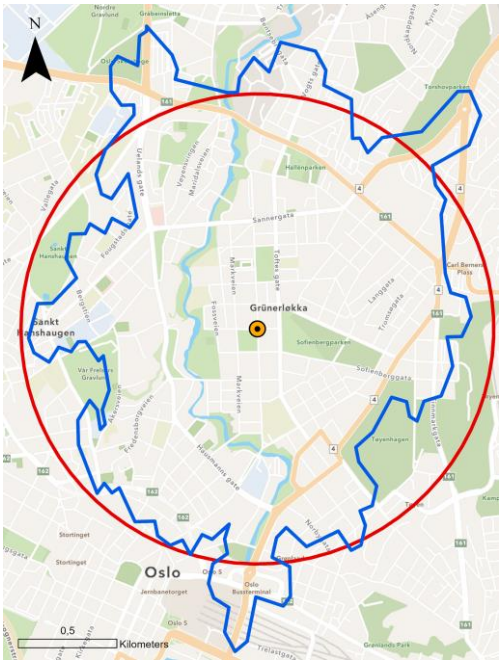
Task (answer both)

1. **Interpret the map.**
    a. **Explain what two types of GIS analyses could have been used to make these outlines.**
    b. **Explain what kind of base information and data is needed to perform these two kinds of analyses.**
    c. **Explain what kinds of phenomena each of these two types of analyses might be more suitable for.**

    You can support your answer with examples.



Answer key:

- The candidate should be able to identify that the red outline is a buffer and that the blue outline shows result of a network analysis (a good indication of this is that the blue outline follows the main roads and does not go into the parks).

- The **buffer** was generated using basic geometry measuring Euclidian distance from the central point to create a circular polygon.
    - The base information needed is the location of the point.
    - Bonus if the candidate writes that the shape of the buffer could be different if instead of a point, the buffer is made from a line or polygon.
    - Bonus if the candidate also highlights the importance of the need to have set the right projection and coordinates.

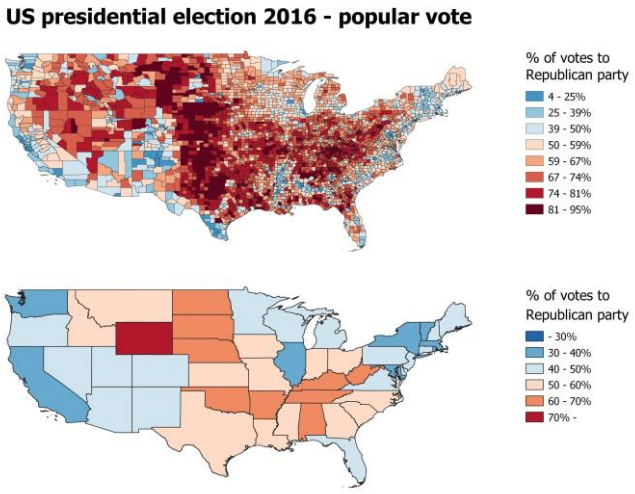
- The candidate should be able to identify a **service area**, which is a result of a network analysis. This is most often calculated by measuring the time travelled or distance from the chosen point (in this case symbolized as star) according to the network information.
    - This could have been done for any type of more of transportation, such as walking, cycling, driving or public transportation.
    - The base information is the location of the point and a network layer.

- Bonus if the candidate highlights the importance of the quality of the network dataset. Bad and/or outdated dataset will give wrong results.
- Bonus if the candidate identifies the basic components of a network: lines (edges), intersections (points) and rules (turns or barriers)
- Bonus if the candidate speculates that this outline was made using walking as a mode of transportation and not for example public transportation (in such case the service area would have looked much different and be longer along the main public transit lines)

- The candidate should specify that a buffer might not be a good indication for showing travel time or human movement, because our choices are usually limited due to irregularities in the landscape, built environment, different types of barriers, private property, etc. However, buffers might be used as approximate indications of distances when good and updated network datasets are not available.
    - Buffers might be useful to show phenomena that are not related to human/vehicle movement on the ground.
    - Bonus if the candidate provides examples where buffers could be useful, such as: air pollution, noise, distance from the coast, etc.

- Network analysis is almost exclusively limited to showing movement on the ground according to the road infrastructure and the movement rules (intersections, turns, barriers, etc.). It can be used to show a variety of related phenomena.
    - Bonus if the candidate provides examples where network analysis could be useful, such as: determining the fastest route, estimating a service area to a chosen facility, identifying best locations for new facilities according to geographic access, finding out which areas are better/worse served by a service, etc.

2. **Interpret the map(s). These two maps show the popular vote in the 2016 election, in which the Republican Party and Donald Trump won over the Democratic Party and Hillary Clinton.**
    a. **Use your knowledge about GIS, spatial analysis, and cartography to explain why the two maps look different.**
    b. **How can those differences be problematic?**



Answer key:

- Why the maps look different:
    - The candidate should directly or indirectly comment that it is about the modifiable areal unit problem (MAUP) – that the shape/zoning and scale (size and amount) of the spatial units influence the result.
    - In addition, there is a difference in data classification schemes. The only way to notice this is through different breaks in the legend.
      Bonus if the student names specifically that one is equal interval while the other one most likely is natural breaks (no penalty for suggesting quantile breaks instead of natural breaks).
      There is also a difference in number of classes, which affect the contrast, and therefore reflect how polarized the voting has been.
    - Bonus if the student explicitly clarifies that MAUP is a matter of the spatial units as *containers*, and not of the shape and scale of the phenomenon that is of interest.
    - Bonus if the student explicitly relates MAUP to revealing/hiding spatial heterogeneity
- Why are the differences problematic?
    - Provides different impressions/results.
    - Bonus of the candidate addresses ecological fallacy as a potential issue.
    - Bonus if the candidate comments on the relevance to policy and real-life etc.
    - ½ Bonus if the candidate addresses the danger of ecological fallacy – which is problematic regardless of the configuration of spatial units.

Question (answer 2 of 3)

1. **GIS and GPS are increasingly integrated with mobile applications. Basing on the discussions in the course lectures and readings, discuss the positive and potential negative aspects. You can support your answer with examples and reflections from your own use of mobile devices.**

Answer key:

- Positive aspects – examples of answers (the candidate should mention at least a few of these and/or add other relevant answers that are not on this list):
    - Helpful in navigation: finding shortest route or information about public transportation, roadwork status etc.
    - Helpful in finding location of services we want to access.
    - Maps on mobile devices are usually more flexible, convenient and useful (have more detailed information) than traditional printed maps.
    - Makes modern logistics possible, fast and efficient (i.e. tracking packages, deliveries)
    - Makes functionality of certain services possible (i.e. electric scooters, Uber) .
    - Emergency services: enabling location information can save lives, as it helps to find people in need and send help quickly (this answer should be particularly rewarded)
    - Allows users to collect, process and edit own data, and make customized maps for personal or professional purposes; all that without specialized technical knowledge or equipment.

- Bonus if the candidate explains how GIS/GPS functions made their everyday lives easier by showing examples of different applications they use.

- Potential negative aspects – examples of answers (the candidate should mention at least a few of these and/or add other relevant answers that are not on this list):
  - Our location and personal data is used by third parties (such as private companies) for their own research and marketing and we have no control over it after we accept the terms. Bonus if the candidate mentions that not accepting the terms could mean that we cannot use these tools/apps/functions.
  - Some authoritarian governments collect a lot of location data in combination with other personal data (for example from social media) to control the population, which may lead to limiting personal freedoms.
  - The user is dependent on access to adequate technology and internet. Such modern technology may increase inequalities between those with and without access.
  - Bonus if the candidate reflects upon the discrimination and potential problems of anyone who chooses not to use modern mobile technology with GIS such as mobile phone applications.
  - Bonus if the candidate mentions the risks and potential problems associated with self-driving vehicles and other kind of modern technology that integrates GIS and automatizes its functionality, or other similar examples.
  - Bonus if candidate mentions the new GDPR regulations and what they mean to GIS (location data is personal data and cannot be used without user agreement/consent)
  - Bonus if the candidate distinguishes between ethical and legal issues in GIS: some issues may be illegal but ethical, others may be unethical but legal (involuntary tracking of people's location is unethical and illegal, but if we agree on the terms and conditions then it usually becomes legal)

2. **Spatial data can be collected in many different ways.**
   - **Explain how vector data and raster data can be collected.**
   - **Explain what are the main differences in the processes of collecting vector and raster data.**

   You can support your answer with examples.

Answer key:

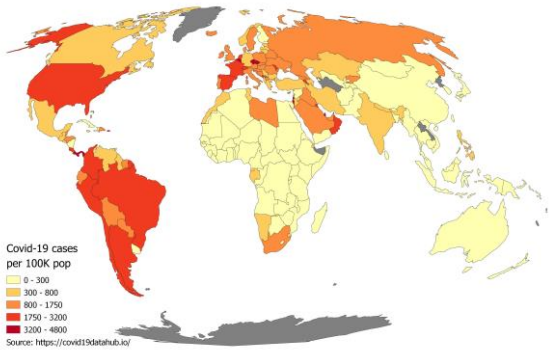
- Vector data is most often (but not always) collected from devices on ground, for example with simple mobile devices or specialized surveying equipment. These devices are connected with the satellites via GPS to save coordinates of point locations that could also later be converted into lines and polygons.
  - The collected information is the exact location – coordinates - that could be later complimented with different types of attributes (text or numbers)
  - Bonus if the candidate explains how vector data could be extracted from raster data, for example by conversion or by identifying and drawing vector features on raster images (such as satellite images or scans of old maps). This could be done either manually or with the use of artificial intelligence.

- Raster data is usually (but not always) collected remotely from devices above ground, such as drones, airplanes or satellites. This usually takes place by taking pictures with digital cameras or scanning with specialized laser or sensors attached to the flying device.
    - These are usually also using the GPS functionality to determine the exact location.
    - Bonus if the candidate explains how raster data could be done by converting observations on the ground into raster. For example samples of temperature as points converted into a raster dataset.
    - Bonus if the candidate mentions some examples of remote sensing beyond aerial photography: multispectral/hyperspectral scanners, thermal infrared detectors, LiDAR (light detection and ranging) and RADAR (radio detection and ranging)

- Examples of use of vector data: property boundaries, building and infrastructure placement, topography and elevation, individual objects (i.e. trees, manhole).
- Examples of use of raster data: land cover and vegetation, sun exposure and shade, topography, temperature.

- Bonus if the candidate comments on how manual input of coordinates is also possible for both vector and raster files, but always in reference to features that are already projected and have a spatial reference.
- Bonus if the candidate explains the functionality of GPS in more details.
- Bonus if the candidate explains the structure of vector data (points, lines and polygons) and raster data (grids and their resolution etc.)
- Bonus if the candidate reflects about the common errors in data collection, such as inadequate precision and accuracy, different kinds of obstacles, selective observations etc.
- Bonus if the candidate discusses how raw vector and raster data can be integrated with GIS (editing, error checking, file conversion, etc.)

3. **Global maps of the spread of Covid-19 are not unproblematic. Data on Covid-19 cases are, for example, collected on a national basis, and there are about as many different testing and measurement regimes as there are countries. Let us say that the World Health Organization (WHO) use this map of Covid-19 cases across the world to plan interventions.**
    - **Discuss the *quality* and *uncertainty* of the underlying data that is used in such a map.**



Answer key:

- Quality is:
  1) situated and based on how well the data suits the purpose of the analysis
  2) a matter of the accuracy (both positional and attribute)/error, logical consistency, completeness and lineage.

- Uncertainty is:
  a measure of doubt and distrust in results – one can for example be certain of the results of analysis conducted with poor-quality data.

  Quality and uncertainty are defined briefly in Unwin (1995) and expanded upon in Girres and Touya (2010).

- WHO's use of the map is mentioned in the question to give the map and the data a *purpose*, which is relevant for the quality assessment.

- Bonus if the candidate expands to discuss quality and uncertainty issues related to the cartographic representation, i.e. MAUP – especially since policy-interventions from WHO is mentioned.

- It is important that the candidate is not judged foremost on their in-depth knowledge about Covid-19, but on how they are able to speculate and make educated guesses based on what they know about quality and uncertainty.