A network approach to airports mobility

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Mobility patterns in public spaces like airports, supermarkets or hospitals, are a topic of main interest to understand how to organize social spaces for economic, health protection and hygienic purposes.

We study a large dataset of anonymized GPS trajectories describing movements inside the London airports by means of temporal and multi-layer networks metrics. Two different behaviors inside airports are found, namely, workers and travelers, showing distinct patterns. We analyze the contact network of all the users in the airport database at different spatial and temporal scales and find a significative assortativity/homophily in the way contacts happen inside the airport between workers and travelers.

Travelers spend more time in contact with other travelers in very crowded spaces as shops, security controls, duty free zones, gates. Conversely, they spend less time with workers. On the other hand, workers spend more time in specific and limited working places with other colleagues for the most of the time and less time on average in contact with travelers at gates or security controls.

We then have to differentiate between arriving, departing and connecting travelers, in order to check if different behaviors may appear. Hence we proceed to associate the four user types to four separated network layers. Each node is an anonymized user and each link represents the presence of two users in the same spatial (10 m^2) and temporal (15 min) discrete space. The resulting networks represent the spatio-temporal coincidences. This allows to infer the main characteristics to be taken into account when modelling epidemic spreading. We randomly subsample the contact network with an increasing number of people, in order to find the critical threshold for a giant component to appear (percolation).

The results are shown in Fig. 1 (left column) for the interactions taking place between 10:00 to 11:00 AM. We have also found that when all the users are present, the system is found above the percolation threshold all day long, even by night as shown in Fig. 1 (right column). With almost one hundredth of the total users we already manage to see a giant component arise, which means an epidemic would be able to spread in the airport. We note that our methodology can be further refined by, within a category, classifying users in communities according to their interaction pattern.

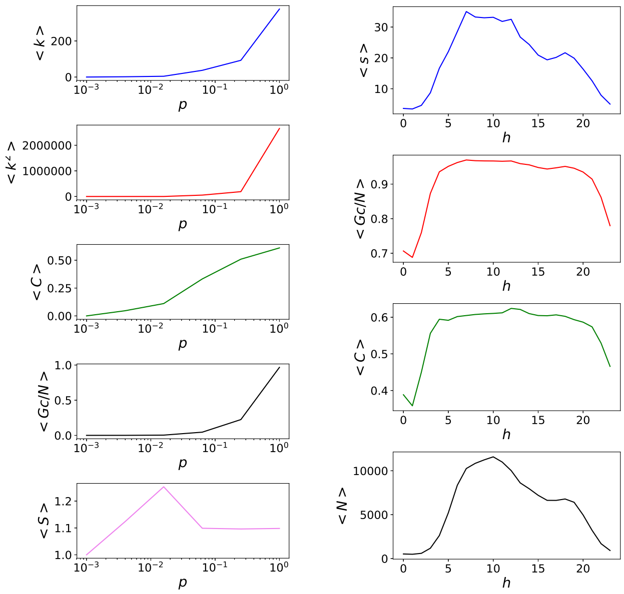

Fig. 1. Characterization of the interaction network. Panels display the mean $\langle k \rangle$ and the second moment $\langle k^2 \rangle$ of the degree distribution, the mean clustering coefficient $\langle C \rangle$, the mean of the giant component relative size $\langle G_c/N \rangle$, the mean size of the components excluding the giant one $\langle S \rangle$ and the number of agents interacting averaged over one hour $\langle N \rangle$.

This study illustrates the opportunity of using the tools of network science for the analysis of spatial trajectories, deepening our knowledge on how humans interact in public spaces. Possible applications include the study of epidemics spreading, opening the doors to the development of models reproducing the observed network features and the behaviors of the different user types and hence to the improvement of epidemics preventions models and policies.

[1] M. Mazzoli, R. Gallotti, P. Colet, and J.J. Ramasco, A network approach to airports mobility, (to appear soon).