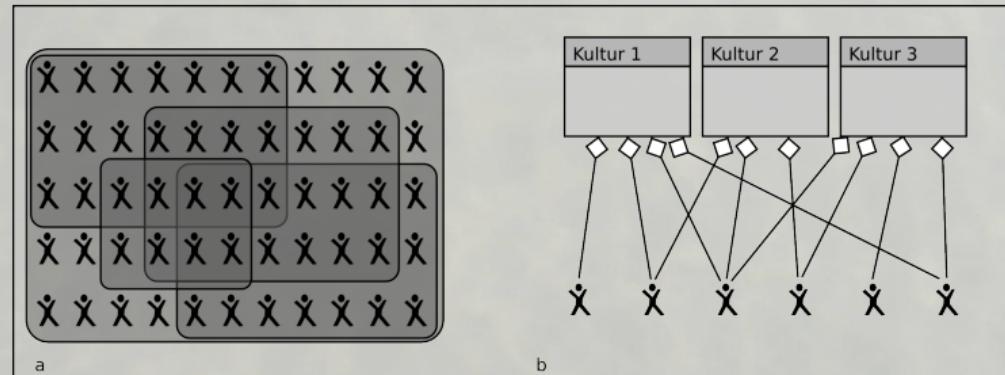
Hansen 2003, 39



Cultures are mapping interaction structures!

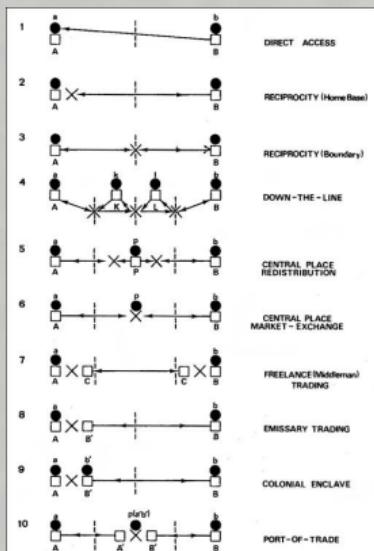
Similarities can be caused by

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

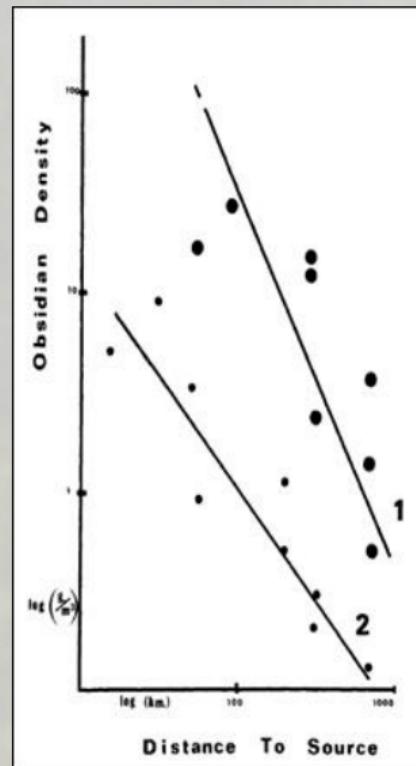


Fall Off Curves

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.

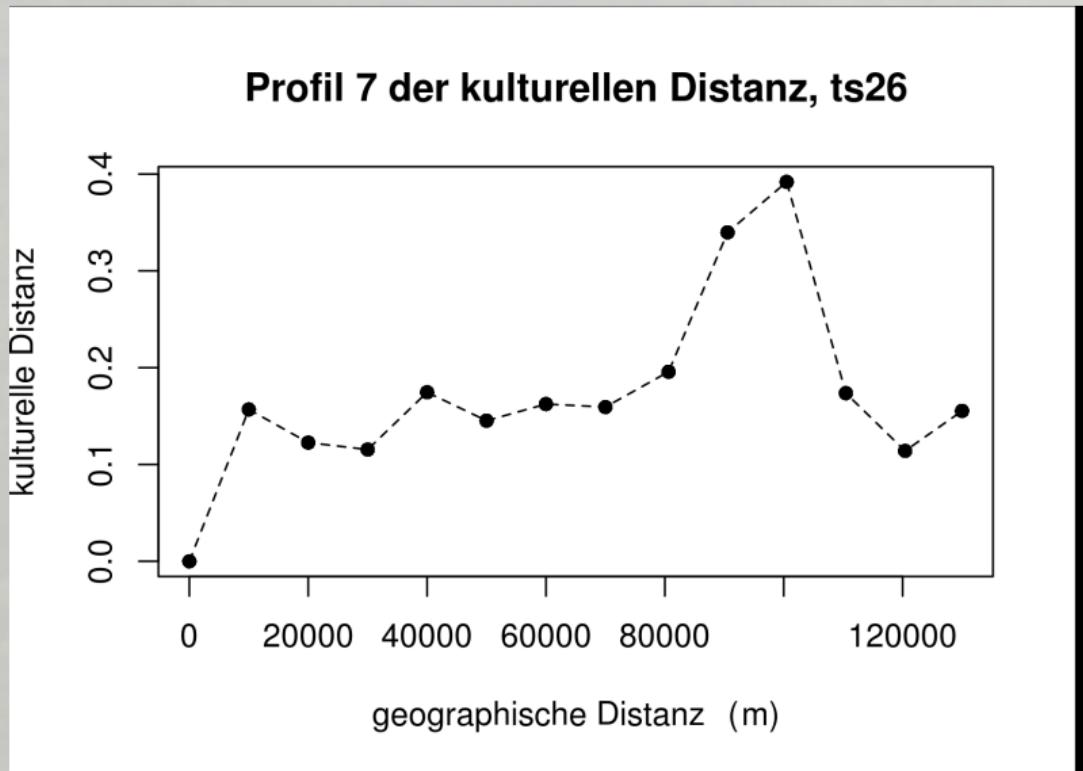
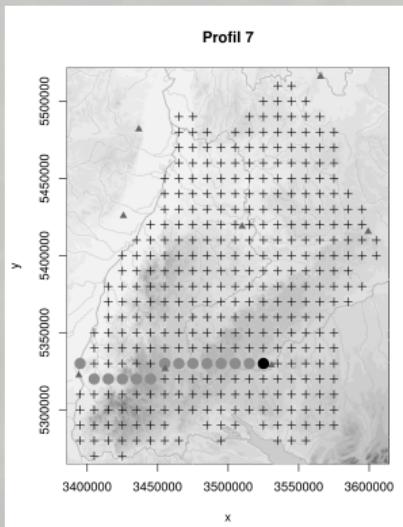
Distance diagram (dd):

- ▶ 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

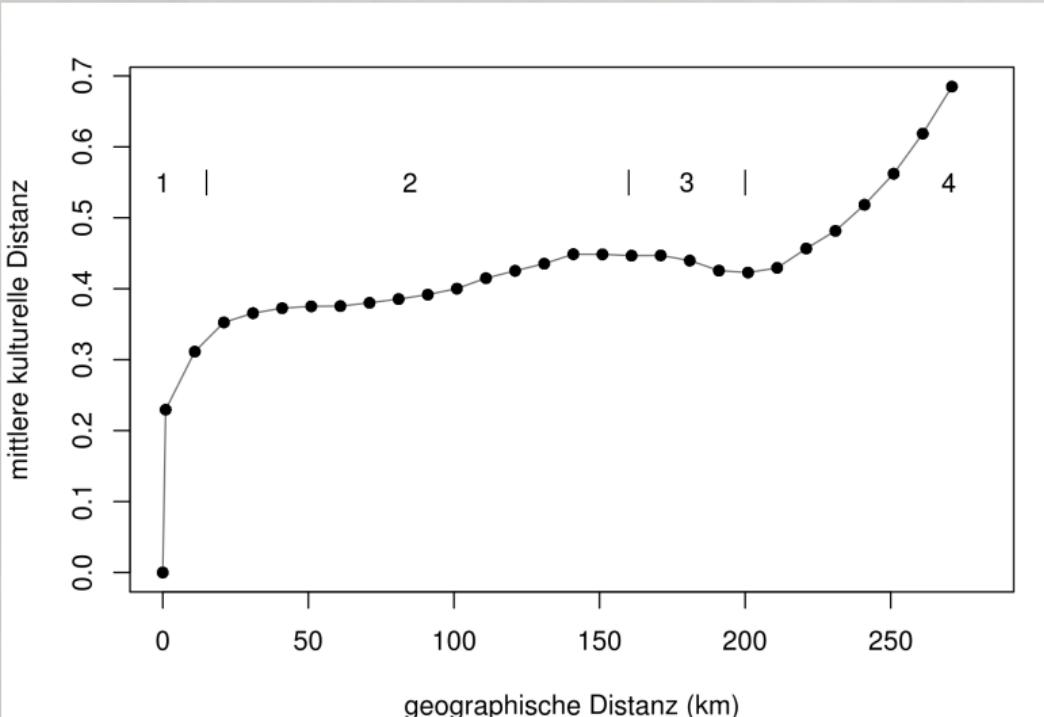
Interaction Model dd1

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

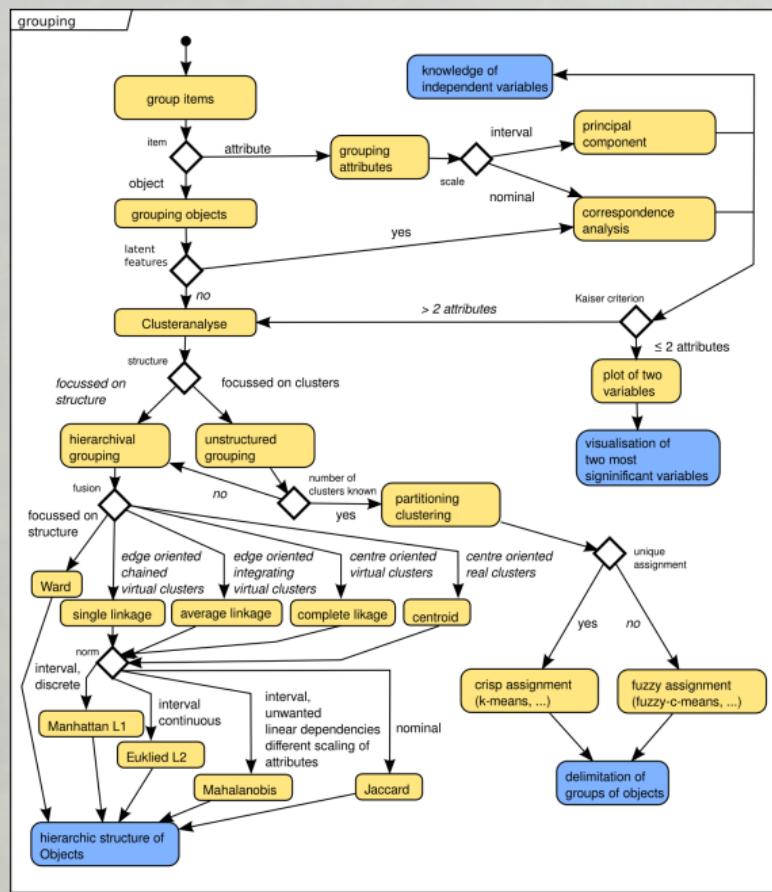
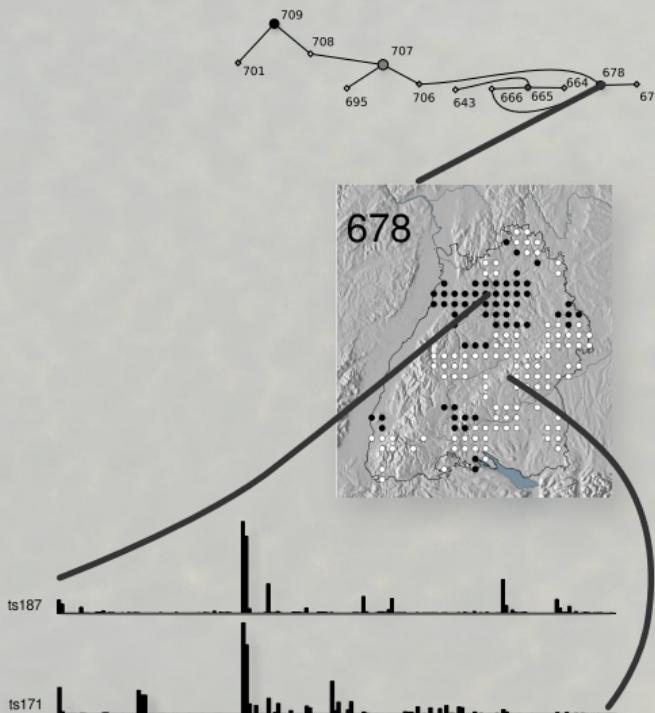


Interaction Model dd9

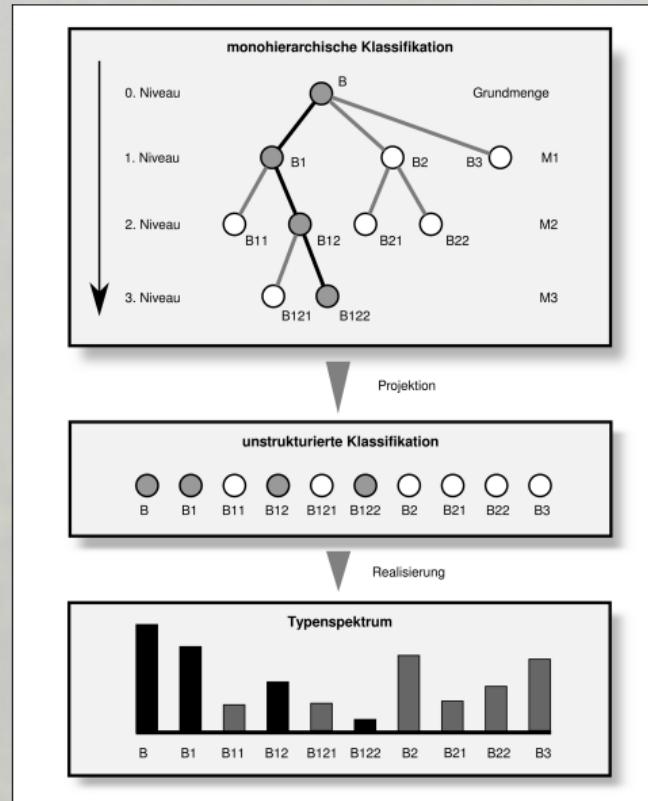
- ▶ from all points
- ▶ to all points
- ▶ fibulae and adornment

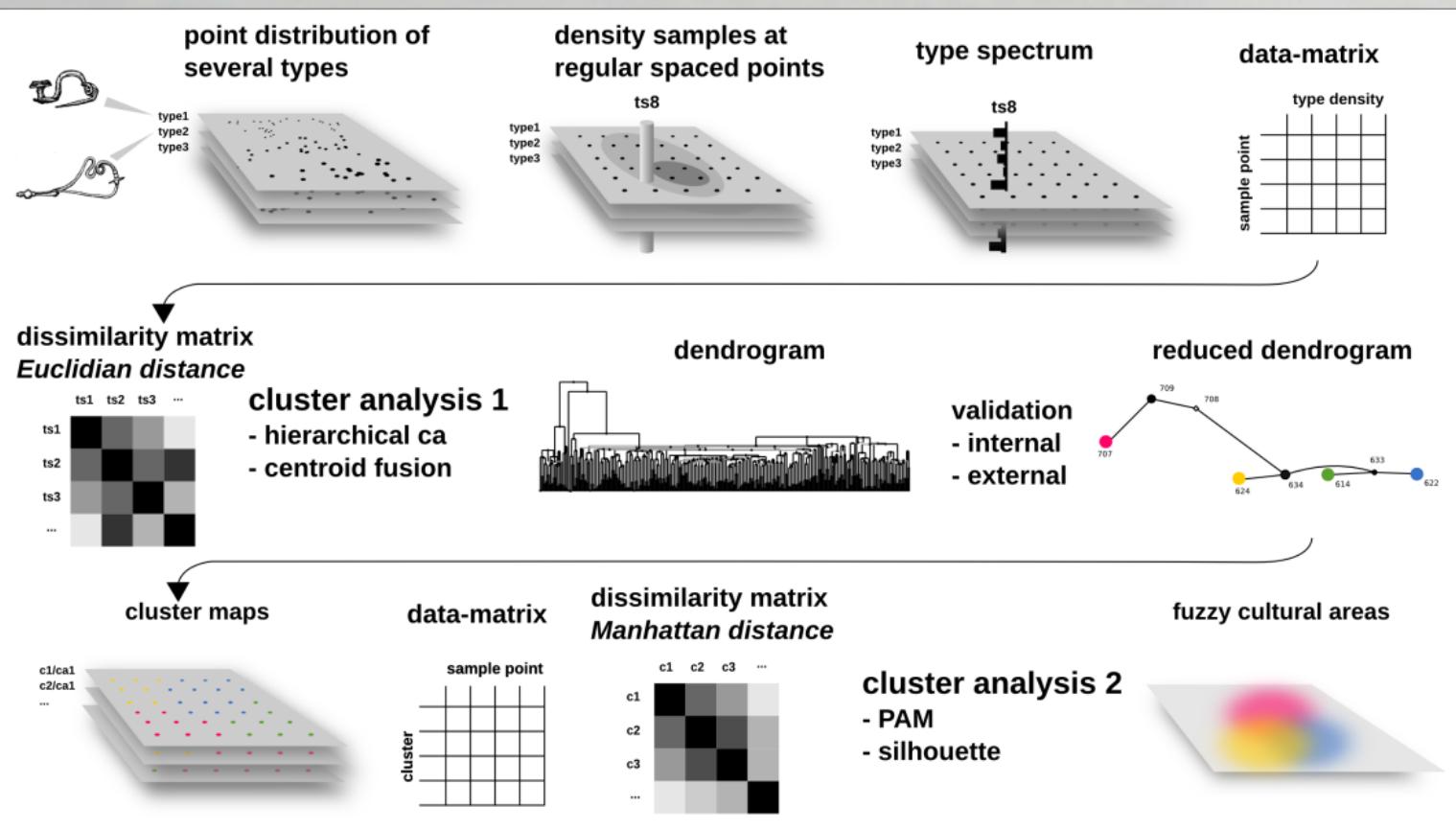


Decision Tree



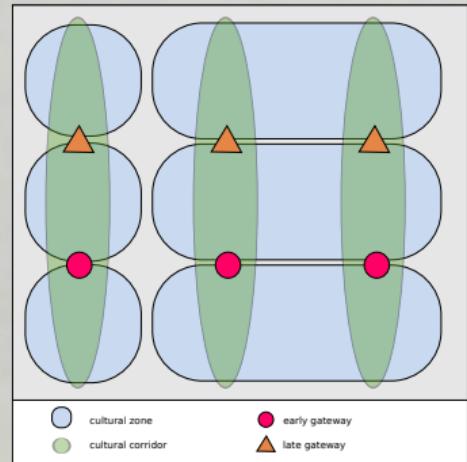
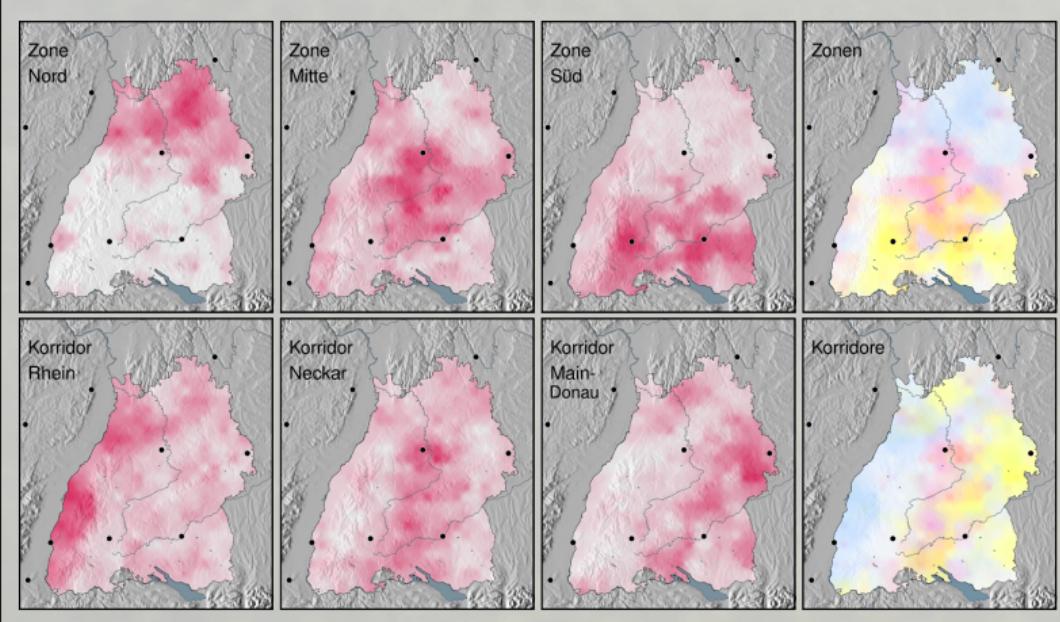
Weighting





SHKR Results

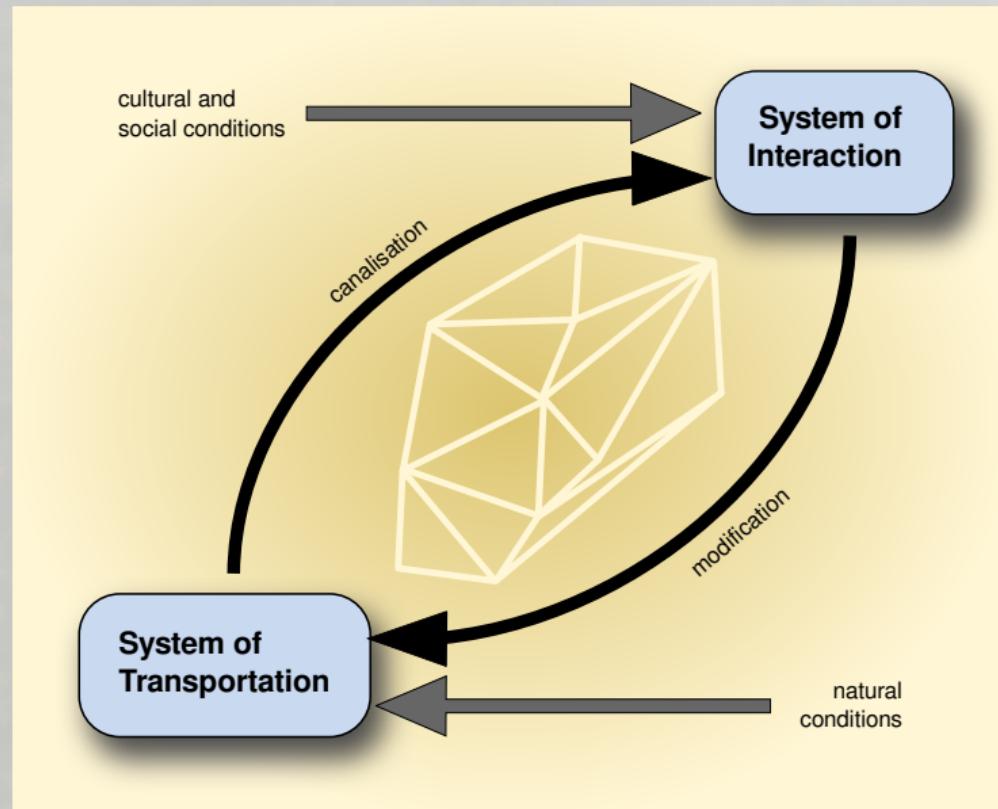
- centres at the border of cultural areas
- network centres rather than Christaller centres
- gateways



Transportation

Modelling systems of transportation

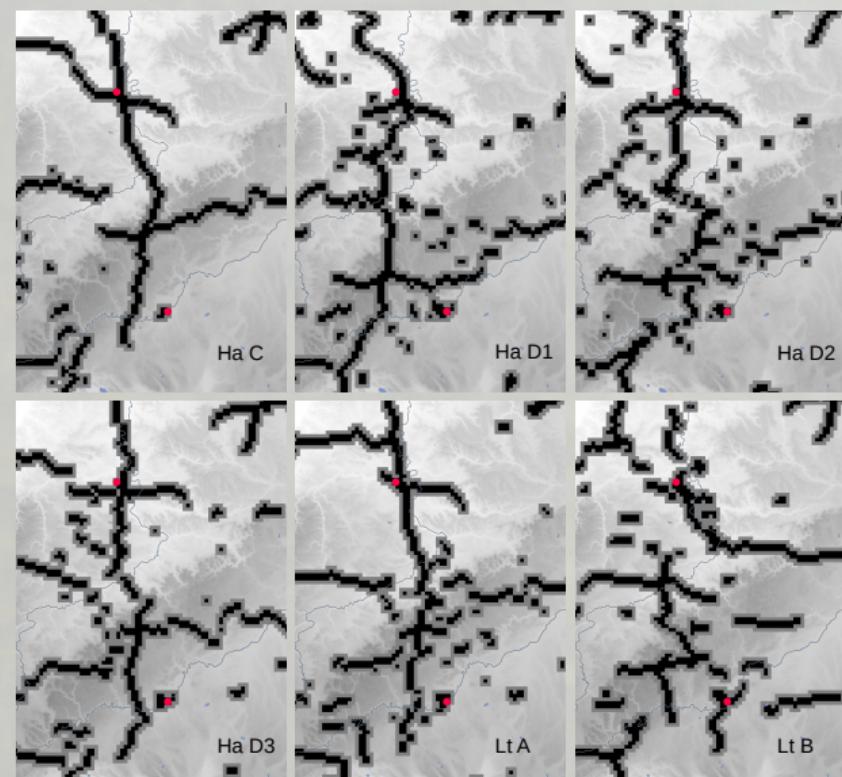
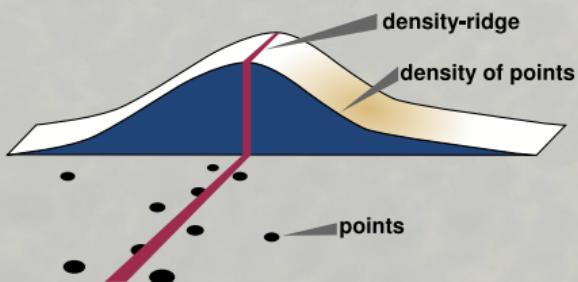
- ▶ is essential for modelling interaction
- ▶ produces knowledge of significant parameters



Transportation

Road system

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

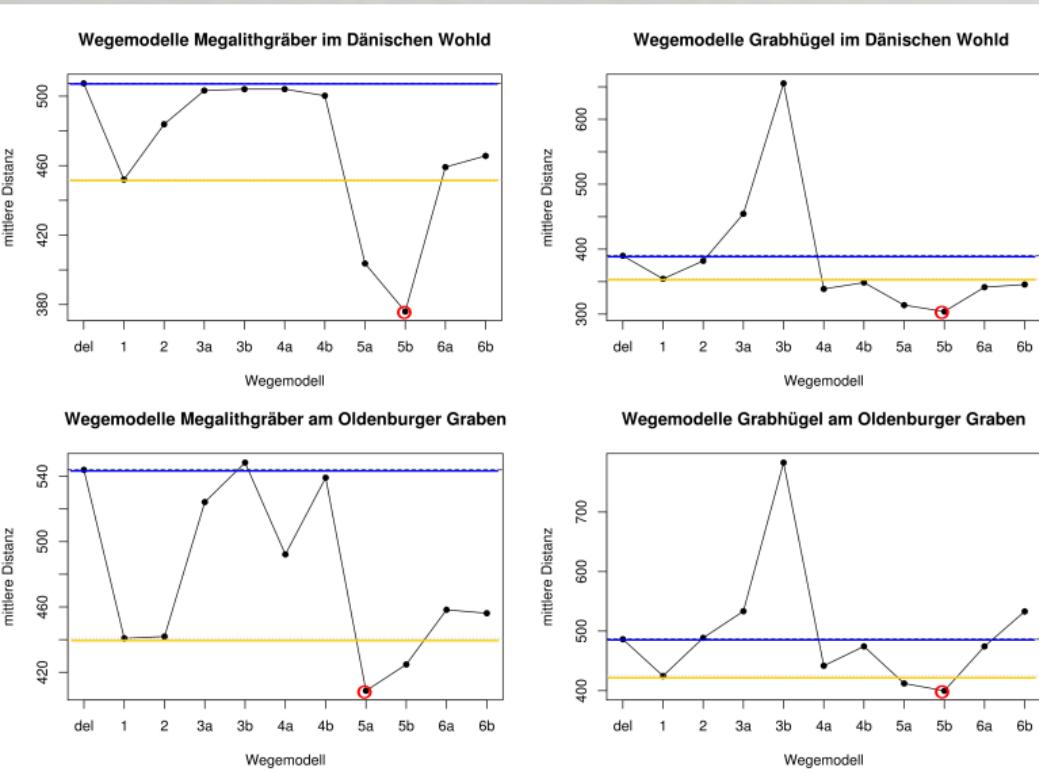


LCP Evaluation

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



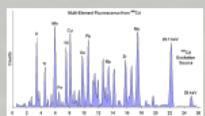
Data



Sites

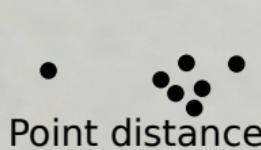


Artefacts

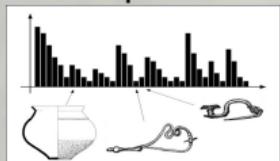


Chemical
components

Measures

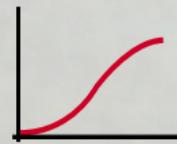


"Imports"

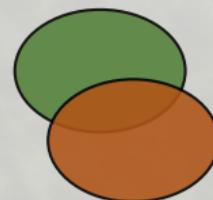


Cultural distance

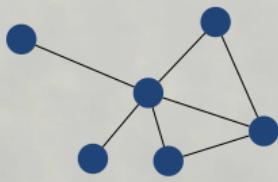
Models



Quantification

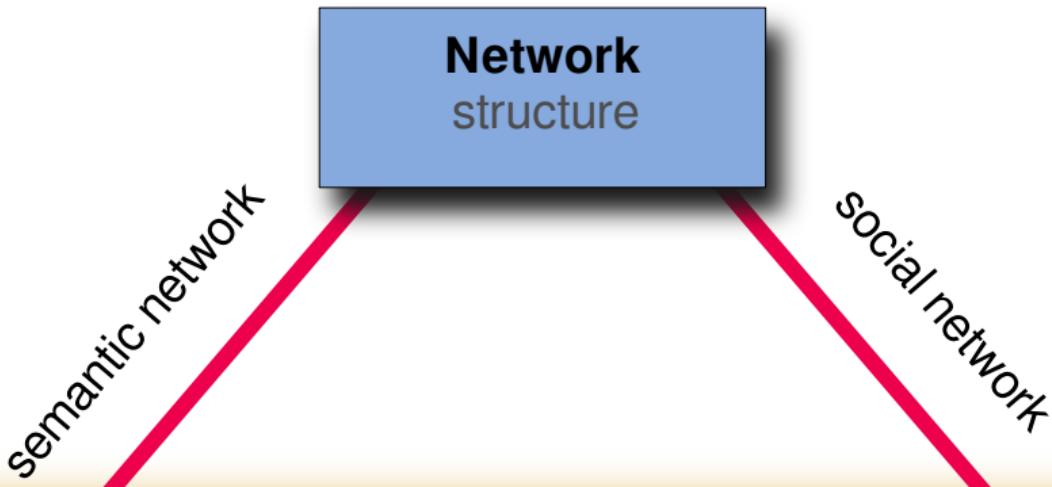


Regionalization



Connection

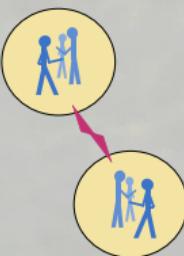
Integration



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