Geographic Information System (GIS)
IS 454

Lecture 7: Data visualization and GIS

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- There is a strong relationship between maps and GIS. More specifically, maps can be used as input for a GIS
- A map can often be the most suitable tool to solve the question contains a "**where?**" and provide the answer. A map would put these answers in a spatial context.
- Maps can do more than just providing information on location. They can also inform about the thematic attributes of the geographic objects located in the map.

- Maps can answer the “**What?**” question only in relation to location.
- A third type of question that can be answered from maps is related to “**When?**”. It might be interesting to see how this changed over the years. A set of maps could provide the answer as demonstrated.
- To summarize, maps can deal with questions/answers related to the basic components of spatial or geographic data: location (geometry), characteristics (thematic attributes) and time, and their combination.

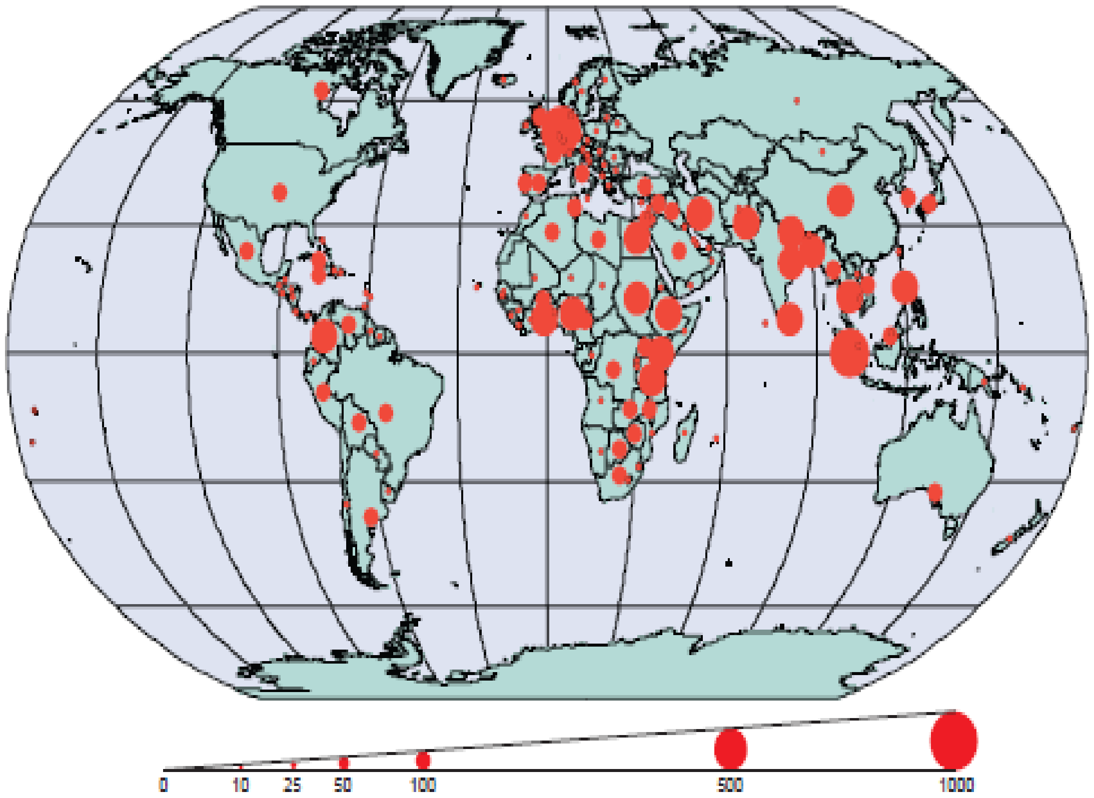


Figure 7.1: Maps and location—"Where did ITC cartography students come from?" Map scale is $1 : 200,000,000$.

The map in the above figure only needs the boundaries Simplification and of countries, and a symbol to represent the number of students per country. In abstraction from reality this particular case there is no need to show cities, mountains, rivers or other phenomena.

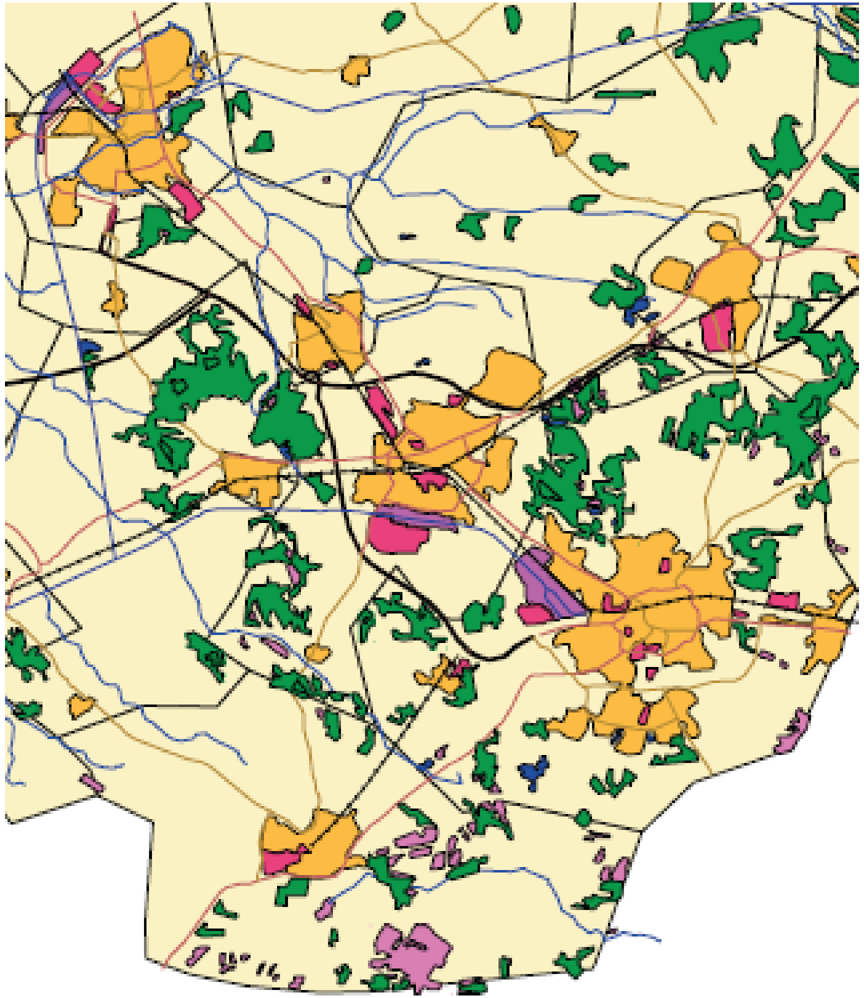


Figure 7.2: Maps and characteristics—"What is the predominant land use in southeast Twente?"

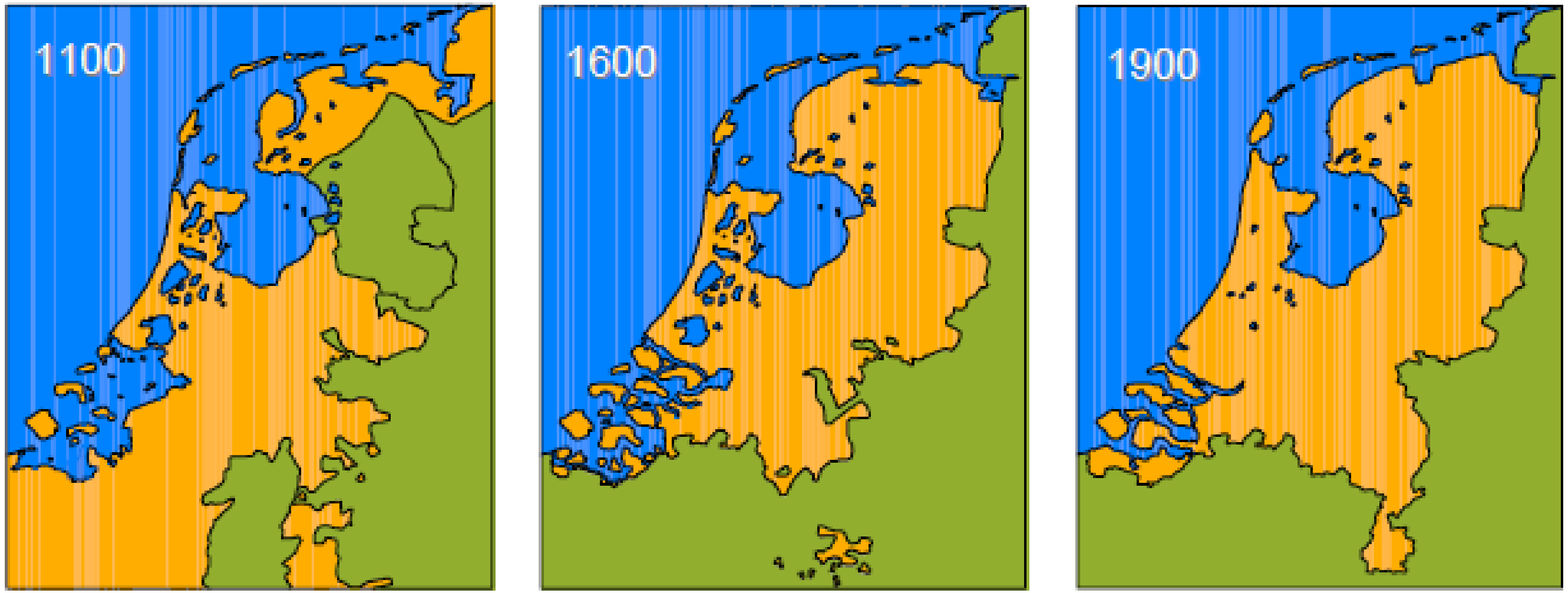
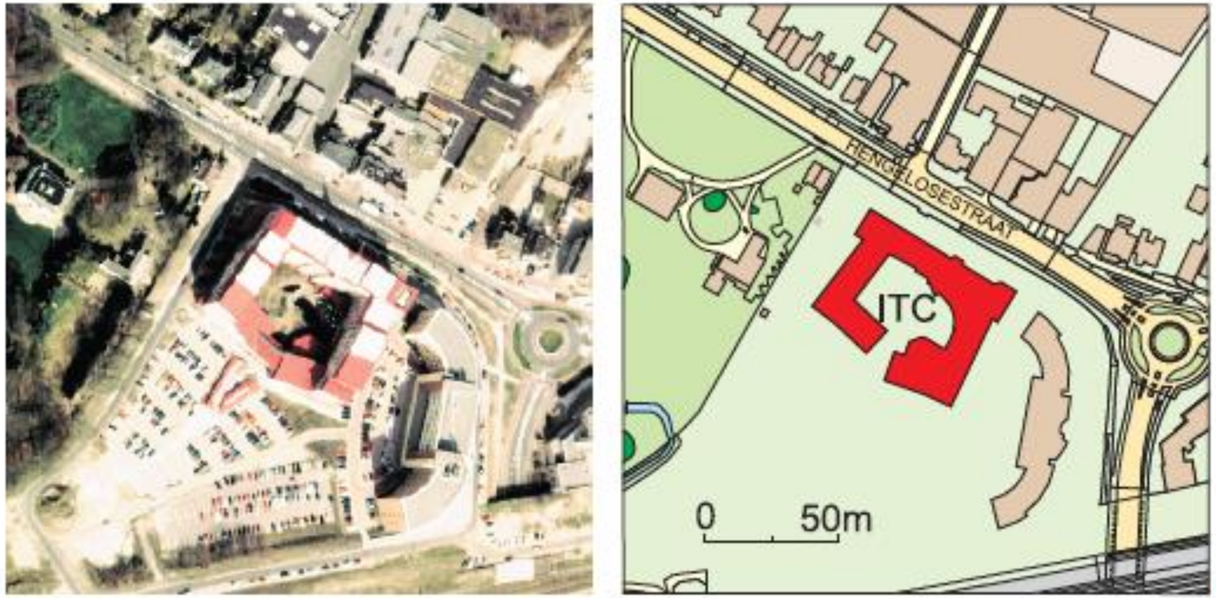


Figure 7.3: Maps and time—"When did the Netherlands have its longest coastline?"

Map insight

- Maps reveal spatial relations and patterns, and offer the user insight in and overview of the distribution of particular phenomena.
- An additional characteristic of on-screen maps is that these are often interactive and have a link to a database, and as such allow for more complex queries.



(a) (b)

Figure 7.4: Comparing an aerial photograph (a) and a map (b). Source: Figure 5–1 in [30].

The map on the other hand, only gives the outlines of buildings and the streets in the surroundings. It is easier to interpret because of selection/omission and classification of features.

Dimensionality of Maps

- Maps can further be distinguished according to the dimensions of spatial data that are graphically represented. GIS users also try to solve problems that deal with three-dimensional reality or with change processes. This results in a demand for other than just two-dimensional maps to represent geographic reality.
- Three-dimensional and even four-dimensional (namely, including time) maps are then required. New visualization techniques for these demands have been dimensionality developed.

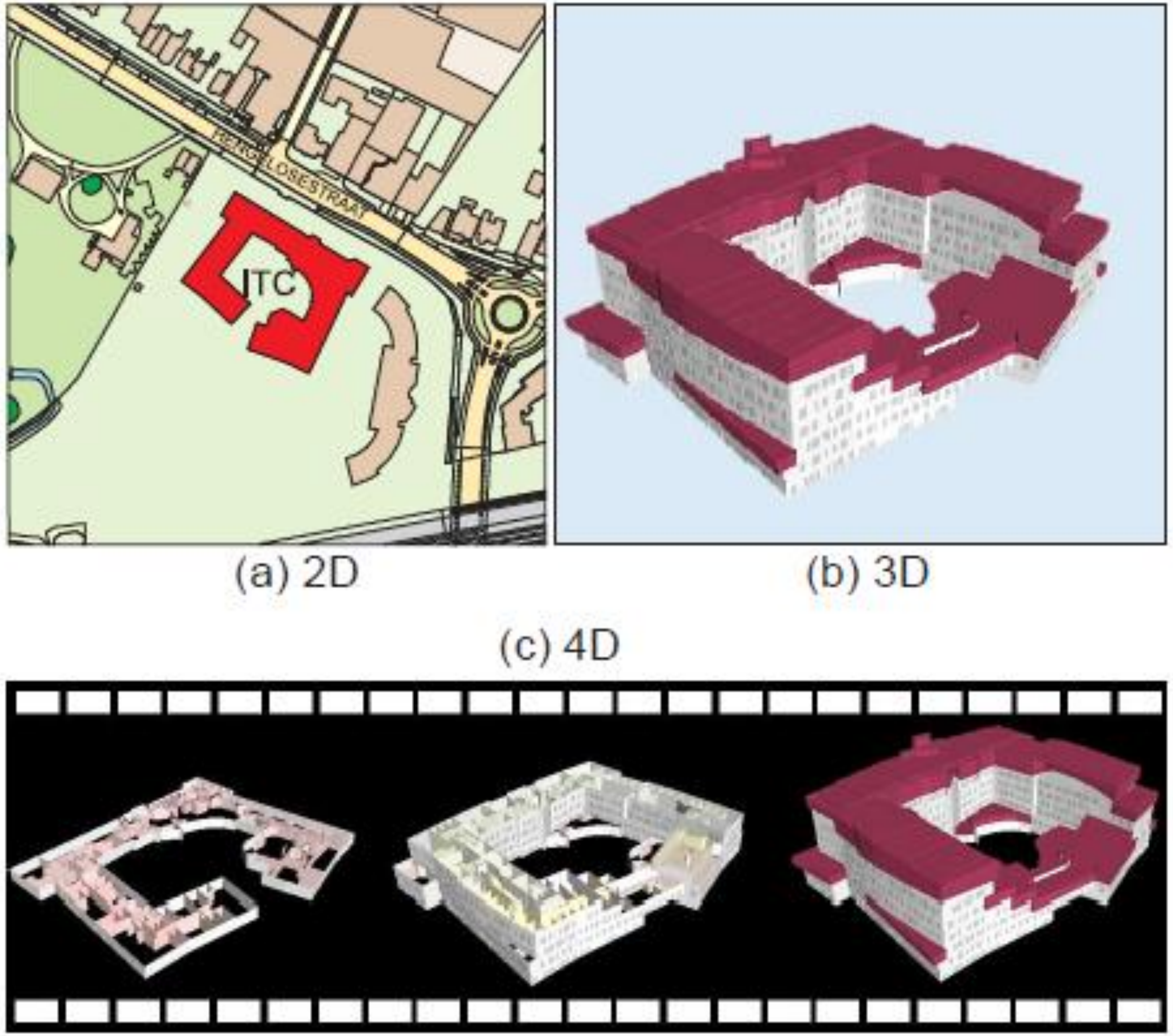
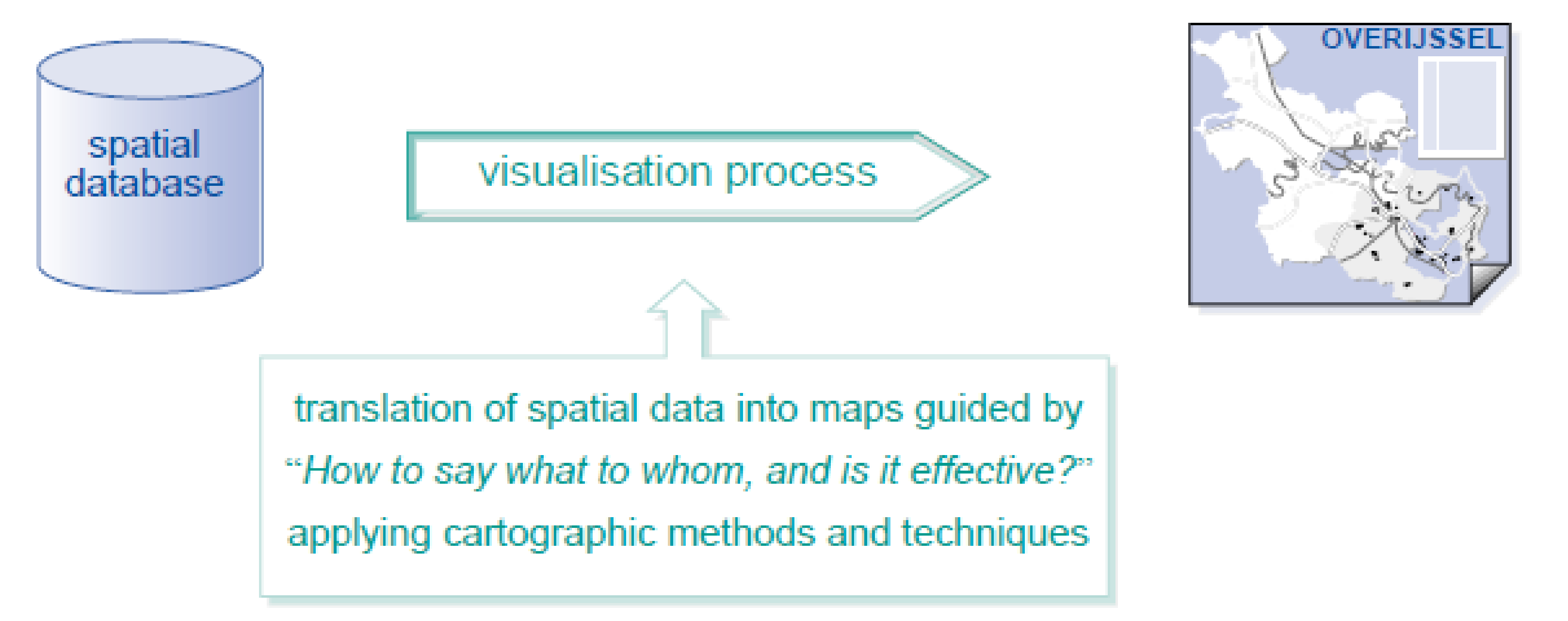


Figure 7.7: The dimensions of spatial data: (a) 2D, (b) 3D, (c) 3D with time.

The visualization process

- In this context the cartographic visualization process is considered to be the translation or conversion of spatial data from a database into graphics. These are predominantly map like products.
- During the visualization process, cartographic methods and techniques are applied.

- The visualization process can vary greatly depending on where in the spatial data handling process it takes place and the purpose for which it is needed.



The visualization process is guided by the question **"How do I say what to whom, and is it effective?" :**

- "How" refers to cartographic methods and techniques.
- "I" represents the cartographer or map maker,
- "say" deals with communicating in graphics the semantics of the spatial data.
- "What" refers to the spatial data and its characteristics, (for instance, whether they are of a qualitative or quantitative nature).
- "Whom" refers to the map audience and the purpose of the map

- “effective” :The visualization process should also be tested on its effectiveness. Based on feedback from map users, or knowledge about the effectiveness of cartographic solutions, we can decide whether improvements are needed, and de- Effectiveness drive recommendations for future application of those solutions.

Visualization of spatial data

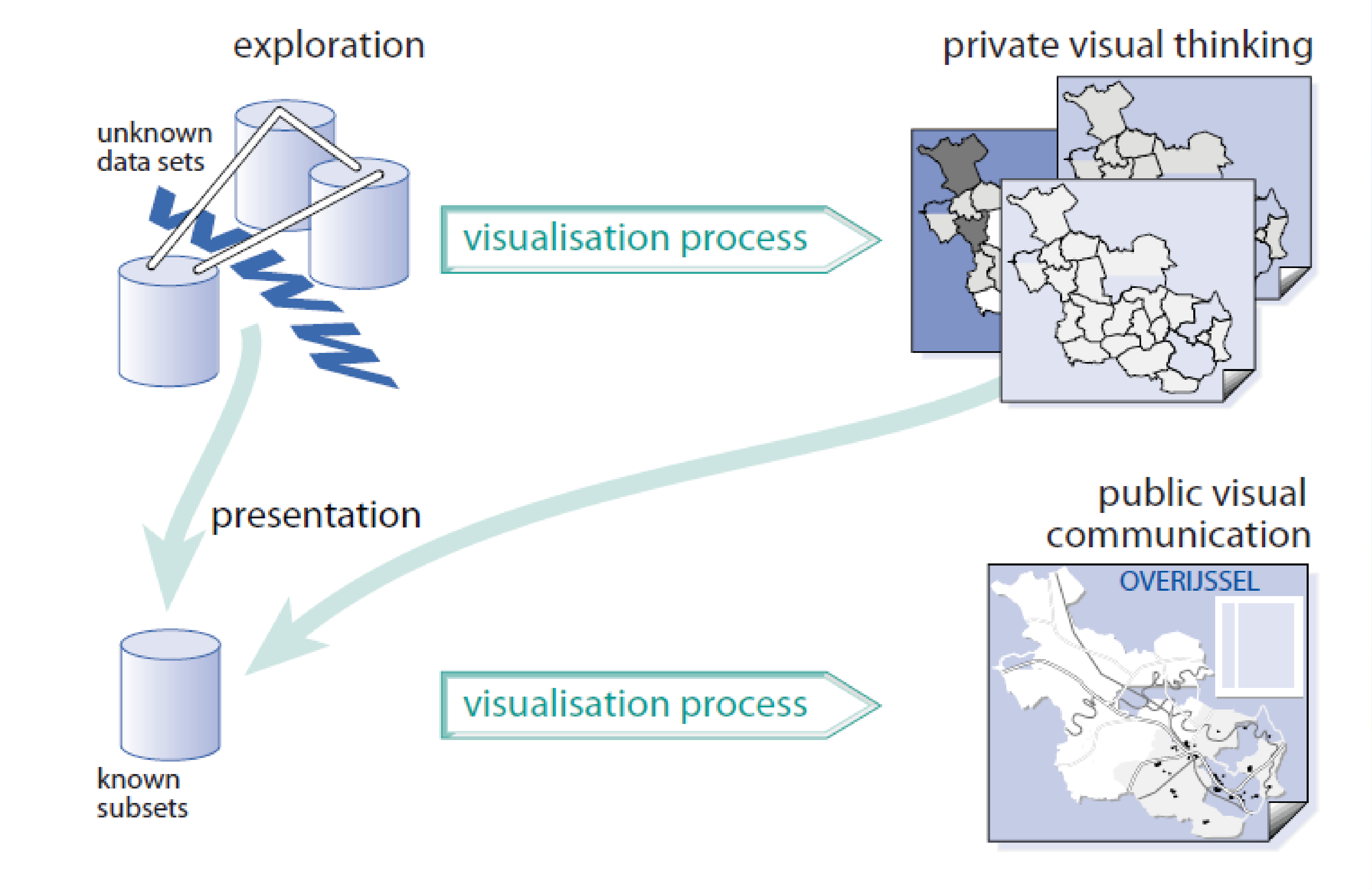
- Data visualization means ‘to make visible’ or ’to represent in graphical form’. It can be argued that, in the case of spatial data, this has always been the business of cartographers.
- However, progress in other disciplines has linked the word to more specific ways in which modern computer technology can facilitate the process of ‘making visible’ in real time.

GIS Visualization problem

- While dealing with the data, the expert should be able to rely on cartographic expertise, provided by the software or some other means.
- Essentially, here the problem of translation of spatial data into cartographic symbols also needs to be solved

Geovisualization

- Exploration means to search for spatial, temporal or spatio-temporal patterns, relationships between patterns, or trends
- A search for relationships between patterns could include: changes in vegetation indices and climatic parameters, location of deprived urban areas and their distance to educational facilities.
- What is unknown for one is not necessarily unknown to others.



To create a map, one selects relevant geographic data and converts these into meaningful symbols for the map

What kind of data do I have?

- To derive the proper symbology for a map one has to execute a cartographic data analysis. The core of this analysis process is to access the characteristics of the data to find out how they can be visualized, so that the map user properly interprets them.
- The first step in the analysis process is to find a common - characteristic for all the data.
- Data can be : qualitative or quantitative nature.

Qualitative data

- Qualitative data is also called nominal or categorical data. This data exists as discrete, named values without a natural order amongst the values. Examples: the different soil types (e.g. sand, clay, peat).
- In the map, qualitative data are classified according to disciplinary insights such as a soil classification system represented as basic geographic units: homogeneous areas associated with a single soil type, recognized by the soil classification.

Quantitative data

- Quantitative data can be measured, either along an interval or ratio scale.
- For data measured on an interval scale, the exact distance between values is known, but there is no absolute zero on the scale.
- Temperature is an example: $40^{o}c$ is not twice as warm as $20^{o}c$, and $0^{o}c$ is not an absolute zero.
- In order to generate maps, quantitative data are often classified into categories according to some mathematical method.

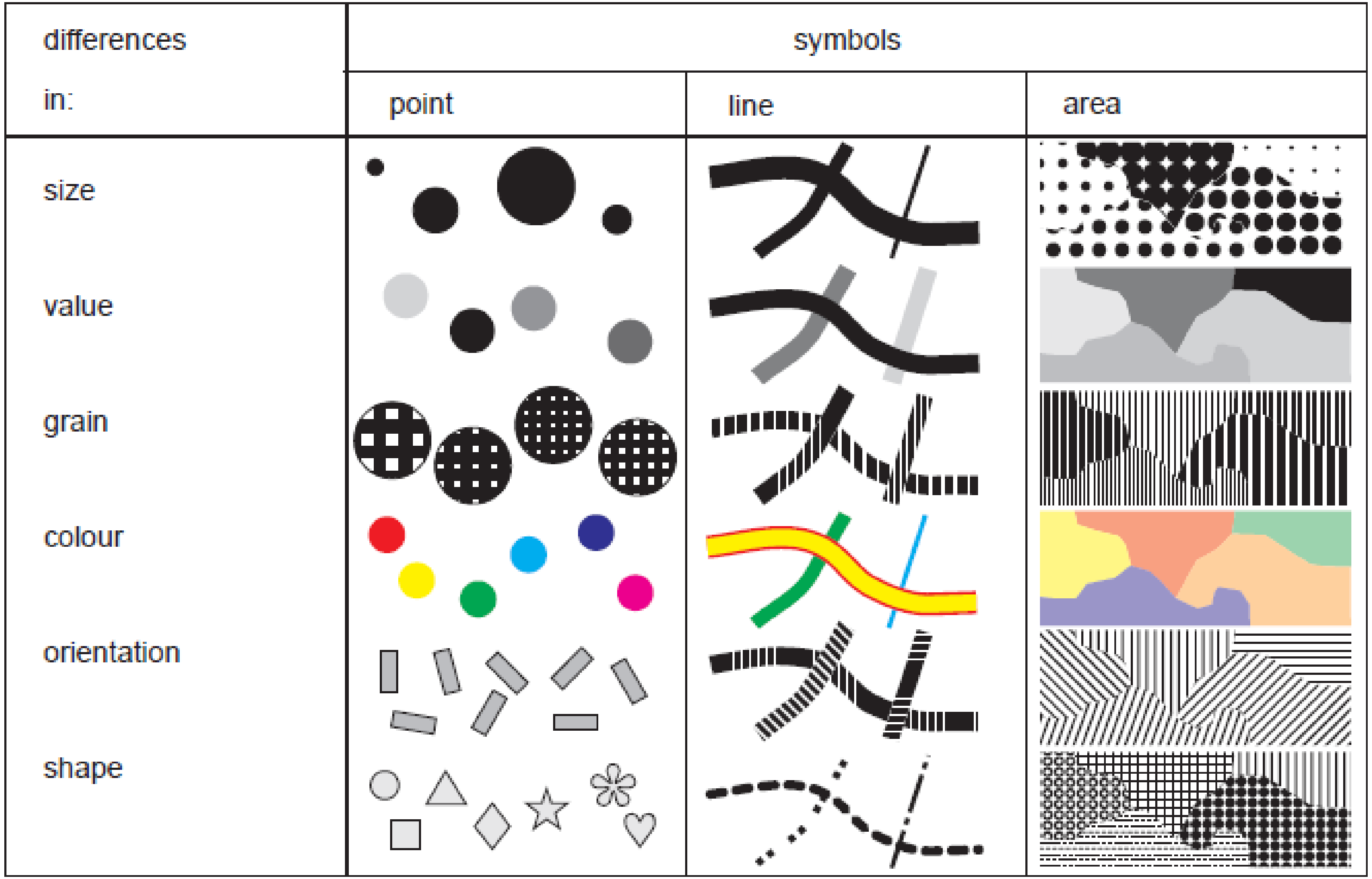
How can I map my data?

- Basic elements of a map are point symbols, line symbols, area symbols, and text. The appearance of point, line, and area symbols can vary depending on their nature.
- Points can vary in form or colour to represent the location of shops. Lines can vary in colour to distinguish between administrative boundaries and rivers, or vary in shape to show the difference between railroads and roads. Areas follow the same principles: difference in colour distinguishes between different vegetation stands.

Visual variables

There are six categories to distinguish, which they called the visual variables and which may be applied to point, line and area symbols. Which are:

- Size,
- Value (lightness),
- Texture,
- Colour,
- Orientation and
- Shape.


differences
in:
symbols
point
line
area
size
value
grain
colour
orientation
shape

These visual variables can be used to make one symbol different from another.

Visual variables influence the map user's perception in different ways.

- What is of equal importance (e.g. all red symbols represent danger),
- Order (e.g. the population density varies from low to high—represented by light and dark colour),
- Quantities (e.g. symbols changing in size with small symbols for small amounts), or
- An instant overview of the mapped theme.

There is an obvious relationship between the nature of the data to be mapped and the ’perception properties’ of visual variables.