Title of the Project:

Use of affinity profiles as a utility function to understand and predict the dynamics of spatial segregation of populations

Abstract:
Understanding and predicting patterns of human mobility in urban systems remains a critical challenge with large implications for urban design, public health, and socioeconomic policy. This research explores a new method of modelling human spatial behaviour in terms of "geo-fingerprints", which are affinity profiles unique to individuals, that summarise how people are attracted to and repelled from different types of Points of Interest (POIs). Using Locomizer's patented approach, which incorporates distance-weighted and density-weighted measures that draw on accepted principles in geography (Tobler's First Law), retail economics (Huff's Law), and psychophysics (Weber-Fechner Law), we derived and validated these affinity profiles as utility functions to predict both individual and collective spatial choices. Furthermore, we demonstrated through comparative analysis with more conventional visitation-based approaches that affinity profiles provided better predictive performance, disclosing complex user preferences that revealed not only where people commute, but also the underlying attractions that inform their movement decisions.

The research extends beyond individual behaviour to examine how these spatial preferences shape urban segregation patterns and demographic sorting. By integrating affinity profiles with census data, we illustrate how the various preference groupings depict socioeconomic characteristics and populations who create distinct patterns of spatial segregation, which exhibit variation temporally within daily and weekly cycles. To investigate the dynamic evolution of these patterns, we designed an agent-based model based on principles of active matter physics, enabling individuals to move in a non-equilibrium Sakoda-Schelling framework, adjusting their movement according to forces driven by their personal affinities. The use of agent-based models is important because this centres non-equilibrium concepts within the model assortment and enables the simulation of new policy initiatives and/or directions in urban planning. This model can be used to intervene with the distribution of places of interest (POI) or alter the physical structure of the area (e.g., the built environment) in order to study how changing POI's or infrastructure could impact segregation dynamics. Using the framework we have outlined, we aim to provide a systematic opportunity to understand the non-linear relationship between individual preferences for space and aggregated urban patterns, with the prospect of being experimental tools for developing more integrated and equitable urban experiences using the mathematical datasets and modelling techniques.