# Modelling Space Appropriation in Public Parks

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## INTRODUCTION

Sustainable park management encompasses the requirement to provide equal opportunities for access and usage of the park, regardless of age, gender or nationality of the visitors. It thereby presents opportunities as well as problems for today's heterogeneous global cities. The research presented here is part of the project "Sustainable design, management and appropriation of urban public parks" (www.geo.unizh.ch/nfp54/)[1].

We assume that the specific park infrastructure in the form of design elements, behaviour settings (in the sense of Schoggen, 1989) and management (Kaplan et al., 1998) affords specific activities while discouraging others. By applying this knowledge to a specific spatial management, conflicts of usage can be minimized and thus social sustainability is ensured.

Our goal therefore is to model the social interaction and resulting space usage in urban public parks at the micro level of individuals, because an understanding of the processes of space appropriation is important for the design and management of sustainable urban environments.

How can we measure the appropriation and usage of park space, and how can we detect (potential) conflicts? We propose an approach that uses the concepts of affordances (Gibson 1986), personal spaces (Hall 1966), and crowding (Altman 1975), coupled with information about location and activity. We aim to visualize and model crowding in the form of overlapping personal and activity spaces in a computational environment and thereby reveal potential conflicts of use.

We show that the use of space and resulting conflicts between park visitors can be modelled using information about the environment (i.e. affordances of the park infrastructure), the activities of the park users and a few individual characteristics such as age and gender. A comparison between several visualization and modelling approaches reveals that dynamic field-based visualizations coupled with multi-agent systems show the most promise.

## CONCEPTUALIZING SPACE APPROPRIATION AND USE

Affordances of objects tell us how those objects could be used (Gibson 1986). E.g., a chair affords sitting, a flat surface affords walking or skidding, and a swing affords sitting and swinging. In our study human users of parks perceive objects or object groupings that allow them, i.e. afford, to carry out an activity. There has been some debate in the literature about how to determine affordance, since a chair also affords standing on it or even writing on it. We model affordance as attributes of relations between a user and an object in the park. This approach lowers the potentially infinite affordances of an object by constraining them to those affordances usable for a certain activity the park user wishes to pursue.

Personal spaces according to Hall (1966) can be conceptualized as a succession of concentric spheres with a person at the core. Hall describes four personal distances, each contained with one sphere: intimate, personal, social and public distance. Intrusion into these spaces by others can lead to anxiety or discomfort, depending on the relationship between the individuals. We challenge this rather static picture and propose to change the shape of the personal spaces according to type of activity, speed of movement and interaction mode. For example, in Fig. 1 the personal space of the jogging person is enlarged along the direction of movement and reduced towards the left and right.

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The potential conflict is most likely to occur in the space just before the person. As shown by Baxter (1970), interpersonal distances also vary with age, gender and ethnicity, but for the beginning we will focus on changes due to activity.

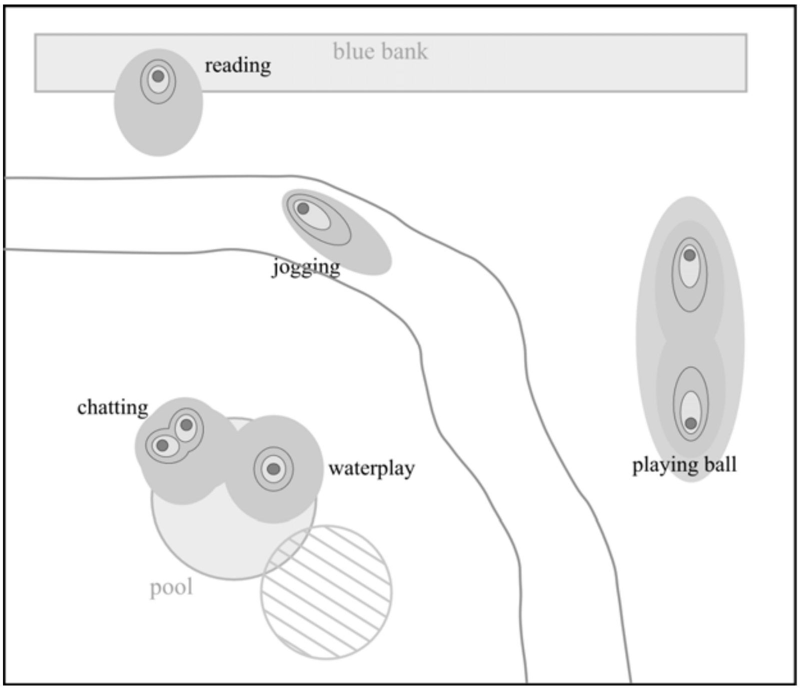


***Figure 1:*** Personal spaces of activities taking place in a park (Timpf et al. 2006)

During our extended observations in the public parks of Zurich, the following groups of activities have been observed: Non-interactive (sleeping, reading, and working), interactive (chatting, observing, overseeing children), eating (picnicking and BBQ), ball games (football, badminton), activities using the park's equipment (such as playgrounds), and other activities on the spot or involving movement (see Figure 2 on the next page for an example). Each of these activities requires a specific space that we call the activity's *footprint*. For example, the footprint of ball games using fields is well defined, and the footprint of chatting is the same as the persons doing the chat, whereas other activities (such as playing space-consuming games) have less well-defined footprints. Their size is estimated from literature and observations.

## CONCEPTUALIZING CONFLICTS IN SPACE APPROPRIATION

We propose that conflicts occur when there is not enough space to carry out the desired activity without interference, or when crowding (Altman 1975) occurs, i.e. the level of desired privacy is less than the level of achieved privacy. Altman develops four interpersonal control mechanisms for privacy: Personal Spaces, Territory, Verbal and Non-verbal behaviour. In our specific case, we will focus on personal spaces as main control mechanism Territoriality does not play an important role in public parks. Its temporary nature can be subsumed under personal spaces. Verbal and non-verbal communication is difficult to record for the entire park. Additionally, we assume from our observations, that personal spaces are the most important control mechanism (i.e. rebuilding a certain distance to a nuisance is more common than engaging in verbal exchange).

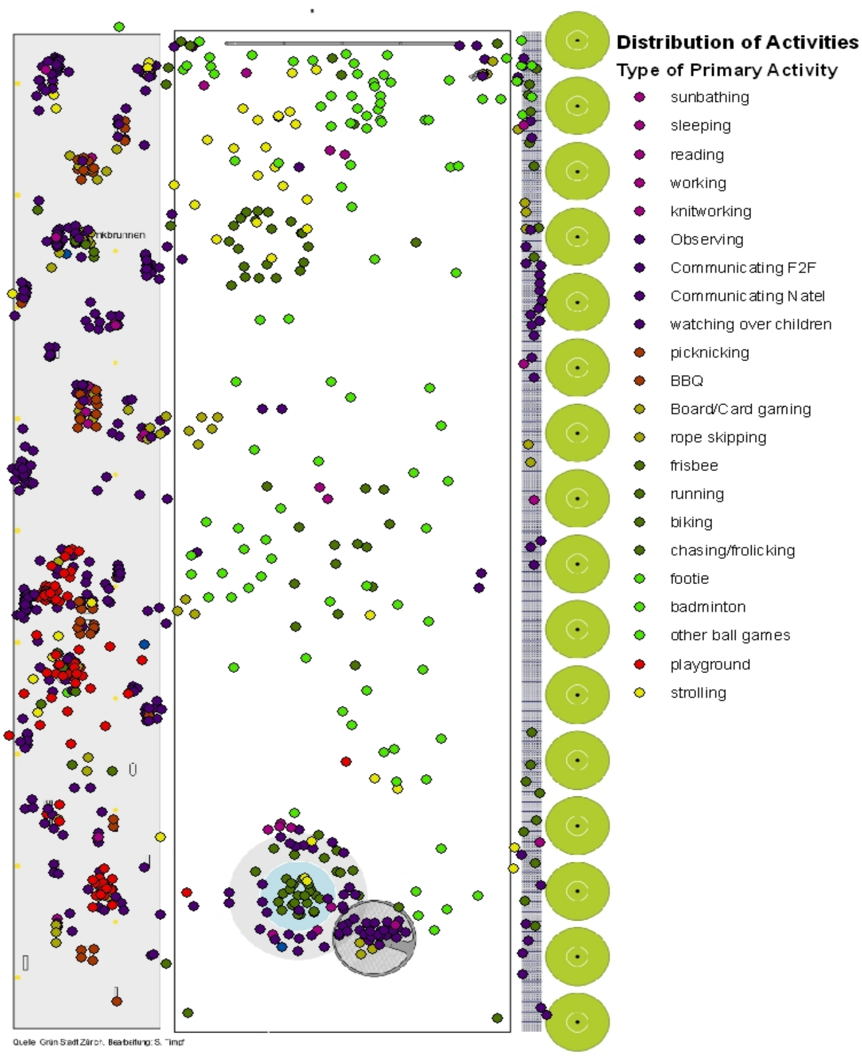


***Figure 2*:** Observed distribution of activities, Wahlenpark (Zurich), summer 2006

Using the two types of spaces (personal spaces and activity footprints) described in the preceding section, we analyze when conflicts might become possible should personal spaces and (incompatible) activity footprints of other park visitors overlap. In an example (see Figure 3 on the next page), we look at a football player (left) and a reader (right) and their respective activity footprints (AF) and personal spaces (PS) where intrusion is experienced as a disturbance. For simplicity's sake we use circular spaces, although as mentioned above, our goal is to adjust the shape according to the type of activity.

The football player's activity footprint is large and disturbs the reader already at the distance of social personal space, thus an overlapping provokes a conflict from the reader's perspective. On the other hand, the small activity footprint of the reader will rarely disturb the small personal space claimed by the football player.

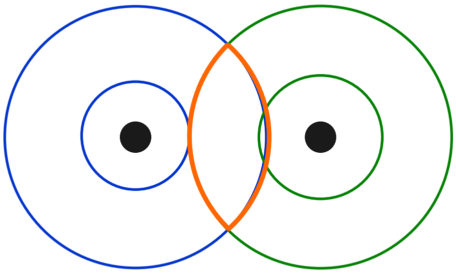

***Figure 3*: **Potential conflicts from overlapping space appropriation

## REPRESENTATION AND MODELLING OF CONFLICTS

The raw empirical data was provided by field observations in two urban public parks in Zurich, Switzerland. During the summer 2006, each park was observed systematically on 14 days for two hours each. Using TabletPCs, the observations were directly coded into a GIS-database. The variables include estimated age (infant, child, teenager, young adult, senior adult, senior), gender (male, female, unknown) and association to a group of visitors. This information is stored in a table and linked via ID to an event table that contains the locations of the individual, time of events and types of activity. Both changes in location or activity constitute an event (compare figure 4, using simplified STER notation from Tryfona, 2003). In 2007, one of the two parks plus a new third park will be observed in the same manner.

AF (football)

PS (football)

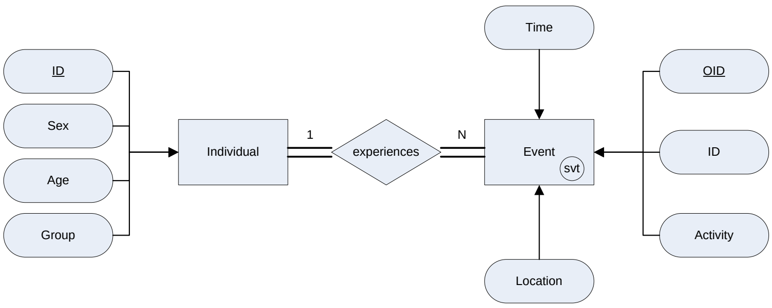


***Figure 4*: **Data Model

### Using a Geographic Information System

First efforts to calculate (potential) conflicts continued with the discreet and object-based approach inherent in the data. In Figure 5 (next page) the workflow is displayed. After calculating activity footprints and personal spaces around the individuals (ignoring overlaps within groups), the data was exported to an external Java program and the potential for conflict for each overlapping segment was calculated. The final visualization of potential conflict was realized by importing the output from the Java program back into GIS.

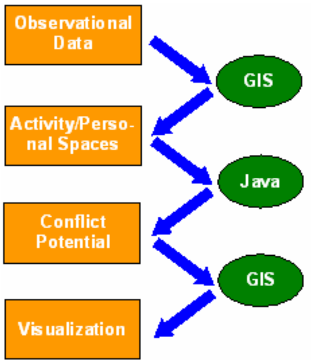


***Figure 5*:** Workflow for calculating conflict potential

The following Figure 6 (below) shows an example output from the first calculations, still using circular spaces to reduce complexity. The calculations were done for scenarios: On the left panel, smaller radii are used than on the right panel.

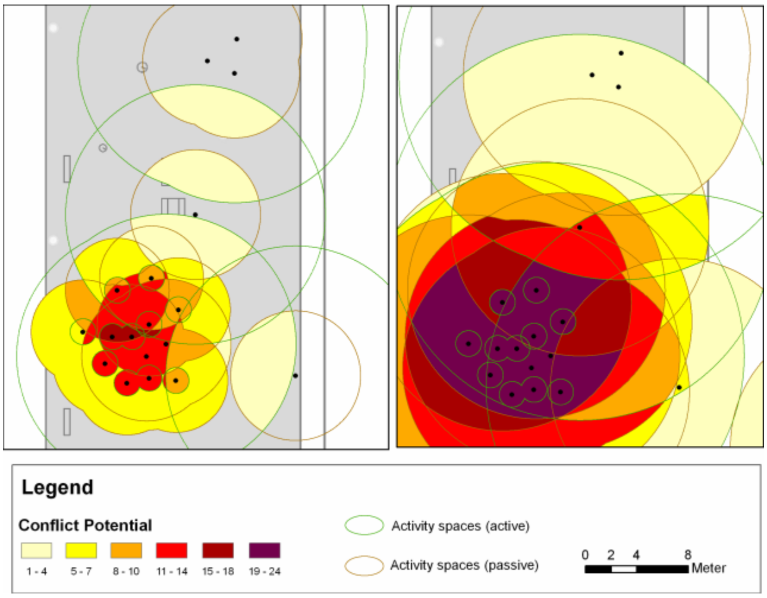


***Figure 6:*** Conflict potential for two different sizes of personal spaces (passive) and activity footprints (active)

This approach proved to be cumbersome and not very efficient. More importantly, personal spaces and activity footprints do not have crisp but only vaguely defined boundaries.

To address these shortcomings, we will use field-based representations of the personal spaces and activity footprints, again eliminating overlaps within groups of visitors first before checking for conflicts. One possibility is to assign different radii according to the type of activity. Then the density for each group or individual is calculated, thereby generating density layers that can be checked for overlaps. At the same time, the value gives an estimation of the intensity of the (potential) conflict (for density surfaces of activities, compare Kwan, 2000). So far, we have used this approach on the attributes of gender and age. Figure 7 shows the relative density of male and female park visitors. The peaks (green) show a higher density of female visitors, while the troughs (red) represent a higher density of male visitors. The visualization suggests a clustering around certain elements of the park infrastructure. The inherent uncertainty of the boundaries can also be addressed by using fuzzy instead of crisp boundaries, with appropriate intrinsic or extrinsic visualization methods.

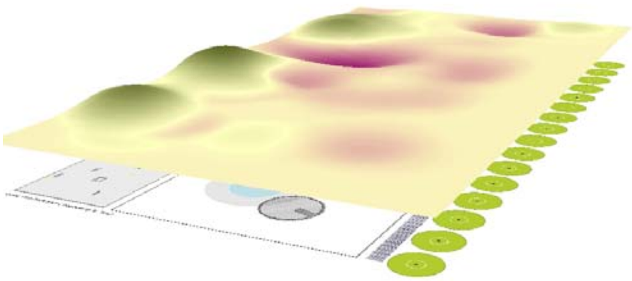

***Figure 7:*** Relative density of female and male park visitors

Finally, the temporal dimension will come into play by the use of dynamic visualizations to adequately represent the change in space appropriation over time. The animation of the object-based event data is already possible, while an animation of 3D density surfaces will require additional effort. Our aim is to provide an intuitively understandable representation for exploratory analysis first, before allowing the user to drill down and analyse the data with geostatistical methods such as clustering, dispersion or motion pattern analysis.

## Representation in a Multi-Agent System

The third method for modelling conflicts of users in our study is the implementation of user behaviour in a multi-agent system (Weiss 1999). A multi-agent system allows for reproducing the behaviour of the environment and of individuals at a micro-level at the same time as at a group level. In our MA simulation potential conflicts show up in the behaviour of the agents - agents try to avoid conflicts and will leave the park if they cannot pursue their activity without conflicts. A potential conflict is highlighted using the colour of the agent icon (from green to red). Other solutions such as change of activity instead of location, or verbal communication would also be possible. Figure 8 shows a screenshot from an early implementation in RePast (repast.sourceforge.net).

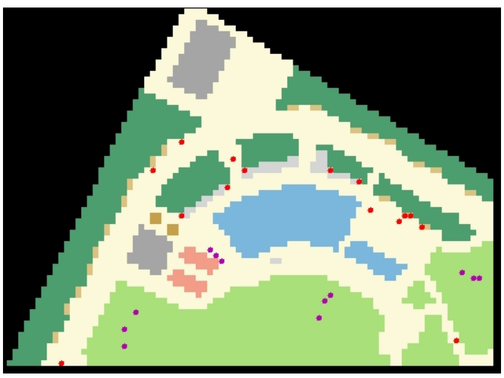

***Figure 8:*** Screenshot of a park use MAS in RePast

## CONCLUSIONS

The first testing of methods and the results show that our goal of modelling social interaction at the micro level is already possible with the use of only the most relevant input information, namely environment and type of activity. Other topics such as gender conflicts, park appeal for varying age groups, nationality or ethnicity could in principle be also modelled with this method. We use both original and already applied methods, integrating them with developments from diverse fields such as environmental psychology, anthropology and geographical information science and visualization.

A comparison of the different methods shows that we have to move from object-based representations to field-based-representations for an adequate model of space appropriation and usage. While this allows us a better representation of socially constructed space, it is more challenging to capture the dynamics of evolving processes of space appropriation.

Multi-agent systems on the other hand promise to simulate space appropriation with different samples of park users and to try out the effects of various elements of park design. Depending on the intention of the user, the integration could be either GIS- or MAS-centric, with both elements closely coupled (compare Brown et al., 2005).

In this respect, our research is meant as a small contribution to the facilitation of park design and management, before changes are actually made. It should be possible to analyse parks already built that do not “function” as planned, and also to aid in the design of new parks.

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