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Social Awareness Concepts to Support Social Computing

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Abstract—**Our social life is characterised by norms that manifest as attitudinal and behavioural uniformities among people. With greater awareness about our social context, we can interact more efficiently. Any theory or account of human interaction that fails to include social concepts could be suggested to lack a critical element. This paper identifies social concepts that need to be supported by future context-aware systems. It discusses the limitations of existing context-aware and Multi-Agent Systems (MAS) to support social psychology theories related to the identification and membership of social groups. We argue that social norms are among the core modeling concepts that future context-aware systems need to capture with the view to support and enhance social interactions. The social concepts identified in this paper could be used to simulate agent interactions imbued with social norms or use ICT to facilitate, assist or enhance social interactions. They also could be used in virtual communities modeling where the awareness of a community as well as the process of joining and exiting a community are important.**

I. Case study

> Imagine that you are driving on a three lane highway (one way). Suddenly, you are facing a situation where all vehicles are queuing slowly on the left (slow) lane. The two other lanes are suspiciously empty. No hazards are within your sight, however no vehicles are engaged on the two right lanes. You are likely to join the queue ...

This social behavior pattern is quite common. Watching what other people do in the same situation provides information about what is normal in a novel and ambigious situation [1]. Other's behaviour provides a consensus information. The greater the number of people behaving uniformly the more correct we will perceive our behaviout to be. Hence, the drivers on the slow lane had adopted a normative behavior which mimicked the group behavior despite the fact that they may personally want to drive on the empty fast lanes.

The driver changed his/her own attitude to fulfil social norms (conformity theory) [2]. Social norms are explicit or unspoken rules about how we ought to behave. This paper discusses social psychology theories underlying such a behaviour and identify relevant concepts to be used in computer applications. Social psychology attempts to understand how behaviours of individuals are influenced by the actual, imagined or implied presence of others. By building computers (or applications) that understand social cues and social context, technologists can dramatically improve collective decision making.

II. Introduction

There are numerous definitions of context emerging from different research disciplines including philosophy, artificial intelligence or psychology [3]. However, we use Dey's definition as it covers our notion of social context. Dey [4] defines context as follows:

> "Context is any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

Although, not explicitly mentioned in the definition above, social context can arguably be considered as included in Dey's definition of context. Social context is relevant to human interactions as it influences or constraints individual's behaviours. Hence, key to understanding and modeling human behavior is modeling their system social organization. The units of social modeling are each individual also called social actors. There are converging evidences from social identity theory asserting that the understanding of social dynamics is not possible by a mere aggregation of the actors' collective behaviour. In other words, it is not possible to study social interactions by focusing on inter-personal behaviour. Social groups are seen as qualitatively different, with the processes that are operating being distinct from those of inter-personal interaction [5],

Our notion of social context broadly refers to the notion of *milieu* where interactions between a group (two or more human) occur. It captures the context and history surrounding social interactions. A social group features members who accept a set of rules as members of the group, and share a common identity. The membership acceptance doesn't have to be explicit. For example people waiting at a bus stop could be identified as a group but the member of the group did not explicitly agreed to be part of such a group. In this example the people waiting have similar goal and are categorized as an ephemer group through a social comparison process.

Social context includes social positions, social roles, customs, standards, values, kinship, ties fashions and culture. We

conceptualize social contexts as essentially norms (whether they relate to roles, customs, standards, unwritten rules, etc) as they represent jointly negotiated rules for social behaviour [6].

Research in norms spans multiple fields. A norm is a social construct that has a widespread social usage as it helps to describe and explain human behaviour. Cialdini et al. [7] defined social norms as follows.

> "Social norms are rules and standards that are understood by members of a group, and that guide and/or constrain social behaviour without the force of law. These norms emerge out of interaction with others; they may or may not be stated explicitly; and any sanctions for deviating from them come from the social networks, not the legal system."

Social norms can be described as conventions emerging from a group of people that direct or specify how people must, should or could behave in various situations. Social norms generally are the rules or regulations that groups adhere to as opposed to rules or regulations that only one individual might adhere to. Social norms can sustain or exhibit arbitrary patterns of behaviours. The existence of a social norm may provide an individual with information on the extent of external cost/benefits associated with a behavior.

Mainstream social computing related research has typically focused their research on formalising norms rather than on formalising the process of adopting norms. Although formalizing norms is an important steps towards its implementation, but existing work does not address the specification nor the implementation of norm adoption. We hypothesized that social norms can be formalised using ontology or deontic logic as described in [8], [9], [10]. To our knowledge there is no research that systematically formalizes the process of how an actor becomes aware of and adopt social norms.

Our aim is to fill the gap between social theories and computer based awareness models. We focus on modeling the social norm awareness. The modeling will help to analyse human interactions and understand its principles. Such knowledge could be used to simulate agent interactions imbued with social norms or use ICT to facilitate, assist or enhance social interactions.

III. BACKGROUND

This section starts with a summary of social identity, social norms and salience theory. These social theories will help us to highlight the limitations of existing context awareness model to support social activities. As social norms are important concepts influencing behavior, we need to understand how an individual become aware of them. Existing research on context awareness systems have mainly focused on awareness of location, presence and identity. There are few attempts by the Computer Supported Cooperative Work (CSCW) community to move the traditional spatial-based context beyond more abstract concepts; however, they arguably failed to comprehensively include social concepts.

A. Social Identity Theory

Social Identity Theory (SIT) is a well-established social psychological theory of group processes and intergroup relations that can help shed light on the complexities of the social context of interactions [5]; [11], [12]. Social identity theory rests on the assumption that groups are not just aggregates of individuals in which processes of interpersonal behaviour operate among a larger group of people but rather also have distinct processes that operate at a group level. Broadly, this theory proposes that our self concept is drawn from several components; a personal identity, as well as various social identities that derive from the groups to which we belong. Social identity refers to the individual's knowledge of belonging to a certain social group, together with the emotional and value significance of that group membership [12]. According to SIT, when an individual is strongly aware of their group membership, and it is of strong value and emotional significance to them, they are said to have strong ingroup identification [13]. Ingroup identification is strongly associated with, amongst other things, group cohesiveness [14], and stronger influence of the group in determining individual members' attitudes and behaviours ([15], [16]). Another important feature of SIT that may make the principles of this theory applicable to the Case study described in Section I, is that the processes it investigates, apply not only to small groups, where all members interact, but also to larger groups and social categories, where it is impossible to interact with or even know all the members of the group [13]. Thus, social identity theory can add insight into how interactions are influenced by the social context.

We can use the notion of social identity to identify a particular behaviour. If a personal identity can be associated with a particular personal behaviour, a social identity can be associated with group behaviours.

B. Salience

Research from a Social Identity Theory perspective has shown that the salience of group membership can have an impact on social identification and consequent behaviours, by highlighting a particular social identity over possible others in a given context, e.g., [17]; [18]. Oakes [19] suggests that the salience of a particular social category in a particular situation is a product of the interaction of the relative accessibility of the categorisation to the perceiver and the fit between the social stimulus (i.e. other person or context) and the social category. Group membership accessibility is defined as the relative readiness of a given group membership to be activated [19]. This accessibility can be separated into two components: chronic accessibility and situational accessibility. Chronic accessibility refers to the ease with which that category can be cognitively activated across all sorts of social situations. For example, categories such as race, gender, or age are likely to be chronically accessible categories. A category is more likely to be chronically accessible if it has been recently activated [20], frequently activated [21], affectively charged, or if one is otherwise motivated to use it [22]. Hence, in any given context

a number of social identities may be present, but the one that will have most influence on behaviour in that context is the one that is most salient. Hence the behavioural and attitudinal norms associated with that category will also be activated.

C. Social norms and agent simulation

Computer scientists have modeled human group behaviour as well-organised autonomous interacting agents. Research in multi-agent systems have defined mechanisms to represent, communicate, distribute, detect, create, modify, and enforce rules. One of the most successful theoretical model of agents featuring human reasoning is the BDI (Beliefs, Desires, Intentions) model. The concepts in BDI are relevant to social norms as norms are subdued by a common belief of a group. For example, Dignum [23] presented an agent model governed by norms. The norms are classified into three levels: private, contract and convention level and described in deontic logic. Deontic logic is a widely used declarative language tool to describe how agents adopt, violate or adhere to rules/norms. Deontic logic could express norms in term of Obligations, Permissions and Prohibitions.

Social norms are abstract or informal rules. While most of some of the rule of conduct of individual behaviour in most societies are formal and explicitly defined by law, many of social norms are not that formal and implicit. For example tailgating could be a social norm for young drivers but not for "safe drivers". However operationalizing such a norm could be difficult. Vasquez et al. [8] highlighted the challenges in formalizing and operationalizing social norms in a multi-agent architecture as they are inherently abstract.

Rules and laws are norms also referred to as formal norms. Informal norms emerge when societal laws are not applicable or the current situation is uncertain or unknown. Informal social norms exert the greatest influence when conditions are uncertain.

The question about when norms emerge has been studied in social psychology. When we interact with each other, we watch, listen and think through intentions of one another and react to them. We adapt our reactions according to the interacting partners and the current situation. We react not only to the actions of other people, but to their intentions as well. During these interactions, social meanings are created, exchanged and learned. A subset of such social meaning may become a social norm. Norms diffusion is a situational process where social interaction is occurring. Norms emerge through social learning during social interactions. Sen and Airiau [24] demonstrated with agent simulation that individual's social learning can successfully evolve and sustain a useful set of social norm that resolves conflicts and facilitates coordination within a group.

Existing agent modeling approaches using social norms assume that norms could be defined and internalized immediately [25] by social actors. The behaviour of the agent is then influenced by the normative behaviour to which it has conformed. However, the process of being a member of a social group has not been thoroughly investigated by the agent research community. A social membership is very situational. A social actor could be a member of multiple groups at the same time. A social actor will join or conform to the most salient group's norm. A group is associated with salience strength. Such a strength is relative to the current context. The context includes actors preferences, the immediacy or proximity between the group and the social actor or priming.

D. Modeling context-awareness

The emerging interests in awareness systems stems from the availability of ICT (Information Communication Technology) which makes it possible to interact remotely and virtually with individual or groups. Awareness of others and their associated context can enhance significantly the quality of virtual interactions. Interactions between individuals are the necessary conditions for social norms to come into being.

Current awareness models have focused on peer interactions. They fail to capture the social aspects constraining and emerging from such interactions. For example, Rodden [26] have defined a model of awareness for CSCW applications. Rodden uses the notion of focus and nimbus, to express different levels of awareness between interacting entities. In their model, objects (e.g., humans or cyberspace avatars) are responsible for controlling interactions on the basis of measurable levels of awareness between them. The use of nimbus and focus is described as follows:

- The more an object is within focus, the more aware you are of it
- The more an object is within your nimbus, the more aware it is of you

The model can express the notion of presence and awareness between peer objects inhabiting shared spaces or applications. The projection of presence and awareness actions such as nimbus and focus onto a shared application is useful for modeling social interactions. However, the model does not consider context as a first class concept and needs extensions to model the notion of social identity and salience as explained in previous sections. Furthermore, social identity theory argues that groups are not just aggregates of individuals (see Section III-A). Using Rodden's terminology, the presence, identification or the salience of a social group cannot be modeled as an aggregation of nimbus.

IV. MODELING SOCIAL AWARENESS

Human interactions are influenced by social rules such as social norms. The pattern of social interactions within a society are to some extent independent of the particular individual. A social interaction is an ever evolving sequence of social actions between individuals. A social action is an action that considers the reaction of other individuals. A social action is very contextual as it is performed relative to other individuals. Our approach to modeling social interactions focuses on the dynamics between an individual (social actor) and a target social group. Prior to joining an existing social group, an individual has to

1) have personal or social interests in joining a group in a given context,
2) be aware of the existence of the social group by differentiating a group from another, and
3) adhere to the most salient group.

The next subsections define concepts required to formalise the three steps.

A. Modeling context

We represent context as abstract objects and use McCarthy and Buvac's [27] formal representation of contexts as axioms. The main formulas defined by McCarthy and Buvac is:

$$c' : ist(c, p)$$

which is an assertion that the proposition p is true in the context c; itself asserted in an outer context c'.

Example:
$c0 : ist(context - of(\text{``}Sherlock\ Holmes\ Stories''),$
$\text{``}Holmes\ is\ a\ detective'')$

asserts that it is true in the context of "$Sherlock\ Holmes$" stories that "$Holmes\ is\ a\ detective$". In this example the outer context $c0$ is similar to the context "$Sherlock\ Holmes\ Stories$".

B. Modeling a social group

Hexmmor et al [28] stated that a social norm $Norm$ in a population Grp can be defined as a function of beliefs and preferences of the members of Grp if the following conditions holds:

- Almost every member of Grp prefers to conform to $Norm$ on the condition that almost everyone else conforms and
- Almost every member of Grp believes that almost every other member of Grp conforms to $Norm$

There is much research on the specification and implementation of social norms. Norms need to be declarative, operational or usable by computers. In [9], norms are defined in a normative language. In [8], is shown how abstract norms can be mapped onto operational implementation for e-institutions. The formal specification of norms is outside the scope of this paper. We hypothesize that social norms are expressed in deontic logic in terms of Obligations, Permissions, Prohibitions and Beliefs. As norms could involve expectations, it requires the description of sanctions and rewards.

We define a social group, abstractly, as a 5-tuple, expressing the 'ingredients' of a group:

$$< Norms, Roles, Sanc, Rewa, Ctx >$$

where $Norms$ is the set of social norms characterizing the Group (Grp), $Roles$ is the set of roles within the the Group, $Sanc$ and $Rewa$ are a set of rules which respectively express sanctions and rewards to be executed when $Roles$ undertake a given behaviour. $Norms, Roles, Sanc, Rewa$ are objects capturing behavioral expectations and has been mainly described with deontic logic in the literature. For simplicity

we hypothesize that these objects can be described in a labelled state transition system. Ctx is the context of the group interaction described as axioms (see previous section).

We have included Ctx as part of the social group definition because the formation of a group as described by social identity theory (SIT) is very contextual. Group norms, which are the central concept in a social group, are only applicable in a particular context. Therefore we argue that the existence of a social group is dependent on the context. For example, the case study described in I identifies the set of drivers slowing on the slow lane as a group of drivers adhering to the normative queuing behavior. Such a group doesn't exist or is not activated in another driving context.

C. Modeling Group Salience

When a social actor has individual interests in performing some actions in an uncertain situation it seeks for a relevant group norm. The salience of group norm, personal interests as well as other social contexts factors such as priming, immediacy, proximity, conspicuity and relevance will determine the choice of the norms to be internalized. Once the chosen norms are internalized, the behaviour of the social actor will conform to the norms.

The degree of awareness that a social actor has on a social group depends on (i) the salience of such a group among others and (ii) the fit between the group norm perception and interests. It can be expressed as a function:

$salience : (Groups \times\ Interests \times Contexts)$
$\rightarrow Degree$
where

$Groups = \{g_1, \ldots, g_n\}$ denotes a finite set of target social groups (see Section IV-B for definition of a social group).

$Interests = \{i_1, \ldots, i_k\}$ denotes a set of descriptions of the interests of an actor.

$Contexts = \{c_1, \ldots, c_l\}$ denotes a set of context descriptions (see IV-A for definition of context).

$Degree$ denote the degree (e.g. integer value) of salience assigned to a group by the social actor given the current interest and context.

Given a social actor with current interest i in the current context c, a group $g' \in Groups$ with the highest salience value, that is, where $salience(g', i, c) = max_{g \in Groups}(salience(g, i, c))$, denotes the social group with the strongest salience value.

An agent would typically join group g' since it has the highest salience.

Table V describes the algorithm that an agent could deploy to choose a group using the $salience$ function.

V. MODELING SOCIAL INTERACTIONS

A social actor will adopt social norm belonging to a category of group if

- the salience of such a group is high relative to other groups given a social context and
- the interest of the social group fit with the actor's perception of the salient group.

The norms associated with a group are internalized by the social actor once the most salient group is selected by a social actors. The new social group exerts a pressure which shapes the actor's individual behavior. Once in a group, individuals derive their identity or sense of self largely from the social group to which they belong, and this means that an individual/agent/actor might prefer group-acceptable actions (actions conforming to a group's norms) more than its own actions (without norms being considered). We can conceptualize the behaviour of agents or actors as a series of actions, transitioning from state to state, where the states refer to the internal state of the agents/actors, or more formally as a labelled state transition system, where the states are the internal states of agents/actors and the transitions are actions of agents/actors.

Let Beh_a and Beh_b denote behaviours expressed in a labelled state transition system $(S, \wedge, \rightarrow)$. Let $X = \{x_1, x_2..., x_n\}$ be a set of alternatives transitions (or actions agents could take), and, for every i and j , a_{ij} a positive number expressing how much the alternative x_i is preferred to the alternative x_j. $a_{ij} > 1$ means that x_i is strictly preferred to x_j; $a_{ij} < 1$ means the opposite and $a_{ij} = 1$ means indifference between x_i and x_j.

Let Beh denote an "or" composition of two behaviours $Beh = Beh_a + Beh_b$, that is, where there is state in both Beh_a and Beh_b, and each specifies a different possible transition, then the actual action is nondeterministically chosen (but possibly influenced by a preference relationship).

For *preferential union* composition $\uplus$, the order of operands denotes preference: $Beh_a \uplus Beh_b$ if and only if $\forall s_i \in Beh$ (s_i is a state) with any two pair of transitions (x_i, x_j) such that $x_i \in Beh_a$ and $x_j \in Beh_b$: $a_{ij} > 1$

Using the newly defined operator, let $Beh_{ind}(A)$ denote the individual behaviour of an actor A without any pre existing social norms. Let $Beh_{grp}(S)$ denote the behaviour attributed to the social norms of a salient social group S. $Beh_{ind(A)}, Beh_{grp}(S), Beh(A)$ are behavioural expressions expressed as labelled state transitions.

The resulting social behaviour of A in the presence of a social group is denoted by $Beh(A)$.

$$Beh(A) \approx Beh_{ind}(S) \uplus Beh_{grp}(A)$$

where $\uplus$ is a preferential union of the two behaviors and the rules (norm) from group S may override A's rules in the case of conflict. $\approx$ denotes the behavioral equivalence relation.

Compliance to group norms may be used tactically to forge new interpersonal connections or to protect, solidify, and strengthen existing social group [7]. The issue related to compliance of an individual to social norms depends on many factors. For example theory on emergent norm [29] says that a set of social actor put together as group with no history or pre-existing norms could develop new norms implicitly imposed by individuals with distinctive behaviours. The inaction of of rest of group acts as tacit confirmation of the norm and pressure against non conformity begins. It has been shown that if a social context exhibits uncertain rules and high degree

```
Agent(Id, goals)
   Interest = goals
   mybehaviour = Behav_ind(Id)

   repeat
       % agent represents environment in an object env
       env = scan(environment)

       % identify all social groups/norms in the current context
       G = groups(env)

       % specify relevant context
       drv_ctx = "driving highway" & "a slow lane"
                & "uncertain situation"

       % Axiomatization of the driving context in drv_ctx
       if(ctx = ist(env, drv_ctx, ))

           % identify the most salient group
           group = g' where  salience(g', Interest, ctx)
                  = max_{g∈G}(salience(g, Interest, ctx))

           % agent adopts group behaviour
           mybehaviour = Beh_ind(group) ⊎ Beh_grp(Id)
   end repeat
end
```

of group salience then individual compliance to the group is high.

As discussed earlier in Section III, the behaviour of a social group Gr noted $Beh(Gr)$ could not be assimilated as an aggregation of individual behavior

$$\forall r_i \in Gr; Beh(Gr) \not\approx \sum_{i=1}^{n} Beh_{ind}(r_i)$$

where $Beh_{ind}(r_i)$ denotes the individual behaviour of each role in the group Gr.

However, in a situation where there is a high norm compliance within a group Gr, the following equation holds

$$\forall r_i \in Gr; Beh(Gr) \approx \sum_{i=0}^{n} Beh(r_i)$$

This is due to the fact that a high individual compliance for a role r to the group's normative behaviour $Beh_{grp}(r)$. In this case there is no room for individual difference. The group's normative behavior suppresses any individual actions. This could be described as follows

$$Beh(r) \approx Beh_{grp}(r)$$

.

VI. MODELING THE CASE STUDY

This section shows how the model presented in previous sections could specify the case study described in Section I. The aim here is to show the applicability of the model in a concrete example.

The context from a driver viewpoint is that there is a group of drivers queuing on the slow lane and the situation is perceived as uncertain. This can be described by a context ctx where $ctx = ist(context\_of("driving highway", "a slow lane" \& "uncertain situation")$

The driver is interested is to keep driving and reach his destination: $Interest = "keep\ driving"$

When drivers are unsure on what decision to make, they are most likely to look to and accept the beliefs and behaviors of other drivers in the vicinity or the most salient group as valid indicators of what they themselves should believe or do. In the context ctx the most salient group is the queuing group on the slow lane due to different factors such as proximity and number of driver performing the same action. $queing\_group = salience(allgroup, Interests, ctx)$

The driver will adopt the normative behaviour of the $queing\_group$".

It should be noted that situational factors affect conformity to the informal norms of "queuing". Asch[2] has shown that participants adopts a group or normative position for two reasons: either because they think they are wrong or because it seems easier to go along with the group rather than disagree. The extend to which the situation is public could also affect conformity. Participants conform more in a public space such as public roads [7].

VII. CONCLUSION AND LIMITATIONS

Social interactions are complex. They are influenced by many factors and cannot expressed in one formulae. This preliminary work has attempted to identify the core concepts, borrowed from social psychology theory, required to model social awareness. We used group salience and social identity theory together with theory on axiomatization of context to model social awareness.

One similarity between the social awareness model presented here and Rodden's awareness model [26] is that our the notion of "social actor's interest" could be modeled as "focus". One could argue that a social group could have a "focus" as well. However the main contrast is that Rodden's notion of "nimbus" could not be mapped to our notion of group salience. In a sense, group salience conveys the idea of difference between group category in a given context which cannot be expressed as a nimbus. It should also be mentioned that our notion of salience is highly contextual and required context to be considered as first class modeling concept as opposed to Rodden's .

Other situational factors such as individual characteristics, gender, personality traits can affect susceptibility to conformity pressures. Conformity to informal social norms is a universal phenomenon, but the level of conformities could varies by cultures.

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