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Topological indexes and community structure for urban mobility networks: variations in a typical day

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ABSTRACT

This work fo-cused in the problem of Urban mobility, which in an unplanned urban growth sce-nario might generate negative impacts, like traffic jams, air pollution and infras-tructure flaws. Based on real data for the city of São José dos Campos, the mobil-ity of a typical day was represented. These data consist of an Origin-Destinationsurvey: the city was divided into 55 traffic zones and more than 20 thousand peo-ple were asked about the time of departure and arrival of each trip. The devel-opment was divided in 3 steps, pre-processing, processing and post-processing.In preprocessing, an origin destination graph was generated with a 3-dimensionmatrix representation, in language C++, in which each vertex represents a traf-fic zone and the edges are weighted by the flux of people, with 24 time variations,one for each hour of the day. In the processing, in C, the igraph library was usedto calculate the topological properties such as degree (number of connections),clustering coefficient (neighbors redundancy) and diameter (longest distance) ofa network of mobility over a typical day and we also applied the textit walktrapalgorithm for community detection. In the post-processing, using the concept of(geo) graphs, graphs represented with geolocation, the GeoCNet was developed. Itis a tool that allows the creation of a textit shapefile with the topological prop-erties of the graph.

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The whole procedure

1 **The whole procedure used:**

The whole procedure used was divided in 3 steps with C++ language in preprocessing, C and igraph library in processing to calculate topological index and posprocessing with PostgresSQL/Postigis and python to creation (geo)graphs and Qgis to visualization.

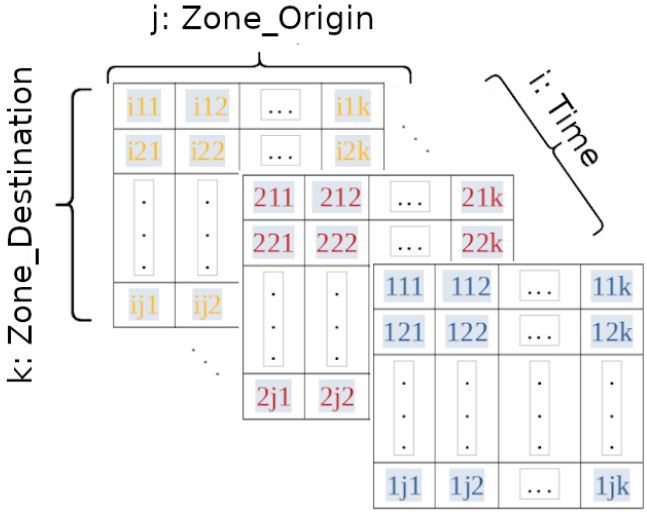
2 The mobility data can be found at https://www.sjc.sp.gov.br/media/56152/atlas_origem_destino_baixa_res.pdf

Preprocessing

3 Preprocessing in C++

3.1 **Input data:** csv file with 5 columns: ZONE_ORIGIN, STARTING_TIME, ZONE_DESTINATION, ARRIVAL_TIME, SAMPLING

3.2 Time, origin and destination represented in a matrix form in 3 dimensions.



3.3 Creation of the matrix

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3.4 Matrix symmetrization: $kj + jk$

3.5 Resulting in the sum between the vertices and the diagonal zero

3.6 For the time window, the data were grouped at 60 min intervals, one for each hour of the day.

3.7 **Output**: file containing matrix sequence for each interval.

3.8 Code in C++ :
main.cpp

Processing

4 Processing in C with igraph lib.

4.1 Calculated topological measures:

igraph
igraph_weighted_adjacency()
igraph_ecount()
igraph_degree()
igraph_transitivity_avglocal_undirected()
igraph_diameter()
igraph_community_walktrap()

Posprocessing

5 To analyze complex networks geographically, the GeoCNET tool (Geographical Complex Networks) was developed. In python, communication is made with the PostgresSQL database and PostGIS extension, which allows the creation of a shapefile to visualize (geo) graphs.

5.1 You can get GeoCNet tools at https://github.com/jessicadominguess/geocnet

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