Sensorveiledning SGO1910 autumn 2021

General comment about the exam:

Due to delivery problems at Akademika, most of the students were unable to access the textbook used in the course until mid-October. This did not impact the type of questions in the exam, but to accommodate the students, there are changes in the exam format. In Part 1, the students have a choice of answering 2 of 3 questions, instead of answering 2 of 2, as it was the case last year.

Task 1____

This series of maps combines vector and raster data.

The first two maps show a polygon feature representing green cover in the same area in 2017 and 2020. The background maps are satellite images in raster format. The green cover has been detected using the NDVI - Normalized Difference Vegetation Index method. The resulted raster layer has been reclassified into green and not green areas and converted to vector.

The last map was prepared using overlay functions (spatial analysis). More specifically, it was done using the union function, and then symbolized based on the overlay (whether the area was covered by both 2017 and 2020 polygons, or just one of them).

Students do not need to be that detailed to get a passing grade. Describing the process and naming the main methods should be enough for receiving a high grade.

Advantages:

- The NDVI tools is a useful method to measure and compare the green cover based on openly available satellite images.
- It is increasingly used for environmental and urban planning in studies related to climate change and quality of life.
- It can be used to compare the green cover between different areas and/or time periods.

Limitations

- Since this analysis is based on satellite image, it only detects green cover visible from above. Therefore, vegetation that may be covered by a roof, or grows vertically (i.e. along the wall) may not be detected using this method.
- The NDVI tool may detect objects that appear green but are not vegetation. Examples: sport fields with artificial grass, some water bodies and buildings with roof made of a green material.
  Students who mention that other methods, such as infrared images may help mitigate this problem should be highly rewarded.

- Seasonal changes and climatic conditions at the time of retrieving the satellite image may impact what areas are detected as green or not. For example, a picture taken in the late fall or winter will show a lot less green than a picture taken in the summer. This is especially important in comparative studies like this one.

Students may also comment on the cartographic qualities of the maps, the choice of layers and symbology, the map elements and the overall presentation. These can be subjective interpretations and there are no right/wrong answers. The judgement should be based on the strength of the presented arguments.

Task 2

The student should recognize that this is an old, hand-drawn map based on azimuthal (equidistant) projection, which is best for representing the Arctic and Antarctica regions and sometimes in aviation.

The student should also mention the large empty space around what we know is Northern Canada and Alaska. This represents uncertainty in cartography. At the time of making, this map there was not enough information to map that region.

Since shapes and exact locations of different landmasses are approximate, one could not be entirely confident about its usability for navigation. This might be useful for navigation for people going to and from the pole.

Distortions: distances (except from the pole), directions (except N-S along the meridians), shapes and area sizes.

The map includes a graticule, which is a grid with longitude and latitude lines.

A deeper interpretation for a higher grade may include the following:

- The process of making ("projecting") the azimuthal projection from a 3D sphere of earth.
- Distances and directions in azimuthal projections are represented correctly only from the centre point (represented here as the North Pole)
- Meridians (lines of longitude) are straight, while latitude lines are circular
- Bonus if the student notices that the prime meridian (0) does not go through London, which means that the map was made before 1884, when 0-Meridian was arbitrary set to the Greenwich Royal Observatory in London.
- Satellite images improved the how the Earth's surface can be represented in a 2D map. They have also helped us in mapping remote regions that have been left blank on this map.
- The students could also comment on the cartography, the choice of colors and other aspects of the map and its purpose.

Task 3

- The polygons are made using a network analysis tool called service area. One can easily see that more central areas where there are more stations, have better access to metro/train stations than more remote areas.
- The polygons are not simply buffers, but measure distance or travel time along the network for walking. The mode of transportation is not specified, but if the student gives good reasons why this could be walking, and not for example driving, he or she should be rewarded.
- There are three breaks / cutoffs symbolized by polygons with three different colors – dark green, light green and yellow. These cutoffs could either be based on distance along the network or travel (walking) time. The dark green polygons are areas closest to the stations and the yellow areas somehow further, but within the last cutoff. All other areas symbolized with shades of grey are beyond the last cutoff.
- Some points are surrounded by very small polygons because of errors in the network. It might be that the network is incomplete, or that there is too much distance between the station and the closest element of the network. Students who relate this to the importance of data quality should be rewarded.

Task 4

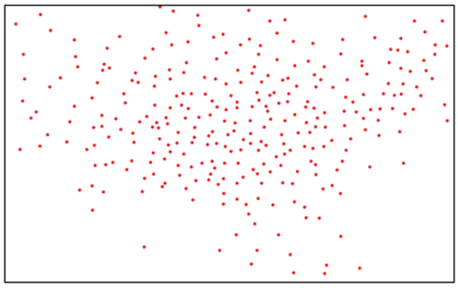
Private data is all data that can be used to identify a person, for example name, address, age etc. In GIS, one important type of private data is location data. It is important to consider the privacy of individuals. If we collect and analyse private data, including location, we need consent from the study participants. It is recommended not to publish studies including location data of individuals, even if we have consent.

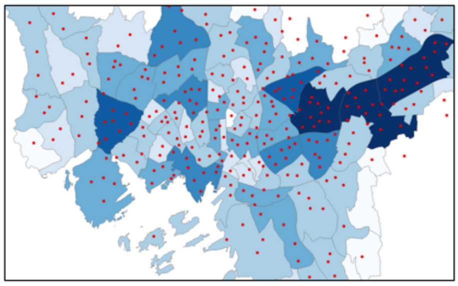
Aggregation of individual data is one way to deal with these issues.

How it works (lecture slides):

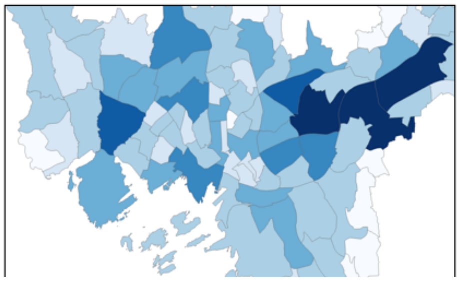
Individual and aggregated data in GIS

Individual data with spatial properties (points)
Higher precision
Identifiable personal data, Privacy issues



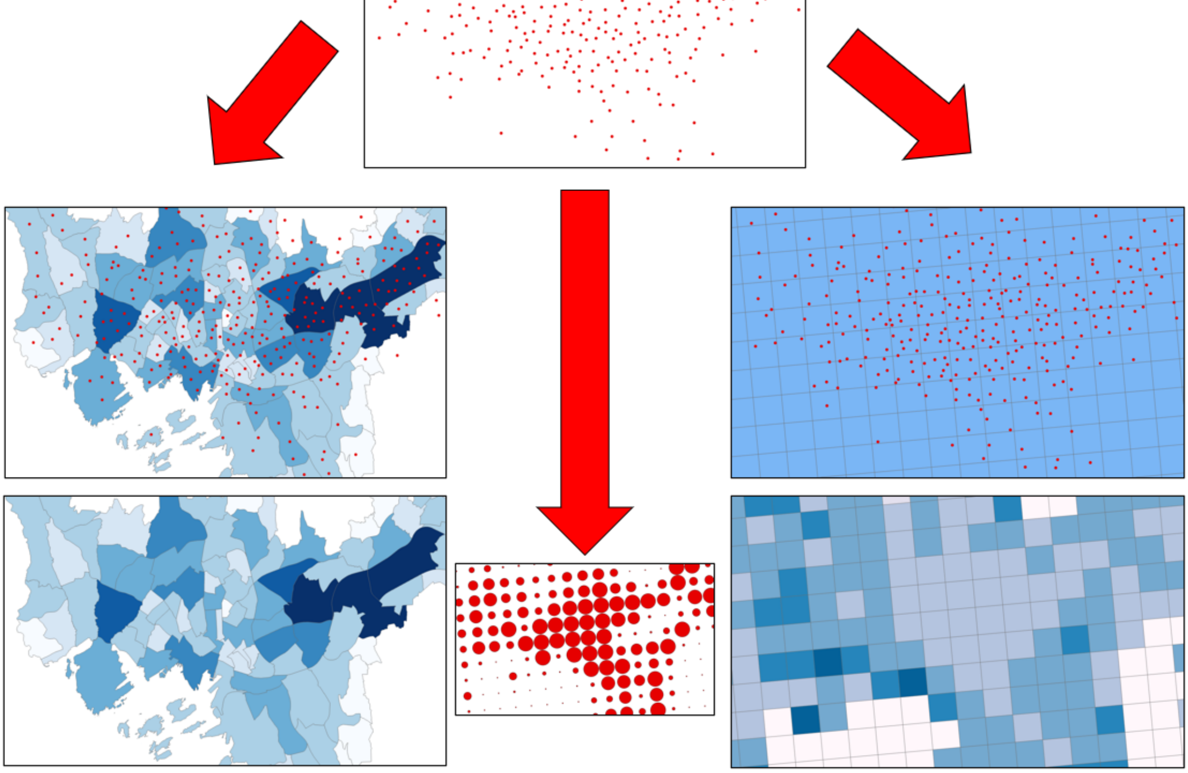


Individual data aggregated (grouped) by spatial properties



Aggregated (grouped) data (polygons)
Removing individual data (points)
Lower precision
Less identifiable personal data, less privacy issues

Different types of aggregation



The type of aggregation on the left is based on administrative boundaries (delbydel), the one in the middle is aggregating to regularly distributed points and symbolized with different point sizes. The one on the right is aggregation to a grid of equal areas (a method used by SSB).

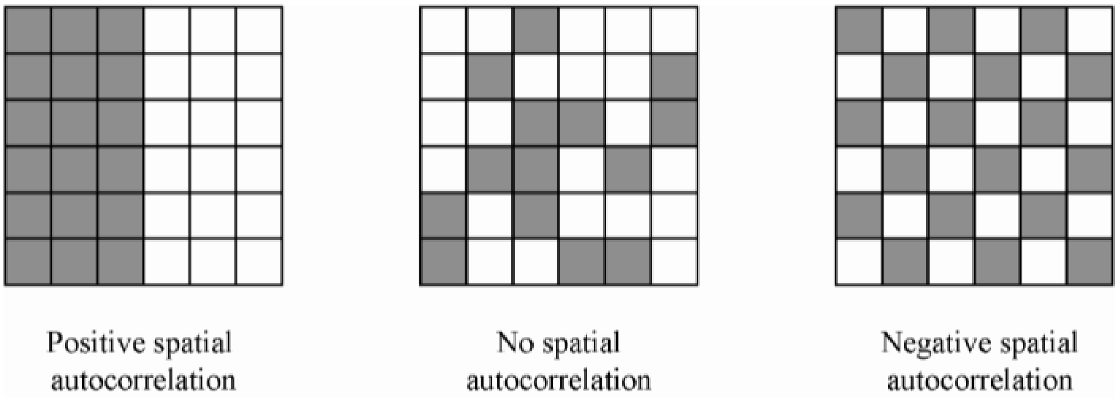
The main limitation of data aggregation is that aggregated data has lower precision than individual point data. Students can also mention problems related to MAUP (Modifiable areal unit problem) and the ecological fallacy, or how choropleth maps may misrepresent spatial phenomena within the boundaries of the polygons.

Students who engage in deeper discussion about the legality and ethics of handling private data, and/or about uncertainties and cross-scale aggregation and inference should be highly rewarded.

Task 5

Students should describe spatial autocorrelation as the tendency of nearby spatial units to have similar values, or to vary in coordinance with each other (or give a similar definition). It is about how spatial phenomena are clustered or dispersed or how nearby spatial units are dependent on one another. Spatial autocorrelation is related to the concept of spatial dependence and Tobler’s first law of geography ("everything is related to everything else, but near things are more related than distant things.") .

Students should supplement their answer by explaining the difference between positive, negative and no spatial autocorrelation. See image (from lecture slides):



Clustered pattern (1) Random pattern (0) Dispersed pattern (-1)

NB! Random is not the opposite of clustered.
And random is not the same as dispersed

The one main way to measure and test for spatial autocorrelation introduced in the course is Moran’s I, where:
value 1 is clustered pattern, 0 is random pattern and -1 is dispersed pattern

Maps with Moran’s I analysis are often supplemented by cartograms.
Values above 0,5 (and below -0,5) are considered as strong degree of correlation
Values below 0,2 (or above -0,2) are considered as no spatial autocorrelation.
Z-score and p-values can tell us about the reliability of the result.

Students can also mention different ways to define neighbours for spatial autocorrelation:

- Contiguity
    - Rook contiguity
    - Queen contiguity
- K nearest neighbours
- Distance

Students who discuss pitfalls and examples of spatial statistics (MAUP, ecological fallacy, gerrymandering, scale etc.) should be rewarded. Students who reflect on the uncertainty of the potential sources of spatial dependence/autocorrelation should be rewarded.

When it comes to topics, students are free to give their own examples. We have discussed it mainly in relation to politics (election results), while one of the readings in the course gave the example of clustering of poverty/income. It can also be used to measure a wide range of other topics, such as well-being, economic development, democracy, accessibility and demographic characteristics.

Spatial autocorrelation can be done for both vector and raster data.

Task 6

In this course we have challenged the technocratic and quantitative tradition of GIS and explained the advantages of adding qualitative information.

Students are open to propose what types of qualitative information can be integrated with GIS. The main condition is that this data is georeferenced, which means that it can be linked to a particular location.

There are basically no limitations when it comes to the types of qualitative data that can be integrated with GIS. Some examples introduced in the readings/lectures are:

- Quotes from interviews or focus groups regarding experiences and feelings about particular places.
- Photographs, videos and sounds
- Notes from observations made by the researcher or study participants
- All kinds of other features that are not stored in a numeric format

Examples of advantages of qualitative in GIS:

- It helps explaining why certain phenomena happen where they do and visualize it.
- It can produce alternative truths to counter-map the mainstream status quo (situated knowledge).
- Gives space for user involvement or community mapping initiatives through participatory GIS (PGIS or PPGIS)
- Maps can be used as starting points for interviews and participation meetings.
- Depending on the purpose, qualitative GIS can work as both a stand-alone method or in addition to quantitative GIS analysis (mixed methods approach).
- It can supplement quantitative analysis by adding supporting data.
  The example we introduced is how network analysis and tracking of users of electric bicycles has been supplemented by interview quotes and pictures, which gave a much richer information that can be useful for making changes to the bicycle network.
- Our spatial understanding is very subjective, therefore limiting GIS only to quantitative data may be reductionist and difficult to interpret for some users. Adding qualitative components makes maps and GIS outputs more accessible to a wider audience.

It can also be done the other way around, that is using quantitative maps and analysis to support qualitative geographic/ethnographic studies.

Students who provide good and valid arguments why quantitative methods are superior over qualitative GIS should get a passing grade.