Structuring Geographic Information to support Semantic and Visual ‘zoom’

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Theme

- Computational techniques to support multi scale viewing and analysis of Geographic Information
- Map centric → Database centric view

Outline

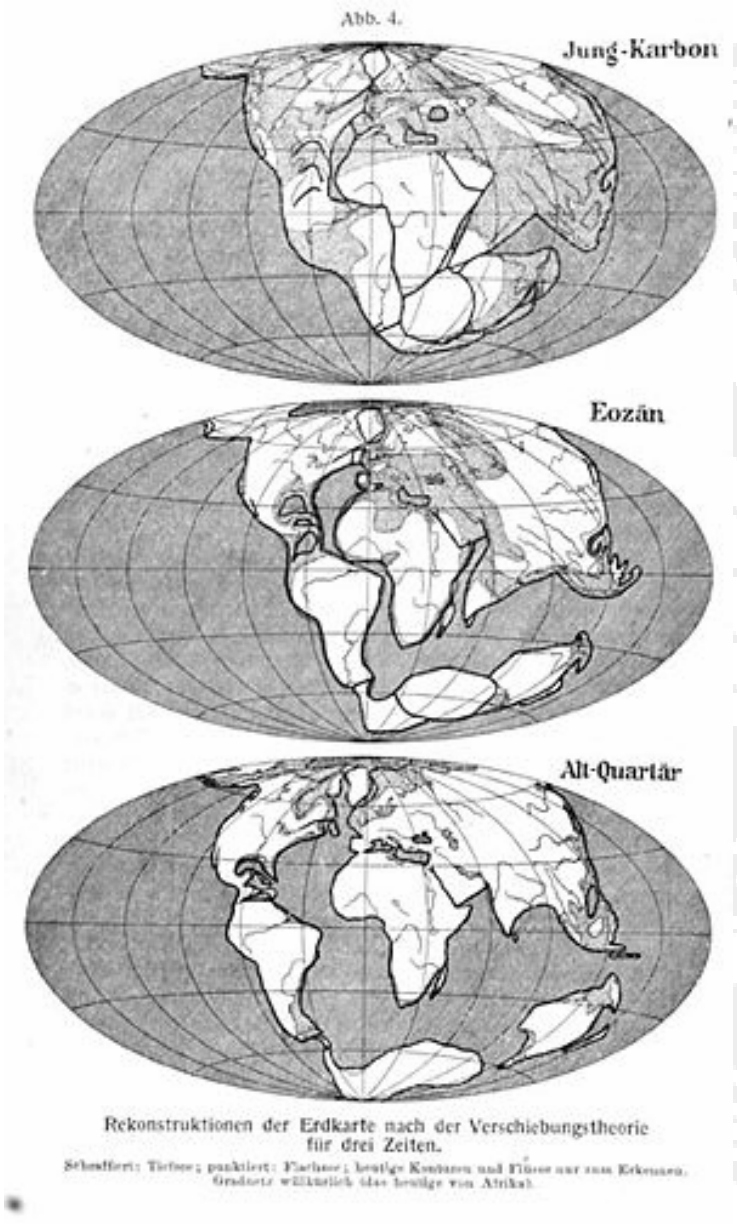
- The power of the map
- Cartography - From an Art to a Science?
- Multiscale Mapping
- Semantic Reference Systems
- Conclusion
  - Geography – the borrower of science


THE INDEPENDENT
OVER £25,000 WORTH OF PRIZES TO BE WON
CHRISTMAS GIVEAW
• XBOX 360 CONSOLES • DIGITAL CAMERAS • CHAMPNEYS LUXURY BR
Expanding tropics 'a threat to millions'
2.5 DEGREES NORTH
TROPIC OF CANCER
EQUATOR
TROPIC OF CAPRICORN
2.5 DEGREES SOUTH
Scientists shocked by dramatic growth of Earth's tropical belt and warn of grave consequences

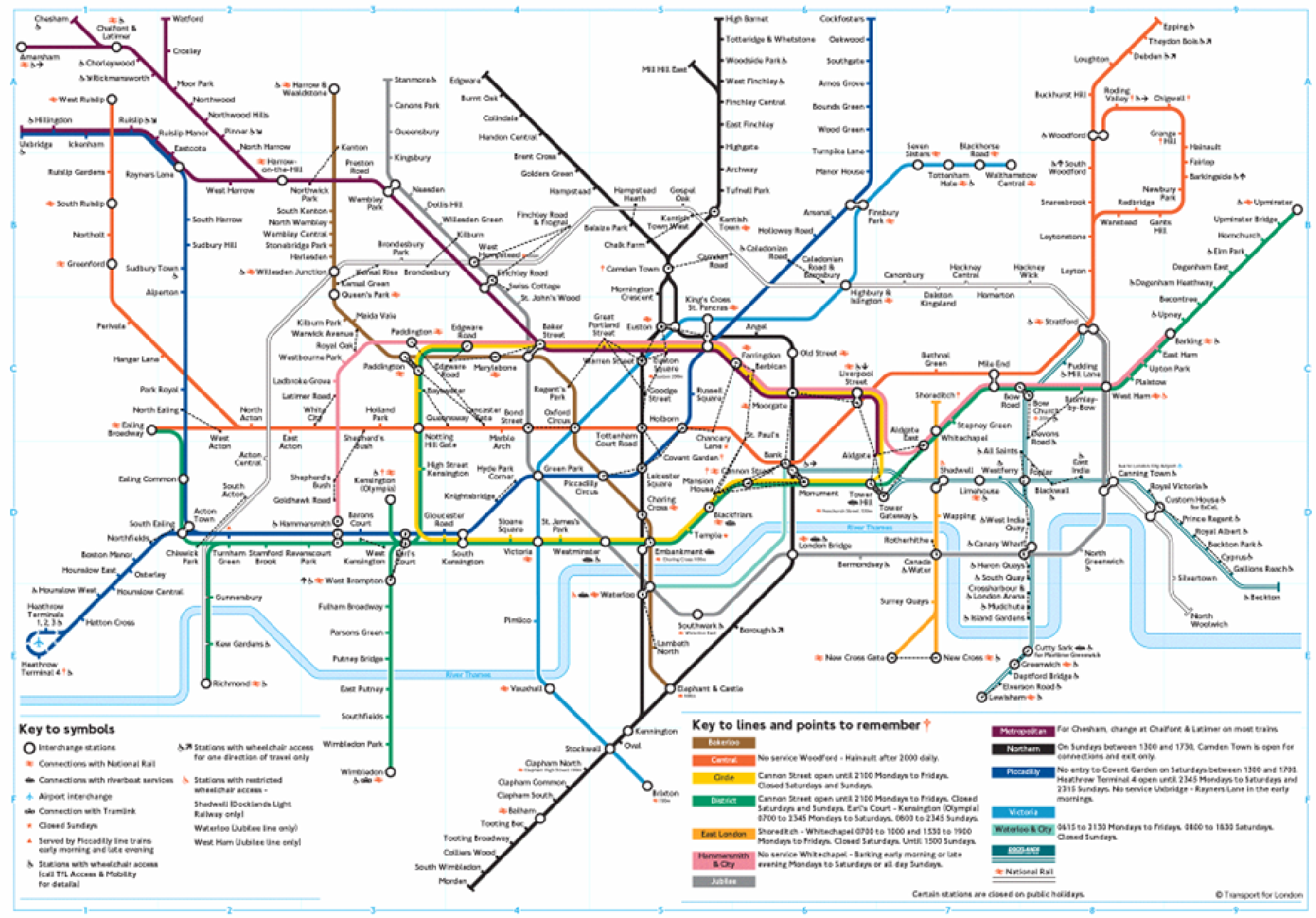
net, in quo terram cum orbe lunari tanquam epicyclo contineri diximus. Quinto loco Venus nono mense reducitur. Sextum deinceps locum Mercurius tenet, octuaginta dierum spacio circũ

Schema huius præmissæ diuisionis Sphærarum.

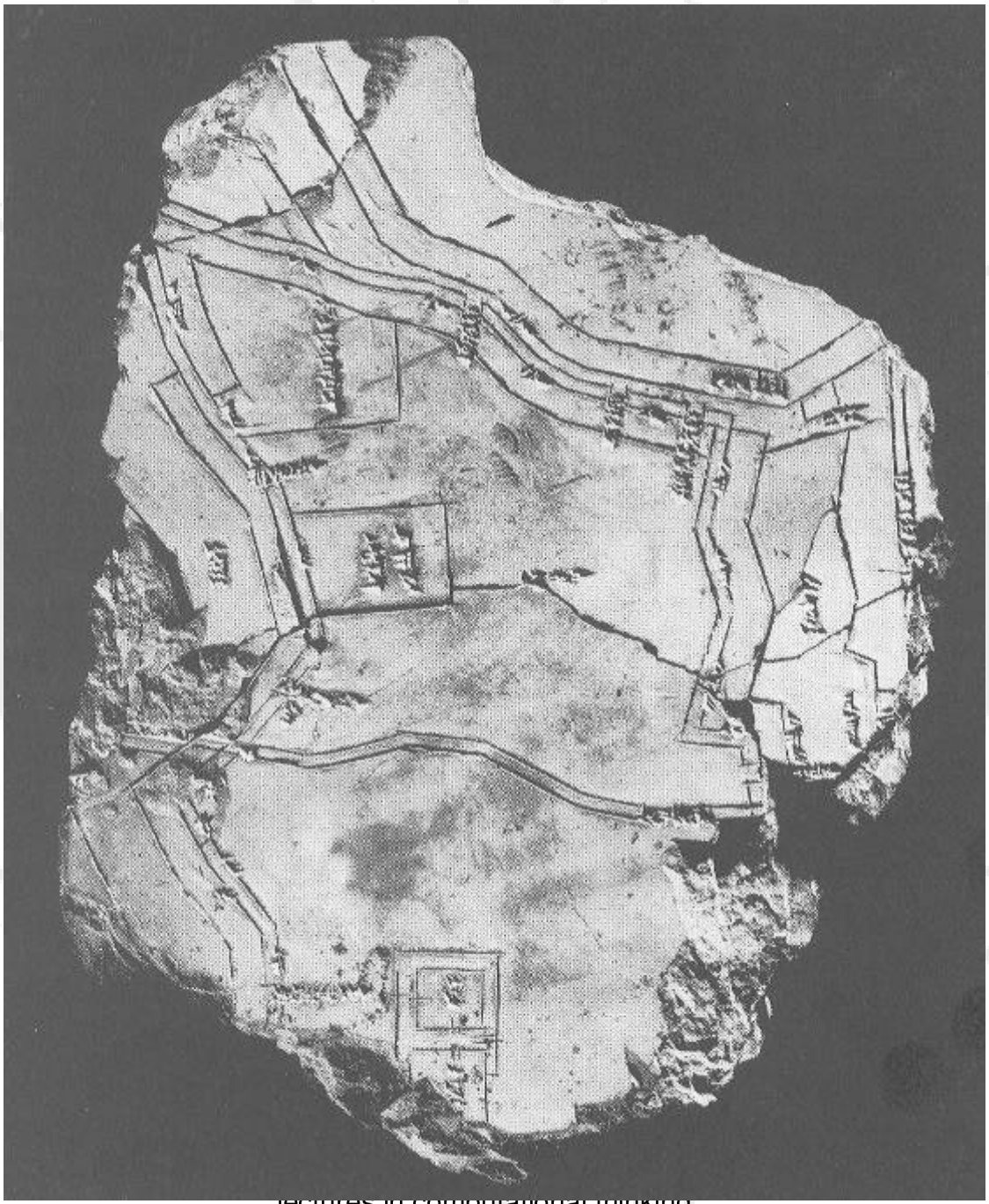
pulcherrimo templolampadem hanc in alio uel meliori loco poneret, quàm unde totum simul possit illuminare? Siquidem non inepte quidam lucernam mundi, alij mentem, alij rectorem uocant. Trimegistus uisibilem Deum, Sophoclis Electra intuentẽ omnia. Ita profecto tanquam in solio regali Sol residens circum agentem gubernat Astrorum familiam. Tellus quoq; minime fraudatur lunari ministerio, sed ut Aristoteles de animalibus ait, maximã Luna cũ terra cognationẽ habet. Concipit interea à Sole terra, & impregnatur annuo partu. Inuenimus igitur sub hac



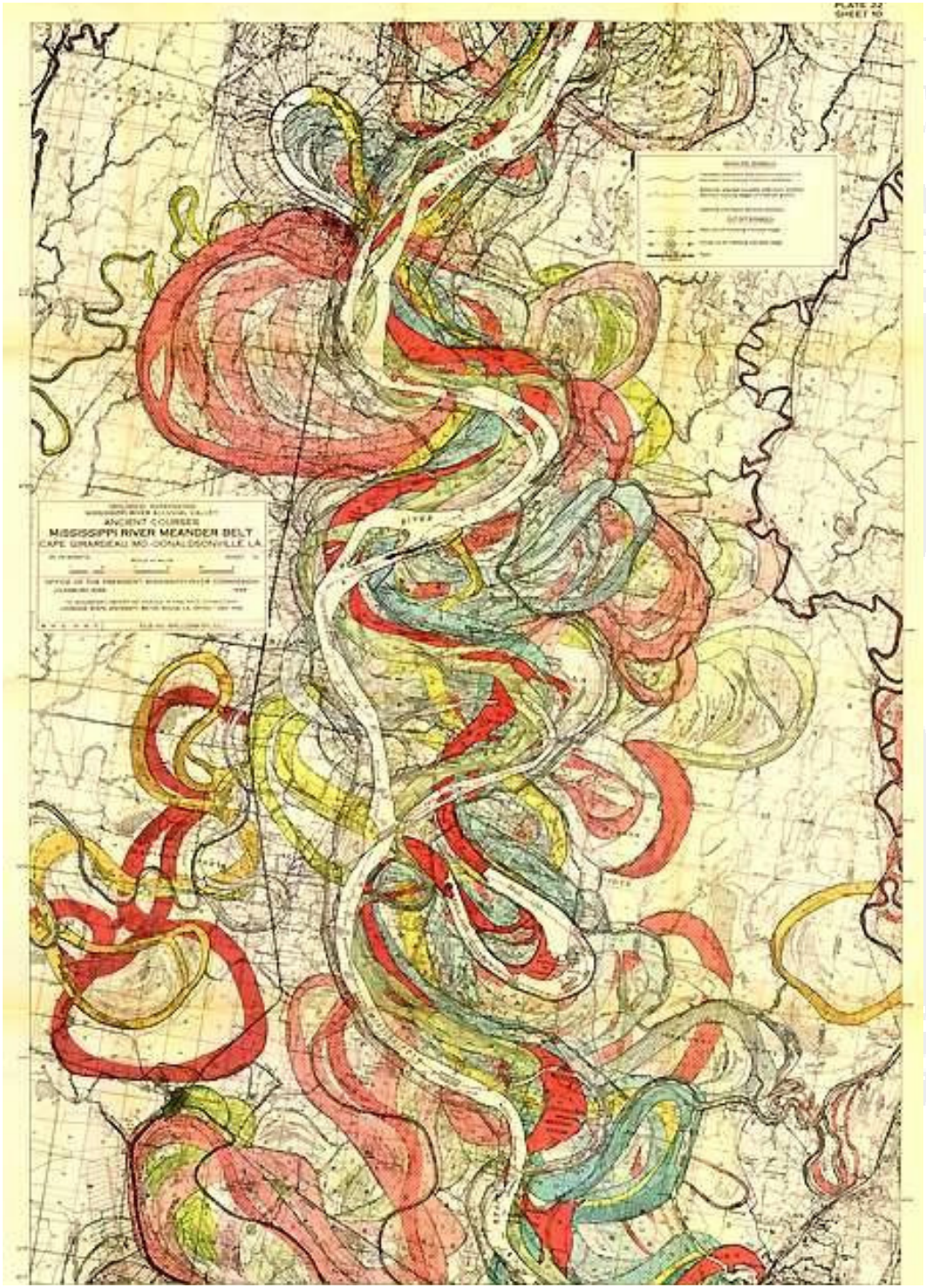
Alfred Wegener


Key to symbols
Interchange stations
Connections with National Rail
Connections with riverboat services
Airport interchange
Connection with Tramlink
Closed Sundays
Served by Piccadilly line trains early morning and late evening
Stations with wheelchair access (call TfL Access & Mobility for details)
Stations with wheelchair access for one direction of travel only
Stations with restricted wheelchair access -
Shadwell (Docklands Light Railway only)
Waterloo (Jubilee line only)
West Ham (Jubilee line only)
Key to lines and points to remember †
Bakerloo
Central
No service Woodford - Hainault after 2000 daily.
Circle
Cannon Street open until 2100 Mondays to Fridays. Closed Saturdays and Sundays.
District
Cannon Street open until 2100 Mondays to Fridays. Closed Saturdays and Sundays. Earl's Court - Kensington (Olympia) 0700 to 2345 Mondays to Saturdays, 0800 to 2345 Sundays.
East London
Shoreditch - Whitechapel 0700 to 1000 and 1530 to 1900 Mondays to Fridays. Closed Saturdays. Until 1500 Sundays.
Hammersmith & City
No service Whitechapel - Barking early morning or late evening Mondays to Saturdays or all day Sundays.
Jubilee
Metropolitan
For Chesham, change at Chalfont & Latimer on most trains.
Northern
On Sundays between 1300 and 1730, Camden Town is open for connections and exit only.
Piccadilly
No entry to Covent Garden on Saturdays between 1300 and 1700. Heathrow Terminal 4 open until 2345 Mondays to Saturdays and 2315 Sundays. No service Uxbridge - Rayners Lane in the early mornings.
Victoria
Waterloo & City
0615 to 2130 Mondays to Fridays, 0800 to 1830 Saturdays. Closed Sundays.
London Overground
National Rail
Certain stations are closed on public holidays.
© Transport for London


TRANSIT MAPS OF THE WORLD
Calgary
Edmonton
Toronto
Ottawa
Montreal
Buffalo
Boston
New York
Newark
Chicago
Minneapolis
Detroit
Cleveland
Salt Lake City
Las Vegas
Denver
Houston
Monterrey
Guadalajara
Mexico City
Philadelphia
Pittsburgh
Baltimore
St. Louis
Washington
Dallas
Atlanta
Jacksonville
Miami
Santo Domingo
San Juan
Valencia
Caracas
Recife
Fortaleza
Salvador
Rio de Janeiro
Maracaibo
Medellin
Lima
Brasilia
Belo Horizonte
Valparaiso
Goiânia
Sao Paulo
Santiago
Porto Alegre
Montevideo
Buenos Aires
Edinburgh
Glasgow
Newcastle
Sheffield
Nottingham
Liverpool
Dublin
Manchester
Birmingham
London
Oslo
Gothenburg
Stockholm
Copenhagen
Hamburg
Hanover
Helsinki
Gdansk
Poznan
Cracow
St. Petersburg
Moscow
Warsaw
Minsk
The Hague
Amsterdam
Rotterdam
Brussels
Antwerp
Bielefeld
Charleroi
Laon
Berlin
Prague
Kiev
Orleans
Paris
Lille
Rhine/Ruhr
Cologne
Bonn
Frankfurt
Nuremburg
Dnipropetrovs'k
Vienna
Rouen
Rennes
Nantes
Bordeaux
Strasbourg
Zurich
Lausanne
Ludwigshafen
Karlsruhe
Stuttgart
Munich
Linz
Budapest
Kryvy Rih
Brescia
Toulouse
Montpellier
Lyon
Milan
Bologna
Bucharest
Porto
Bilbao
Grenoble
Turin
Genoa
Parma
Belgrade
Sofia
Madrid
Barcelona
Palma de Mallorca
Marseille
Nice
Rome
Naples
Thessaloniki
Seville
Alicante
Palermo
Salerno
Athens
Izmir
Lisbon
Malaga
Valencia
Tunis
Catania
Haifa
Algiers
Alexandria
Dubai
Cairo
Under Construction
Lagos
Tel Aviv
Jerusalem
Esfahan
Baghdad
Shiraz
Delhi
Kolkota
Bangalore
Mumbai
Chennai
Kazan
Perm
Chelyabinsk
Yekaterinburg
Nizhniy Novgorod
Ufa
Omsk
Novosibirsk
Krasnoyarsk
Kharkiv
Donets'k
Odessa
Samara
Volgograd
Tbilisi
Istanbul
Bursa
Ankara
Adana
Yerevan
Baku
Tehran
Tashkent
Mashhad
Chengdu
Almaty
Chongqing
Guangzhou
Hanoi
Chaing Mai
Ho Chi Minh
Bangkok
Kuala Lumpur
Singapore
Melbourne
Sydney
Shanghai
Wuhan
Xi'an
Pyongyang
Seoul
Tianjin
Beijing
Shenyang
Changchun
Sapporo
Kawasaki
Yokohama
Nagoya
Kyoto
Kobe
Hiroshima
Kitakyush
Incheon
Daejeon
Daegu
Gwangju
Busan
Nanjing
Hangzhou
Taipei
Shenzhen
Kaohsiung
Hong Kong
Manila
Jakarta
Auckland



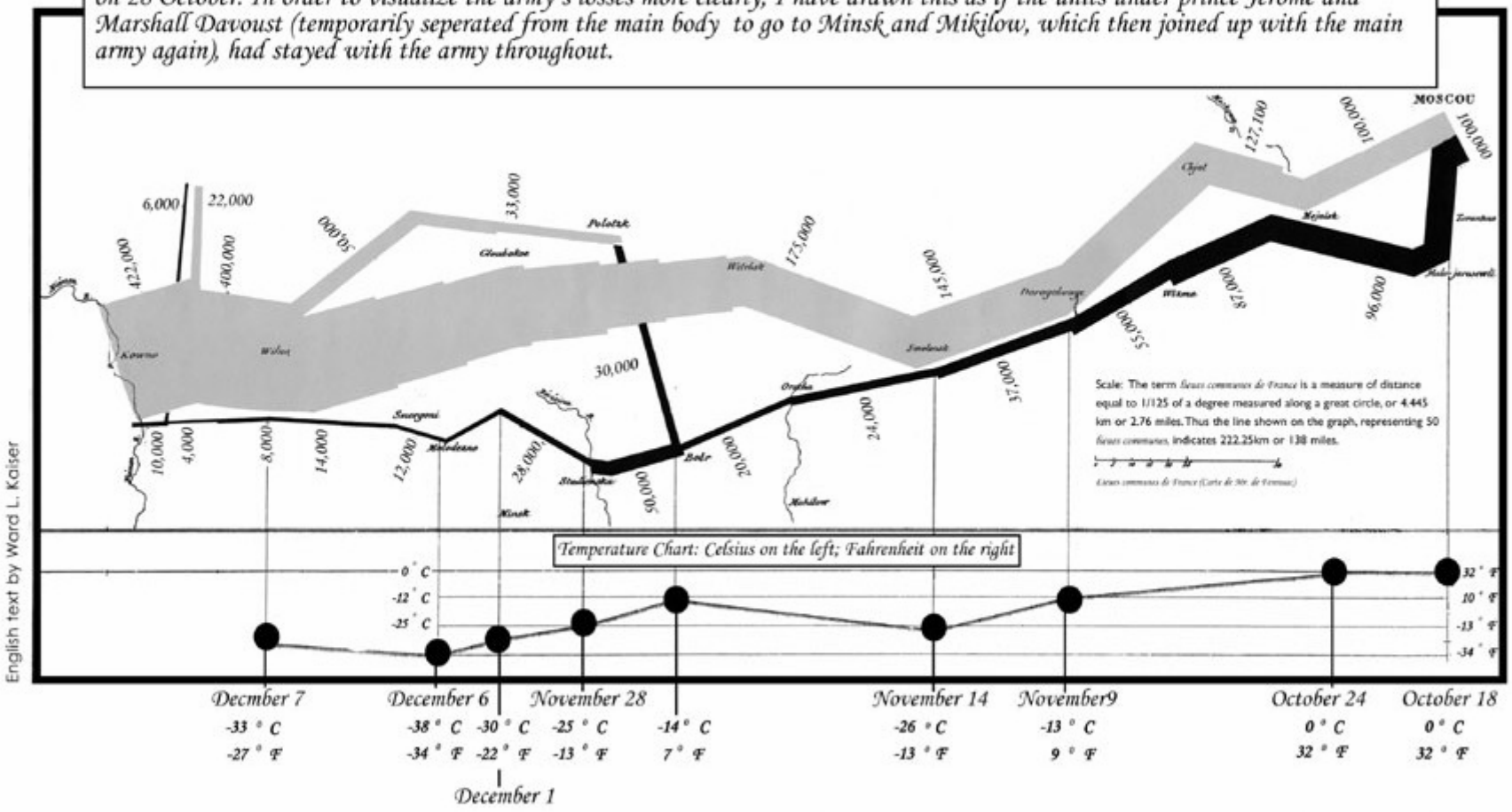

STRATA
ENGLAND and WALES,
SCOTLAND,
THE
GERMAN
OCEAN
IRISH SEA
THE ENGLISH CHANNEL


ANCIENT COURSES
MISSISSIPPI RIVER MEANDER BELT
CAPE GIRARDEAU MO.-DONALDSONVILLE LA.

Map representing the losses over time of French army troops during the Russian campaign, 1812-1813. Constructed by Charles Joseph Minard, Inspector General of Public Works retired.

Paris, 20 November 1869

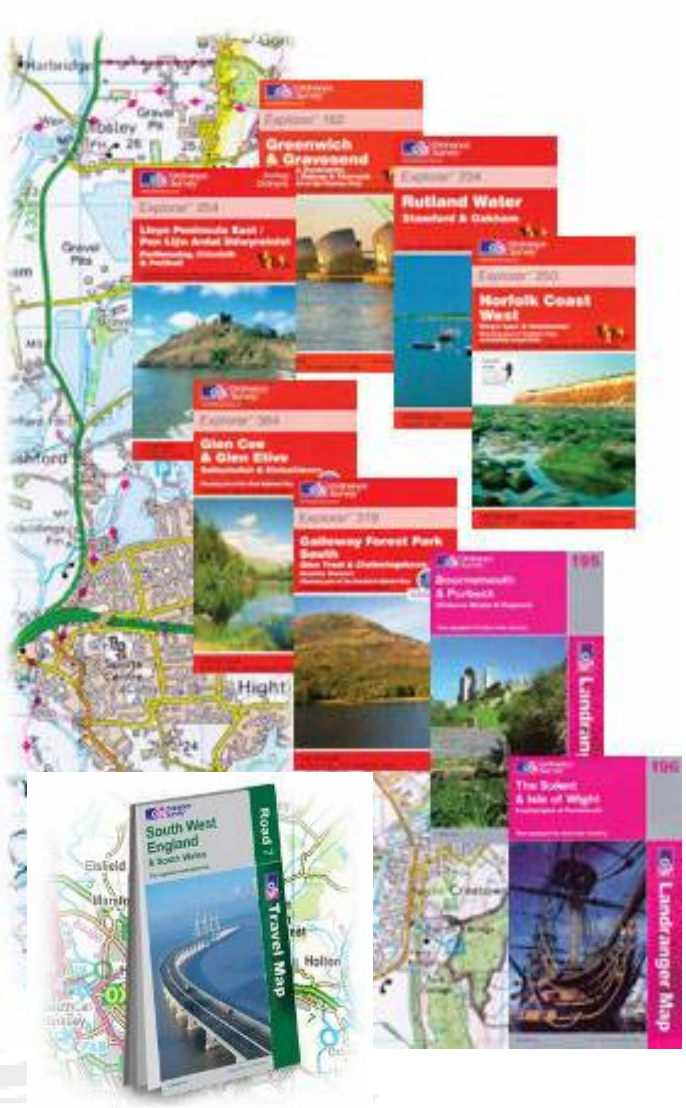
The number of men present at any given time is represented by the width of the grey line; one mm. indicates ten thousand men. Figures are also written besides the lines. Grey designates men moving into Russia ; black , for those leaving. Sources for the data are the works of messrs. Thiers, Segur, Fezensac, Chambray and the unpublished diary of Jacob. who became an Army Pharmacist on 28 October. In order to visualize the army's losses more clearly, I have drawn this as if the units under prince Jerome and Marshall Davoust (temporarily seperated from the main body to go to Minsk and Mikilow, which then joined up with the main army again), had stayed with the army throughout.



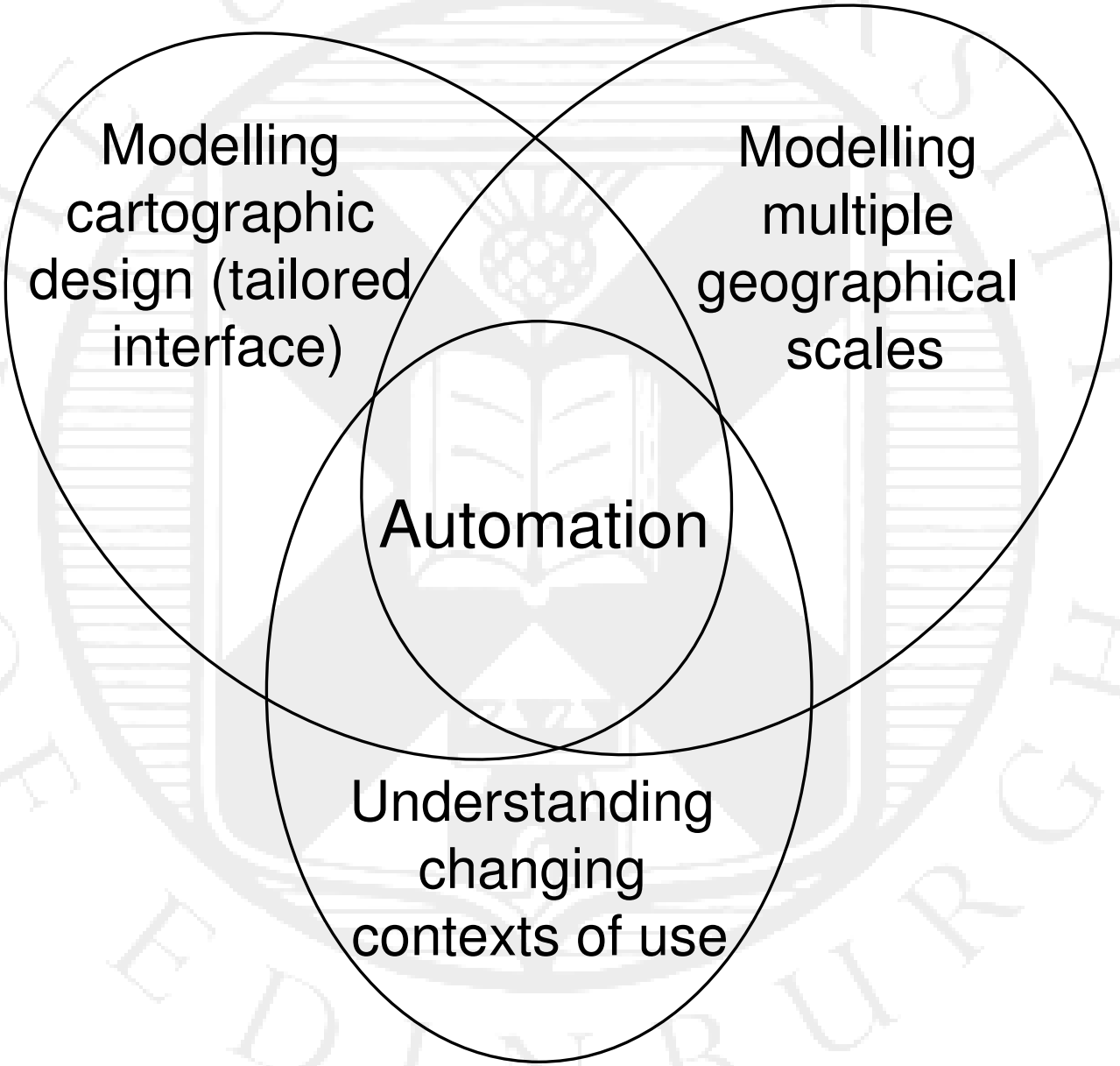
English text by Ward L. Kaiser

Editor s note: dates & temperatures are only referenced for the retreat from Moscow

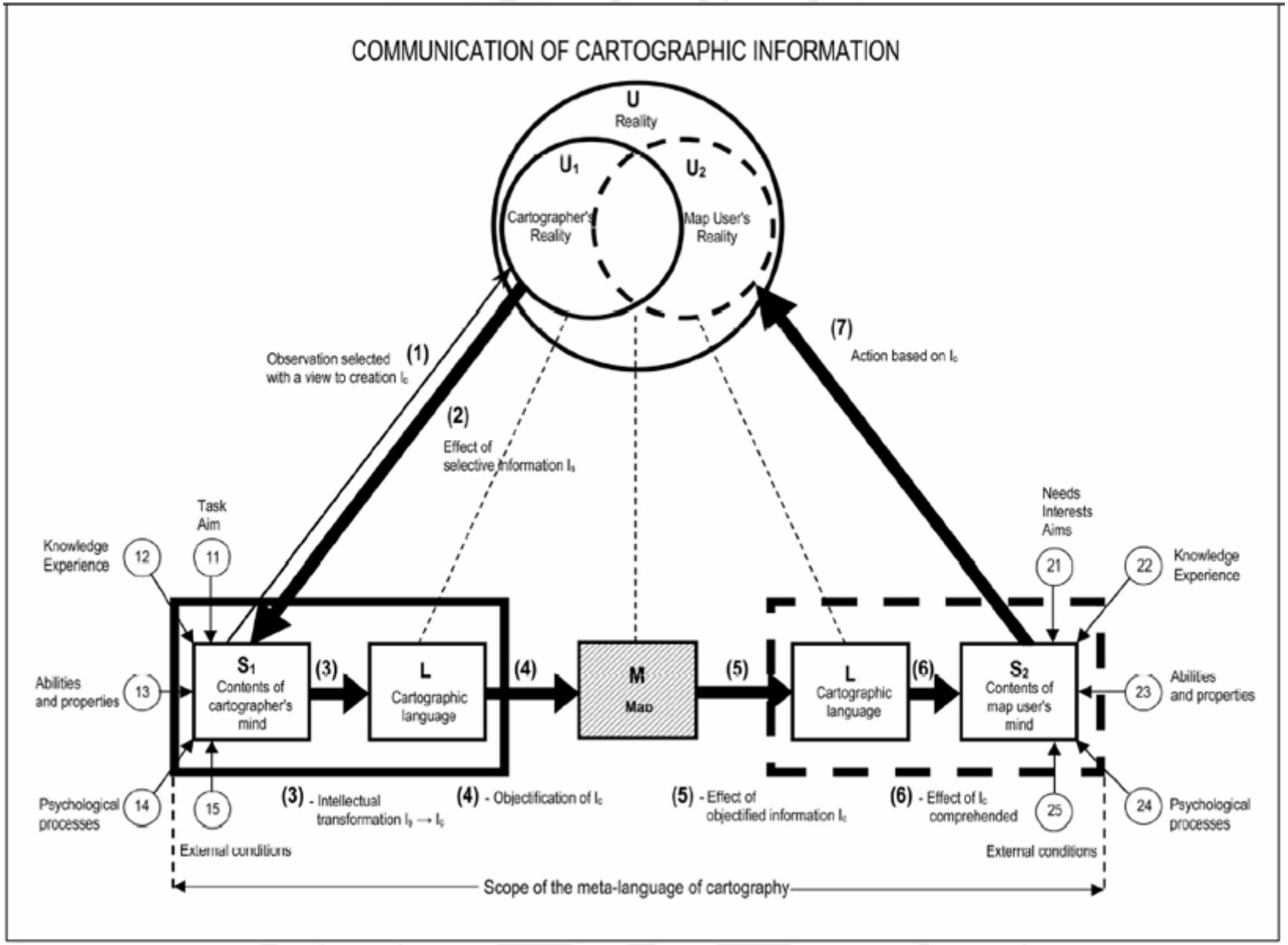
Figure 58. ***Minard s map of Napoleon s Russian campaign.***
This graphic has been translated from French to English and modified to most effectively display the temperature data.


Greenwich & Gravesend
Rutland Water
Norfolk Coast West
Glen Coe & Glen Etive
Galloway Forest Park South
Landranger
South West England
Road 7
Travel Map
The Solent & Isle of Wight
Landranger Map

Technology Driven…..



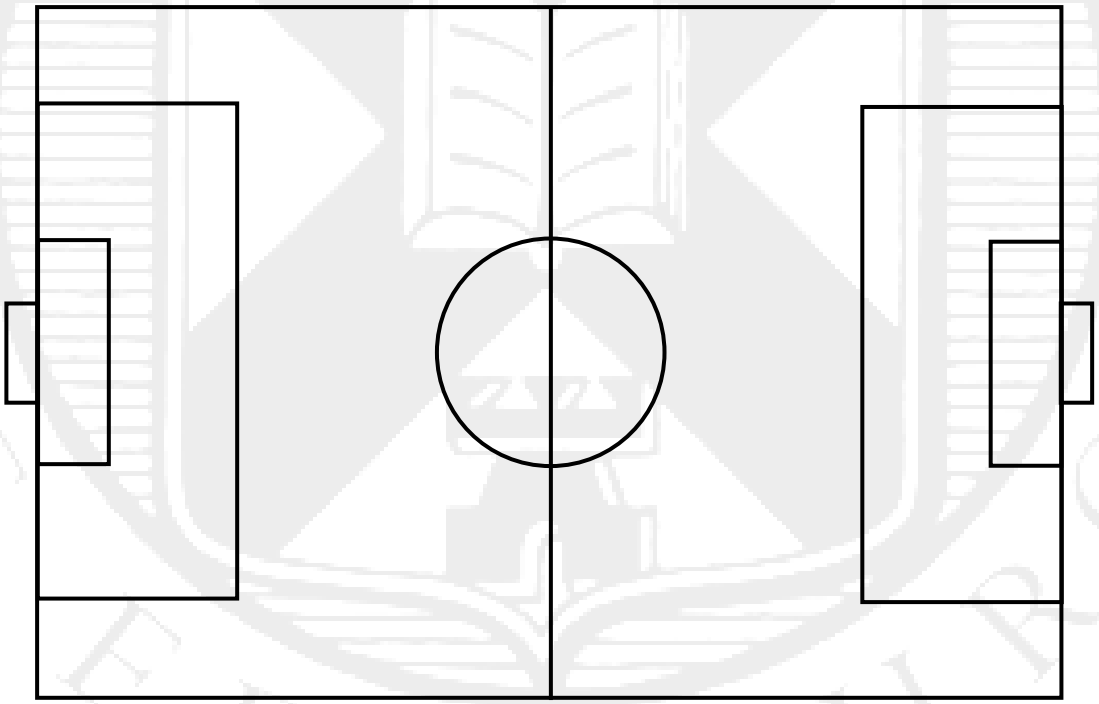

Design & Meaning



Semiotics: 1969, Kolácny

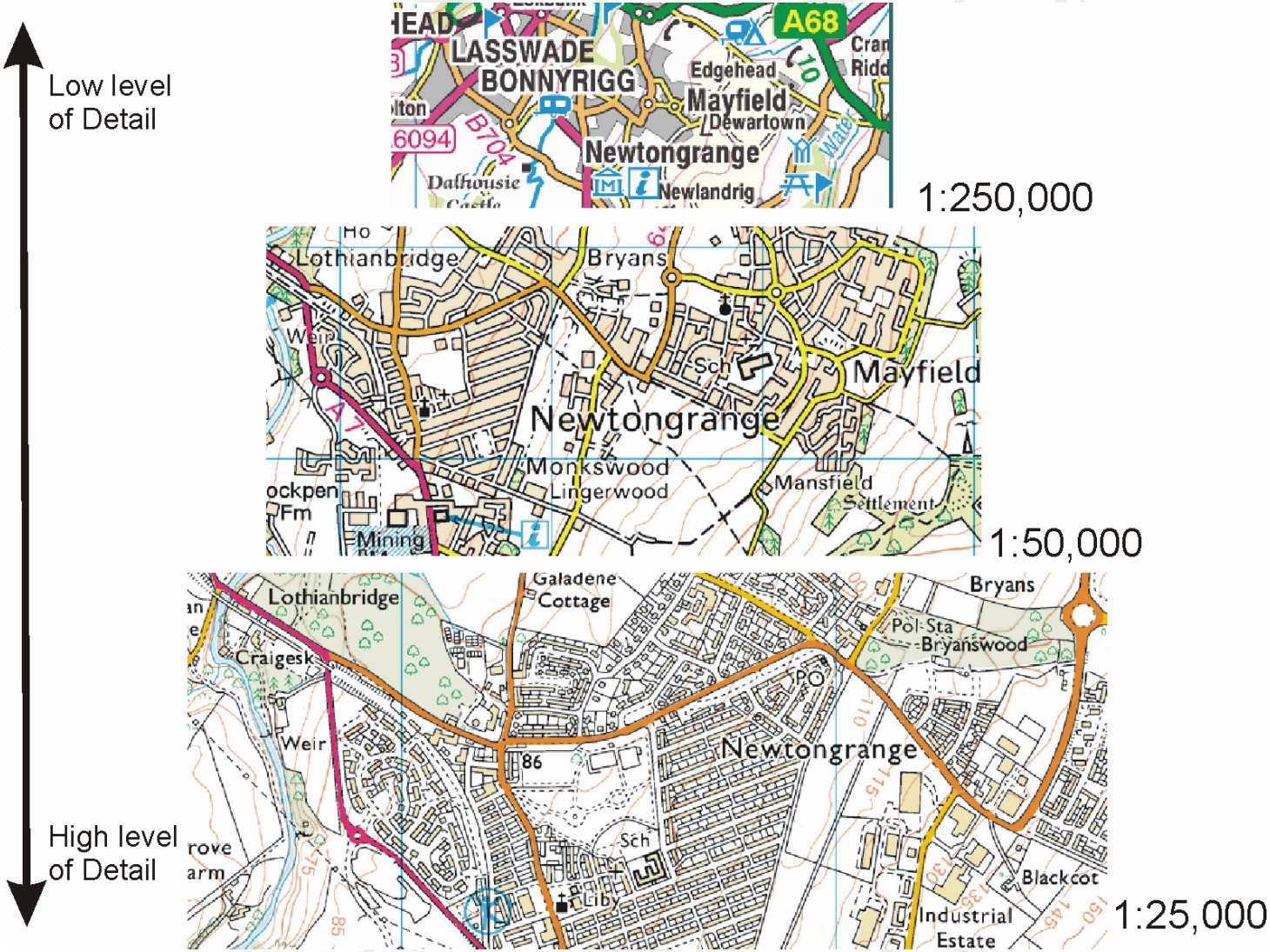
Importance of
1) scale;
2) prototypical views
...to semiotics/ sign systems:

Put your arm down when you think you know what it is?



Multiple views of the world…

Multiple representations

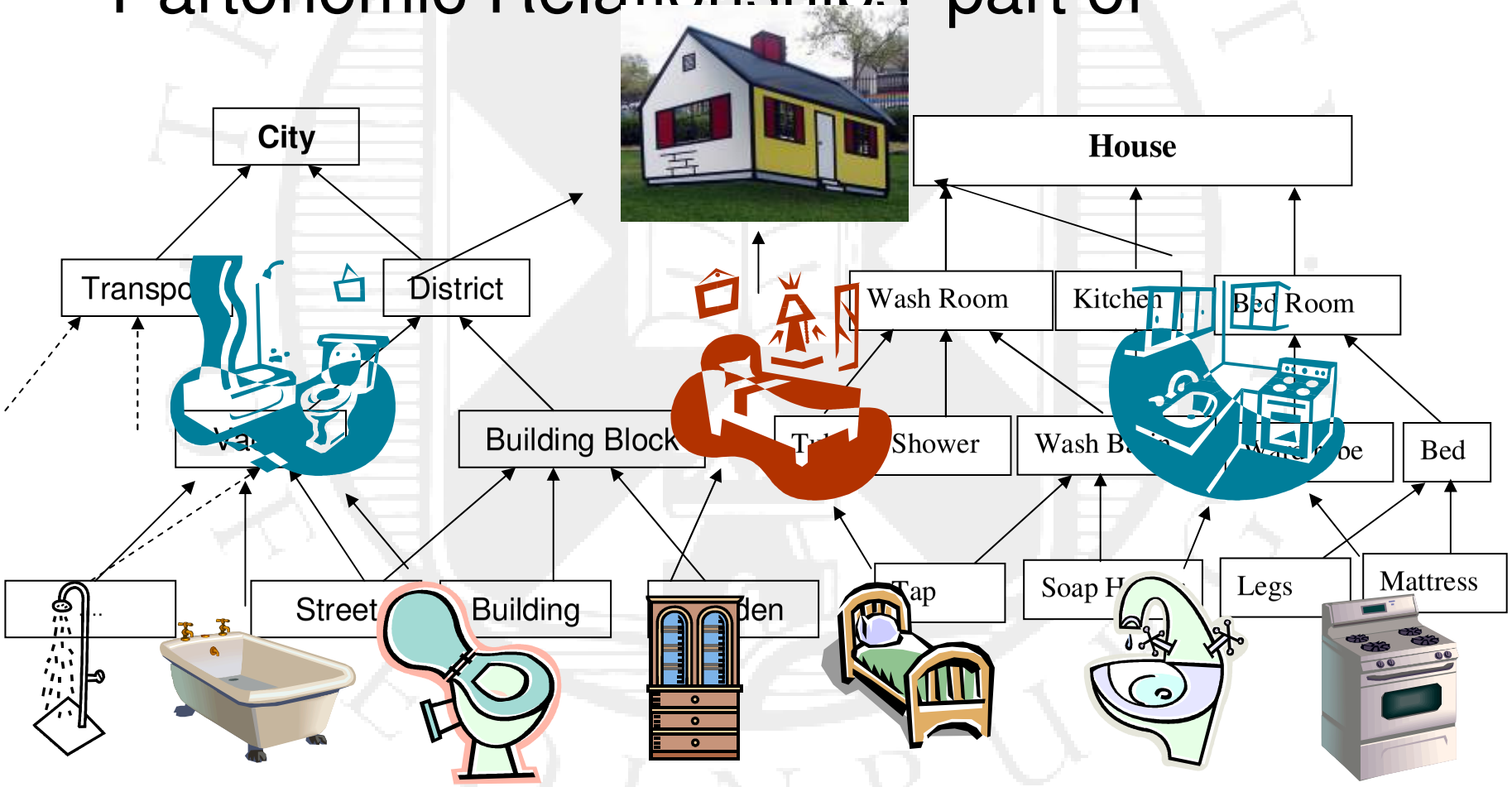


MRDB – requires very rich models of Geographic Space

- Topological modelling
- Neighbourhoods: Tessellations of space: Voronoi
- Modelling networks: graph theory
- Statistical techniques: clustering techniques
- Classification methodologies: Taxonomies and Partonomies (Mereology)

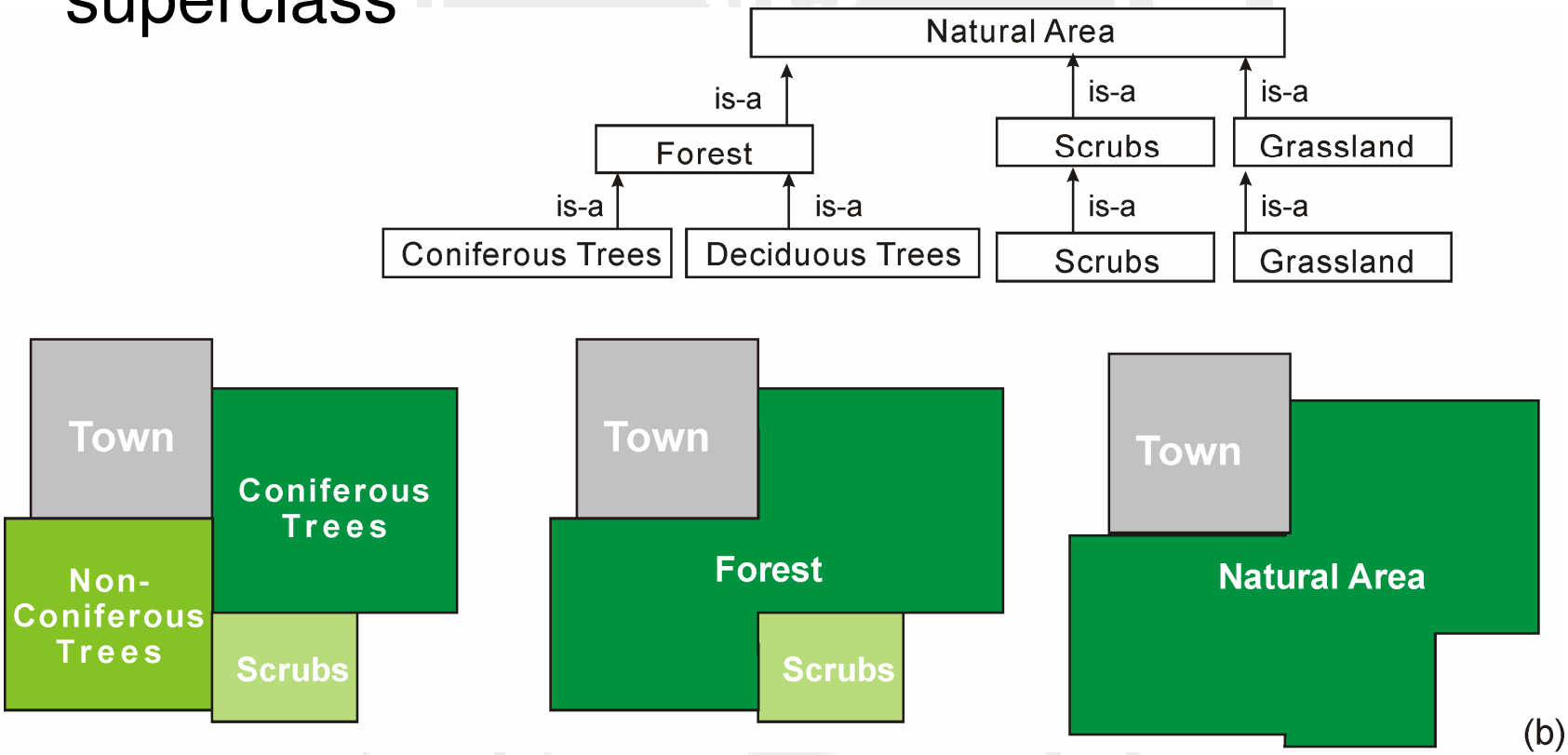
Objects and Relationship

- Partonomic Relationships 'part of'



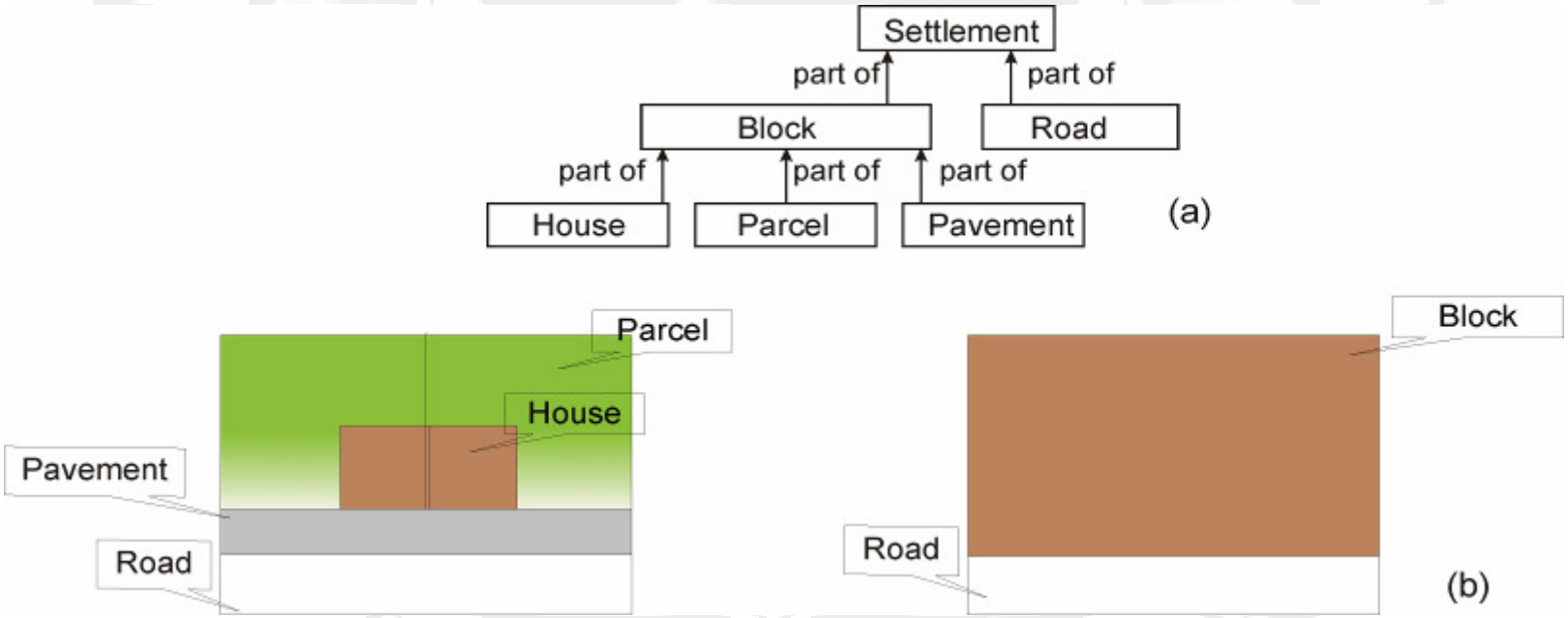
Taxonomic Classification

- Aggregation *within* a superclass



Partonomic Classification

- Aggregation of *different* classes

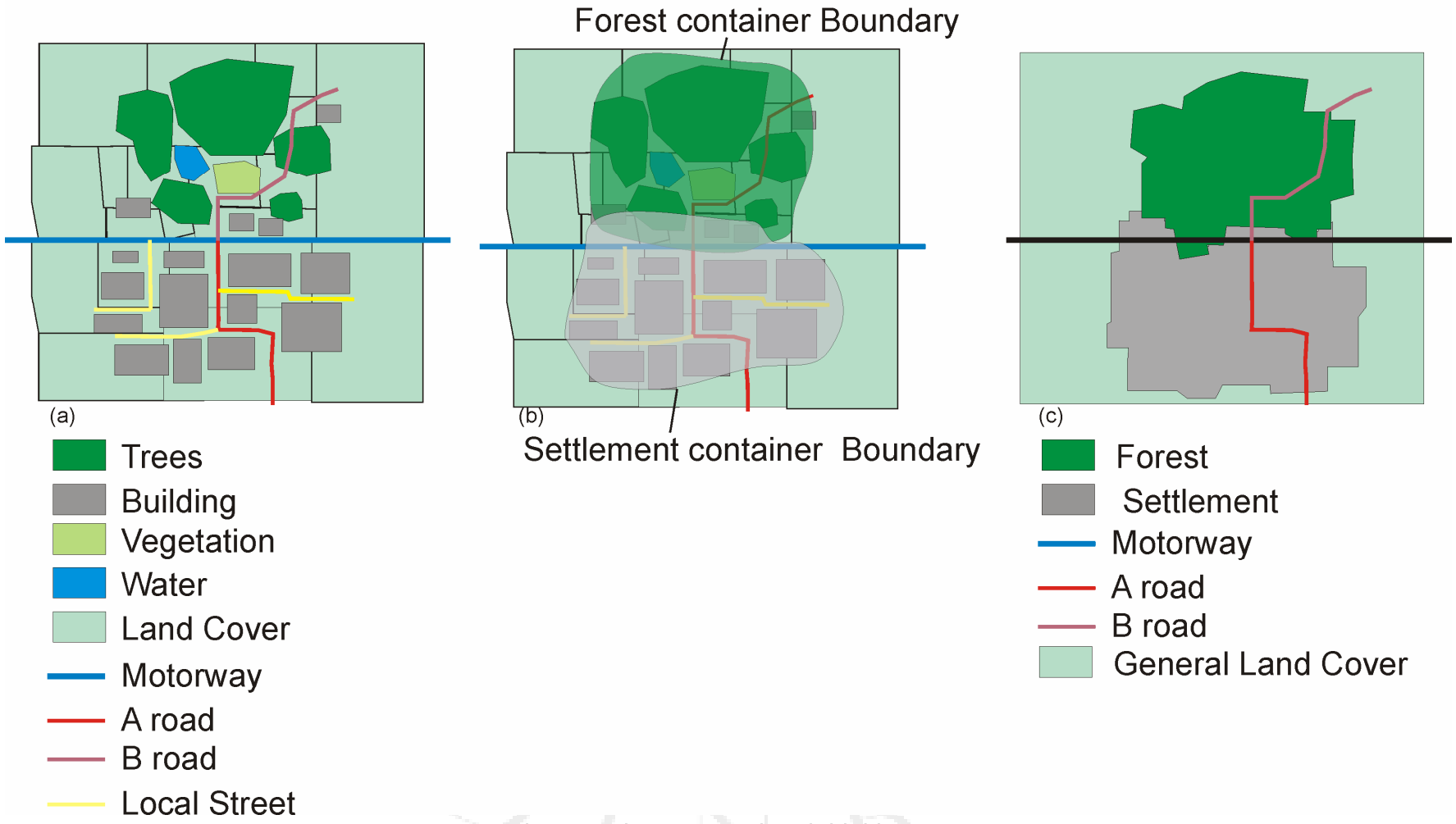


Container Boundaries

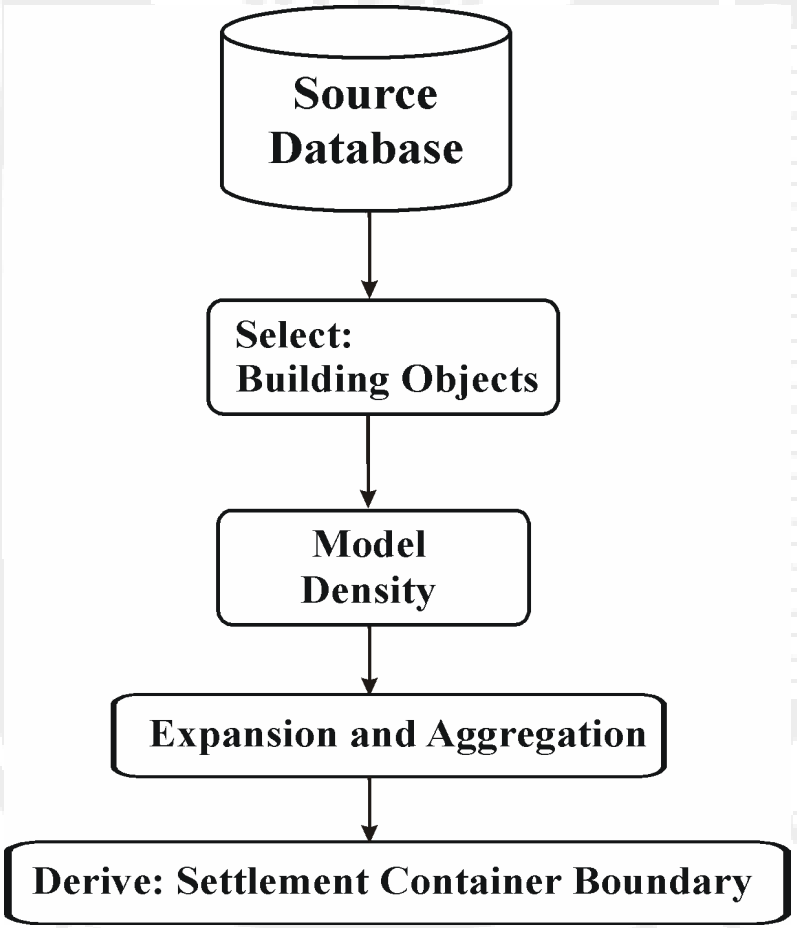
- Container Boundaries that ‘fit’ with our conceptual understanding of the world:
  - (pebbles → Islands)
  - Houes →Settlement
  - Tree stands → Forest
  - Hills → Ranges

Automatic creation of partonomic information

Source Objects | Database Enrichment | Aggregation



Settlement Container Boundary



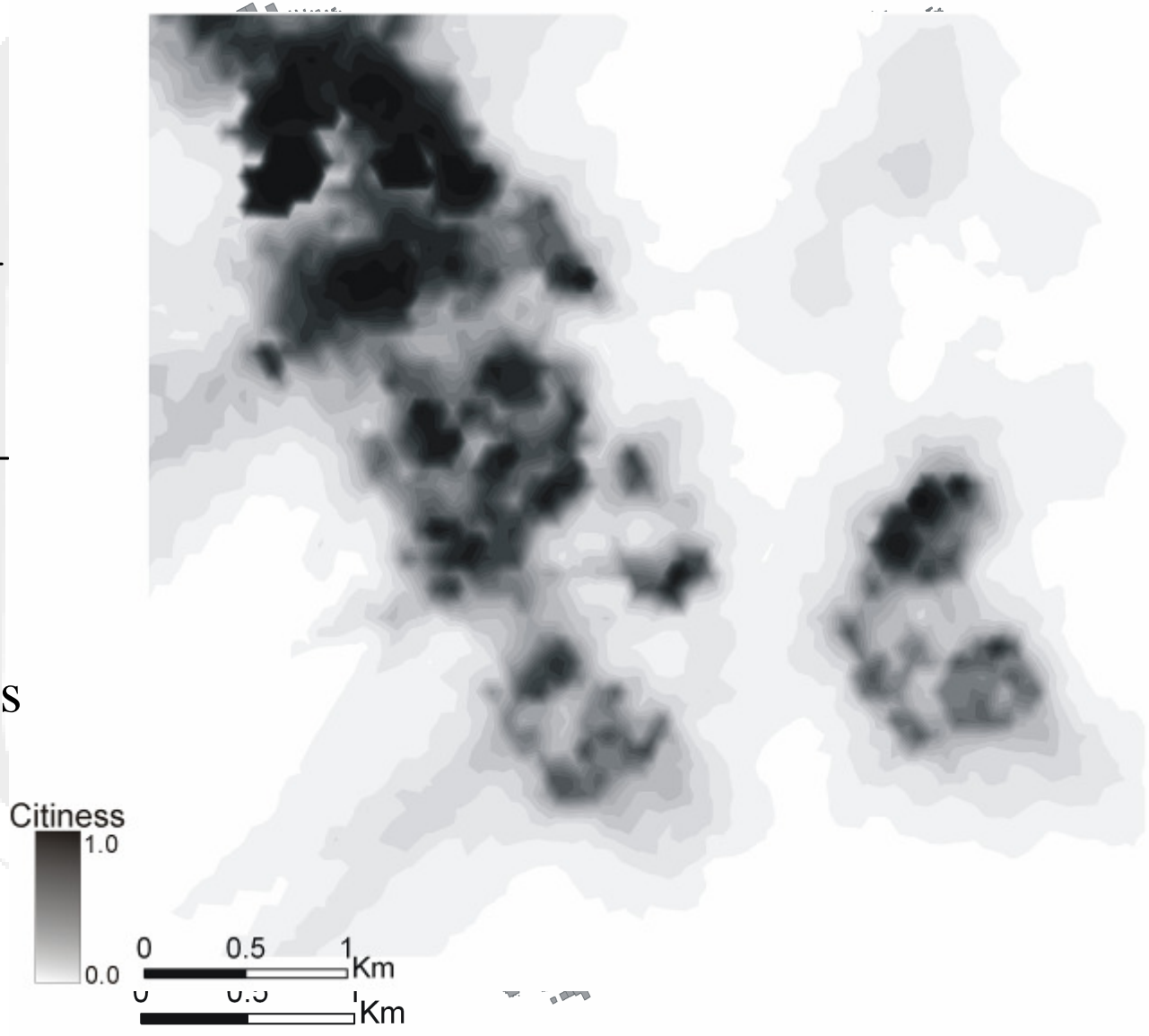
Settlement Container Boundary

Settlement Container Boundary

- Modelling ‘Citiness’

$$c_j = \frac{\sqrt{a_j}\sqrt{\sum_{i=1}^{n} a_i}}{\sum_{i=1}^{n} d_i^2}$$

50 closest buildings

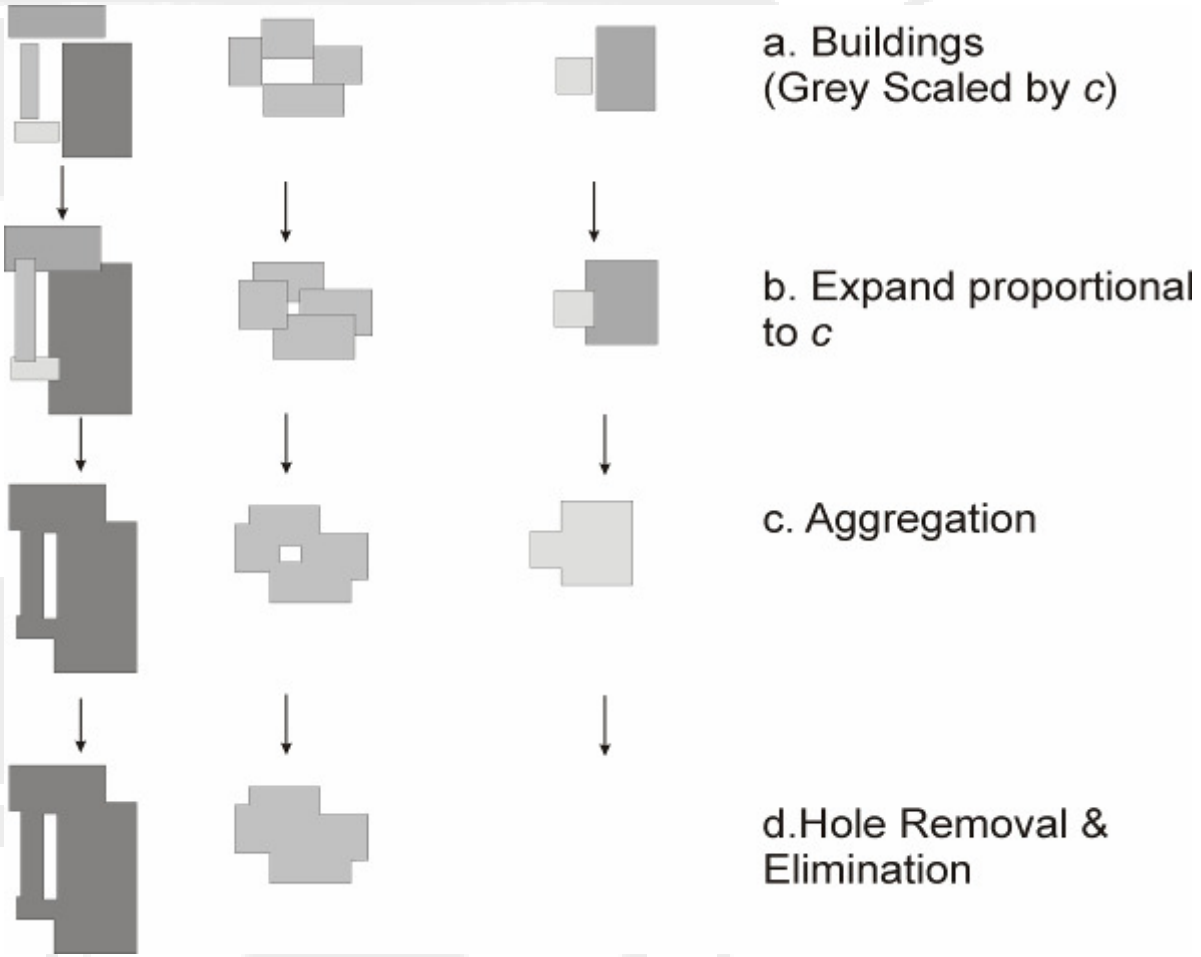


Settlement Container Boundary

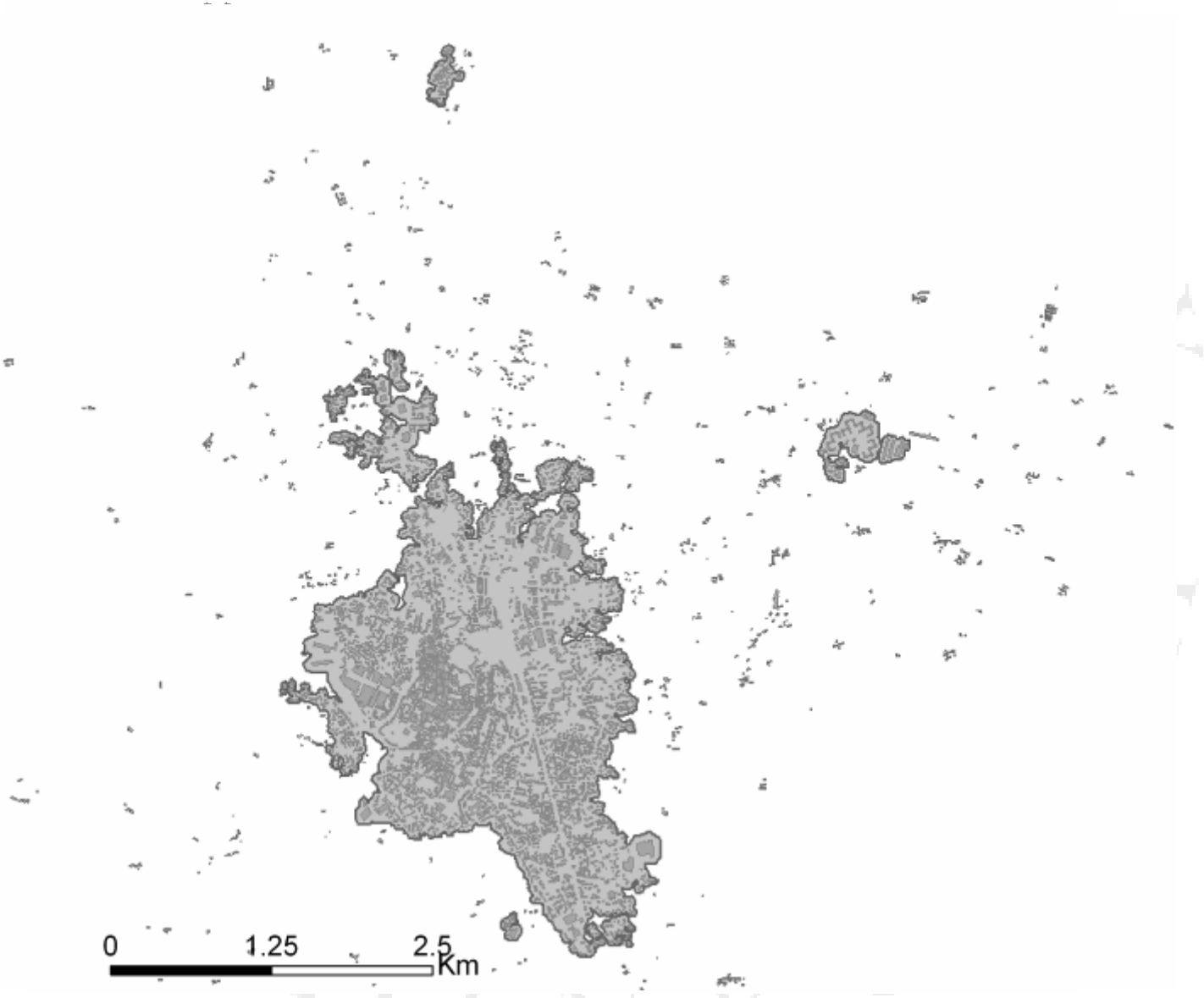
$$e_a = k.c$$

Provided

$$e_a <= k$$

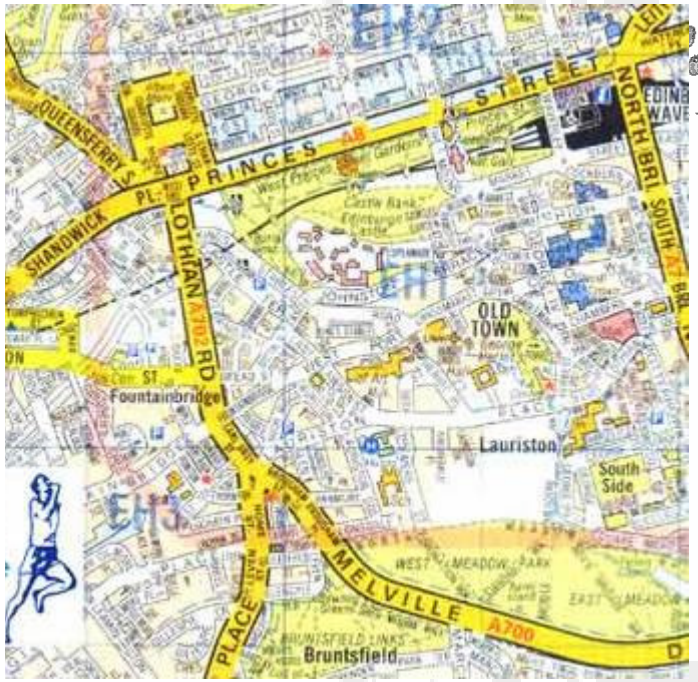


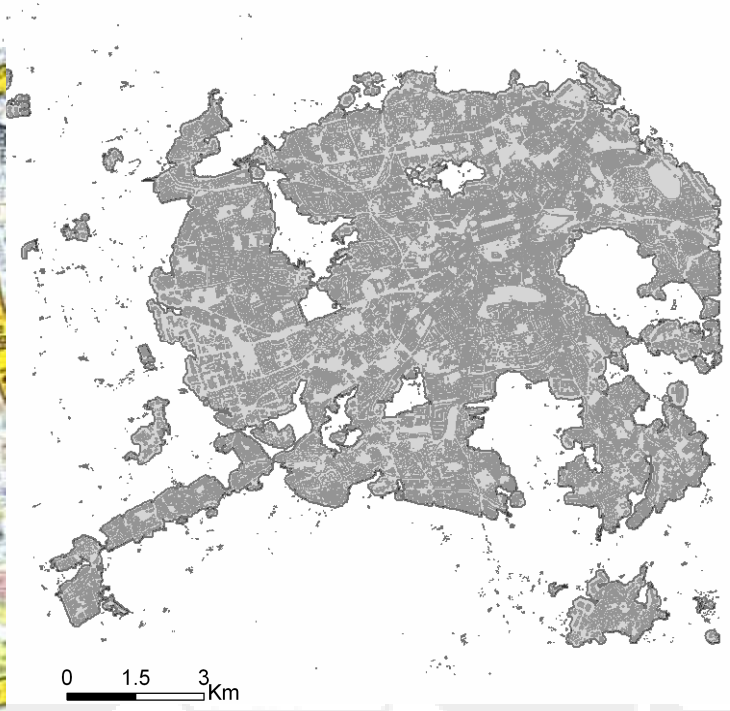
Settlement Container Boundary



Connecting geographies

- Semantic zoom…..Visual zoom….

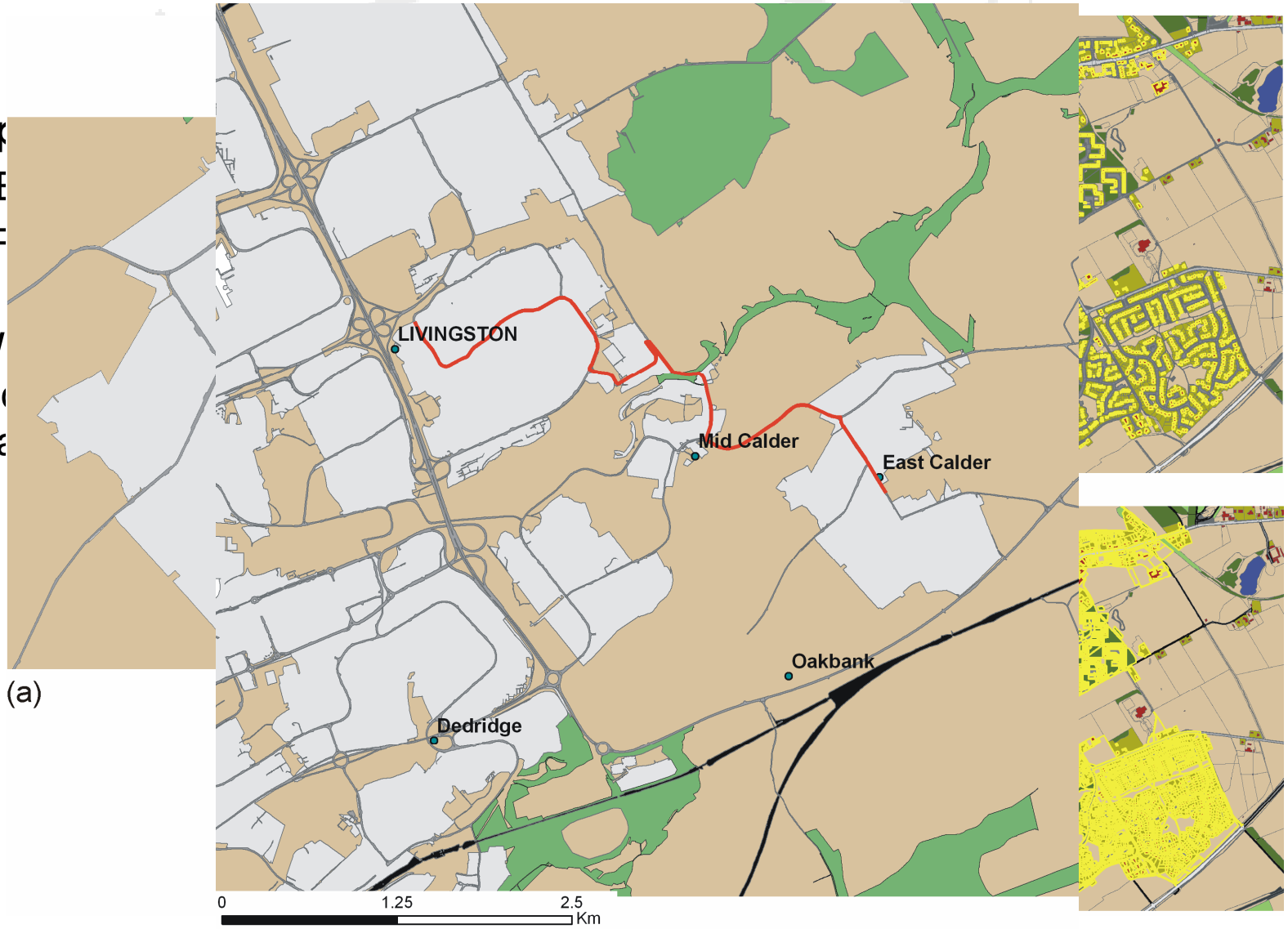




‘These partonomic structures provide a ‘conceptual skeleton’ linking appearance and function.’ Tversky

Meaningful database queries

- **Sp**
- SE
- FF
  c
- W
  b.
  Ca



(a)

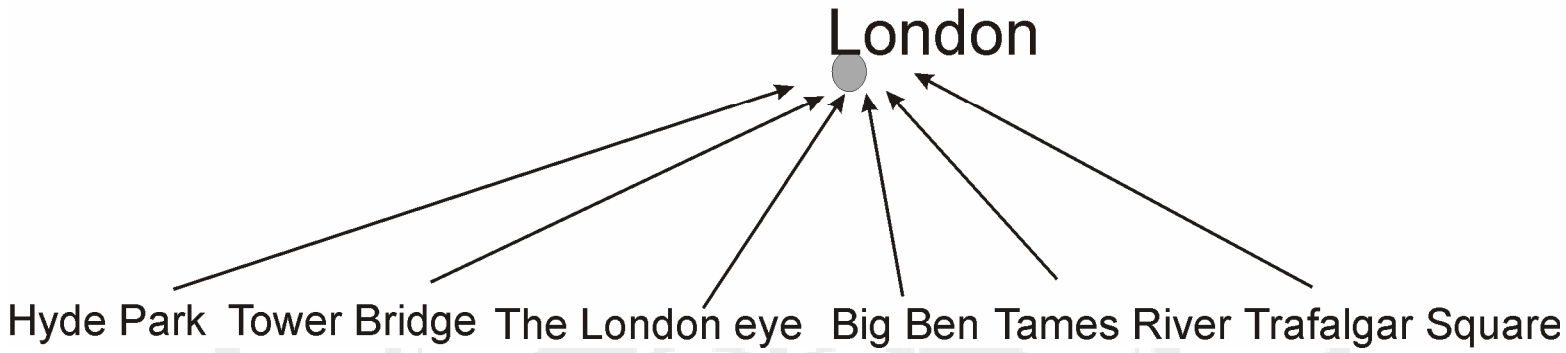
Utilitv


Winchburgh
Ecclesmachan
Broxburn
Burnside
Uphall
0
0.5
1
Km
000

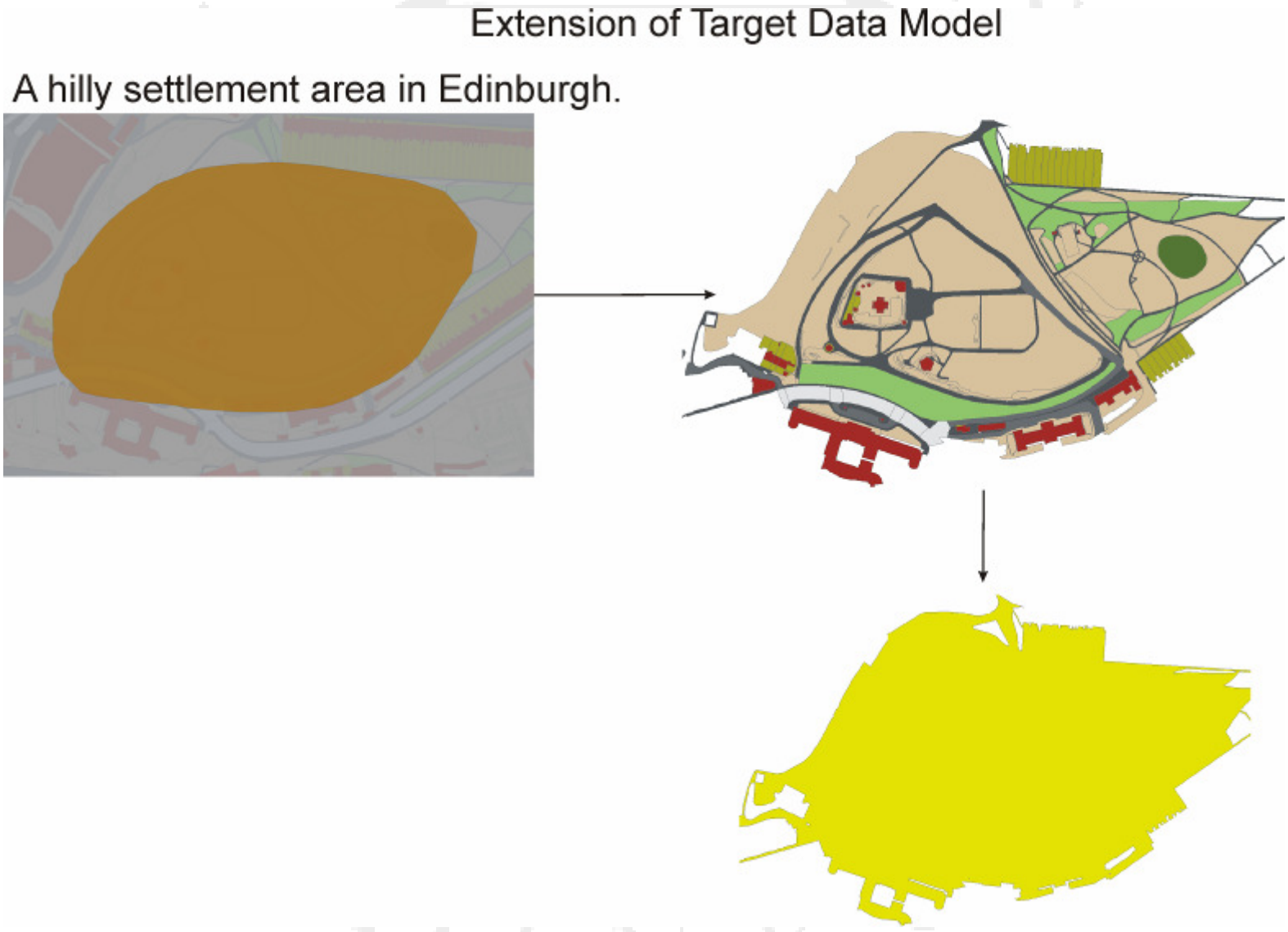
Utility

Higher Level of Abstraction

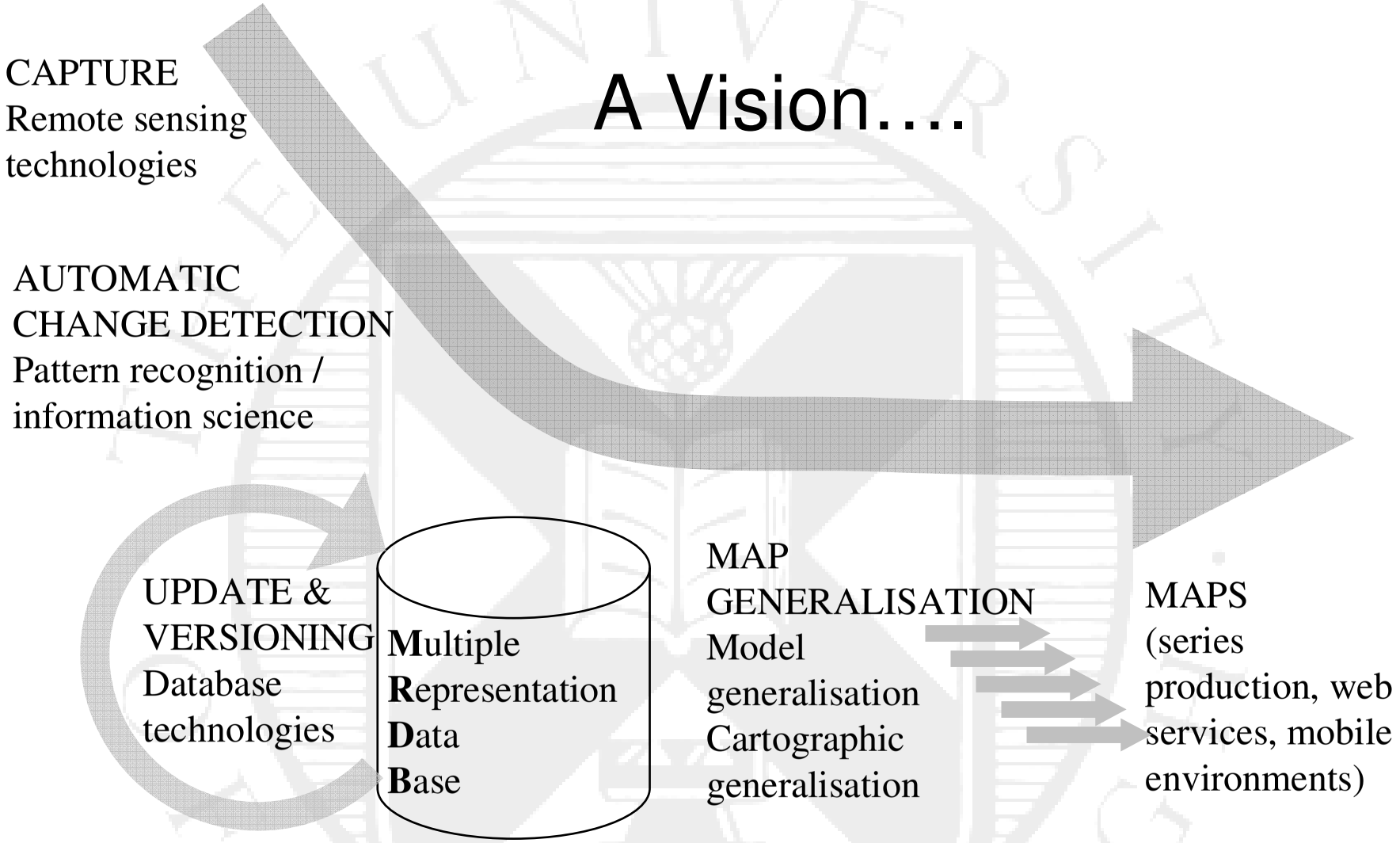
Meaning



Thematic mapping



A Vision….

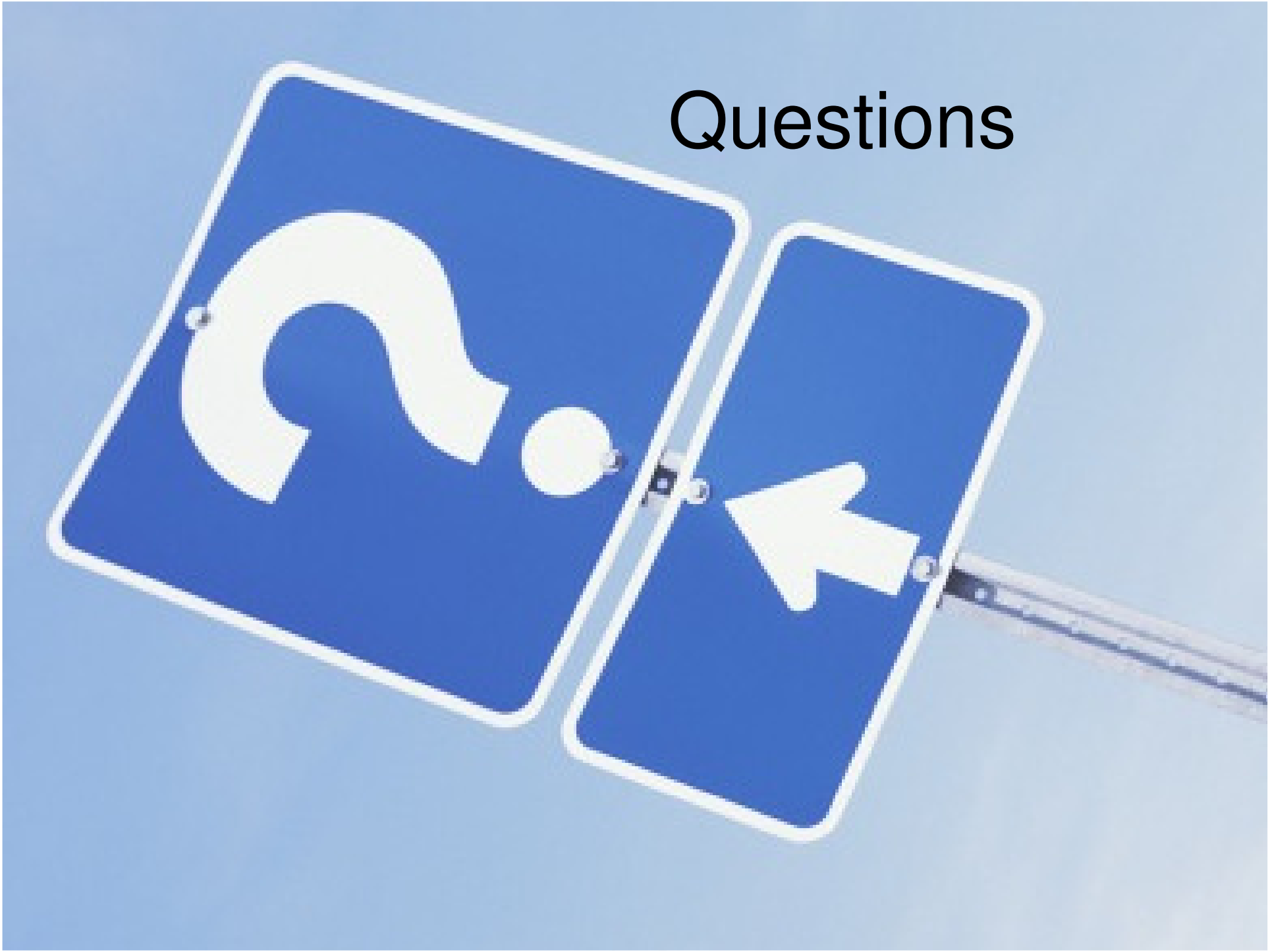

CAPTURE
Remote sensing technologies
AUTOMATIC CHANGE DETECTION
Pattern recognition / information science
UPDATE & VERSIONING
Database technologies
Multiple Representation Data Base
MAP GENERALISATION
Model generalisation
Cartographic generalisation
MAPS
(series production, web services, mobile environments)

Geography – the borrower of science

- Cartography - geography
- Semiotics, communication theory – linguistics
- Mereology (partonomies), ontologies – philosophy
- Pattern recognition, scale space – robotics
- Models of space – mathematics & computer science
- Reasoning about space – psychology
- Models of Interaction – informatics
- …. Truly interdisciplinary nature….

Conclusion

- Different: Map as a system of Relationships
- Weave: model ←→ visual form
- Geography – the borrower of science
- Technology – changing science of cartography
- Not subsumed by scientific visualisation and VR, but *complimentary to*…


Questions