Animal movement "on track": reconciling the spatial and temporal nature of animal trajectories

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Animals do not occupy the space at random, but in dependence of distribution of resources allowing survival and reproduction. Indeed, the position of animals in space and time relate the animal to its environment; vice versa, most animals respond to environmental heterogeneity in space and time by moving. Different strategies have been described for animals to occupy the environment, from residence to migration, to nomadism, to commuting. One of the most relevant concepts in animal ecology is the "home range", i.e. "that area traversed by the individual in its normal activities of food gathering, mating and caring for young", according to the classic definition of Burt (1947). The same definition quotes that "occasional sallies outside the area, perhaps exploratory in nature, should not be considered as in part of the home range". According to this definition, the spatial correlation between individual locations is the main descriptor of resident animals (i.e., holding a home range).

The advent of animal-borne tracking (mainly GPS-based) has enabled to sample animal trajectories systematically and at relatively high frequency (although still far from what human tracking can rely on). Under this renewed empirical framework, the boundaries between different animal strategies in occupying the space were showed to be much more blurred than previously believed. Residence itself derives from a sequence of movement modes, that are affected by spatial and temporal heterogeneity of the environment. Therefore, not only spatial correlation between locations, but also their temporal sequence is fundamental to evidence animal behaviour in an evolutionary perspective (i.e., determining fitness or performance). Typically, trajectories within the home range may result in diffusion or advection movements, i.e. diffusion from the centre or return

to locations already visited. Similarly, locations can be modelled in probability distribution, where the probability to locate the animal differs along a gradient.

In this showcase we consider different attempts to reconcile the spatial and temporal nature of animal movement. We first computed the spatial correlation of locations (spatial clustering), to then classify the residence time in each cluster; in a further informative approach, the sequence of locations were fed to a spatial clustering procedure. Moreover, we addressed the problem of spatial interactions between trajectories of different individuals. Indeed, individuals occupy the space within communities, populations, social groups. Interactions among individuals (e.g. predation, competition and mating) are fundamental for determining individual fitness, but the temporal dimension of the spatial overlap among individuals has been largely overlooked due to the inadequacy of computing tools. Thus the advent of spatio-temporal databases could revolutionise the way animal tracking data are queried, visualised and analysed. Finally, these geographic approaches could be made spatially explicit in environmental layers, for large scale predictive modelling, on the basis of sequence of environmental characteristics associated to the trajectory. Although many challenges still holds, we foresee this as an extremely promising field of research, both in ICT and in the ecological domain. .