Visitors in an exhibition room: human mobility and stopping patterns

Josep Perelló[1,2] and Enric Sanmartí[1,2]

[1]OpenSystems Research, Departament de Física de la Matèria Condensada, Universitat de Barcelona.
Martí i Franquès, 1, 08028 Barcelona (Spain).
[2]Universitat de Barcelona Institute of Complex Systems (UBICS).
Martí i Franquès, 1, 08028 Barcelona (Spain).

The study of human mobility in the context of complex systems science has gained popularity over the last years [1] and has a wide range of applications, from epidemic spreading to the inference of census data in third world countries [2]. Recently, there has been a surge in the number of data sets related to human mobility thanks to the availability of massive digital traces of human whereabouts and the development of mobile GPS technology.

We developed a public experiment of human mobility with the collaboration of a cultural center of the city. The movement of the visitors in an exhibition room of the *CCCB* in Barcelona was tracked by six infrared depth camera sensors in order to study their movement patterns. The geometry of the room is shown in Fig. 1. In its center there is a short wall section that divides the room in two main spaces. The entrance is at the right of the room and the exit at the left, both closer to the upper space than to the lower one. The six cameras were placed on shelves on the central wall section, three on each side, with a combined field of view covering a wide extent of the rooms floor surface. Those cameras determine visitors positions in the room at any given time and track their movements through it. Furthermore, the cameras are able to single out the positions of a particular individual and keep track of the movement of each of them simultaneously. The uniqueness of this data set lies on both the location studied and on the actual amount of data collected. Indeed, we were provided with camera acquired data spanning four consecutive months (almost the actual time extent of the exhibition) and we estimate that, during this period, around 15000 people visited the exhibition.

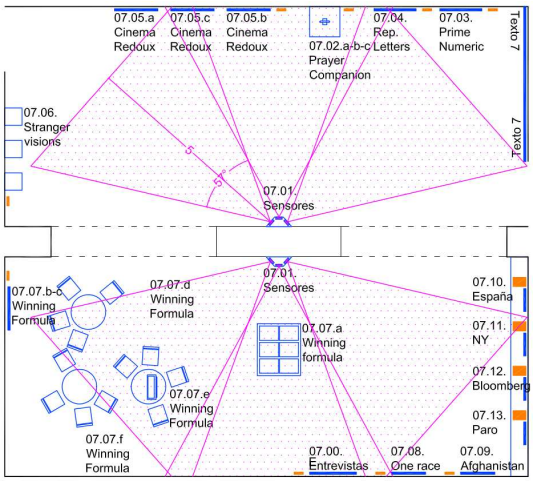

Figure 1: **Schematics of the room under study:** the field of view of each of the cameras is marked in purple and the exhibition objects are marked in blue.

We attempt to separate the data points of each visitor into two different classes. Stopped points, where the visitor is not moving, mostly correspond to the visitor watching one of the exhibition objects or points of attraction. Moving points are those where the visitor is moving from a point of attraction to another. Stopped points (see Fig. 2) are detected with a simple algorithm based on the distance between two consecutive data points [3]. The stopping statistics allow us to establish different characteristic stopping times, associated to diverse levels of attention of the visitor in front of an exhibition object, as well as the stopping patterns. From moving points, we compute the orientation of the trajectories, from which we can infer the preferred direction of exploration of the room, ie if a visitor is more likely to go left or right when they enter the room, and how many visitors leave the room without exploring a half of it.

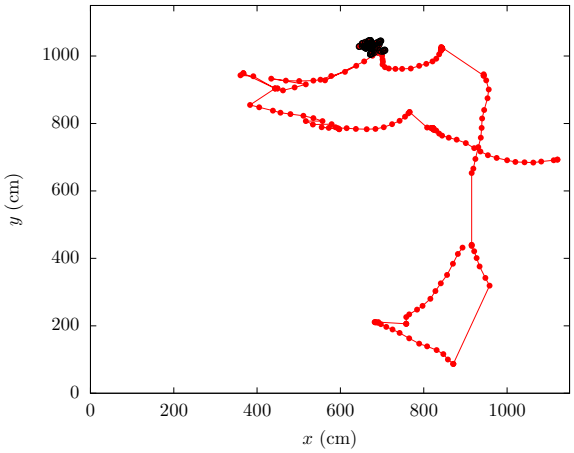

Figure 2: **Example of an individual trajectory in the exhibition room:** the origin is placed at the lower left corner of the room and stopped points are marked in black.

[1] González MC, Hidalgo CA, Barabási AL. *Understanding individual human mobility patterns* (Nature **453**: 779782, 2008).

[2] Palchykov V, Mitrovic M, Jo HJ, Saramäki J, Pan RK. *Inferring human mobility using communication patterns* (Sci. Rep. **4**: 6174, 2014).

[3] Gutiérrez-Roig M, Sagarra O, Oltra A, Palmer JRB, Bartumeus F, Díaz-Guilera A, Perelló J. *Active and reactive behaviour in human mobility: the influence of attraction points on pedestrians* (R. Soc. open sci. **3**: 160177, 2016).