Representation of socio-spatial processes of identification by a multiagent system model approach

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1 INTRODUCTION

With the relocation of the Munich Airport into the outer suburban fringe in May 1992, an area of 560 ha, located in Riem at the eastern edge of Munich, was available for real estate development (Fig. 1 and 2). Therewith the foundations of one of the biggest urban planning challenges in Munich's postwar era were laid. Due to several locational premises Munich city planning intended a so-called 'one-third-solution' (http://www.muenchen.de/Stadtleben/BUGA05/Historie_Hintergrund/100737/01wieallesbegann.html): One third of the area is determined for houses and flats, one third for commercial use (mainly offices, and including 440.000 square meters for the relocation of the Munich Trade Fair Center) and one third for open space. The New Munich Trade Fair Centre was inaugurated in spring 1998, and during winter the same year the first persons moved into 'Messestadt Riem'. Currently about 4.000 inhabitants are living at this new place – it will increase to 16.000 inhabitants and 13.000 employees until completion in 2013.

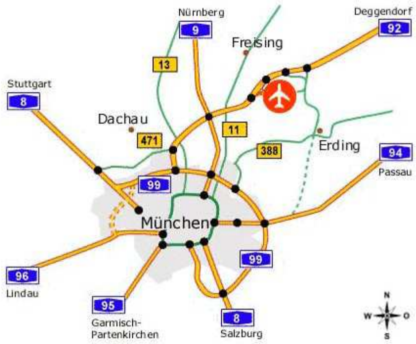

Fig. 1: The new airport location

An urban development project of this size made it necessary to improve the transport infrastructure and to generate an adequate social infrastructure. Since the area is located close to the highway A94 it was sufficient to increase the number of access possibilities. Furthermore, the network of roads to the suburban settlements in the vicinity was improved. Concerning the public transport system an existing underground line was extended to the Messestadt and the supply of bus lines has been increased. The relative high share of open space provides a sufficient value for recreation which is going to be increased due to the federal exhibition of flowers in 2005. However, this share of open space is compulsory for climatic reasons and has therefore been fixed by local planning authority. Structural relations to the vicinal settlements of Riem (the old village), Trudering, Feldkirchen, or Haar can hardly be found. Insofar, one can circumscribe this current state as a locally bounded development (Fig. 2).

Fig. 2: The Messestadt Riem

Up to the erection of the shopping center called 'Riem Arcaden' in February 2004 the retail situation was quite bad – the provision of food and other daily things like newspapers was limited to only a few small stores. Compared to the retail situation there is an extensive supply of social institutions in the Messestadt: Besides a large elementary school and two kindergartens, a forum for citizens, a familiy centre, several meeting places, a greenery workshop, and a centre for children and teenagers, just to mention a few, serve as public institutions for interested inhabitants. These institutions are completed with printed media and virtual offers like for example a quarterly published magazine, local TV and radio programs (http://www.messestadt-tv.com/), at which inhabitants can actively participate, or the project 'E-neighbourhood', an online bulletin board that enables virtual contacts among neighbors (http://www.messestadt-riem.com/msr/pl_neighbors/fr_neigh.htm).

Since the question should be investigated, how social and spatial processes of identification can emerge and develop under these circumstances then the above mentioned premises and conditions are highly relevant. The Messestadt Riem is characterized by a dynamic and independent growth, there is no historical nucleus for organic development. This specific situation is responsible for a more or less identical starting point to build up social networks among the new inhabitants. There were no networks, therefore, the process of assimilation is not based on gradual adaptation to existing social structures. An influencing element of Munich urban planning is given by a different supply of property and houses to achieve a balanced social mixture. 28% of property and houses are determined for low income households, 30% for those Munich residents with an average income who want to purchase a flat or a house (the so-called Munich model), 14% are provided for non Munich residents with an average income, and 28% are privately financed. A further impressive fact is the relatively high share of foreigners (30%), mainly from Turkey, Bulgaria and the former Yugoslavia.

The conditions for the creation and development of local networks are quite similar – they too are starting at the very beginning. The mentioned social institutions serve here as appropriate local nodes, but spatial networking is not restricted to them. Local points of identification and non-identification – each case obviously gradually differentiated – emerge with the development of the city quarter and they emerge under the condition, to live temporarily with a building site. This condition has to be constantly kept in mind while studying those processes. We can, to a certain degree, compare this field study with a work in a laboratory, i.e. the empirical results we would like to obtain in our project called 'place-making and place-relation' are only partly generalizable.

2 THE MULTIAGENT SYSTEM MODEL APPROACH

Investigations of socio-spatial processes of identification are a complex matter and could not be elaborated sufficiently by adopting just one single method. The generation of social as well as spatial interactions depends on a variety of facts, including personal settings of attitudes, meanings, opinions towards other people and/or its build environment, but also including inter-personal aspects like norms, rules, and laws. This is the social point of view to examine interactions among individuals and between them and space. Complementary, the local settings like built space, public or open spaces are as well to include as inter-local facts like settlement structure, infrastructural networks or spatial access. This is the spatial focus on interactions among spatial objects and between them and individuals.

In trying to grasp the mutual relations between social and spatial facts different methodological approaches can be utilized. A quantitative survey, conceptualized for example as a standardized random poll, is one common possibility to receive data about demographic and economic facets of the interviewees. These data are appropriate to statistically correlate them with individual statements about identification processes. The statements itself are hardly to explore and to understand by using a standardized questionnaire. A qualitative enquiry, conducted for example as a personal interview with a coarse set of non-standardized questions in mind, is a useful approach to achieve a deeper comprehension of individual attitudes to assessing chances and hindrances of social interactions and place-making. Both approaches, however, have one disadvantage in common: They are not appropriate to observe people in action, realizing what they have expressed verbally. This disadvantage can obviously be surpassed by observing them at specific locations. Even if one has the knowledge of these specific locations (which is not always completely clear, very often one has to detect them first), it requires a great deal of time to obtain satisfying results. This is exactly the situation at which the multiagent system model approach can be brought into action.

According to Conte et al. (1998, 3) a multiagent system (MAS) can be characterized as a set of autonomous agents with the following properties: "[…] a strong emphasis on the whole agent, rather than solely on its actions; careful attention paid to the process of plan-construction, not just decision-making and choice; familiarity with […] agents mental, as well as their behavioral states; a tendency to provide the social agent with specific capacities for actions answering social requests and tasks […], rather than modelling social processes as mere emerging properties of agents' interaction". In spite of many important agents' properties which are currently not completely implemented in our model, one terminological difficulty is given: a lack of any spatial context. In other disciplines like political science or sociology (Epstein & Axtell 1996), the spatial context has not to be considered as a necessary part of the model, in geography it has. The geosimulation approach of Benenson and Torrens (2004, 6) emphasises precisely this need: "Agent-based models often represent space in a cursory manner, if at all. The geosimulation paradigm demands explicit representation of space, spatial behavior of objects, and their spatial relationships". Thus, a MAS consists of

a community of mobile social agents, representing properties of real human beings

a community of spatial agents, representing properties of real spatial facts

an environment as an abstract medium to embedding social and spatial agents

operations which enables agents to perceive, transform, and interact (Mandl 2003, 13).

The term 'community' doesn't indicate that there necessarily has to be a sociality or spatiality at the very beginning of the phenomenon being modelled – it also could emerge. Our model, however, doesn't assume a complete emergence of sociality and spatiality, the original conditions of the model include for example the fact that there already exists a plan how to develop the Messestadt Riem and also that social agents are already equipped with (currently very simple) capabilities to communicate. Provided with these capabilities, our goal is to explore where, how, and who is interacting socially and spatially – this is the emerging part of our approach.

The above given characterization of MAS is related to autonomous agents. "An autonomous agent (1) is a system [we would say 'automata'] situated within and a part of an environment; (2) that senses that environment and acts on it, over time; (3) in pursuit of its own agenda, and (4) so as to effect what it senses in the future" (Benenson & Torrens 2004, 154; from Franklin & Graesser 1996).

This definition of agents' properties which can be further differentiated (Tab. 1) indicates that it is related to social agents, i.e. spatial agents do have other properties.

Property	Other names	Meaning
Reactive	Sensing and acting	Responds in a timely fashion to changes in the environment
Autonomous		Excercises control over its own actions
Goal-oriented	Proactive, purposeful	Does not simply act in response to the environment
Temporally continuous		Agent behavior is a continuously running process
Communicative	Socially able	Communicates with other agents, perhaps including people
Mobile		Able to transport itself from one location to another
Flexible		Agent actions are not scripted
Learning	Adaptive	Changes its behavior based on its previous experience
Character		Believable "personality" and emotional state

Tab. 1: Properties of agents in MAS (source: Benenson & Torrens 2004, 156)

The fact that we are developing a model framework with social *and* spatial agents has two reasons. The first reason is of conceptual nature: In contrast to cellular automata with its restricted neighborhood relations due to its stationarity – "[t]he position of cells and their neighborhood relations remain fixed over time" (Benenson & Torrens 2004, 6) – spatial agents are capable of generating neighborhood relations among each other being arbitrarily located (see also Parker et al. 2003). The second reason has to do with our theoretical approach. Very briefly, we conceptualize sociality and spatiality in a system theoretical manner (Koch 2004a; 2004b). Social systems are composed of communications between individuals which are structurally linked to them. And spatial systems are composed of communications (defined distinctively compared to social systems) between material and network objects which too are structurally linked to them. Both types of systems are structurally linked through mutual coding processes.

The realization of the MAS model approach which will be described in the subsequent chapter is one of four accesses to explore socio-spatial processes of identification in the Messestadt Riem. The standardized poll with a sample size of approximately the half of the inhabitants will take place in spring 2005. The qualitative enquiry with a couple of non-standardized interviews is part of a diploma thesis which will be finished soon. The fourth approach of investigation will be a participating observation at particular locations. This part will start instantaneously after a first statistical analysis of the poll results.

3 THE MULTIAGENT SYSTEM MODEL OF MESSESTADT RIEM

The MAS model of Messestadt Riem is currently implemented in StarLogo, a freely available simulation software developed at MIT, Cambridge, Massachusetts, and conceptualized as "[…] a programmable modeling environment for exploring the workings of decentralized systems – systems that are organized without an organizer, coordinated without an coordinator" (http://education.mit.edu/starlogo/; see also Colella et al. 2001). The representation of the spatial dimension embraces several steps: First, a raster image, produced in ArcGIS, will be imported into StarLogo (in a future step we intend to link GIS and simulation software more tightly). Due to the fact that the raster image is rather fuzzy in its resolution, a preprocessing is then necessary to sharpen the image. After that step the development of the area takes place. During 200 time steps the buildings of the first phase of construction will be erected (represents past and present development). According to the above mentioned planning guidelines three categories of houses/apartments are differentiated: those for low income households (blue colored), those for medium income households (sky blue), and those for high income households (purple). In addition to houses, also three categories of commercial buildings are discriminated: retail stores, including the shopping centre 'Riem Arcaden' (at the end of the first phase) (orange), social services (dark red), and others which are of no relevance in our model (brown). The second phase of construction (future development) with the same differentiation lasts 200 time steps too (houses are colored turquoise, magenta, and pink; the colors of retail stores and social services remain unchanged; others in dark brown). All retail stores except the shopping centre and all social services (currently 24 facilities each) are distributed randomly (Fig. 3). At step 200 and 400, respectively, a random sample of houses will be drawn where social agents live. This step is for transparency reasons. At this point, hoewever, the model doesn't represent the real situation appropriately, because inhabitants at a whole do not move into their new homes at a time at which the entire area is completely developed. This is not due to programming restrictions but due to drawing a random sample – we will overcome this in a later stage.

The representation of the social dimension is characterized by the following properties: Partly depending on the result of the random sample and partly on the chosen coloring scheme, about two hundred low income households (called 'poors'), about three hundred medium income households ('averagers') and about 200 high income households ('riches') are distributed randomly to their social state specific homes, i.e. a social agent is representing one household. This aggregate level will be disaggregated in a subsequent stadium of model development. Agents' sociality is currently created in a very simple manner, namely by themes of communication. There are four different sets of codes with which agents can 'talk about': code 1 comprises 'weather' and 'sports', code 2 'politics' and 'culture', code 3 'science' and 'economy', and code 4 'place' and 'hobby'. Each set also includes a 'none' for having no theme to communicate. Every agent, regardless of its social state, receives one theme per set by picking it randomly (Fig. 4). So, it could happen that an agent is unable to communicate due to the possible fact that it picks 'none' four times. The intention behind is to create a premise for emerging sociality from an initial stage (but not yet implemented). The mobility of agents is also quite simple at the moment, they move in their environment without prior planning.

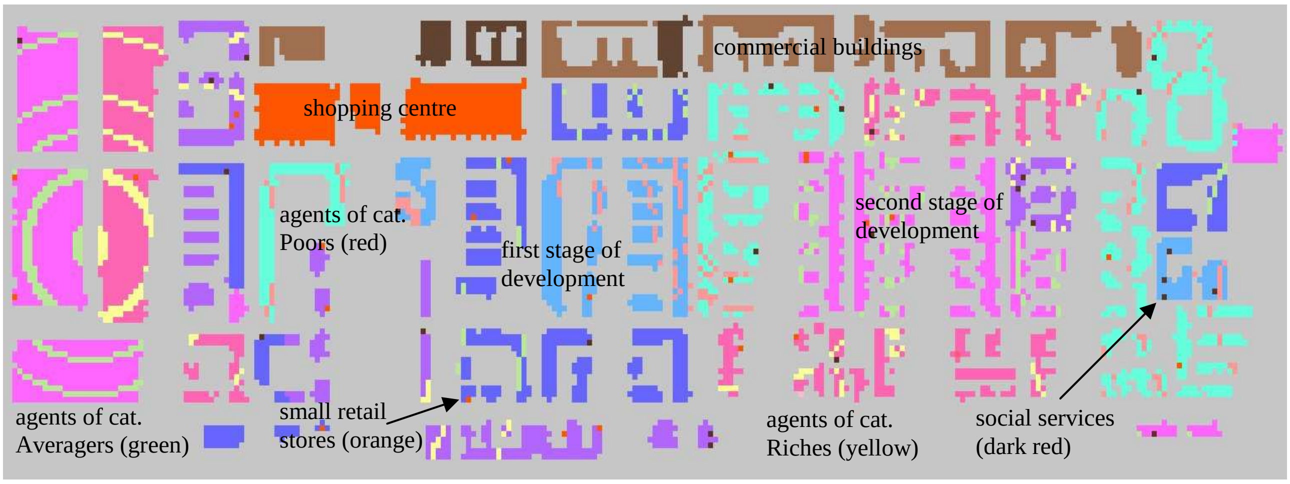

Fig. 3: The grid of the MAS model Messestadt Riem (without Fair Trade Centre (north) and open space (south))

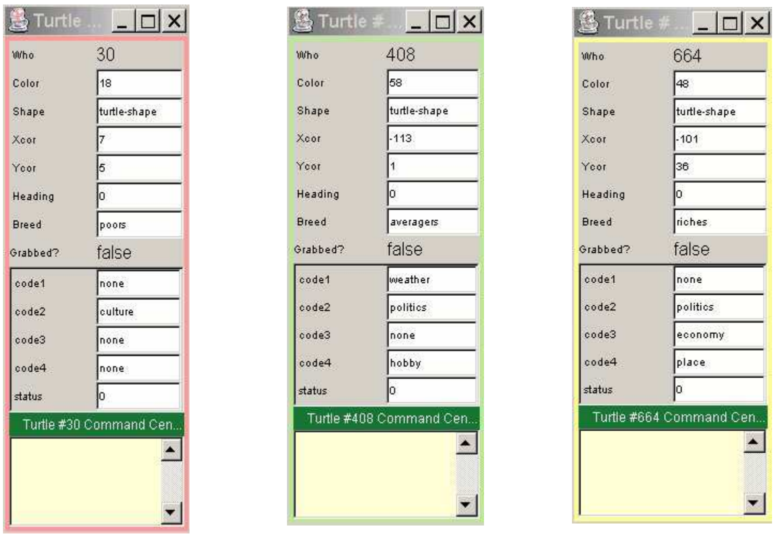

Fig. 4: Three representations of social agents – 'poors' (left), 'averagers' (middle), 'riches' (right)

Although this approach of generating sociality and social identification, respectively, is currently rather simple conceptualized, it enables a remarkable variety of social interactions through communication. A few of them are presented here. One distinguishing feature is related to the locations of social interactions, a second differs between communication among social agents of the same social state and of different social states, and the third feature differs whether social agents 'only' talking about the given themes or whether one social agent accepts themes from another social agent in order to capture the theme of interest (learning in some way). The principle process is as follows: as soon as two agents meet each other in a retail store or a social service institution, they are able to interact as far as they have at least one theme. Fig. 5 shows the result after 10.000 time steps (one time step is equal to one movement or grab of every agent) for the case that communication takes place among agents of the same social state. After that time only 4% of the 'averagers', 12% of the 'riches' and 13% of the 'poors' interacted at the selected locations. If one enlarges the places where communication could take place to streets (colored gray) then, obviously, the interaction level increases dramatically as is shown in Fig. 6. After 2.000 time steps the share of interacting agents, independent of its social state, reaches already values of about 70%.

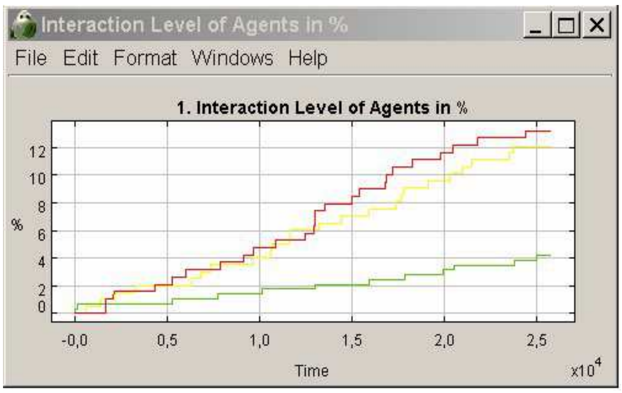

Fig. 5: Interaction level of agents (without streets)

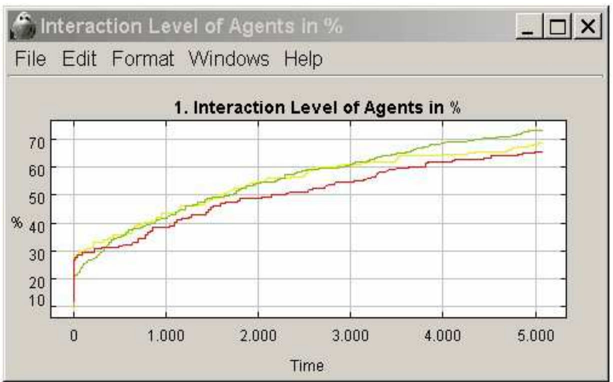

Fig. 6: Interaction level of agents (including streets)

Agents who entered a retail store or a social service institution and interacted with another agent, return to their homes and then move again elsewhere. This repeated circle of movements is visualized by a shading of agents' colors from light to dark (Fig. 7). Allowing agents for grabbing each other wherever they meet then a relatively high share of agents move repeatedly at home (Fig. 8). In addition to the pure measurement of contacts it is, herewith, possible to relate private locations (the homes) with public spaces.

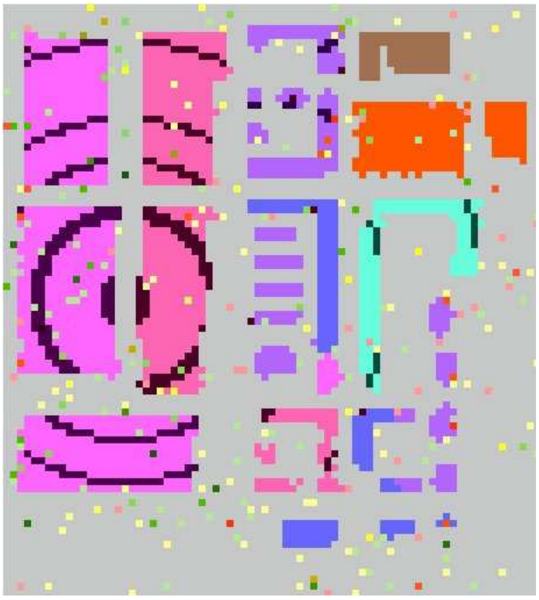

Fig. 7: Agents with different shades depending on their returns

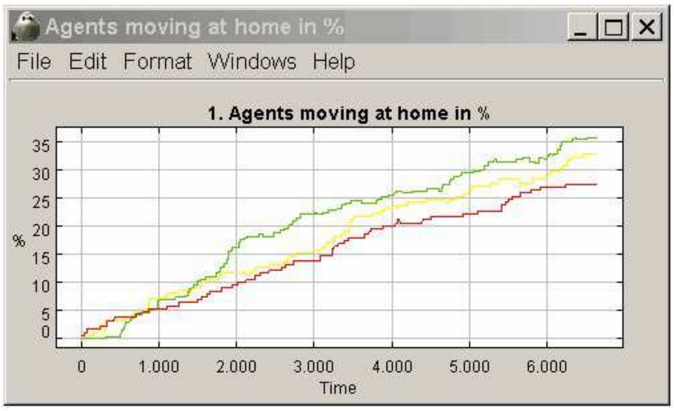

Fig. 8: Share of agents moving at home (after 2.500 time steps)

The random walk of social agents is, no doubt, unsatisfactory. To reach a more goal-oriented behavior of agents, i.e. to improve their headings towards particular sections of their field of perception, requires a deeper spatial segmentation of agents' locations (or better, a tight coupling with a GIS). Nevertheless, the conceptualization of social agent made here points out that some of the agents' properties mentioned in Tab. 1 are realized, at least in a rather weak form of agency (Benenson & Torrens 2004, 157). This is especially true for the properties of mobility and communication. Others like reactivity and goal-orientedness have to be implemented in a more realistic fashion.

4 FUTURE WORK

The MAS model in its contemporary stage is still in its infancy. Several steps towards a sophisticated agent-based simulation model have been achieved, others still have to be realized. Moreover, we do not intend to include every facet of social and spatial interaction. For example, social interactions of the new inhabitants with their former neighbors are excluded. Future tasks are among others concerned with an implementation of social interactions in the surroundings of agents' places of residence. Representing particular locations where spatial interactions among and between places of residences, public and open spaces generate spatial networks is a further challenge. Based on these modes of *interaction* the question of processes of *identification* can be elaborated. More precisely, our aim is to discriminate individual elements of socio-spatial behavior from general ones and to represent the patterns of the latter in its dynamic complex structure. For this reason statistical data and qualitative information are necessary. No model is an end in itself. It is, however, a model of sufficient generality (related to the framing conditions). In principle, social agents have the ability to talk to each other regardless of their social state. This might happen under certain circumstances, like for example when parents meet at the playing grounds; it might be unprobable at other locations and because of different conditions. In social interactions, communication themes can have an excluding as well as an including effect. It therefore enlarges the range of tools of exploration and recognition. Nevertheless, the MAS model of Messestadt Riem represents in its current state of development an appropriate tool to fill the gap of methodological approaches in exploring socio-spatial processes of identification. The model is able to visualize processes and relations of identification in a dynamical manner which is unable for the other tools. As soon as real world data are available and an adaptation of the model to actual conditions can be realized then satisfying outcomes are expected.

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