Dynamic Identity Model for Agents

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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 in order 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 the agent's identity has not been passed unnoticed. Because of its influence in thoughts, feelings and behaviours, many researchers have been focusing on identity and the way it can impact the agent's processes and reactions.

Two of the currents focal points of building believable agents, has been the development of the agent's identity trough 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 [6, 14, 17, 22, 23, 30], whereas in real life identity is not unchangeable and free of influences [10, 25, 26, 35]. 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 [16, 25, 35].

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, have a great impact on how someone is going to perceive oneself and others but also on one's behaviour [29, 35].

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 [16, 25, 35]. One of the most studied aspects is the presence of in-group or out-group members. When in presence of members of a person's own in-group, he or she 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. The 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.

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 [28].

In virtual worlds, several scenarios can require agents to adapt their identity to their current social context, and the agents should be prepared to behave in each situation. One of the possible applications for this model would be, for example, a social dilemma situation, since it has been shown that on those settings people can easily make decisions biased by their social identity [3, 12].

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 section 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 section 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 approach used to build identities in agents is the use of personality. A study was carried out by [14], who develop an architecture to support rich-personality expression on agents, called Hap. Another personality-driven model was introduced on [23]'s study where it was presented a goals and plans-based model of personality for agents. On [30]'s work it was developed a framework that allows agents to adapt their personality to the player trough a punishment-reward learning system. These are interesting and useful works done in the agent's personality area, but still these only covers one side of an agent's identity disregarding its social identity.

To address the other side, other studies tried to achieve human-like consistent behaviour trough the implementation of cultural features. On that direction [6] proposed an embodied animated agent able to generate culturally appropriate behaviour, while [22] built a system where embodied conversational agents are capable of adjusting their expressive non-verbal behaviour to the user's culture. On [17]'s work it was developed an existing agent architecture, enabling agents to express different cultural behaviour trough the use of rituals.

Some other authors worked directly with social identity theories, implementing this concept on crowd behaviour [8] and opinion dynamics simulations [9, 11, 15, 24]. But also like the research done on cultural agents these studies lack the agent's personal identity, one important component of one's identity.

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. 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 influence by it. Because this model follows a psychological approach, we worked not on the group level, but on an individual and cognitive level of the agent, without however disregarding the cultural influences. For that we used Social Identity and Self-Categorization theories that explain very well how those two components (individual and social) work together on one's identity.

3.1   Agent

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 the model 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 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 and its prototypical characteristics.

3.2   Agent's Identity

While *personal identity* is the part of the self-concept defined in terms of idiosyncrasies derived from the intra-group differentiation [7, 28], *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 [28]. As such, the agent is not only going to be able to express its individual identity, but also, for each social group an agent belongs, the agent will hold a social identity that can be expressed if the situation leads it. On this note, in DIMA, an agent's *salient identity* can have two different levels. It can be social, if an agent's group memberships becomes salient trough inter-group differentiation, or it can be personal when no social identity is salient. 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.

In order to represent these two levels, both social and personal identities are defined by:

- **Name:** a label used to identify the type of identity;
- **Characteristics:** representation of the agent's attributes or features that are going to be taken into consideration on the agent's decision making, defined by a name and value.

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, i.e., then the agent's expressed characteristics' values are going to shift towards the values of the prototypical characteristics of that specific social group.

3.3   Characteristics

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

- **Name:** a label used to identify the characteristic;
- **Value:** 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 characteristic 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 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 achieve, 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, for example, can not be "I want to gather resources" but instead should be represented as "How willing am I to gather resources" on a scale from 0 to 100.

3.4   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 will 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 an *identity salience* [1, 2, 25, 27, 33].

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 talk about politics) or by an event (e.g. travelling outside), 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:

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

It is while looking at each other agents' characteristics that the theme defines as relevant to the current situation, that the agent calculate 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.

3.5   Identity Salience

Fundamentally, the level of identity that 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 [5] but also by several other factors inherent to the social identity itself.

According to Social Identity and Self-Categorization theories [28, 31, 34], the salience 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) [34, 35]. Following [19], in this model a social identity salience is the product of fit and accessibility (see equation 1).

$$Salience_{(SI)} = Fit * Accessibility \tag{1}$$

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 [34], 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, [35]

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.

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 one or more social groups. If the number of clusters is one, 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 agent will use its personal identity. Only in the presence of two or more groups, the agent proceeds in calculating the fit.

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 the agent already knows and had experience with. So for all social groups in the agent's knowledge base that has those relevant characteristics, the 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, and 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 equation 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) and Beta (β) are weighting values 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 for α and 0.2 for β.

$$Fit_{(SI_i)} = \alpha \frac{\left| Ct_{(SG_i)} - Ct_{(SG_o)} \right|}{Kmd} + \beta(1 - \frac{MD_{(SG_o)}}{Kmcw}) \tag{2}$$

The *distance* between the agent's group (SG_i) and another group present in the social context (SG_o) is going to be measured by calculating the difference between the prototypical members of each group. If the agent recognizes the groups through the normative fit process then it will use the the prototypical members' characteristics to calculate the distance between two groups, if not, it will use the prototypical members' characteristics of the clusters found trough the clustering process.

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. 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 equation 3, where N is the number of characteristics used for clustering and MAX is the maximum value a characteristic can have;
- **Kmcw:** is the maximum distance between the prototypical member and another member for it to be considered as member of that group. It is a parametrized value, which is currently set to 50.

$$Kmd_{(SG_n, SG_m)} = \sqrt{N} * MAX \tag{3}$$

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

bellow a certain threshold are not strong enough to be acknowledged by the agent as such it 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 [35]. 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 [35]. 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 equation 4. The sum of all agent's identities is normalized so when one identity accessibility increases all the others suffer a decay.

$$Acc(SI)_{t+1} = Acc(SI)_t + Salience(SI)_t * EmotionalValence(SI)_t \qquad (4)$$

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 rationality [18]. In a social dilemma situation, for example, individuals rationality can be at conflict with social rationality [13].

One classic example of a social dilemma is the prisoner's dilemma [20] 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 this situations (e.g. [12, 4]) and our model recognize those processes of social bias. With it is possible to achieve four effects besides the baseline:

- **Baseline:** From one agent's perspective, is when all the present agents are from the same social group its decisions will be 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 that itself its decisions will be made based on its social identity;
- **Social context effect:** Regrouping due to changes in the social context. Happens when the presence of another agent leads to one agent to shift from one social group to another;
- **Theme effect:** Regrouping due to changes in the theme. Happens when the changing of the theme leads to a new identification for the agent.
- **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 [27] all agents individually had to answer a question regarding which was 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).

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

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 the colour of their t-shirt, and because they are both using vivid blue t-shirts ($BlueShirt_{Adam} = 90$ and $BlueShirt_{Brian} = 100$), looking through Adam's perspective, he will then start processing the clustering of all present members regarding those characteristics. From Adam's clustering calculation analysis, the results show that he is in the presence of only one group. 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 is 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 an account all the present members. Because Chloe's t-shirt has a lighter blue colour ($BlueShirt_{Chloe} = 60$), 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 wear a vivid blue t-shirt.

Because now two groups were found, 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, as such it is going to use the characteristic values of the present members to calculate it. The fit (from equation 2) in this situation, is going to be calculated according to equations 5, 6, 7, 8 and 9.

$$Centroid_{SG_{BlueShirt}} = \frac{90 + 100}{2} = 95 \tag{5}$$

$$Centroid_{SG_{NotBlueShirt}} = \frac{60}{1} = 60 \tag{6}$$

$$Distance_{SG_{BlueShirt}, SG_{NotBlueShirt}} = |95 - 60| = 35 \tag{7}$$

$$MD_{SG_{BlueShirt}} = \frac{|90 - 95| + |100 - 95|}{2} = 5 \tag{8}$$

$$Fit_{(SI_{BlueShirt}} = (0.8 * \tfrac{35}{100}) + 0.2 * (1 - (\tfrac{5}{50})) = 0.28 + 0.18 = 0.46 \tag{9}$$

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 replace 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's that represents them.

4.3 Social context effect

Now, someone mentions that Dave, which wears a white t-shirt ($BlueShirt_{Dave} = 0$) 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 shares the same t-shirt colour, Adam might think, while Dave does not even wear the colour at all (equations 10, 11, 12, 13 and 14).

$$Centroid_{SG_{BlueShirt}} = \frac{90 + 100 + 60}{3} = 83 \qquad (10)$$

$$Centroid_{SG_{NotBlueShirt}} = 0 \qquad (11)$$

$$Distance_{SG_{BlueShirt},SG_{NotBlueShirt}} = |83 - 0| = 83 \qquad (12)$$

$$MD_{SG_{BlueShirt}} = \frac{|90 - 83| + |100 - 83| + |60 - 83|}{3} = 15.6 \qquad (13)$$

$$Fit_{(SG_{BlueShirt}} = (0.8 * \tfrac{83}{100}) + 0.2 * (1 - (\tfrac{15.6}{50})) = 0.66 + 0.14 = 0.80 \qquad (14)$$

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, the four agents 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 equations 15, 16, 17, 18 and 19)).

$$Centroid_{SG_{Outdoors}} = \frac{90 + 100}{2} = 95 \qquad (15)$$

$$Centroid_{SG_{NotOutdoors}} = \frac{0 + 10}{2} = 5 \qquad (16)$$

$$Distance_{SG_{Outdoors},SG_{NotOutdoors}} = |95 - 5| = 90 \qquad (17)$$

$$MD_{SG_{Outdoors}} = \frac{|90-95| + |100-95|}{2} = 5 \tag{18}$$

$$Fit_{(SG_{Outdoors}} = (0.8 * \tfrac{90}{100}) + 0.2 * (1 - (\tfrac{5}{50})) = 0.72 + 0.18 = 0.90 \tag{19}$$

4.5   Normative effect

Considering now that the previous social group do 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 process 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).

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

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 equations, 20, 21 and 22 using the Centroids from the table 3 and not from the table 2.

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

$$MD_{SG_{Hikers}} = \frac{|95-65| + |100-65|}{2} = 17.5 \tag{21}$$

$$Fit_{(SG_{Hikers}} = (0.8 * \tfrac{67.5}{141}) + 0.2 * (1 - (\tfrac{17.5}{50})) = 0.38 + 0.13 = 0.51 \tag{22}$$

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 equation 23).

$$Salience_{(Hikers'\ Social\ Identity)} = 0.51 * 0.8 = 0.41 \tag{23}$$

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 had have 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 was not first glanced by him before, such as

"Interest in Walking", what could be important in helping Adam in following 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 start with the implementation of DIMA on multi-player platform developed within the Project INVITE [1] (social Identity and partNership in VIrTual Environments) [21], 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 introducing will introduce changes in the social group categorization and bringing not only different social bias but also more uniqueness to each agent. In the example where two teams are rivals, even though the perceiver shares the same team as another person, if the other person had some connection with a member from the other team (such as being a dating couple), then that other person might be considered as out-group member even though it shares most of the relevant characteristics with the perceiver.

One other aspect that we would like to extend is the concept of identity levels. According to Turner and his colleagues [31, 34], the self can be categorized at many different levels of inclusiveness [31] 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 allow for the simulation of situations such as having two members belonging to two different groups (e.g. a biologist and a computer scientist) but that 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 [32], 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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[1] http://project-invite.eu/

6   Acknowledgements

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