WRITTEN EXAMINATION
SGO1910 – Geographical Information Systems 2018

ANSWER GUIDE

Part 1. Five questions (25% of grade)

1.1. Describe the difference between a **reference map** and a **thematic map**? *(max 150 words)*
A satisfactory answer should explain that a reference map first of all describes the *location* of places/map features, while a thematic map describes the *characteristics* of these places/features. A good answer might specify that maps often are a combination of both kind of maps. Answers should be rewarded if they refer to special-purpose maps, such as a map of designated bicycle lanes in Oslo.

1.2 Describe what in GIS is meant with **error** and **uncertainty**? *(max 150 words)*
A good answer contains that error refers to 'the difference between reality and our representation of reality", while uncertainty refers to doubt and distrust in results. An answer that relates error to accuracy and blunders should be rewarded. An excellent answer clarifies how errors, and other aspects such as precision and quality, should be taken into consideration in the uncertainty evaluations.

1.3 Describe what is meant with **discrete** and **continuous geographic features**? Give an example of each? *(max 150 words)*
A very good answer describes that discrete geographic features represent objects with known and definable boundaries at fixed locations (e.g. road, parcel, lake), and that continuous geographic features represent phenomena that occur continuously across space, where each location indicates its intensity (or level).

1.4. Describe what is meant with **in-situ data** collection and **remote sensing**? Give an example of each? *(max 150 words)*
A satisfactory answer contains that in-situ refers to data collection that is in place or ground based, while remote sensing refers to data collection from a distance, or from the sky. A good answer mentions a correct example of in-situ data (e.g. GPS, land surveying, sampling/census, digitisation of analogue maps) and remote sensing (e.g. aerial photography, multispectral/hyperspectral scanners, thermal infrared, LiDAR, RADAR). A very good answer adds to remote sensing that it is based on information collected by instruments (e.g. cameras, scanners, etc.) on a (suborbital/orbital) platform. A reference to active versus passive remote sensing should be rewarded.

1.5. Which four types of **distortion** may take place in map projections? *(max 150 words)*
Shape, area, distance, direction. All 4 good = A; 3=C; 2=D, 1=E, 0=F.

Part 2. Task (15% of grade)

2 Above you see two maps. Give an example of what could be located at the points a and b in map 1? Give an example of what could be indicated by the green area in map 2? Explain step by step and as detailed as possible how the output in map 2 is created based on the input in map 1? Mention all GIS procedures. *(max 250 words)*
- The green area in map 2 is the output based on an overlay of some inclusion and exclusion criteria in map 1. It is enough if the student mentions just an example (e.g. suitable area to build housing).
- Point a and point b are both facilities in map 1. It is enough if the student just mentions an example of each, but is important that he/she identifies that location a identifies some sort of amenity or utility, while point b identifies some sort of disamenity or disutility (e.g. a=school; b=factory).
- A good answer discusses all inclusion and exclusion criteria listed below to get from the input in map a to the output in map b. Especially detecting the service area is important: not having it should cost one grade.
  - Suitable area is <u>within</u> the ±50m <u>buffer</u> from roads

  - Suitable area must be (within 50m from roads that are) within the 400m service area around location a. It is important that students see that this is not a buffer, but that it is a service area, or that they specify that it is network/manhattan distance (rather than euclidean distance).
  - Suitable area must not contain area occupied by roads.
  - Suitable area must be outside the ±100m buffer around highways
  - Suitable area must be outside the ±50m buffer around power lines
  - Suitable area must be outside the ±100m buffer around the land fill.
  - Suitable area must be outside the ±250m buffer around location b.
- An excellent answer discusses step by step all tools that are used. *Intersect* of inclusion criteria. *Union* of exclusion criteria. Erase union of exclusion criteria from intersect of inclusion criteria.

Part 3. Essays (60% of grade, each answer is worth 30%)
The students answer **TWO** of the following three questions, and leave one blank. Correct use of references to the course literature (not necessary when it is a reference to the lectures or text book) should provide for a minor reward. If three answers are given **randomly** select to grade two (for example by throwing a dice). The student is supposed to use all listed key words in the right context so that it becomes clear that he/she knows what the key words mean.

3.1. Give a description of what a **network** and a **network analysis** is? Discuss different types of network analyses and how these are carried out. Use all following key words in your essay: distance decay, facility-to-demand, impedance, location-allocation, maximise coverage, service area. *(max 400 words)*
- The answer should contain an understanding of a network as interconnected lines and intersections that can be directed (e.g. rivers) or undirected (road network), and of a network analysis as a type of spatial analysis that estimates impedance between locations throughout a network, by defining impedance as resistance (e.g. in terms of distance or time).
- The answer should discuss how different types of network analysis (for example shortest route, closest facility, service area, location-allocation or OD-cost matrix) are carried out. The students are in principle free to choose which types of network analyses they describe in detail, but since they need to use the list of key words, it would make most sense if they discuss at least service areas and location allocation.
- A good answer makes correct use of following key words in right context so that it becomes clear that he/she knows what the key words mean
  - Impedance: see above
  - Service area is a type of network analysis where you define the total area that can be reached in a specified time or distance from a facility by following the network.
  - Location-allocation is a type of network analysis to locate the facilities in a way that supplies the demand points most efficiently
  - Distance decay: interaction between locations declines when distance between them increases. This can for instance be mentioned in the context of location allocation problem types of *maximising attendance* (which is based on distance decay) or *maximising coverage* (where distance decay function is lacking). They also learnt about distance decay in the lecture when we discussed Hotelling's law.
  - Maximise coverage is a problem type in location allocation analysis where you want to find the most suitable location for facilities (typically used for emergence services) based on that as many demand points should be covered in a predefined distance or response time.
  - Facility-to-demand is a setting that specifies the direction of travel in a network analysis: i.e. from a facility (e.g. fire station) to the demand points (e.g. population).

3.2. Identify and discuss potential pitfalls of spatial analyses such as **modifiable areal unit problem** (MAUP) and **ecological fallacy**. Describe what **spatial autocorrelation** is and how it can be measured. Discuss how pitfalls like MAUP and ecological fallacy can be relevant for spatial autocorrelation tests. Use all following keywords in your essay: Tobler's first law of geography, MAUP, ecological fallacy, spatial heterogeneity, scale. *(max 400 words)*

- The answer should contain an understanding of Modifiable Areal Unit Problem (MAUP), in how the size (scale) and shape (zoning) of spatial units may influence analysis results. The answer should also contain an understanding of how ecological fallacy is about wrongly making conclusions about individuals (or more disaggregated level of data) from results in larger groups (aggregated level of data).
- A good answer will explain how different configurations of spatial units (MAUP) may provide different analysis results, and in the extension result in different ecological fallacies.
- The answer should include a basic understanding of how spatial autocorrelation discerns how places near each other are more related than distant places, and that Tobler's first law of geography basically is about spatial autocorrelation.
- A good answer should describe patterns of both negative (dispersed) and positive (clustered) spatial autocorrelation.
- The answer should describe how Moran's I can be used as a spatial autocorrelation test, and ideally demonstrate how the index values are related to different spatial patterns (clustered – random – dispersed)
- Answers that distinguish between global and local Moran's I should be rewarded.
- Answers that describe how larger units lower the variation (spatial heterogeneity), and thus make it less likely to identify strongly clustered or dispersed spatial patterns, are excellent.
- How ecological fallacy can be related to spatial autocorrelation tests is not given from readings or lectures and requires creative thinking. Any answer that attempts this successfully should be extensively rewarded. A most basic example of ecological fallacy related to spatial autocorrelation test could be that everyone within an identified cluster have high values of whatever that is measured.

3.3. Discuss what the term **qualitative GIS** implies and provide examples of methods and/or cases that involve qualitative GIS. Furthermore, how is qualitative GIS related to the critique of traditional GIS? Use all following keywords in your essay: method, quantitative, situated, 90s, data *(max 400 words)*
- The answer should contain an understanding of how GIS can be understood as qualitative in multiple ways: 1) How qualitative data can be combined with GIS, 2) how GIS can be used to mix methods, and 3) how GIS can be understood as qualitative in itself.
- A good answer discusses how qualitative data can be combined with GIS in different ways, such as: 1) transformed for geovisualisation (e.g. making pie chart symbols based in in-depth interviews), 2) how multimedia data, such as images, sounds, videos etc., can be linked to GIS and map features, and 3) how GIS can be combined with qualitative data analysis software. It is okay if approach 3 is not mentioned.
- A good answer mentions how GIS can be used in a mixed method approach, for example on the combination of satellite images and ethnographic fieldwork/in-depth interviews to study land use change and ecological narratives.
- An answer that extends into the discussion about the openings for how GIS in itself can be understood as qualitative, ref. Pavlovskaya's book chapter, should be rewarded. The students are not expected to go through all the openings, but they are the following ones:
    - GIS origins are mainly non-quantitative
    - Computerisation is not quantification
    - Spatial analysis in GIS is non-quantitative
    - Digital data are not always for counting
    - Database management and querying are based upon geographic location
    - Mathematical modeling and statistics are still outside GIS
    - Visualisation can be a qualitative analytical technique
- The answer should briefly present the critique of GIS during the 90s, particularly on how GIS was embedded within positivism and applied quantitatively to identify 'laws' (1st wave of critique). Answers should be rewarded if they link qualitative GIS to the call for acknowledging situated and partial knowledge.