WRITTEN EXAMINATION SGO1910 – Geographical Information Systems 2019 GRADING GUIDE

The exam consists of three parts.

Part 1. Five questions (25% of grade)

Part 2. One task (15% of grade)

Part 3. Two out of three essays (60% of grade)

Part 1. Five questions (25% of grade)

Answer ALL of the following questions.

1.1 Provide an overview of the volunteer GIS community and the open source and free GIS software. Mention some examples. (*max 150 words)*
A satisfactory answer acknowledges that there is a growing global GIS community, whose members contribute to generating and updating maps available online and developing GIS software. At least one example should be provided. Some examples that were mentioned in the lectures are:

Open Street Maps platform as an alternative to Google Maps

HOT (Humanitarian OpenStreetMaP Team) and their mobilization to draw maps after the 2015 earthquake in Nelap to facilitate emergency response

The freeware QGIS (or Quantum GIS) open-source software developed by users

An excellent answer mentions multiple examples or mentions and reflects upon some reasons why these volunteering GIS initiatives emerged, such as the fact that one company (ESRI – the developers of ArcGIS) monopolized the GIS software market and sell the product for a high price.

1.2 Describe what is Global Positioning System (GPS) and why is it important in GIS *(max 150 words)*
A satisfactory answer gives a simple definition of GPS, for example, that it is *a satellite based radio-navigation system where satellites in space interact with receiving devices on ground in order to determine and save the exact x, y and z location coordinates*. The student should also mention that many of the spatial datasets used in GIS are collected using GPS devices.

An excellent answer provides additional information, for example:

- More detailed explanation of how the GPS works and the relation between the number of satellites and the accuracy of location measurement,

- The military origins of GPS in the USA and the development of alternative satellite based navigation systems in other countries/regions,
- The different applications of GPS, such as in transportation,
- The way in which modern mobile phones and many of the applications we use every day depend on GPS functionality, or

More details about vector and raster data collection processes using GPS, including land surveying or remote sensing

1.3 What is scale and how is it relevant when conducting spatial analyses? *(max 150 words)*

A satisfying answer should identity that scale as a term can be understood in three ways. First, as a map unit, i.e. the scale bar, that identifies the ratio of distances on the map to the corresponding real-world distances. Second, as the extent of a map/study, as in what area that is included. Third, as in spatial resolution, i.e. the size of the spatial units that are used as observations in a GIS study/map.

Answers should be rewarded if they stress how both the extent and spatial resolution can have a major impact on any analysis. Extent foremost in how it can change the variation of values (plus if spatial heterogeneity/homogeneity are mentioned), and number of observations/units. Resolution also in how it changes the variation, and number of observations/units, but foremost in how the variation is changed/reduced through *(dis-)aggregation* of data.

Answers that introduces Modifiable Areal Unit Problem (MAUP) and ecological fallacies as consequences of these scale issues should be extensively rewarded. Answers should be rewarded extensively if they mention that scale (as in map unit ratio) should not be mistaken for precision (or accuracy), and that one should avoid to work with spatial data that is made for coarser scale than the scale one conducts analyses at.

1.4 Some of the common misconceptions about GIS are that it is "simply a cartographic mapping program" or "just a software package with no theory". Respond to these misconceptions. *(max 150 words)*

A satisfactory answer challenges these misconceptions by explaining that there is a lot of theory behind GIS and that its application goes well beyond just creating maps. Student can mention that GIS is a comprehensive analysis tool that supports decision-making and that software processing is just one of many steps in the GIS process.

An excellent answer goes deeper into the arguments and mentions the types of theories and logic behind GIS (i.e. cartography, surveying, analysis and data display) and/or how GIS allows interaction and management of maps and multiple types of non-spatial data, which makes it much more than just a program to draw maps.

However, if the student agrees with these assumptions and uses convincing and valid arguments to defend his/her position, then a passing mark should be given.

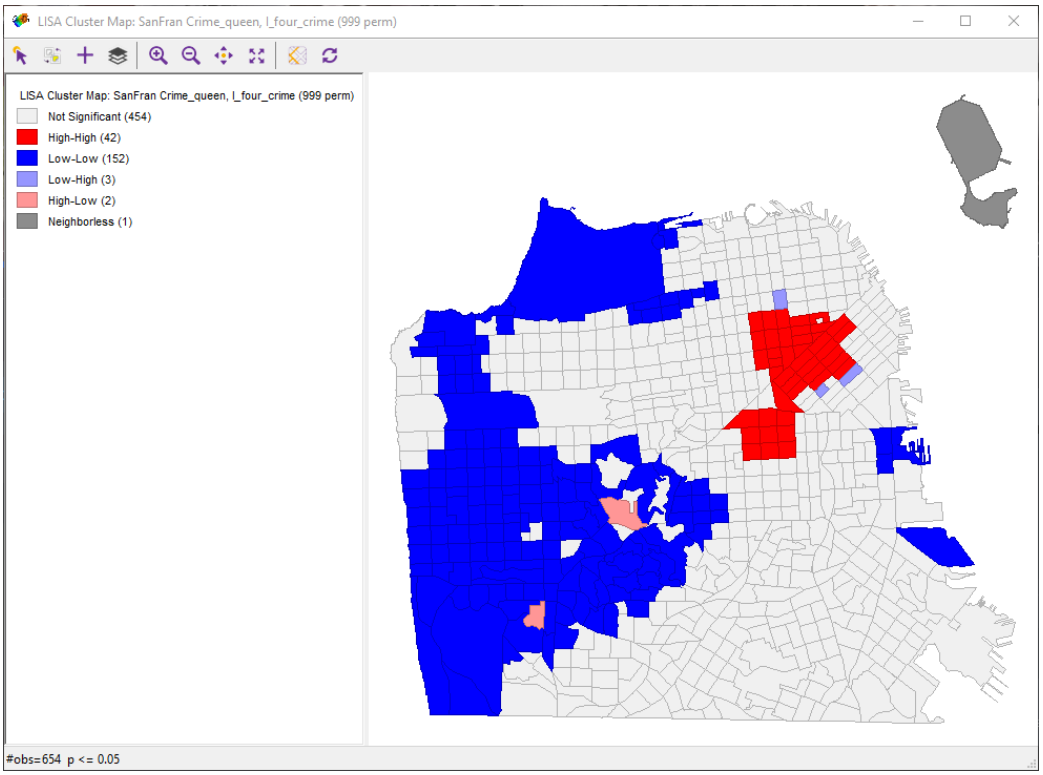
1.5 What is a choropleth map? Why should people be careful when they interpret/read a choropleth map? *(max 150 words)*

A satisfying answer should identify a choropleth map as a thematic map (which is more concerned about the value of a place rather than (only) the location itself). Answers should be rewarded the more concise they describe how a choropleth map is "constructed from values describing the properties of nonoverlapping areas" (Longley et al. 2013: 46), with *nonoverlapping areas* and *values* being the keywords. The candidate should be rewarded if s/he provides examples that shows a clear understanding of what a choropleth map is.

As for issues when interpreting choropleth maps, in a satisfying answer the distinction between spatially intensive and extensive values should be presented, and that extensive values usually should be avoided in choropleth maps. The reason being that extensive maps usually will identify just densely and sparsely populated units, and not intensity of the phenomenon of interest in the map. It should not make any difference if the student use the terms absolute and relative values instead of spatially extensive/intensive. Answers should be rewarded if they address varying size (and shape) of spatial units as a problematic issue of choropleth maps, both in how the value of large but sparsely populated units can be exaggerated, while small but densely populated units (i.e. cities) become under communicated. The main issue is that absolute values matter somehow; 30 percentage of 2000 people in a municipality with large area is far fewer than 4 percentage of 75 000 people in a dense city. Answers that criticise the use of pre-given administrative units, and/or touches upon Modifiable Areal Unit Problem (MAUP) should be rewarded.

Answers should be exceedingly rewarded if they suggest point maps or cartograms as alternatives that can present the data in both absolute and relative terms, by letting size of unit represent absolute value, for example population size, and colour grading the relative value, for example percentage of population that is unemployed.

<u>Part 2. Task (15% of grade)</u>



Above you see a map with the local moran statistic for the crime rates in San Francisco, US.

1. Give a meaningful interpretation of the map.

2. There is one spatial unit (dark grey) without any neighbours in the dataset. Do you have any explanation why that could be the case?

(max 250 words)
A satisfying answer should easily identify and describe the high-high and low-low clusters in a basic manner. A description of what local Moran's I measures should preferably be presented on its own, but thorough and convincing interpretations of the map can ease that requirement in a satisfying answer. The description of local Moran's I should need to include a clarification of what a cluster is (places near each other with similar (high or low) values), and that local Moran's I locates the clusters.

An excellent answer should describe concisely and convincingly what low-high and high-low outliers are.

Answers that identify the use of queen contiguity (to define neighbourhood/spatial relationship) as the (likely) reason to the spatial unit to be without neighbours should be rewarded extensively. The neighbourless unit is after all an actual island.

Students are not expected to know the geography of San Fransisco (and the city was chosen over Oslo, for example, to avoid privilege of local knowledge in the interpretation), and the use of compass directions and up/down/right/left to describe locations of clusters and outliers is expected.

Part 3. Essays (60% of grade, each answer is worth 30%)

Please write an essay on **TWO** of the following three questions of your choosing *(max 600 words each)*. **Leave the answer box of the other of the three questions blank.**

If you wish you may use references to the course literature articles (this is not necessary when it is a reference to the text book or the lectures).

3.1 GIS is carefully designed to handle data with spatial qualities. What is it that makes spatial data special? *(max 600 words)*
A satisfying answer should be able to identify three aspects that makes spatial data special: First, they can be localised, with the use of coordinates. Second, spatial dependence, that places closer to each other depend more on each other than distant ones. Candidates should be penalised somewhat if they insist that spatial dependence state that closer places are more *similar* than distant ones. Dependency can also result in negative spatial autocorrelation. Third, spatial heterogeneity; that places are different, or phrased in another way, that there is variation in the values in a spatial dataset.

An excellent answer should link both spatial dependence and spatial heterogeneity explicitly to and present Tobler's first law of geography, as spatial heterogeneity is a necessity (places need to be different if distant places are to be more different than near places), and spatial dependence is the fundamental process in the law. Candidates should also be rewarded if they associate spatial dependence with spatial autocorrelation, spatial dependence being the more conceptual/theoretical term, spatial autocorrelation being the technical term.

Candidates should be rewarded extensively if they also follow up on what Anselin and Getis (1992) refers to as a problematic issue of spatial dependence; that we can experience spatial dependence between the spatial units (i.e. grid cells or 'delbydeler') that are used to study a phenomenon, instead of spatial dependence in the phenomenon itself.

3.2 Network analyses are powerful tools that are used to estimate optimal routes between locations. Present and discuss sources of error and uncertainty, and their implications when conducting a network analysis. *(max 600 words)*
A satisfying answer should provide clarifications of the terms error and uncertainty, as presented by Unwin (1995), where error can be understood as deviations in the data/results from what we deem to be the true world/results. The candidate should be rewarded if s/he makes a distinction between error and accuracy. Uncertainty relates to the inherent occurrence of errors in a GIS and one's ability to acknowledge and account for both them and the overall quality of the data. Quality would in this case mean how well the data or method fits with the purpose of the work/research, and is thus contextual.

A satisfying answer should ideally explain what a network and a network analysis is (yet, clarifications of error and uncertainty are more important). Answers that explicitly adresses topology as the core aspect of networks should be rewarded.

In terms of network-related errors and uncertainty, a satisfying answer should mention the most obvious issue of poor digitisation and how it can cause network segments, such as streets, to not connect together. Candidates that mention and describes overshoots and undershoots should be rewarded. Answers should be rewarded if they identify poor digitisation as a typical blunder. An excellent answer should explicitly mention how errors, such as blunders in the digitisation, influences/worsens the topology. Digitisation blunders has been used extensively as an example of error in lectures, while other sources of error and uncertainty in network analyses have gotten much less, or none, attention. Students should therefore be rewarded extensively if they present other relevant issues than digitisation blunders.

An excellent answer should be well structured and make clear distinctions between errors/uncertainty that origins from data collection/management (i.e. digitisation, completeness) and choices made when conducting network analyses, such as the reductionism in how points are supposed to represent larger places. Candidates that second-guess the fundamental assumptions of (typical) network analyses, that people always choose the shortest/fastest route, should be exceedingly rewarded.