Assessment for CASA0002 – Urban Simulation

Deadline: 27th April 10am.

Word Limit – 3,000 words

The following assessment is designed to assess your understanding and application of the different urban modelling methodologies introduced in the course. The questions are based on the coursework developed during the course and posted in Moodle. This should be your main source to complete the assessment, all the necessary codes for the assessment have been explained and reviewed during the practical sessions. Carefully explain and illustrate your analysis with appropriate graphs and plots. The assessment should not exceed 3000 words in total. (References, numerical tables, plots and their caption, do not count towards the total number of words.)

The assessment is divided in two parts: I) Network science, and II) Spatial Interaction Models.

Part I): This part consists in critically investigating the resilience of the London's underground as a network and the methodological limitations. You will do this in two ways. In the first section, you will only take into consideration the infrastructural network, where stations are nodes, and connecting lines are links, but there will be no distinction between lines and hence, there will be no consideration for changes of lines at a station. In the second part, you will take into account the flow of people in the network and discuss the resilience of the underground in terms of the impact of closures on the travellers.

Part II): This part consists in modelling two scenarios to determine the best location for a new supermarket in a specific part of the city. You will be given a dataset of population and supermarkets. You will need to select the appropriate spatial interaction model, calibrate it, and then test two given locations which are possible scenarios, and select the best location.

Structure: please follow the structure provided below for your work. Follow the instructions in each section and respect the order. All code needs to be put in a **non-public** Github repository, and invitations should be sent to: ElsaArcaute, TomMurat, MiaoZeng and xnzhang-33.

Part I: London's underground resilience

1. Topological network

In this part, you will evaluate the resilience of the London's underground through the removal of stations that can potentially make the underground vulnerable. Through the procedure outlined below you will investigate which are the stations that are most critical for the functioning of the underground, and which methodology is more appropriate to finding these stations.

1.1. Centrality measures:

Select 3 centrality measures to characterise nodes, aiming at identifying the most important nodes in the underground network. Give the definition of each of the measures (including their equation), put the measures into the context of the underground, and explain why they will allow you to find the stations that are most crucial for the functioning of the underground. Compute the measures for your nodes in the network and give the results in a table for the first 10 ranked nodes for each of the 3 measures.

1.2. Node removal:

To investigate the resilience of the network, for each of the centrality measures selected in 1.1. remove the nodes sequentially and compute the Largest Connected Component (LCC). Note: by "sequentially" it is meant that after each removal, you need to re-compute the centrality measure.

Remove the highest ranked node in the new network and evaluate the impact. Continue until removing at least 10 nodes. Discuss which measure would be more appropriate to identify the most important stations with respect to the vulnerability of the underground, and comment on the results.

2. Flows: weighted network

In this section, you will include passengers into the underground and assess the impact of disruptions on travellers.

Consider this time the weighted network constructed in the last practical of networks, where the NUMBAT dataset was used to map the OD data as flows in the underground.

2.1. Consider the same 3 centrality measures explored in 1.1. Which is the most important station according to each these 3 measures in the weighted network, and how did you compute it? Would you consider a different measure for the weighted case?

2.2. Which are the two stations representing the largest OD flow? If the Origin station is closed, how many people will be affected?

2.3. If the origin station is closed, which station should they go to reach their destination? Considering that people would walk to the station, how long would it take them? Please use the road network to compute this.

Part II: Spatial Interaction models

Consider the datasets given to you: population, supermarkets location and area from Geolytix, the distance matrix between OAs and supermarkets, and the flows between OAs. Look at the code used to derived the distance and flow matrices: "Part2_SIM.ipynb".

1. Models and calibration

1.1. Introduce the different spatial interaction models using equations and defining the terms, taking particular care in explaining the role of the parameters. Give examples of when each model would be used.

1.2. Select a model to fit the flows and calibrate it. Show how you ensured that the flows are conserved. For this section you do not need information about the supermarkets.

Cost function: Assume that everybody is using the same mode of transport, in this case it is constrained to the road network. Even though we could assume that people are walking the cost can be seen as corresponding to a deterrence factor, say the effort/money willing to spend to get to a supermarket.

2. Scenarios

2.1. An investment in a new supermarket is to be undertaken, and two possible locations are being discussed: A and B (E00011326 and E00011710, see code). Imagine that you are a consultant, and you need to advise where the investment should take place and why. Please consider that both supermarkets have the same area in the 2 possible scenarios: 1) both are small supermarkets (use the smallest area in the dataset), and 2) both are large supermarkets (use the largest area in the dataset).

2.2. Assume that there's a sharp increase in transport cost. Propose a scenario for this increase and explore whether the results would be the same. Explain how you ensure that the flows are conserved.

2.3. How many people would be able to access the new supermarket within a 15mins walk?