Agent-Based Modelling of People's Behaviour in Public Parks

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Abstract. Public parks are important urban spaces to promote physical and mental health, in addition to inducing social interaction between visitors. Within the context of geo-design and sustainability issues, urban designers are interested in designing parks for visitor's use as well as easy management – a bottom-up approach often resulting in public participation processes. As an alternative, people's behaviour may be simulated during the design process thereby testing different design alternatives. This course of action is also feasible when renovating or redecorating parks. However, validated models simulating people's behaviour in public parks at a very local level are very scarce. In this project, we use geodata on people's activities collected in three public parks in a European city to derive a model of behaviour for an agent-based simulation. We discuss this process as well as the problem of modelling human behaviour at the local scale.

Keywords: urban public parks, behaviour, activities, geodesign

1 Modelling behaviour in public parks – the challenge

Urban green spaces play an important role in the discussion on sustainable and resilient urban systems. Especially public neighbourhood parks are said to promote physical and mental health when visited regularly. In addition, public parks may induce social interaction between visitors. Analytical approaches (in the form of surveys and interviews, see e.g. [5]) show these benefits of urban public parks for existing parks. Public participation planning processes allow potential park users to express their preferences for the design of planned parks. However, these processes are time- and resource-consuming for an urban planning department.

Within the context of geodesign and urban sustainability, urban designers and city officials are interested in designing parks for visitor's use as well as easy management. As an alternative to public participation processes, we propose to simulate people's behaviour during the design process thereby testing different design alternatives. This course of action is also feasible when renovating or redecorating parks. However, validated models simulating people's behaviour in public parks, i.e., at a very local level, are very scarce. Existing models often focus on specific behaviours, such as walking [3], place selection [6], space appropriation [4], or others.

The challenge for modelling behaviour at a local level is that generic models for typical park activities, such as strolling, supervising children or playing catch, as well as more structured activities such as climbing, badminton or soccer (passing the ball), are missing. Furthermore, some of these activities may be carried out anyplace within a public park and the selection process for these places is not well understood. While we believe that theories from environmental psychology and anthropology may be helpful in this regard, we still have to contend with the problem that these theories are not (yet) implemented.

In our research, we use geodata on observed people's behaviour that was collected in three public parks in a European city. Within the project the observed behaviour was classified into activities [1]; from these we derive initial models of activities for an agent-based simulation in section 2. It is important to note that these models are based partly on the observations, partly on some knowledge about human-environment interactions as well as common knowledge about these activities. In section 3, we sketch the current implementation of the activities in an agent-based model. In the final section 4, we discuss the process of deriving models of activities from observation data as well as the problem of modelling human behaviour at the local scale.

2 People's activities in public parks derived from case studies

The case studies were undertaken from 2005 to 2007 in close collaboration with the administrative department responsible for the design and maintenance of public parks, i.e., GrünStadtZürich, as part of a larger research project. The three parks were selected on the basis of four criteria: their function in the city context as neighbourhood parks, their age (established vs. new), their style of design, and their suitability for observations (size, visibility). Figure 1 shows the model of the Bäckeranlage as an example of one of the oldest parks in Zurich, located in a densely built neighbourhood with a potentially precarious social constellation of low income and ethnically diverse population.

The observations were realised over a period of three years, including a pilot study. Each of the three parks was observed on 7-14 days for 2-4 hours. As two parks were observed in consecutive years, this amounts to almost 150 hours of observations with over 8000 park visitors recorded. The results of the extensive analysis may be found in [1].

The observations recorded individual visitors, their age, gender, time, location, type of activity, and group affiliation (groups of park visitors that know each other and spend their stay together). Age was classified into the broad groups of children, teenagers, adults and elderly (retired). The 26 observed activities were grouped into Static Solitary (e.g. reading, sleeping), Static Interactive (communicating), Eat/Drink, Dynamic Irregular (e.g. running around), Dynamic Regular (some kind of playing field, e.g. football), Playgrounds and Water after a pilot study. All observers had to undergo special training in order to be able to conduct the surveys according to the specifications.

3 Implementing the activities in an agent-based model

The agent-based model shows the activities of people in three different parks in Zurich (Switzerland) that were derived based on the data described above. It visualises how spaces are used in parks and how agents (spatially) interact with each other and with features in the park. The model was created with NetLogo 6.2.1 and its GIS-extension. Please note that the model itself is not attached to a GIS (there is no need for a coupling) - the data we use is derived from a GIS. At the beginning of the simulation the park is set up with all its observable features according to Shapefiles that were created using satellite images of the respective parks. Figure 1 shows an annotated screenshot of the model of the Bäckeranlage. This geodata forms the input for the setup of the agent-based model.

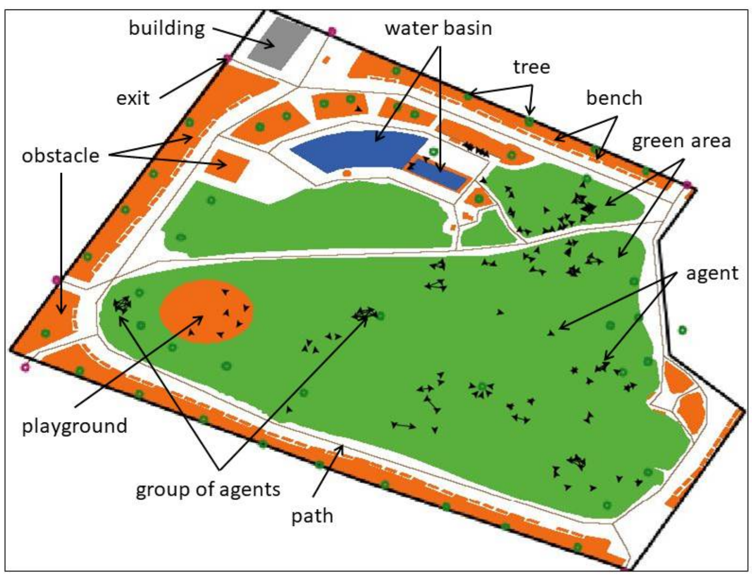

Fig. 1. Annotated screenshot of agent-based model of Bäckeranlage, Zurich

The park is populated with agents carrying out different individual and group activities - this setup is based on the collected geodata. The initial location of agents corresponds with the first recorded observation; subsequent observations of the same agent are currently disregarded.

There are 26 different activities. For stationary activities, the individual or group stays at their original location without movement (e.g., sleeping, picnicking) or they move inside a circumscribed area represented as a polygonal feature (e.g., playgrounds) or area defined by the agent's locations (e.g., romping, football). For dynamic activities, individuals or whole groups move freely (randomly) through the park without (currently) being restricted to certain features or group areas (e.g. running around, chasing around) or follow a path until they reach an exit point (biking). They adapt their direction if they encounter an obstacle.

4 Discussion and Conclusions

In this project we endeavour to model activities of agents at a local level within a public neighbourhood park. Our approach is data-driven in that we use observations of real people's activities and locations in three parks in Zurich, Switzerland. We identified different types of activities and recreate their spatio-temporal footprints using a combination of theory and empiricism. However, the current initial implementation is lacking especially in the rich type of interaction between agent and environment that expresses a diversified understanding (or ontology) of the environment. We distinguish between obstacles, other agents, and free space. This minimalist interpretation already provides verisimilitude to some agent's movements, but we still needed to add specific concepts (such as boundary and exit). To make things potentially more complicated, each activity may require a different interpretation of obstacle, boundary, and free space, thus enforcing a "functional perception" on our agents.

The distinction between stationary and location-changing activities allows us to ignore all stationary activities, where the most important part, i.e. selecting a suitable location, is not modelled due to initialising all agents at the observed locations. The location selection process is mostly cognitive and may be modelled using the notion of affordances [2, 6].

The models for the location-changing activities currently use random movement, which needs to be substituted by rules for suitable moves (for that specific activity). This kind of "suitability assessment" will take much more processing time in addition to (again) changing the ontology.

A point to discuss is the need to adhere to/be informed by the data for validation purposes while at the same time freeing ourselves from the data in order to arrive at generic rules for modelling people's behaviour. How much difference between modelled and observed behaviour is still acceptable?

In conclusion, we have to admit that we are still rather far from using our agent-based model for geodesign simulations. It is however encouraging that the initial implementation shows expected and verisimilar movement patterns. We will therefore continue to work on implementing rules for the different activities with the goal to transfer these implementations to other case studies and serve as basis for geodesigning public parks.

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