

Dynamic Identity Model for Agents

Joana Dimas^(✉) and Rui Prada

INESC-ID and Instituto Superior Técnico, University of Lisbon,
Av. Prof. Cavaco Silva, 2744-016 Porto Salvo, Portugal
joana.dimas@gaips.inesc-id.pt, rui.prada@ist.utl.pt

Abstract. Our identity plays an important role in our lives - it regulates our thoughts, feelings and behaviours. For that reason researchers have been focusing on identity and the way it can impact an agent's processes and make them more believable. Because identity is dynamic, people's behaviours will differ according to different contexts. The presence of others as well as several other social context's factors have an effect on the way someone is going to perceive oneself. Whether as part of a group with shared interests among its members, or as unique and distinctive individual, the perception of group membership is going to determine if one's behaviour is going to be influenced by one's social identity or personal identity. When a social identity is salient, people tend to cooperate more with members of their group even when the group's goals differ from their own personal goals. Due to that impact, we believe that a dynamic identity is especially important if the aim is to build believable agents with the ability to adjust their decisions to the social context they are in. In this paper, we present a Dynamic Identity Model for Agents that provides agents with an adaptive identity and behaviour that is adjustable to the social context.

Keywords: Context-situated agents · Dynamic identity · Identity · Socially intelligent agents · Social identity

1 Introduction

In virtual worlds research the importance of agent's identity has not been passed unnoticed. Because of its influence in thoughts, feelings and behaviours, many studies have been focusing on identity and the way it can impact the agent's processes and reactions.

Two of the current focal points in building believable agents has been the development of the agent's identity, through the implementation of personalities and more recently culture's traits. While these approaches provide some consistent agent's behaviour, personality-driven or culture-based agents' identity remains unchanged across different social contexts [7, 17, 20, 26, 27, 35], whereas in real life identity is not unchangeable and free of influences. Instead, a person's identity is dynamic as the expression of their individuality has a great dependence on the social situation the individual is in [13, 19, 30, 31, 40].

Building autonomous agents that are able to adapt their identity and behaviour to social contexts, however, still presents some challenges.

One of the processes that greatly influences a person's identity is how one sees oneself and others regarding each other's social groups. Seeing a person as a distinct individual or as member of a group that shares the same interests and norms with all its belonging members, not only have a great impact on how someone is going to perceive oneself and others, but also on one's behaviour [34,40].

Those different approaches regarding oneself and others are dependent on several factors and many of them related to the social situation the person is in [19,30,40], but one of the most studied aspects is the presence of in-group or out-group members. When in the presence of members of a person's own in-group, that person becomes aware of each other's uniqueness and specific personal attributes, relating to others in an interpersonal manner dependent on their personality traits and close personal relationships with them. However, when in the presence of an out-group, the perception as group member strengthens, as a person tends to focus his or her perception on the shared features with other in-group members. That person sees itself as less distinctive from the rest of its own group and when that occurs there is a shift of their own motives and values from self-interest to group interests [34,40].

How a person categorizes oneself and others is going to affect what type of identity that person is going to embrace and behave according to. When people refer themselves as "Me" and "I" their expressed self is being defined by the one's personal identity. When referring themselves as "We" or others as "You all" that is when a social identity became salient [33].

In virtual worlds several scenarios require agents to adapt their identity to their current social context and the agents should be prepared to behave in each of those situations. One of them being, for example, a social dilemma situation where individual interests were in conflict to the team's interests, since it has been shown that on those settings people can easily make decisions biased by their social identity [4,15].

In this note we believe that in order to build agents that perform with more believable behaviour their own identity should be dynamic. In that direction, we propose a Dynamic Identity Model for Agents.

The paper is organized as follows. Section 2 presents some relevant related work. On Sect. 3 we present the Dynamic Identity Model. Section 4 describes a possible social dilemma scenario that uses this model. Finally, we present some conclusions on Sect. 5.

2 Related Work

Different approaches have been considered in order to create believable agents with human-like behaviour. In order to develop unique and distinct agents there has been a growing interest on the agent's identity and individuality aspects. Since a person's expressed identity can be determined by the distinct characteristics of the individual, or the shared ones with other members of a social

category he or she belongs to, current studies have been developing those two components alongside.

One of these two approaches used to build identities in agents is through personality. Loyall [17] developed an architecture to support rich-personality expression on agents, called Hap. Rizzo et al. [27] presented a goals and plans-based model of personality for agents by attributing specific behaviour (personality) to the pursuit of each goal; Prada et al. [24] addressed the problem of creating better interactions by agents in small teamwork scenarios; and Tan and Cheng’s [35] developed a framework which allows agents to adapt their behaviours to the player’s personality, through a punishment-reward learning system.

To address the social side of identity, other studies tried to achieve human-like consistent behaviour through the implementation of cultural features. On that direction De Rosi et al. [7] proposed an embodied animated agent able to generate culturally appropriate behaviour, while Rehm and his colleagues [26] built a system where embodied conversational agents are capable of adjusting their expressive non-verbal behaviour to the user’s culture. On Mascarenhas et al.’s work [20] it was developed an existing agent architecture, enabling agents to express different cultural behaviour through the use of rituals. Some other authors worked directly with social identity theories, implementing this concept on crowd behaviour [10] and opinion dynamics simulations [11, 14, 18, 28]. But also like the research done on cultural agents these studies lack the agent’s personal identity, which is one important component of one’s identity dynamics.

Although some efforts have been taken in developing agent’s own identity and individuality, these approaches have been taken separate ways and none of the systems address both concepts of identity together and working dynamically. When working with complex social virtual worlds we are dealing with dynamics that are difficult to predict. Yet, many of this works are context specific, and some even task specific without handling with the identity’s ability to adjust to the social context, nor how these dynamics can impact the agent’s thoughts, feelings and behaviours as a whole. As such, we are developing a new approach where both personal and social identities play a large role on the agent’s decisions and behaviour.

3 Dynamic Identity Model

The Dynamic Identity Model for Agents (DIMA) aims at providing agents with a dynamic identity that is adaptive to the social situation they are in, while at the same time is also influenced by it. Although this model follows a psychological approach, it affects both individual and group level working from the individual and cognitive level of the agent without, however, disregarding the cultural influences on one’s identity. For that we sought inspiration on Social Identity [33] and Self-Categorization [36, 39] theories that we believe to explain very well how those two components (individual and social) work together on one’s identity.

3.1 Agent's Identity

According to this approach, instead of showing a fixed personality, the agent features a sub-set of characteristics that represents the part of the self that is currently salient on the agent. So in DIMA each agent, besides its *name*, has a *salient identity* that will filter the characteristics that will determine the agent's decision, but also a set of social groups that it is known by the agent and kept in its *knowledge base*.

- **Name:** a label used to identify the agent;
- **Salient Identity:** representation of the agent's expressed identity that is going to influence the agent's decision making;
- **Social Groups' Knowledge Base:** representation of the agent's known social groups (aggregation of agents that share the same characteristics) and its prototypical characteristics and values (a set of characteristics that represents the typical agent of that group).

While *personal identity* is the part of the self-concept defined in terms of idiosyncrasies derived from the intra-group differentiation [9,33], *social identity* refers to the aspects of a person's self-concept that are derived from the knowledge and feelings about his or her in-group [33]. Following that, in DIMA an agent's salient identity can have two different levels: it can be social, if an agent's group memberships become salient through inter-group differentiation, or it can be personal when no social identity is salient. As such, the agent is not only going to be able to express its individual identity, but also for each social group it belongs, the agent will hold a social identity that can be expressed if the situation leads it. This way, the agent's salient identity can be:

- **Social:** a set of characteristics that the agent shares with the other members of the in-group;
- **Personal:** a set of characteristics that distinguishes the agent from it's in-group.

3.2 Characteristics

In order to represent these two levels, both social and personal identities are defined by characteristics that represent the agent's attributes or features that are going to be taken into consideration on the agent's decision making. When an agent's salient identity is personal the agent's decision will be determined by its personal identity characteristics, but when the salient identity is social, then the agent's expressed characteristics' values are going to shift towards the values of the prototypical characteristics of that specific social group.

Each characteristic is defined in DIMA by a *name*, a *type* and a *value*:

- **Name:** a label used to identify the characteristic;
- **Type:** a category that defines how a characteristic can be perceived;
- **Value:** an observed and measurable attribute or feature.

Characteristics can be one of the two types: explicit or implicit. Whereas *explicit characteristics* can be easily observed and obtained by other agents (for example: skin or clothes colour, symbols, skills and gender), *implicit characteristics* are gleaned indirectly by observing the agent’s behaviour and expressions and requires agents with inferring mechanisms. Characteristics that are implicit can be *social values, norms, interests or goals* [12,29] and these four types of manifestations can be described as follows:

- **Social value:** indicates the degree to which something is considered good or bad. Values are related to norms, but tend to be more general and abstract. They are used as an evaluative criterion to assess specific desirability or repulsion of a certain behaviour. They can be orientations such as “I should be a good member to my group”;
- **Norm:** is a socially and culturally situated standard for behaviour, which is also used as an evaluative criterion that specifies a rule of behaviour regarding what can and cannot be done in a given context, producing the feeling of obligation. Norms can be translated to rules such as “I cannot steal even if to help my group”;
- **Interest:** is the direction of attention and action to a set of desired resources. An interest can be “I would like to gain status within my group”;
- **Goal:** is a world state to be achieved, like “Having my team as a winner on this game”.

All characteristics must have a numeric comparative function which returns the distance between two vectors ranging from 0 to 100, where 0 means the absence of that characteristic on the agent and 100 means that it highly represents the agent. Because of that, an interest cannot be for example “I want to gather resources”, but instead should be represented as “How willing I am to gather resources” on a scale from 0 to 100.

3.3 Social Context

Like previously stated, the social context the agent is in will have a great influence on how the agent will perceive itself and others. It will increase the likelihood of the agent behave according to its personal identity or to its social identity, and also determine which type of identity is going to be salient and influence the agent’s behaviour. Several important social and cognitive factors are known to influence the salience of an identity [2,3,30,32,38].

In DIMA, we represented these factors with a *theme*. When a specific theme is introduced on the social context, either by a place (e.g. a university), by a topic of a conversation (e.g. a discussion about politics) or by an event (e.g. a football match), the theme will bring out the characteristics that are relevant in that specific social context, and then this set of relevant characteristics is going to be processed by the agent. Because our current focus is the presence of in-group and out-group members, in the model, the social context is also going to be defined by the set of *agents present* in the current social situation. This way, the two aspects from the social context represented in DIMA are:

- **Theme:** the set of relevant characteristics manifested by a place, a talk or an event;
- **Agents Present:** the agents present in the social environment. They could be introduced in the environment through their physical presence, by being referenced in a conversation or by an event.

It is while looking at each other agents' characteristics, which the theme defines as relevant to the current situation, that the agent calculates and perceives if it is in the presence of members with which it shares the same social group (*in-group*) or not (*out-group*). If the agent perceives itself as in presence of only in-group members, its identity is going to be determined by its personal identity. But if the agent is in the presence of out-group members, its identity can be determined by a social identity, according to a formula that we will see next.

3.4 Identity Saliency

Fundamentally, the identity the agent is going to take in account when processing its decision-making and to generate its behaviour, is going to be determined by the presence or not of the the out-group [6] but also by several other aspects inherent to the social identity itself.

According to Social Identity and Self-Categorization theories [33,36,39], the saliency of a particular social identity (*SI*) is determined by the interaction between how accessible in memory that social identity is to an individual (*Accessibility*), as well as how well it fits the social context (*Fit*) [39,40]. Following Oakes [22], in this model a social identity saliency is the product of fit and accessibility (see Eq. 1).

$$Saliency_{(SI_i)} = Fit_{(SI_i)} \times Accessibility_{(SI_i)} \quad (1)$$

The **fit** between a social identity and the context where the agent is situated is composed by two aspects: comparative fit and normative fit. Comparative fit is defined by the principles of the Meta-Contrast theory [39], which states that:

“any collection of people will tend to be categorized into distinct groups to the degree that intra-group differences are perceived as smaller, on average, than inter group differences within the relevant comparative context”, p.455, [40]

Normative fit refers to the content of that categorization and how well does it match with the characteristics of a social group from the agent's knowledge base.

In order to determine the fit of a social identity with DIMA, first the agent needs to define the social groups present in the context given the actual theme. To do that, all agents present in the social context are going to be clustered into categorizations, according to the relevant characteristics given by the theme. According to the clustering algorithm results, the agent might perceive as being in the presence of zero, one or more social groups. If the number of clusters is one or less, that means that the agent is in the presence of one social group. In

this case, because of the absence of an out-group, the fit is zero. As such, the social identity is not salient and the agent will use its personal identity.

If in the presence of two or more groups, the agent will be able to determine if it is in the presence of a social group that it already knows and had experience with. So for all social groups in the agent's knowledge base that have those relevant characteristics, the normative fit is computed by comparing them to all the clusters resulted from the previous clustering process. If no match is found, its because the agent is in the presence of ad-hoc groups (groups who the agent does not have previous knowledge or past experiences with). In those situations the prototypical member, or centroid (Ct), of each social group that is going to be used later by the fit is going to be determined by the prototypical member of the present clusters. If there is actually a match between the social groups found by the clustering algorithm, the agent will use the centroid from the normative social groups that it already knows.

Calculating the fit of its social identity (SI_i) is going to be done according to the Eq. 2 where the distance between the agent's group and any other group is going to be calculated (inter group differences) and the dispersion of its own social group is measured (intra-group differences). Alfa (α) is a weighting value for both distance and dispersion, and since we want to attribute more weight to the distance than to the social group's dispersion, we set the default to 0,8.

$$Fit_{(SI_i)} = \alpha \left(\frac{Distance_{(SG_i, SG_o)}}{Kmd_{(SG_i, SG_o)}} \right) + 1 - \alpha \left(1 - \frac{Dispersion_{(SG_i)}}{Kmcw} \right) \quad (2)$$

The *distance* between the agent's group and another group present in the social context is going to be measured by calculating the difference between the out-group centroids ($Ct_{(SG_o)}$), that represent the group's prototypical members, and the in-group centroids ($Ct_{(SG_i)}$) (see Eq. 3). If the agent recognizes the groups through the normative fit process then the group's centroids used will be the prototypical members' characteristics from the social groups from the agent's social group's knowledge base, if not, it will be the prototypical members' characteristics of the clusters found trough the clustering algorithm.

$$Distance_{(SG_i, SG_o)} = |Ct_{(SG_o)} - Ct_{(SG_i)}| \quad (3)$$

The *dispersion* of the agent's social group is measured by calculating the average of absolute differences (MD) of all its members from the prototypical member of the social group (see 4).

$$Dispersion_{(SG_i)} = MD_{(SG_i)} \quad (4)$$

Both distance and dispersion are normalized, using the constants Kmd and $Kmcw$, where:

- **Kmd:** is the maximum distance two clusters can hold, and can be calculated according to the Eq. 5, where $NChar$ is the number of characteristics used for clustering and $MAXChar$ is the maximum value a characteristic can have;

- **Kmcw**: is the maximum distance between the centroid member and another member for it to be considered as member of that group. It is a parametrizable value, that by default was set to 50.

$$Kmd_{(SG_i, SG_o)} = \sqrt{NChar} \times MAXChar \quad (5)$$

Social groups with higher fit are the ones with less clustering dispersion and higher distance from the other social groups. Social groups with fit's values below a certain threshold are not strong enough to be acknowledged by the agent. As such, the agent will use its personal identity. Above that threshold, the social groups are strong enough to turn salient their corresponding social identity on that agent.

Accessibility of a particular social group, reflects a person's past experience, expectations, motives, values, goals and needs [40]. Identities have higher or lower accessibility depending on how accessible is that specific categorization in a person's memory. Identities that have been used more times and displace more emotional valence are more accessible. Accessibility is not applied to ad-hoc social groups, and will not be considered in order to determine the agent's social identity.

However, in the presence of normative groups the agent's social identity can have an accessibility value determined by the emotional memory and the easiness of bringing that social identity into the agent's mind [40]. The emotional valence of a memory is defined by the emotional impact of the actions taken by the agent supported by that identity. So, for example, if an agent from the social group "Blue Football Team fans", being in the presence of other agents from the out-group "Red Football Team fans" makes decisions using its social identity "Blue Football Team fan" and then he is punished for those decisions, its identity emotional valence will decrease the accessibility value. If the accessibility value is 0 that means that identity is not going to be remembered by the agent, and thus not used at all. This way, accessibility works as an stimulus to not use that specific social identity in later situations, but can in other cases increase the receptiveness of the agent to use a specific social identity in different settings.

For every time a social identity is salient its accessibility is updated according to the Eq. 6. The sum of all agent's identities is normalized so when one identity accessibility increases all the others suffer a decay.

$$Accessibility_{(SI)_{t+1}} = Accessibility_{(SI)_t} + Salience_{(SI)_t} \times EmotionalValence_{(SI)_t} \quad (6)$$

The salience of a social identity will be highest if both accessibility and fit are high. The higher a social identity, more impact that will have on the agent's behaviour.

4 Example

Many times, agents are placed in situations where they should act rationally and try to maximize their expected utility according to their individual and social

preferences, however, the perception of membership in humans leads many times to social bias in their decisions strategies [21]. In a social dilemma situation, for example, individuals rationality can be at conflict with social rationality [16].

One classic example of a social dilemma is the prisoner’s dilemma [23] where two prisoners, being caught by the authorities, have been given the opportunity to testify against each other’s partner or remain silent. Regardless of what the other decides, the prisoner gets a higher pay-off by betraying its partner, making this choice the most rational one in terms of utility. Still, several studies shown that social identity positively influence cooperation rates in these situations (e.g. [5, 15]) and our model recognizes those processes of social bias. With it is possible to achieve four effects besides the baseline:

- **Baseline:** from one agent’s viewpoint is when all agents present are from the same social group and its decisions are made based on its personal identity;
- **Out-group effect:** from one agent’s perspective is when some of the present agents are from another social group than its own and its decisions are made based on its social identity;
- **Social context effect:** it is when regrouping occurs due to changes in the social context. This effect happens when the presence of another agent leads to one agent, that was previously set in one group, to shift to another group;
- **Theme effect:** regrouping due to changes in the theme. Happens when changes on the theme leads to a new identifications.
- **Normative effect:** happens when the social groups found in the social context match the normative social groups known by the agent.

To demonstrate these processes let us imagine a scenario similar to the prisoner’s dilemma. There are four agents, Adam, Brian, Chloe and Dave, but only Adam and Brian are playing the prisoner’s dilemma game.

4.1 Baseline

In a simplified, but similar way to [32], all agents had to individually answer a question regarding their favourite colour and after that, Adam and Brian were allocated to a room, dressing a t-shirt of their favourite colour (see Table 1).

In that room Adam and Brian can see each other, but they are not allowed to talk according to the rules of the game. The theme of that social context is their colour preference, and because they are both using strong blue t-shirts

Table 1. Agents and the percentage of blue in their t-shirts.

	Blue Color on T-Shirt
Adam	90
Brian	100
Chloe	60
Dave	0

($Blue_{Adam} = 90$ and $Blue_{Brian} = 100$), looking through Adam's perspective, he knows which colour Brian prefers, and starts processing the clustering of all present members regarding those characteristics. From Adam's clustering calculation analysis, the result shows that he is in the presence of only one group, where everyone seems to like a strong blue colour. Because of that, Adam's social identity will not be salient and Adam is going to express his personal identity and focus on his personal goals on achieving his own personal welfare. Because the way the prisoner's dilemma was designed, this will result in Adam, and also Brian, defecting, ending up with the worst pay-out for them of the possible four.

4.2 Out-Group Effect

Another agent enters the room, Chloe, and because the social context has changed, Adam starts processing a new clustering taking into account all the present members. Because Chloe's t-shirt has a lighter blue colour ($Blue_{Chloe} = 60$), the clustering will result in two different social groups and Chloe will be identified by Adam as belonging to the social group of agents that do not like a strong blue t-shirt.

Because now two groups were found, people who like strong blue and people who prefer light blue, Adam is going to start processing normative fit of its own social identity. Since these are ad-hoc groups, Adam does not have a previous knowledge of the prototypical characteristic of that social group, meaning that he does not have previous experience of how much preference a strong or light blue colour fan should be having. As such it is going to use the characteristic values of the present members to calculate it. So, following the Eqs. 7, 8, 9, 10 the fit in this situation is going to be low but present (see Eq. 11).

$$Centroid_{(SG_{Blue})} = \frac{90 + 100}{2} = 95 \quad (7)$$

$$Centroid_{(SG_{NotBlue})} = \frac{60}{1} = 60 \quad (8)$$

$$Distance_{(SG_{Blue}, SG_{NotBlue})} = |95 - 60| = 35 \quad (9)$$

$$Dispersion_{(SG_{Blue})} = \frac{|90 - 95| + |100 - 95|}{2} = 5 \quad (10)$$

$$Fit_{(SI_{Blue})} = (0.8 \times \frac{35}{100}) + 0.2 \times (1 - (\frac{5}{50})) = 0.28 + 0.18 = 0.46 \quad (11)$$

And since the accessibility is not considered in this situation, the salience is going to be the same as the fit value. With a threshold of 0.4 the agent's social identity becomes salient. Due to that, their own personal goals are going to be replaced by his social group goal, which is achieving their social group's welfare. Because of that, Adam will choose to cooperate, as well as Brian, because they now feel as part of a social group that represents them.

4.3 Social Context Effect

Now, someone mentions that Dave, which wears a white t-shirt ($Blue_{Dave} = 0$) is soon to be entering the room. Note that the agent Dave does not need to be physically present in order for Adam to reprocess a new social identity salience.

When the social context changes, a new clustering is processed by Adam, and because this time Dave does not present any shade of the colour blue in his t-shirt, the clustering will result again in two different social groups, but now Chloe will be identified by Adam as belonging to the same social group as him. At least she seems to like blue while Dave does not, Adam might think, since Chloe shares the same t-shirt colour while Dave does not even wear the colour at all (see Eqs. 12, 13, 14, 15 and 16).

$$Centroid_{(SG_{Blue})} = \frac{90 + 100 + 60}{3} = 83 \quad (12)$$

$$Centroid_{(SG_{NotBlue})} = 0 \quad (13)$$

$$Distance_{(SG_{Blue}, SG_{NotBlue})} = |83 - 0| = 83 \quad (14)$$

$$Dispersion_{(SG_{Blue})} = \frac{|90 - 83| + |100 - 83| + |60 - 83|}{3} = 15.6 \quad (15)$$

$$Fit_{(SG_{Blue})} = (0.8 \times \frac{83}{100}) + 0.2 \times (1 - (\frac{15.6}{50})) = 0.66 + 0.14 = 0.80 \quad (16)$$

Presenting a high fit value, the salience of Adam's social identity is going to be also high. Adam will continue to choose to cooperate because Brian is still perceived as part of its social group.

4.4 Theme Effect

After Dave's arriving, all four agents are asked to leave the room, and the theme is set to the outdoors. Imagining that now Adam and Dave share the same interesting in being outdoors, while Brian and Chloe do not, the changing of the theme will now allow for two different sets of social groups than seen previously (see Table 2).

Table 2. Agents and their interests in outdoors.

	Interest in outdoors
Adam	90
Brian	0
Chloe	10
Dave	100

Because now Adam's perception is that Brian belongs to an out-group, Adam would opt to defect in the prisoner's dilemma game in the case they were still playing it (see Eqs. 17, 18, 19, 20 and 21).

$$Centroid_{(SG_{Outdoors})} = \frac{90 + 100}{2} = 95 \quad (17)$$

$$Centroid_{(SG_{NotOutdoors})} = \frac{0 + 10}{2} = 5 \quad (18)$$

$$Distance_{(SG_{Outdoors}, SG_{NotOutdoors})} = |95 - 5| = 90 \quad (19)$$

$$Dispersion_{(SG_{Outdoors})} = \frac{|90 - 95| + |100 - 95|}{2} = 5 \quad (20)$$

$$Fit_{(SI_{Outdoors})} = (0.8 \times \frac{90}{100}) + 0.2 \times (1 - (\frac{5}{50})) = 0.72 + 0.18 = 0.90 \quad (21)$$

4.5 Normative Effect

Considering now that the previous social group does have a normative social group known by Adam, calculations would be different. So imagine this new situation. Adam determines, by clustering all four members, that he is in the presence of two groups. He then processes the normative process that shows that he is standing before a previously known social group with similar prototypical characteristic values, as the ones found in his social context (see Table 3).

Instead of using the prototypical characteristics of the present group to calculate the distance between both groups, he will use the ones from his knowledge base. The fit will be calculating according to the following Eqs. (22, 23 and 24) using the Centroids from the Table 3 and not from the Table 2.

$$Distance_{(SG_{Hikers}, SG_{NotHikers})} = \frac{|80 - 15| + |85 - 20|}{2} = 65 \quad (22)$$

$$Dispersion_{(SG_{Hikers})} = \frac{|95 - 65| + |100 - 65|}{2} = 17.5 \quad (23)$$

$$Fit_{(SI_{Hikers})} = (0.8 \times \frac{67.5}{141}) + 0.2 \times (1 - (\frac{17.5}{50})) = 0.38 + 0.13 = 0.51 \quad (24)$$

Table 3. Prototypical members of the social group Hikers and Non Hikers from Adams knowledge base

	Hikers	Non Hikers
Interest in outdoors	80	15
Interest in walking	85	20

Assuming that the Hikers social group accessibility on Adam is 0.8, and that the threshold is now 0.2 (because we are using two variables to determine the salience) Adam’s social identity is going to be salient (see Eq. 25).

$$Salience_{(SI_{Hikers})} = 0.51 \times 0.8 = 0.41 \quad (25)$$

Because the prototypical characteristic values were not so extreme as presented by the members in Adam’s social context, the fit will not be as high as in the previous example. But now, since this is not an ad-hoc social group, Adam would have had previous experiences with that social group before. Although the theme only made relevant the characteristic “Interest in Outdoors” because Adam recognized his group as the Hikers social group, he could now assume other characteristics values that were not first glanced by him before, such as “Interest in Walking”, what could be important in helping Adam in his next decisions.

5 Conclusion and Future Work

With DIMA is possible to create interesting agents with a dynamic and contextual identity able to generate diverse behaviour and decision making and yet keeping the consistency found in humans. Because social identity has a positive impact on in-group cooperation and negative effect on out-group cooperation, it is our opinion that agents in social dilemmas scenarios could benefit from this model.

At the time of writing we have started with the implementation of DIMA on multi-player platform developed within the Project INVITE¹ (social Identity and partNership in VIrTual Environments) [1, 8, 25], but in the future we would also like to extend DIMA to include more features.

As future work, we would like to support degrees of importance regarding the characteristics given by the theme. Since that in some situations, in order to process the clustering of the present members, some characteristics are more important than others, this will introduce changes in the social group categorization and bringing not only different social bias, but also more uniqueness to each agent. This would allow scenarios where although two agents share the same characteristics (e.g. same nationality and history background), in a situation of war, the other one could be considered an out-group, because it belongs to a rival military group.

One other aspect that we would like to extend is the concept of identity levels. According to Turner and his colleagues [36, 39], the self can be categorized at many different levels of inclusiveness [36] and self-categorization can exist at several different levels of abstraction that can be more or less inclusive than just personal and social identity, (e.g. individual, occupation, nation, gender and finally human being). The concept of multiple identity levels allows for the simulation of situations such as having two members belonging to two

¹ <http://project-invite.eu/>

different groups (e.g. a biologist and a computer scientist) which also share a more abstract identity (e.g. they are both scientists).

Another aspect that we think is important is to introduce multiple identity salience and relations among themselves (positive or negative). In many social situations it is possible to have factors that increase the salience of several identities, and some identities can have opposite forces between them. Either because there is a conflict between a personal and a social identity [37], or between two social identities that might occur for example when someone is a children of an intermarriage couple. Including relations between identities allows us to simulate situations where two or more identities work against each other.

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