A City-Wide Artificial Society for Mobility Studies Problem Statement
M.EIC@FEUP, Modeling and Simulation

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1. Problem Description

Advanced simulation techniques are useful for effective urban planning and management. Acknowledging this need, this work is centered around a modeling project aimed at creating a comprehensive model of an artificial society that mirrors the activities and mobility patterns within Porto.

Utilizing diverse data sources, including census data and other activity descriptors, we plan to comprehensively capture and depict the dynamics of activities within an urban environment and their impact on mobility patterns.

By harnessing the capabilities of agent-based simulators such as MATSim[1], the model is poised to facilitate data-driven decision-making processes concerning the enhancement of public transportation infrastructure and sustainable urban development, providing a better insight and a tool for urban planners and other researchers to make decisions, possibly integrate into their work or further improve.

2. Project Goals

2.1. Activity Distribution Modeling

The core challenge involves creating a robust model that accurately describes how activities are distributed over time and space in an urban setting, specifically in Porto's town. This includes the spatial and temporal aspects of activities carried out by the population.

2.2. Data Integration

To accomplish this, the project will involve the integration of various data sources. This includes using INE's Census[2] data to gather geospatial data in the form of shapefiles and geopackages that'll be used to map the urban environment and identify statistical sections and subsections within Porto. Furthermore, OpenStreetMap[3] and official datasets from STCP and Metro do Porto will be used to gather information on public transport stops and itineraries.

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[1] MATSim, https://www.matsim.org/
[2] INE's Census, https://mapas.ine.pt/download/index2021.phtml
[3] OpenStreetMap, https://www.openstreetmap.org/

2.3. Geospatial Analysis

Once the geographical areas are identified, the project aims to draw their centroids and polygonal areas on an open street map. This step is crucial for accurately representing the spatial distribution of activities.

2.4. Mobility Pattern Analysis

The project goes further by analyzing the connectivity from and to each statistical section in the map, primarily focusing on public transportation routes. This will help understand the existing mobility patterns, including how people move within the city.

Moreover, we could estimate the number of trips originating from each statistical section, incorporating socio-demographic factors. Consider factors like income, age, and other relevant variables to predict trip generation patterns. Areas with lower incomes, higher elderly populations, or other specific characteristics should generate more public transport trips. Richer statistical sections can go from one to another directly through personal means of transportation. We plan to study how modifications of socio-demographic factors alter the utilization of public transportation and overall transit needs.

Additionally, determine if it's possible to travel from one section to another through a single trip or if multiple modes of public transportation are required. Create matrices that record the minimum number of transfers needed to reach any other statistical section and the minimum distance to reach any other statistical section (taking into account the distance from the centroid of the statistical section to the relevant public transportation stop). Graph centrality will also help us determine which stops are the key hubs of the transportation network.

Further assess the consequences of creating strategic stops to increase connectivity, decrease the average number of transfers distance aforementioned.

2.5. Pendular Movement Modeling

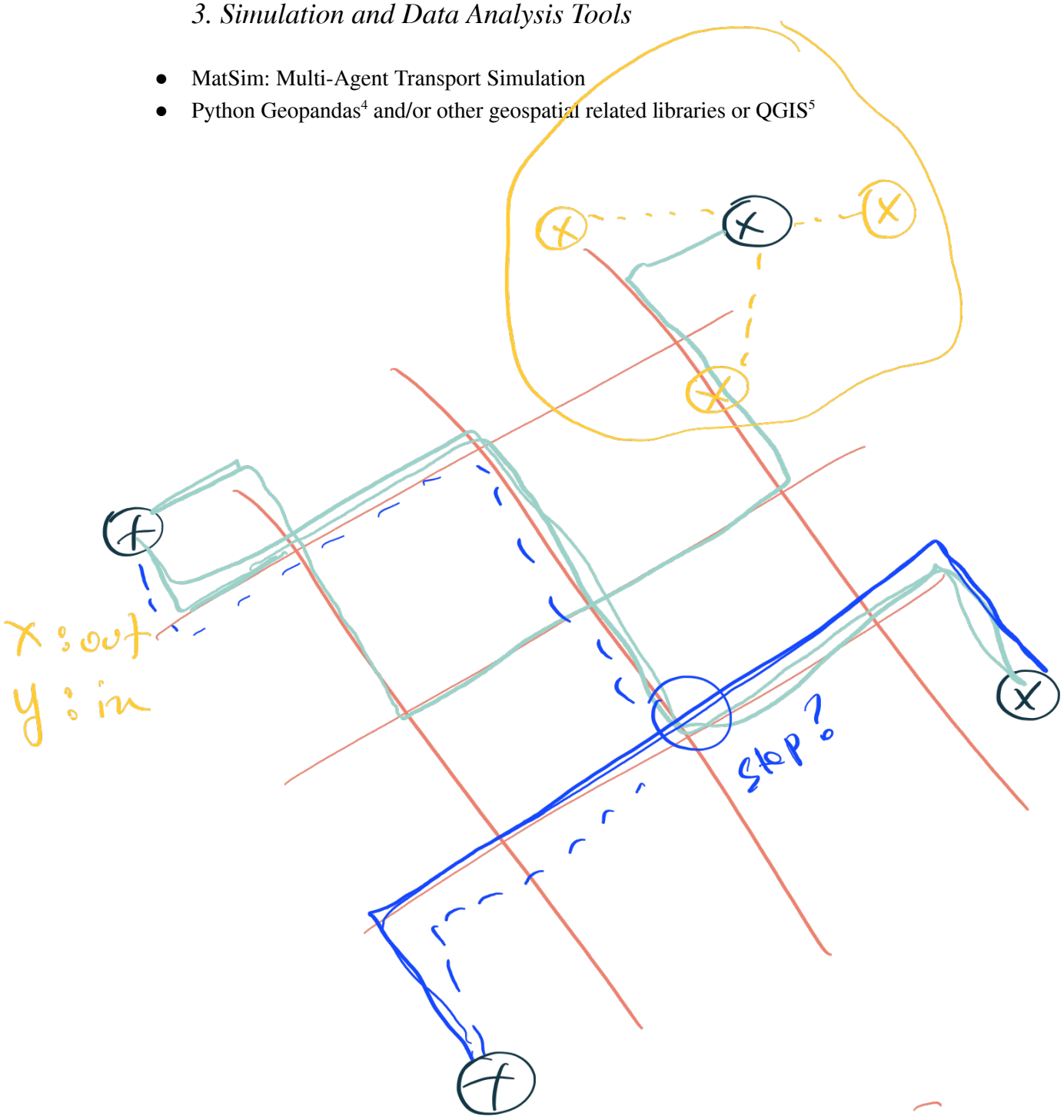
Additionally, the project can infer pendular movements of the population. This involves understanding and modeling the commuting patterns of individuals to and from industrial sections within the city. This is essential for capturing the daily work-related mobility dynamics.

2.6. Incorporating Points of Interest

Integrate points of interest, such as malls, hospitals, educational institutions, and other landmarks into the simulation. These points will serve as reference points and influence the in and outflow of people from their respective statistical sections. For example, the proximity of a hospital may increase trips to and from a specific section. Simulate trips generated by points of interest. Determine how these landmarks attract people from different statistical sections and influence mobility patterns. Assess the impact of various points of interest on mobility patterns, including changes in the in and outflow of people, and how these landmarks affect travel behaviors.

3. Simulation and Data Analysis Tools

- MatSim: Multi-Agent Transport Simulation
- Python Geopandas[4] and/or other geospatial related libraries or QGIS[5]



1. Modelação: Rede, secções, parag's, etc.
2. Simulação de disrupções
3. Modelação demográfica / modelos gravitacionais

Matriz OD

[4] Geopandas, https://geopandas.org/
[5] QGIS, https://www.qgis.org/en/site/

	1	2	3	4	5
1					
2	a) distância mínima				
3	b) escadas				
4					