Movement: animal strategies, spatial patterns, fragmented landscapes

CMPD5 Mini-symposium proposal

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1 Organisers

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2 Introduction

Biological populations are subject to changes through births, deaths, and migration. From a landscape perspective, these populations grow and spread across heterogeneous space and along time. The dynamics of these population variations are addressed in studies of Population Dynamics (topic of this conference) with either continuous or discrete state variables [1]. Also, one may consider the space variable either implicitly or explicitly, according to the questions being asked. Our proposed mini-symposium focuses on movement questions where space is considered explicitly.

For animal populations, there are a variety of reasons for which individuals decide to move, such as finding food or a suitable habitat, mating, or escaping from predators or adverse environmental conditions. For many animals, the ability to move is essential for survival. Therefore, suitable methods to analyze the movement patterns of populations combined with individual movement mechanisms are fundamental to the understanding of the ecological characteristics of populations and the effects of movment on population dynamics. Indeed, a relationship as fundamental as the functional response, which determines the per capita consumption of prey by a predator population, is shaped by movement patterns on the landscape [2]. It has also been recognised that the epidemiology of disease is also strongly influenced by patterns in human movement [3, 4].

In this context, models of movement using mathematical and/or computational frameworks are important, and this mini-symposium aims to present researchers who are thinking explicitly between the patterns and strategies of individual movements and the resulting population redistributions. We are interested in fostering a discussion aimed at understanding how spatial heterogeneities and the particularities of individual movement patterns affect overall populations dynamics. We include speakers who use a wide variety of modelling tools, ranging from differential and difference equations to computer simulations.

3 Justification

From the point of view of population dynamics and its applications in ecology, it is important to be able to translate descriptions of movement centered on individuals into corresponding space-centered descriptions, that is, to find a correspondence between individual- and population-level models. For example, one may consider the simplest model of movement, brownian random motion, in which an individual's movement is indifferent to the environment or the presence of other individuals. This movement can be outlined at the individual level by a random walk over a discrete one dimensional space on which individuals move to the right, left or remain in the same position. This pattern of movement can then be described by a Master equation and translated into the redistribution of an entire population through a partial differential equation, in this case the diffusion equation [5].

Animals, however, do not move only randomly [6, 7, 8, 9, 10]. Their movements are influenced by a variety of factors, such as landscape peculiarities (spatial heterogeneity, temporal predictability of resources, landscape persistence, etc.), behavioral status (hunger, fear, etc.) and the physiology of the animal at the time of movement. One of the most active areas in the study of spatial population dynamics is the incorporation of these factors in the description of population dynamics. That is, ways are sought to incorporate these influences into the individual models and, as in the case of purely random movements, to "translate" these more complex movement rules into corresponding population-level models describing patterns of use of space and time.

The causes and consequences of animal movement are of great interest to ecologists. In particular, through the study of movement of individuals, researchers have gained a clearer understanding of population distributions [11], of the importance of particular resources for certain animals [12], of dispersal strategies [13], of social interaction [14], and of the patterns of space use [15]. All of these movement patterns also have effects on the spread and intensity of epidemics [4]. Mathematical and computational models play an important role in helping researchers understand how individual-level behaviours scale up to population-level patterns, and so suitable methods for analysing and modelling movement patterns are critical.

In this context, our proposed mini-symposium is closely related to the conference topics. Population and disease dynamics are mediated by spatial movement, so much so that they are inextricably linked. While we can mathematically separate the two, and much has been gained from these models, there is now a need to develop more sophisticated approaches that examine the bilateral relationship between movement and population dynamics. This research is the focus of our proposed mini-symposium.

4 Confirmed speakers

Our minisymposium is composed by two blocks, one focussed on ecological questions and the other focussed chiefly on epidemiological ones. The speakers below have all expressed an interest in participating in our mini-symposium.

Block 1

1. Celia Anteneodo: celia.fis@puc-rio.br
2. Joseph D Bailey: jbailef@essex.ac.uk
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