# Social life versus enjoyment of nature: Modeling competing psychological needs underlying housing decisions as parallel constraint satisfaction

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## Introduction

People's preferences to live in specific residential environments, i.e. urban, suburban or rural areas, vary over the life course (de Groot et al., 2011, Mulder, 2007; Stockdale and Catney, 2014). Individual choices are triggered by specific life events (Kley and Mulders, 2010), demographic and socioeconomic factors (Geist and McManus, 2008) as well as various housing related attitudes, beliefs, and feelings (Schröder, Huck, & de Haan, 2011). Approaches to model the impact of individual decisions on land-use-changes at urban scale, have been criticized recently for not adequately capturing social, cultural and political constraints (Briassoulis, 2008, Couclelis, 2005, Caldas et al, 2015, McCauley et al., 2015) – emergent properties and structures that shape individual thoughts and decisions in this domain. Here, we propose a modified version of a previously developed agent-based model, InnoMind (Schröder and Wolf, 2015; Wolf et al., 2014) that accounts for the multilevel mechanisms (i.e. individual, socio-spatial and cultural) underlying these complex decisions.

## Model description

The InnoMind model (for Innovation Diffusion by Changing Minds) was developed to model peer and mass-media influence on individual mental representations and actions in the context of sustainable mobility innovations. As we showed recently, (Schröder and Wolf, 2015) due to its generic framework it can be adapted easily to research questions other than mobility decisions. The spatially explicit agent-based model is informed by psychological theories of motivated cognition and emotional decision-making (Kunda, 1990; Thagard, 2006), dual-process models of persuasion from social psychology (Petty & Cacioppo, 1986), sociological studies of homophily in social networks (McPherson et al., 2001), and ideas from sociology and anthropology construing culture as cognitive-affective structures shared among members of the same social groups (Ambrasat et al., 2014; DiMaggio, 1997; Heise, 2010). The framework also enables scientists to calibrate the model based on empirical data gained from classical social-science research such as experiments, surveys, or interviews.

For the present version *UrbanMind*, which is work in progress, we modified the InnoMind model for case-specific representations while maintaining the generic structure. At the individual level, decisions of agents are driven by emotional coherence (Thagard, 2006), formalized as a parallel constraint satisfaction network (PCS) (e.g., Glöckner & Betsch, 2008; Monroe & Read, 2008; Thagard & Verbeurgt, 1998, Thagard, 2006). In PCS models, different mental representations such as beliefs, feelings, or behavioral intentions are modeled as interconnected nodes in artificial neural networks. By mutually exchanging activation or inhibition, the nodes compete with each other interactively for control over decisions.

Fig. 1 shows the resulting architecture of an agent. The two central layers of nodes represent agent's housing needs and decision options. The valence node on the top, connected to the first layer of nodes (i.e. needs) models emotional influences on the agent's choices. Cognitive beliefs of agents are modeled by excitatory and inhibitory links between need and action nodes. To account for the impact of life course related dynamics and events (e.g. age, family status etc.) on residential decisions, agents' mental representations are dynamically modified as a result of changes of their socioeconomic characteristics – e.g. the need for cost efficient housing decreases with increasing income – over their life time.

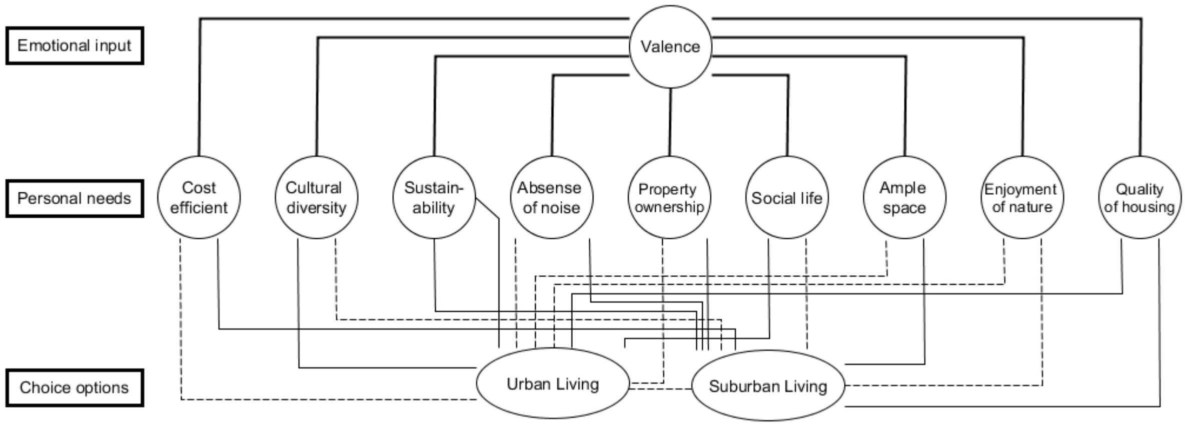


Figure 1: Parallel constraint satisfaction model of agents

At the interaction level, *UrbanMind* models changes in mental representations that result from a) communicating with other agents and/or b) variations of physical, cultural or political features of their residential environment as a change in the strengths of the links between nodes of the neural networks that represent the agents' beliefs, emotions (cf. Monroe & Read, 2008).

At the societal level, *UrbanMind* generates an artificial social network that defines the possible exchanges of information among agents in the simulated social system. Social structure is based on geographical parameters and the principle of homophily, i.e. the tendency of people to prefer interaction with other individual who are similar to themselves in terms of sociodemographic characteristics (McPherson et al., 2001).

## Discussion and Future work

We described here a blueprint for UrbanMind, a multi-level agent-based model of residential decision-making that is informed by cognitive, social psychological, and sociological theory. We hope to provide a sound theoretical basis and flexible framework for scientists as well as decision-makers in urban-planning and politics to manage the incremental expansion of low-density housing in many western countries and its adverse environmental consequences. In the future we seek to implement the model based on empirical data, partly existing (Schröder et al., 2011), partly to be generated, and use scenarios generated in simulations for advising decision-makers on suitable policy measures related to sustainable urban development.

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