Chapter 6
Social Identity in Agent-Based Models—Exploring the State of the Art

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Abstract A key challenge in social simulation is how to represent human behavior, specifically in its social context. The Social Identity approach (SIA) reflects a promising potential as it describes how people behave while being part of a group, how groups interact and how these interactions and 'appropriate group behaviors' can change over time. SIA is used in a variety of fields and increasingly implemented in agent-based models. A systematic review and comparison of SIA formalizations and implementations is so far missing. We present our impressions from a pre-review of the current state of SIA models, such as what key SIA concepts have been formalized and how their formalization compares. We found a diversity of application areas of models that use (parts of) SIA. We further noted differences in how parts of SIA have been formalized and used, e.g. the widespread use of the emergence of group norms and behavior, while other SIA aspects such as different strategies to positive self-esteem received little attention.

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Introduction

A key challenge for designing an agent-based model (ABM) is to represent human behavior in a way that is contextually and psychologically plausible. While the social sciences and social psychology offer numerous theories to explain human behavior in specific contexts, the hurdles involved in selecting a reasonable theory and implementing such a theory in an ABM are high [1]. One particular need and challenge is formalizing human behavior and decision making in its social context—representing how people might decide what to do within a specific context and social-physical situation. Part of the reason for this difficulty is the complex relationship between the individual's identity and the social situation they happen to be in. One combination of theories with the explanatory potential to be of use here is the Social Identity approach (SIA), referring to the Social Identity Theory (SIT) [2] and the Self-Categorization Theory (SCT) [3, 4]. SIA proposes that people derive a significant part of their self-concept from the social groups they belong to [2, 3, 5], thereby presenting a promising theory of an important social situation: group behavior.

SIA describes how people behave while being (psychologically) part of a group, how groups interact and how these interactions and 'appropriate group behaviors' can change over time. When a social identity is salient, group membership becomes an important factor in peoples' beliefs and behavior. What is important for the group becomes important for the individual. Moreover, groups have social norms and expected behaviors, so when a particular social identity is salient the group members are expected to act within the norms. SIA is used in a variety of fields that relate to the building of group belonging or exclusion of others, e.g. social psychology, organizational psychology, cultural studies, political psychology, and politics. The broad application context is reflected in the diversity of application domains, e.g. decisions on sustainable agricultural practices [6], differing perceptions of history [7], leadership in groups [8], party identification [9], and environmental behavior [10]. In social simulation, the richness of SIA has been recognized as well [11], e.g. with models that use SIA to explore inter-ethnic conflicts [12] or the emergence of riots [13].

While SIA seems to hold great promise for diverse application cases of models, a systematic review and comparison of SIA formalizations and implementations is missing. For the crowd modelling literature, a systematic literature review revealed that none of the models analyzed adequately incorporated the theoretical underpinnings of social identification [14]. By providing a comprehensive theory on how individuals behave in a social context, SIA seems to be applicable for diverse model applications, while being challenging to specify and formalize. How a theory is understood and implemented is crucial, as even subtly different assumptions of how to represent human behavior may result in very different model results [15, 16]. We aim to make a step towards exploring the state of the art of SIA formalizations in ABMs. To this end, we conducted a pre-review of the current state of SIA models using Google Scholar, and compared key SIA concepts of selected models. In this extended abstract we share our impressions and present possible ways forward.

Pre-review of the Current State of SIA Models

To get an impression of the availability and current state of Social Identity models, we executed a pre-review. In a Google-Scholar search (on 21-10-2017), using "agent-based model" AND "social identity theory" as search terms, we found 54 papers that actually concerned ABMs that mentioned using the Social Identity Theory. Our pre-review concerns 38 (of 54) model papers that were accessible to us, which were each read by at least one of the authors. We inductively discussed and developed categories for which we analyzed models further. In this extended abstract, we discuss the first impression we gained and present examples from some of the models we reviewed.

The ABMs in this review cover a diversity of research areas. The most predominant research area is generically concerned with social science, e.g. [17–19], whereas others are more domain specific, such as models from social psychology, e.g. [20], crowd simulation, e.g. [21], peace and conflict research, e.g. [22], business management, e.g. [23], and environmental system science [24]. The usage of the aspects or parts of SIT differs from one model to the other. We found only two models—of which one is built upon the other—that tried to implement all aspects of the social identity theory [20, 25]. Most models use aspects of SIT concerned with:

- Explaining the emergence of group norms and behavioral differences between social groups, e.g. [26, 27];
- In-group favoritism or out-group devaluation, e.g. [13]; and/or
- The possibility of multiple social identities of one agent in different occurring social situations, e.g. [28].

Only few models implemented strict explanations for the agent's motivation for acting on SIT, i.e. namely the need for a positive self-esteem, e.g. [29]. Of which only some modelled the theoretical possibility of agents having different strategies to contain or enhance positive self-esteem, e.g. [20]. Lastly, we found models that relate to SIT by mentioning it only in the simulation results section, e.g. [30].

To highlight the differences in formalizations of SIA in ABMs, we will zoom in on a few formalizations of key SIA concepts, namely (a) identity and self-concept of an agent and (b) processes of social categorization and group formation.

Identity and Self-concept. Models that formalize identity or self-concept focus on formalizing aspects of the SCT, which describes the self-concept as a structure that comprises personal and social identities. Depending on the situational context, different aspects can be salient and influence an individual's behavior. Salience is defined as the product of relative accessibility and situational fit of a social categorization [31]. An equivalent formula can be found in some models, e.g. [32]: Salience = Accessibility × Fit. Hereby, accessibility is determined by an individual's experience and situational motivations. Some models focus on the cognitive aspect of accessibility using (un-)certainty (e.g. "bounded confidence", [29]), while other models focus on the emotional component of accessibility using the concept of emotional valence (e.g. [32]). The situational fit refers to a normative as well as a comparative component. Normative fit evaluates the extent to which an observed behavior

matches the perceiver's stereotypical expectations. Hence, it refers to the relative accessibility of known categorizations. The normative fit has been formalized in [32] by determining which social groups are present in the current context and then comparing them with already known social categorizations. If there is no match, an agent's known categories don't fit and the agent has to adapt. The comparative fit is equivalent to the meta-contrast ratio, which we describe in the next paragraph.

Social categorization and group formation. In SCT, the process of social categorization is closely connected to the process of social comparison (meta-contrast principle, [3]). As the comparative categorization of perceived group-membership as well as the perception of typical group-members or behavior is precisely described, it is no wonder that we found similar formalizations. Thereby, the following formula is used to formalize the meta-contrast ratio modeling "prototypicality" [33, 34]:

$$P(x_p, X) = \alpha * d_{inter}(x_p, X) - (1 - \alpha) * d_{intra}(x_p, X) \tag{6.1}$$

Here, the agents calculate the comparative fit of a social categorization by determining the difference of the perceived distance between groups (inter-group similarity d_{inter}) and perceived intra-group similarity (d_{intra}). Available categorizations are determined by an individual's representation (x_p) in a perceived context (X). Results are weighted by a factor (α) that is parameterized. Finally, the number of available social categorizations is determined by the number of maxima of the function $P(x_p, X)$ which can be interpreted as a social group's "Prototypes" [33, 34] or "Centroids" [32].

Preliminary Conclusion and Ways Forward

The diverse application areas of the models in our pre-review confirm the great promise we see in SIA. Furthermore, the use of SIA in models is on the rise. However, how SIA is used differs a lot, with some aspects being widespread (e.g. the emergence of group norms and behavior) and other parts (e.g. different strategies to positive self-esteem) receiving little attention. Our brief comparison of the formalizations of key SIA concepts in models points to some components that are formalized in a similar way (e.g. the principle of meta-contrast ratio), while other components of SIA are formalized in different ways (e.g., the accessibility).

SIA is not directly translatable into program code. Like most non-formal theories, some aspects have to be interpreted and filled in by assumptions that are not made by the theory [35], leading towards differences in and plurality of models. While differing model foci and application cases might create the need for different formalizations, transparency and a comparison of different options and their consequences would facilitate an informed choice for a specific option.

Although we understand the presented work as useful to get an impression on whether SIA is used in models as well as how, more work is needed to gain a full picture of the state of the art. To this end, we have started a more in-depth review. Several new models have been published in the last year, including doctoral theses that make serious attempts to use SIA for model applications. To gain a full picture of the state of the art, we will move beyond the work presented here, including systematic and more detailed comparisons of SIA formalizations in ABMs. More specifically, we envision (i) a more systematic and in-depth review, (ii) replications of ABMs using SIA, and finally (iii) a widely available intuitive and psychologically plausible formalization of SIA that is applicable for diverse application contexts/cases.

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