

Identity in Agent-Based Models: Issues and Applications

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Abstract

Identity plays a central role in many current events of interest and importance. This paper examines a representative sample of the computational social science (CSS) literature which incorporates notions of identity or processes of identity formation. Building on some of the ideas present in the modeling literature, we then proceed to introduce a multilevel conceptual framework for the modeling of complex and fluid identity dynamics, with a focus on competing and loosely defined political groups.

Introduction

Identity, as a topic of research in the social sciences is at once broad, not particularly well defined and, perhaps as a consequence, a focus of ongoing debates. Its relevance to our understanding of many current events, though, can be argued to be substantial. From discussions of Muslim identity, to sectarian strife in Iraq, to Pashtun tribal affairs in Waziristan, to factional politics in Iran, and even to U.S. domestic issues regarding changing Democratic or Republican identities, in all of these topics, a common thread of identity plays a central role.

As mentioned above, identity as a topic of scholarship is somewhat broad and diffuse. In fact, while some argue that the term is used to encompass too much to be useful, others have pointed out its often overly narrow focus. As an example of the multiplicity of definitions, Fearon (1999) lists fourteen different uses of “identity” in publications from various social science fields. Nevertheless, despite the criticisms, there have been frequent attempts to make the term analytically meaningful.

Identity as socially constructed (as opposed to a more essentialist, primordialist view) is currently the dominant paradigm in identity scholarship (Cerulo 1997). This process of social construction can arise from a number of different progenitors or mechanisms, among them discursive logics, strategic actions of elites, and strategic actions of the masses (Fearon and Laitin 2000), as well as actions of entrepreneurs (Collins 1999), just to name a few. The “ground-up,” or emergent, qualities of identity construction, combined with the likely requirement of multiple, and possibly even opposing, mechanisms for a

meaningful description, lend themselves naturally to the vocabulary of complex systems. While the claim is not that notions from complexity science are broad enough to encapsulate the full social complexity of identity formation and evolution, these properties do suggest that methodologies such as agent-based modeling could prove to be useful in their exploration.¹

Another issue to be confronted is the differentiation between notions of a collective identity as opposed to, or as an aspect of, an individual’s identification with or allegiance to particular collectives². These two notions are often conflated and can lead to muddled argumentation. The collectives, from the individual’s perspective, can be seen as constituting fields of attraction, operating at multiple scales and with varying amounts of coherence among them. The work by Abdelal, et al. (2006), identifies “content and contestation” as the important characteristics necessary to describe collective identities. A group’s content is argued to include the group’s “constitutive norms; social purposes; relational comparisons with other social categories; and cognitive models,” where these properties can possess various levels of stability, while contestation is used to refer to the degree of agreement (or disagreement) existing within the group regarding the content. This type of description allows for a better representation of different *types* of collective identities, placing them in a multidimensional attribute space, instead of treating them as generic or homogeneous variables.

Turning the attention to individuals’ perspectives, the literature on microsociology³ and social psychology of small groups⁴, refers to the multiple identities or social

¹ One point to note here is that, while the constructivist view of fluid and dynamic identities is generally accepted, not every type of identity can be argued to be equally fleeting. Hence, one of the challenges in modeling identity formation processes would be the ability to demonstrate identities that manifest different durations.

² Brubaker and Cooper go a few steps further and break the term into five different key uses in Brubaker and Cooper (2000). They then propose to replace the term identity with three terms: identification and categorization; self-understanding and social location; and commonality, connectedness and groupness.

³ Work by Erving Goffman (e.g., Goffman (1959)) and Harold Garfinkel (e.g., Garfinkel (2005)) to name a few.

⁴ Work by Robert F. Bales (e.g., Bales (1950)).

roles that an individual adopts or has access to. Depending on the *salience* of a specific identification (with respect to the context the individual finds themselves in), that identification will become more or less relevant to the individual's decision making process. In addition, the *intensity* of an individual's identification to various collective identities can inform their decision making.

In this paper we examine a representative sample of the computational social science (CSS) literature which incorporates notions of identity or processes of identity formation. We discuss the various contributions made by these works, and highlight the features most relevant to identity processes. Building on some of the concepts present in the modeling literature, we then proceed to introduce our conceptual framework for the modeling of identity dynamics, where the framework is understood to be the precursor for building computational agent-based models of identity. We direct our attention to the modeling of interacting political groups, jockeying for power, where we take into account the small group dynamics within the decision making group of elites, the actions of entrepreneurs, and the emotional valences and allegiances experienced by the general population towards the various parties. Finally, we demonstrate the applicability of the notions of our conceptual framework to an example of interest, the political factions in the Islamic Republic of Iran¹.

The overall aim of the paper is to draw upon ideas from the vast body of identity scholarship and to investigate how one might meaningfully apply the salient notions to a particular area of interest. As computational social science, and agent-based modeling in particular, become increasingly viewed as valuable tools for understanding social phenomena and for informing policy and decision making, we hope that such endeavors will further illustrate the utility of the field in tackling issues of interest and concern.

Identity in Computational Social Science

There are a few examples of computational modeling of identity and identity related processes within the Computational Social Science (CSS) field. This section will review two representative samples from the CSS literature, MacKerrow's Threat Anticipation Program (TAP) model (MacKerrow 2003) and Rousseau's SharedID model (Rousseau 2006). The contributions made by these works will be highlighted and discussed.

TAP model

MacKerrow's TAP model addresses the spread of social grievances on social networks, with the ultimate goal of determining, or anticipating, regional and temporal

propensity for the emergence of terrorism. The TAP model is an agent based model, where the agents have adaptive capabilities, allowing them, for example, to develop negative sentiments toward oppressive entities or to learn which other agents it would be advantageous to avoid or associate with. The simulation world is split up into Nations and further split up into various Districts, populated with a number of different types of agents, where the distributions of types of agents and their attributes is determined from regional demographic and ethnographic sources.

Focusing on issues more directly related to identity, the agents are allowed to take on multiple roles, some of which are Terrorist, Student, Cell Leader, Weapons Engineer, Recruiter. Each of these roles comes with a set of associated actions that the agent can employ. While not specified in the model description, it is possible that the agents choose to activate the various roles as the situation dictates. This type of flexibility in agent construction, where agents have access to multiple agent roles, begins to support some of the theoretical and empirical findings regarding roles in social interactions from such fields as microsociology and small group social psychology.

An important ingredient in the TAP model is the inclusion of the abstract notion of "social capital", which is defined as "...a weighted sum of income, ethnicity, religion, education, and pedigree..." along with the associated concept of "social rank." The agents use this information mainly to determine the outcome of their interactions. For example, after a "successful" interaction between two agents, where both agents decide to "agree," the agent with the lower social rank will absorb more of the higher socially ranked agent's characteristics than the higher ranked agent will adopt from the lower ranked agent. The evolution of social rank can also illustrate emergent hierarchical structures within the agent world.

One of the main concern of the TAP model is the spread of information and sentiments over the social networks that the agents are a part of. There are a variety of types of networks employed, namely, kinship, religious, organizational, and friendship networks. In addition to acting simply as conduits for the flow of information, however, the networks also play a pivotal role in shaping agent behaviors and opinions as many of the agent behaviors and opinions originate from and are reinforced by the social structures to which the agent belongs. To quote an example given by MacKerrow, "... a young adult's proclaimed dislike toward the United States may be socially inherited from parents and reinforced through family circles, friendship circles, and by the media." As an additional note, while simulated networks are used for the social networks in the model, one can use known networks to populate the model.

¹ See Moslem 2002.

The agents in the TAP model carry with them an “allegiance vector.” This data structure tracks the degree of positive or negative allegiance that the agents feel toward specific nations, organizations, and ethnic or religious groups. Gallup Poll data is used to determine the aggregate allegiance vector values for the agent populations. As agents interact through their local social networks and are exposed to global information via media outlets, the agents experience social learning and the values in their allegiance vectors evolve, allowing one to track the changing individual as well as aggregate attitudes towards groups. Thus, questions regarding changing self-identifications with groups can be asked.

SharedID model

Rousseau presents his SharedID model as one chapter in his book, “Identifying Threats and Threatening Identities.” The book’s main focus is on the concept of shared identity, where the primary premise is that perceptions of threat are inextricably intertwined with how similar (along a number of criteria) potential adversaries are perceived to be. The book’s central conceptual model of threat perception and identity is the “Bridging Model.” This model offers a framework where three relatively distinct levels of analysis, which are argued to be necessary for the proper description of international threat perception, the Individual, Domestic and International levels, are interlinked. Within this “Bridging Model” the SharedID computational model is used to explore some aspects of the three levels of analysis and their relations.

The underlying structure of the SharedID model is based on Ian Lustick’s Agent-Based Identity Repertoire (ABIR) model (Lustick 2000). There are a number of other modeling efforts based on the ABIR model (including, of course, the ABIR model itself), most of which investigate, in some form or other, topics related to identity (see Lustick and Miodownik 2002, Lustick 2003, Eidelson and Lustick 2004, Miodownik 2006). While the choice of the SharedID model as our focus was partly arbitrary, we felt that it provided the most comprehensive investigation of the identity issues we were interested in.

The SharedID world is a simple grid filled with agents. An agent possesses identity dimensions and identity traits and these evolve based on an agent’s local interactions with its Moore neighbors (8 nearest neighbors), as well as through global influences. To be a little more specific, each of the agents is assigned five randomly chosen identity dimensions which make up their identity repertoire, where the dimensions are chosen from a total of twenty possible dimensions. Two identity traits are attached to each identity dimension, one representing the agent’s opinion of its in-group’s trait along that dimension and the other representing the agent’s opinion regarding the out-group’s trait. (There are four identity types associated with each dimension.) A population’s degree of shared identity (with its out-group) is determined by the degree to which the out-

group traits match the in-group traits. As mentioned earlier, Rousseau’s hypotheses revolve around the relationship between shared identity and threat perception, so the evolution of this quantity plays a central role in the analysis.

The identity dimensions in an agent’s repertoire are not equally significant but are weighted with different salience values. These salience values determine the importance of keeping certain dimensions and discarding others as well as the influence that those dimensions have on neighbors of an agent. SharedID also incorporates global biases which indicate society wide biases regarding different dimensions. In the version presented in the book, the bias associated with each dimension is changed randomly with a certain probability, reflecting the waxing and waning of the popularity of ideas due to factors exogenous to the specification of the model.

In addition to the regular agents, there are also four different types of leader agents. A “powerful leader” is given twice the influence level of regular agents in local interactions as well as the ability to initiate opinion changes by allowing it to update its attributes earlier in a simulation “turn” than other agents. A “leader with reach” can interact with its nearest neighbors but also with distant agents. A “pragmatic leader” has twice the influence of a regular agent but is more likely to adopt an opinion as that opinion becomes popular, locally or globally. Finally, an “ideological leader” has twice the influence of a regular agent but is less likely to modify its opinions.

During the course of a simulation step, each agent determines the most popular identity dimensions and identity traits by observing its neighbors and accounting for global biases. The saliences of each of the identity dimensions present in the local neighborhood (i.e., the identities possessed by the agent and its neighbors) are tallied, and, if leader agents with double the regular influence are present, those agents are counted as two regular agents. After accounting for global biases, the agent is left with a list ranking the dimensions according to popularity. Depending on the degree of popularity of the most popular dimension, the agent will either keep its previous dimensions unchanged, increase the salience value of one of its dimensions, add the most popular dimension and get rid of its least salient dimension, or add the most popular dimension and promote it to a high salience value and get rid of its least salient dimension. In this way, identity dimensions are spread throughout the SharedID space. (The identity traits are spread in a similar manner to the identity dimensions.)

According to Rousseau, the SharedID model “...captures all six of the central elements of identity construction highlighted in the ethnic conflict and nationalism literatures...” which he discusses in another chapter of his book. Those six elements are:

- identities are allowed to vary across time and space
- agents can have multiple identity dimensions and the agent is allowed to shift between identities
- entrepreneurs play a major role in the transmission of information
- identities evolve locally via individual level social interactions
- there exist local and global incentives for the adoption of certain identities
- the agents and the opinion structures are mutually constituted

Conceptual Framework for Modeling Identity

Building on many of the concepts present in the TAP and SharedID models, we now turn our discussion to some of our ideas of how to incorporate currently available techniques and research programs into the creation of rich and useful social models of identity processes. For clarity and focus, we will restrict our discussion to the computational modeling of identity and identity processes in the realm of politics. We will explore the interactions and collective behaviors of political actors, which we call political agents, of P-Agents.

In real political settings, politicians engage in ideological discourse in an effort to advance their personal public status, promote their ideological view, or bolster the power and influence of their “in-group”. In this way, the ideological discourses can be seen as the means employed to achieve the ends of increased influence and power consolidation. Since we would like our P-Agents to have ideological positions, about which to “politick”, we begin our definition of our P-Agents by assigning to each of them a set of coordinates depicting their ideological beliefs in an abstract ideological space (IdSpace). We will see in the next section discussing the political factions in Iran, that in some cases three dimensions are seen as sufficient to span the ideological positions held by real politicians. Thus it is possible for the IdSpace to not require a large number of ideological dimensions to apply to real political situations.

We saw in both the TAP and SharedID model that the agents were given well defined agent types and associated capabilities. In the TAP model an agent behaved like a student, for example, because it had chosen to activate its Student role. In the SharedID model, an agent had more influence than a regular agent and was able to initiate opinion changes because it was a “powerful leader” type of agent. Since real political actors are born with and develop different sets of capabilities and characteristics through which their political selves emerge, we choose to assign more basic characteristics to our P-Agents, allowing complex categories to emerge endogenously. To be more specific, we assign to the P-Agents values along three basic continuous dimensions. The Pragmatic/Ideological (P/I) dimension determines how accommodating (positive) or

stubborn (negative) a P-Agent will tend to be when considering the possibility of changing its ideological position (similar qualitatively to the “Pragmatic” and “Ideological” leaders in the SharedID model). The Aggressive/Passive (A/P) dimension determines how likely a P-Agent will go on the offensive to reach a goal. The third dimension is a Cognitive Capacity (CC) dimension. There are a number of ways one could implement cognitive capacity. One way is to utilize the notion of the Miller number (Miller 1956). The Miller number (7 ± 2) is the number of distinct items a person can simultaneously account for. Thus P-Agents with high CC values, when confronted with tasks requiring them to discern between different categories, would be able to observe a larger number of gradations than P-Agents with lower CC values. By assigning to the P-Agents attributes along these basic dimensions, one hopes that in the course of a simulation, different recognizable P-Agent types would become visible. That is, some P-Agents would be seen to act according to expected roles (e.g., “powerful leader”, “ideological leader”, etc.) but the continuous dimensions would allow for more nuanced “mixed role” P-Agents or even previously unimagined roles of P-Agents.

Agents in the TAP and SharedID models possessed well defined behaviors relative to their agent type. In the SharedID model, the focus was mainly on the flow of information between agents, so the only activities the agents took part in were determining the popularity of ideas (in the form of identity dimensions and traits). In the TAP model, agents have access to many different types of behaviors, but these are all associated with particular roles and are fixed ahead of time by the model creator. In addition, there is an implicit assumption that when agents interact, they are fully cognizant of the one type of interaction they are taking part in. However, in a real social setting human actors can “play multiple games, select from among available games, shift from one to another, misunderstand what games their counterparts are playing, and act in ways that are (more or less) effective simultaneously within multiple games” (Sallach 2006). Thus, we would like the P-Agents to be able to engage in more fluid and flexible interactions via “multigame” game artifacts. A multigame is a game involving more than one type of reciprocal interaction. In the case of the P-Agents, since we are interested in political interactions, we choose coercive, economic and supportive games. Coercive games involve an interchange of threats. Economic games involve rationally balanced interchanges of materials, products, and/or services. Supportive games involve mutual support where close accounting may not be maintained. Since we are interested in the political realm, the P-Agents can be seen as engaging in the exchange of various forms of abstract social capital (e.g., prestige, political capital) as well as more concrete items (e.g., funding, votes). In addition to the “on diagonal” games (i.e., mutually coercive, economic or supportive interactions) the P-Agents are also allowed to engage in “off-diagonal”

exchanges. An example of an off-diagonal exchange could involve two interacting parties, where the first one threatens the second and the second party pays off the first.

Looking forward, it would be desirable to incorporate elements such as deliberate misdirection into the multigames, where a P-Agent could seek to engage in an interchange with another P-Agent under false pretenses. Another interesting path that we are currently pursuing is the endogenous assembly and parameterizing of particular games from component actions. A number of relevant capabilities of the computing language Groovy (König 2007) (e.g., Meta Programming and function composition) are being investigating. This would allow for even more fluid and nuanced P-Agent interactions. Finally, it is clear that any compelling multigame implementation will require communication and coordination capabilities between the P-Agents. Here, once again, we are investigating the use of Groovy for the development of such an agent (embedded) domain specific language (eDSL).

In terms of social structures through which agents can interact, the SharedID model employs a simple grid, where local agent interactions occurs between Moore neighbors. In the TAP model, on the other hand, agents are allowed to be a part of multiple social contexts which are implemented as social networks. The TAP model's approach allows for social structure that can be more closely calibrated to actual cases of interest. For our P-Agents, we introduce the more general notion of P-Agent "locales". These locales are defined as structures where P-Agents can interact locally. They can be implemented as social networks, but they are allowed to be more dynamic too, allowing, for example, agents to enter and exit them. Similarly to the TAP model, P-Agents would, in general, be present in multiple locales. We allow for restrictions to be specified regarding the inclusion of certain P-Agents in certain locales and, additionally, we can attribute functions and capabilities to particular locales. Thus, one is able to implement a locale which has, for example, the legal authority to restrict a P-Agent's access to another locale.

One of the claims of the SharedID model is that it represented a Constructivist approach to identity formation where, for example, "the agents and the opinion structures are mutually constituted". While it is true that the model allows for the agents to affect the opinion structures and vice versa, the *types* of opinions that the agents possess and pass on to other agents are hard coded into the model. In an effort to embody the P-Agents with the ability to fluidly form and detect endogenously emergent groups and, through downward causation, have those groups restrict or enable actions of the P-Agents, we turned to the Interpretive Agent (IA) research program (Sallach 2003) and the Interpretive Heatbugs (IHB) reference application in specific (Sallach and Mellarkod 2005, Mellarkod and Sallach 2005). Interpretive heatbugs have the ability to

note the behavior of other bugs and, on the basis of their observations, construct mental groupings of the bugs they have interacted with according to "niceness", "similarity", or other derived notions. This is done through a combination of hierarchical agglomerative clustering analysis and reference point reasoning¹ (Rosch 1983). This grouping is uniquely tied to the history of the particular bug's experiences.

In a similar manner, we enable our P-Agents to form ideological mental groupings (i.e., in the IdSpace) of other P-Agents based on the observed activities and interactions. P-Agents convey implied ideological leanings to other P-Agents both through their multigame interactions and through publicly visible means (e.g., public proclamations, newspaper editorials, public voting results). When a P-Agent categorizes a group of other P-Agents as "ideologically similar", it will take their opinions into account when making decisions, resulting in downward causation effects. There are a few things to note regarding these groupings. First, since these groupings are based not only on private information, but also on readily visible public displays, it is likely that there will be overlap in the mental groupings that P-Agents possess. Thus some consensus on categorizations, as would be expected in a real social situation, can be expected. Second, referring to the notion of "content and contestation" introduced by Abdelal et al. (2006), we see that the P-Agent groupings naturally possess various degrees of ideological contestation. Third, the groupings are not static and can change due to new information, changes in ideological positions of P-Agents, and changes in the balance of social capital. Fourth, it would be interesting to allow for groupings which develop a high degree of consensus among the P-Agents to be promoted to locales, thereby allowing for the emergence of formal structures.

Finally, exogenous factors play an important role in our framework. These can take the form of economic events, environmental events, swings in public opinion, and war, just to name a few relevant possibilities. These factors affect the salience of the various ideological dimensions and fundamentally affect the reasoning processes of the P-Agents. For example, a prolonged period of economic recession might result in pressure from the general population to concentrate on small differences between positions advocated along an economic policy dimension, forcing the P-Agents to take notice or risk being left politically isolated.

¹ The following simple example should aid in clarifying the concept of reference point reasoning. Psychological studies relying on reaction times have shown that, while all odd numbers are technically odd, some numbers, such as the number "3", are in certain senses regarded as "more odd" by study subjects, than a number such as "2037". Thus, the number "3" can be thought of as being situated closer to the core of the concept of "oddness" than the number "2037" in the conceptions of the study subjects. The distance from this core manifests itself through the longer time taken by the subjects to identify the particular number as odd. See Gleitman et al. 1983.

Factional Politics in Post-1979 Iran

The case of political factions and their interactions in post-revolution (post 1979) Iran is an interesting example for illustrating how the formulation of our conceptual framework can be useful in capturing some aspects of the unique identity and political processes involved. The following are excerpts from Moslem 2002, along with brief discussions of the relevant concept(s) from our framework.

“Factions in Iran comprise groups, organizations, and classes, clergy as well as nonclergy, who supported Khomeini, the revolution of 1979, and the idea of Islamic state, but who disagree on the nature of the theocracy's political system and its policies in different spheres.”

A particularly interesting aspect of Iranian politics is the contention by some Iranian experts that the relevant political units are the political factions, rather than the more formally demarcated units of political parties. Since membership in these factions is not official and one is forced to infer membership through indirect means (e.g., voting records, show of public support), the mental groupings of the P-Agents appear to have the right qualitative features to represent these factions.

“The Iranian state is composed of three ideological elements (dimensions), the religious, the populist, and the revolutionary. These elements are used by the factions in the construction of various political, economic, and sociocultural discourses.”

According to Moslem, one can hope to encapsulate most of the ideological contentions using three ideological dimensions. Whether this is strictly true or not, at the very least a computational model with an IdSpace of only a handful of dimensions has the potential to be useful.

“... political power in the Islamic Republic is distributed unequally in a hierarchical and preferential way among state institutions... the various factions in the political system in Iran can manipulate this uneven distribution of power among state institutions to compete for stronger position.”

“... while factions express their differences and challenge each other's views on an ideological plane, the struggle for power among them is conducted through institutional battles.”

If we conceptualize the various state institutions as locales, we see that the two excerpts suggest the importance of flexible and meaningful implementations of interaction locales. By giving the P-Agents the ability to recognize the strategic potentials of certain locales, the factions, through the P-Agents, can “conduct institutional battles”.

“regardless of their ideological inclinations, factions rely on the same methods to compete and promote

their interests and views. ... factional politics in Iran is, by and large, patterned and predictable.”

Finally, if we believe the above statement, we end with some good news for computational modelers. The statement suggests that, once a model is built and run, it should be easy to compare its aggregate dynamics to the “by and large, patterned and predictable” historical dynamics.

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