Toward a Commonsense Theory of Microsociology: Interpersonal Relationships

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Abstract. We are developing an ontology of microsocial concepts for use in an instructional system for teaching cross-cultural communication. We report here on that part of the ontology relating to interpersonal relationships. We first explicate the key concepts of commitment, shared plans, and good will. Then in terms of these we present a formal account of simple exchanges, the host-guest relationship, and friendship.

Keywords. Commonsense reasoning; microsociology; cross-cultural communication; immersive training systems

Introduction

We have been developing a commonsense theory, or ontology, of microsociological concepts, to support an instructional system for teaching cross-cultural communication. By "ontology" we mean a logical theory of a coherent domain, that is, a set of predicates together with a set of axioms that constrain the possible interpretations of the predicates, where the predicates express types of entities, properties of and relations among entities, actions and events involving entities, and causal relations among these events.[2]

By microsociology we mean the sociology of small groups, prior to large-scale institutions, including those aspects of social life that we would have had in pre-modern times. This includes concepts relating to interpersonal relations; group structure and roles; the presentation of the social self; authority, compliance, and sanctions; and conflict, negotiation, and resolution. This is in contrast with macrosociology, which is concerned with large-scale institutions.

In our project we have focused on microsociology as the most likely locus for intercultural differences. There can be different beliefs in any domain. But in the physical domain, the world imposes tight constraints on what we can believe about it; all cultures have concepts of "up" and "down". The macrosocial domain is heavily influenced by global culture; all airports are alike. By contrast, the microsocial domain is less constrained by the real world because mutual beliefs and shared plans are constitutive of reality (cf. e.g., [1]), and it is heavily influenced by traditional, pre-global culture.

Our ontology provides a conceptual vocabulary for expressing rules of behavior for conversational agents in an instructional system. To insure adequate coverage, we employ a detailed data development process that begins with interviews, by a team of anthropologists, of native informants. Initially, we focused on native speakers of Dari who had lived in urban Afghanistan, because of the high volatility in the modern world of Western-Islamic cultural misunderstandings. Subsequently we have also focused on speakers of Colombian Spanish. The interview material we gather is annotated with ethnographic and sociolinguistic observations.

Based on these, example dialogs are composed representing the performance target at which the final system aims. The instructional system is intended to train users in cross-cultural communicative competency, using a task-based curriculum: learners engage in conversations that simulate the situations where they expect to use these skills (e.g. discussing humanitarian aid and reconstruction tasks, negotiating with local leaders, purchasing supplies). Thus, we have developed example dialogues with more successful and less successful outcomes. Excerpts from a more successful dialogue are as follows:

1	John:	Salaam Alikum, Aziz
2	Aziz:	Salaam Alikum, John
3	John:	⋯ And how are things with your family?
4	Aziz:	My family is in good health, thank you
5	John:	⋯ We have some forms we need to fill out
6	Aziz:	⋯ I promise you that I will have the forms for you on Thursday

Excerpts from a less successful dialogue are as follows:

1	John:	Listen, I need to talk to you about paperwork ⋯
2	Aziz:	Oh yes? What is it?
3	John:	I have some forms that you need fill out
4	Aziz:	⋯ It is no problem

The locally comprehensible politeness, the solidarity, and the sense of joint activity on display in the first example is absent from the second. In the first the task is presented as part of a shared plan and in the second it isn't. As a result, the expressed degree of commitment to the task is less in the second and the task is less likely to be done.

Ethnographic annotations on the dialogues are converted as faithfully as possible into expressions provided by the ontology. The microsocial ontology provides a formal way to specify the noted differences, and conversely, the dialogues provide a mechanism for evaluating the ontology—can the differences be expressed.

In this paper we focus on the ontology itself rather than the application, although we do address the latter briefly in Section 8. Specifically, we focus on one aspect of the microsocial domain—interpersonal relations. However, a number of background theories

are necessary in order to get this enterprise off the ground; we have developed these previously and described them in other publications. In Section 1, we briefly describe the essential features of the theories we are assuming for causality and cognition. In Sections 2 and 3 we present the key notions of commitment and shared plans. Section 4 gives the example of a simple exchange as a shared plan. In Section 5 we discuss the important issue of good will among agents. Then Section 6 and 7 explicate the host-guest relation and friendship in these terms. In Section 8 we briefly describe the role of the ontology in the instructional system.

The full theory of interpersonal relationships currently consists of 63 axioms, but due to space limitations we present the actual axioms sparingly. The axioms are all written in a variant of Common Logic.

1. Background Theories

In order to deal with a domain as complex as microsociology, one must build up a great deal of conceptual and notational infrastructure and make a large number of warranted but highly controversial decisions about representation. We have done that, and we cite the relevant papers below as appropriate. In this presentation of the necessary background, we do not present the arguments in favor of our decisions; the interested reader can consult the references. Citations of the appropriate literature in these areas occur there as well.

The concepts we introduce in the background theories are often not *defined*, but are rather *characterized*, by richly axiomatizing the concept and thereby constraining the possible interpretations of the corresponding predicate. For example, we do not attempt to define `cause`, but we do encode its defeasible transitivity and make it available for expressing causal knowledge in many specific domain theories.

The domain of discourse is the class of possible individual entities, states, and events. They may or may not exist in the real world, and if they do, it is one of their properties, expressed as (`Rexist x`). In a narrowly focused inquiry it is often most perspicuous to utilize specialized notations for the concepts under consideration. But our view is that in a broad-based effort like ours, this is not possible, and that it can be avoided by sufficient judicious use of reification.

The term "eventuality" is used for both states and events [3,2]. Eventualities like other individuals can be merely possible or can really exist in the real world. We can speak of the "arguments" of or participants in eventualities. The expression (`arg x e`) says that entity x is an "argument" or participant in the eventuality e. The expression (`arg* x e`) is the recursive version of this; it says that x is a direct argument of e or an `arg*` of an eventuality argument of e. Thus, Pat is an `arg*` of Chris's believing Jan said Kim saw Pat.

We have axiomatized a theory of time [5], and eventualities can have temporal properties. Thus, (`atTime e t`) says that e occurs at time t. Because we can express temporal properties in this way, we do not need temporal arguments in predications.

A notational convention we use is that whereas the expression (`p x`) says that predicate p is true of x, the expression (`p' e x`) says that e is the eventuality of p being true of x. The relation between the primed and unprimed predicates is given by the axiom schema, instantiated for every predicate constant p, where x stands for p's arguments.

```
(forall (x)
  (iff (p x)(exist (e)(and (p' e x)(Rexist e))))))        (1)
```

This notational convention allows us in our axioms to avoid the clutter of explicit eventualities except where the eventuality is the argument of some other predication.

We have developed a theory of causality [4] where the key distinction is between the monotonic notion of a "causal complex", which includes all the eventualities that need to happen or hold for the effect to occur, and the nonmonotonic or defeasible notion of "cause", which is the context-dependent eventuality which is viewed somehow as central in the causal complex. The principal properties of a causal complex are that if the whole complex really exists, then so does the effect, and that every eventuality in the causal complex is relevant to the effect in a sense that can be made precise. Elements of a causal complex other than the cause are said to "enable" the effect.

Agents have beliefs. We take the objects of belief to be eventualities. Because eventualities are very finely individuated, there is a straightforward translation between talking of belief in an eventuality and belief in a proposition. The expression `(believe a e)` can be read as saying that `a` believes the proposition that eventuality `e` really exists.

Mutual belief is central in microsociology. The chief inferences associated with mutual belief are that if a set `s` of agents mutually believes `e`, then they mutually believe they mutually believe it, and every member of `s` believes it. Mutual belief can never be derived from a finite number of individual belief statements. but the latter can successively approximate mutual belief in a sense that can be made precise

In our theory of goals and planning [6], the chief inference is that if an agent wants an effect and there is some causal complex that causes that effect, then the agent wants the elements of this causal complex. This generates hierarchical plans.

Any treatment of commonsense knowledge requires a mechanism for defeasibility. We are assuming in our work that a system using weighted abduction would be applied to the set of axioms. We indicate the defeasibility of a rule by including the conjunct `(etc)` in the antecedent of implications. It is really an abbreviation of a predication unique to that axiom of the form `(etc-i x y ...)`. It can be thought of as the negation of the abnormality predicates in circumscription [7]. It should be straightforward to translate these indications of defeasibility into the formalisms required by other adequate approaches to nonmonotonicity.

2. Commitment

Researchers have explicated notions of transmitting information between agents. [4,8] We can define an interaction in terms of that. But an interaction happens only once, and when it is over, it is over. It is not enough to build a society on. For that we need interpersonal relationships that extend across greater stretches of time. The simplest of these relationships is acquaintance. An agent is acquainted with another agent if there has been at least one interaction between them before, if the agents remember the interaction, and if they know some identity properties of each other, where an identity property is a property that allows one agent to identify another across time.

Being acquainted with one another is not a strong enough relationship to create a society from. For that we need commitment and shared plans.

Imagine a trapeze artist planning a maneuver. The plan consists of three steps: She swings out on her trapeze; she flies through the air; she is caught by her partner. How

does she know this plan will work? She knows the first step will succeed because this is an action she is capable of executing. She knows the second will succeed, because physics will take care of that. But how does she know the third step will succeed? That's the role of commitment.

The expression (`committed a e`) says that agent `a` is committed to bringing about the actual occurrence of event `e`. The principal implication one can draw from a commitment is that, defeasibly at least, if `a` is committed to `e` happening at time `t`, where `a` can cause `e` to happen, then `e` will happen at time `t`.

```
(forall (a e e1)
  (if (and (committed a e1)(atTime' e1 e t)(agentOf a e)(etc))
     (atTime e t)))                                                    (2)
```

This rule enables us to incorporate the actions of others in our own plans, because it gives us some assurance that the action will actually be performed.

There are many ways a commitment can be brought about. The most basic is by the speech act of promising, or asserting that one is committed to perform the action in question (cf. [9]). Weaker evidence than the utterance "I am committed to doing e" is the utterance "I will do e." This has the form of a prediction, but if I am able to perform the action, it is under my power to make my prediction come true. There are other less direct ways to acquire commitments, for example, by accepting a role in an organization.

Rule (2) has an inconvenient `etc` proposition in the antecedent. Sometimes the rule does not hold when we have been depending on the commitment being honored. A great deal of our social calculations involve attempts to reduce the defeasibility of this rule. Many of the personal attributes we assign to others, like "dependable" and "untrustworthy" are expansions of that `etc` proposition, in an effort to reduce the defeasibility. Because these kinds of calculations are such a huge part of our thinking, we can replace the `etc` proposition by a predicate on which we can hang a theory (cf. [10] for a formal theory of trust).

```
(forall (a e e1)
  (if (and (committed a e1)(atTime' e1 e t)(agentOf a e)
          (dependable a e1))
     (atTime e t)))                                                    (3)
```

The expression (`dependable a e1`) says that agent `a` can be depended upon to make `e1` happen if `a` has committed to it.

A commitment is honored by an agent if the agent was committed to it and it actually happened, and furthermore the commitment played a causal role in it happening.

If all of an agent's prior commitments have been honored, then we can conclude that he is dependable for honoring his future commitments. We could specialize this to specific classes of actions. For example, a man might always honor his commitments to show up when he said he would. Agents can also be depended on to do those things which are in their own interest. That is, if an agent has some action as a goal independently of the commitment, then the agent can be depended on to honor the commitment. It is often critical in intercultural interactions to establish one's dependability. Some observers have noted that in Afghanistan, Americans have developed a reputation for not honoring their commitments, and have urged that American personnel begin to build up a history of dependability early by promising simple things and delivering on them.

An offer is a statement from which it can be inferred that the offeror will be committed to doing what is offered, should the offer be accepted (cf. [12]). To accept an offer is to make a statement, after the offer is made, from which it can be inferred that one desires what is offered.

3. Shared Plans

In the strong AI perspective that treats people as planning mechanisms, when we do things, we are following an explicit or implicit plan. When we do things together, we are following a shared plan. Thus, shared plans are the basis of social life [11].

A group s of agents share a plan p just in case

- the group itself has the top-level goal.
- defeasibly the members mutually believe the subgoal structure of the plan.
- if a member of the group is involved in an action in the plan, then the member is committed to performing that action.

Thus, we can define a shared plan as follows:

```
(forall (p s g)
  (iff (sharedPlan p s g)
       (and (forall (a)(if (member a s)(agent a)))
            (goal g s)(plan p s g)
            (forall (a e g1 g2)
              (if (and (subgoal' e g1 g2 p)(etc))
                  (mb s e)))
            (forall (a e)
              (if (and (member a s)(goalIn e p)(arg* a e))
                      (committed a e)))))))                           (4)
```

The expression (sharedPlan p s g) says that p is a shared plan by a group s of agents to achieve goal g. Line 3 says that all members of s are agents. Line 4 says that the group has g as a goal and p is a plan for achieving the goal where s is viewed as the agent that has the goal. The latter establishes that the causal connections are believed to be adequate for achieving the goal. Lines 5-7 say that all the members of s believe in the structure of the plan and believe the rest of s believes in it too; this implication is only defeasible because each member of the group may not know the entire plan. Lines 8-10 say that the members of s are committed to performing their parts in the plan.

Joint action, or doing something together, is executing a shared plan.

We view people as planning agents continually going through the world developing, executing, monitoring the results of, and modifying plans to achieve the goal "To Thrive". For each member of a group s that has a shared plan, the shared plan is a subplan of their goal "To Thrive". The reasons someone might incorporate a shared plan into their own plan is that it promotes their own goals, or that it provides a resource for promoting their own future goals, which can be viewed as enabling conditions, and hence subgoals, of those future goals.

More precisely, suppose a group S has a plan P to achieve goal G. Suppose also that G causes or enables G1, which is a goal of agent A. That is, the situation can be characterized by the expressions

```
(sharedPlan P S G), (cause/enable G G1), (goal G1 A).                 (5)
```

Under these conditions, by the rules of goals and planning, the shared plan `P` might be incorporated as a subplan in `A`'s goal to achieve `G1`. The shared plan may or may not involve actions by the agent `A`.

Perhaps a more interesting case is where it is only a subgoal in the shared plan that has one of the agent's goals as a side-effect but that other parts of the plan involve actions by the agent, where the agent has nothing to gain from these actions except the completion of the shared plan. This situation is described by the expressions

```
(sharedPlan P S G), (subgoalIn G2 P), (cause G2 G1),
(goal G1 A), (agentOf A G3), (subgoalIn G3 P),
(not (causallyInvolved G3 G1)).                          (6)
```

That is, shared plan `P` has `G2` and `G3` as subgoals. `G2` leads to something `A` wants. `G3` doesn't. But `G3` involves some effort on `A`'s part. For example, a company that makes tobacco products hires me and pays me well (`G2`), thereby enabling many of my goals (`G1`), if I promote their products (`G3`), which I have no specific interest in. In these cases, it might seem that the agent would be better off forgetting about the shared plan `P` and just making sure its subgoal `G2` comes about. But often the execution of the shared plan is the best or only way to bring `G2` about, and if `G3` is not too costly for `A`, the trade-off may be worth it.

The incorporation of shared plans into personal plans has been presented here in a very rationalized manner, as though we came to the shared plans we participate in as fully free, independent thinking adults who judge alternatives and make sensible choices. But in fact we are born into society, and our beliefs about what is required to thrive are very much conditioned by the mutual beliefs and shared plans of that society. Like all children, an Afghan child is born into successive layers of group structure, for example, family, clan, tribe, and the world of Islam, each with its own set of mutual beliefs, interactional norms, and shared plans.

In the full theory we explicate fairness in shared plans in terms of proportionality of cost and value to the agents. When a shared plan is fair, its agents are more likely to carry out their parts of the plan, and thus are more reliably depended upon.

4. Exchanges

Perhaps the simplest kind of shared plan is an economic exchange. Each party has something the other wants. They each adopt a shared plan to exchange the desired entities in order to achieve their goals. An exchange can be defined as the conjunction of two giving events. Giving causes the recipient to have whatever was given. The most basic meaning of "have" is "to be in a special access relationship to", and it can be specialized to owning, knowing, experiencing, and a number of other relations. Thus we can exchange goods, information, or services. An exchange happens when two agents form a shared plan to exchange things for each other, where it is a goal of each agent to have the thing they will receive.

Where what is exchanged is a physical object, the givers no longer have the given. The agents have to assess the impact of not having it on their overall plans to thrive. Similarly, if what is given is a service requiring some effort, the agent has to decide whether what is gained is worth the effort. We can thus speak of the fairness of an exchange.

In the full theory we explicate favors and relationships of mutual dependence as something like exchanges.

5. Good Will

We would all like to live in a world where, whenever we needed help, there were people around us willing to give it, where everyone felt good will toward everyone else. The actual world is of course very far from this, but people have engaged in various efforts, for example, in the context of religions, to make it more like this. In this section, we first construct a rationalized account of why it would be in an agent's interest to behave in a way that exhibited such good will to others. Then we will discuss very briefly other factors that lead to this behavior.

There are various notions of the concept of "help". What does it mean for one agent A2 to help another agent A1? In the simplest sense, agent A1 has a goal E, and agent A2 does actions in a causal complex for E. In this sense, John McCain helped Barack Obama become president by choosing Sarah Palin as his running mate. In a stronger sense, agent A2 has the intention that his actions bring about the goal E. For example, I might take away your car keys so you can't drive home drunk from a party. In this way, I help you live and thrive, even though my actions are no part of a plan you have to live and thrive. The strongest sense of "help" is when agents A1 and A2 construct a shared plan in which A2 performs many of the actions required to bring about A1's goal E. The sense of "help" we use here is at least the second one, involving an intention to help but not necessarily a shared, agreed-upon plan.

A world filled with good will is characterized by the axiom

```
(forall (a1 a2 e e1 e2)
  (if (and (person a1)(person a2)(goal' e1 e a1)(believe' e2 a2 e1)(etc))
      (exist (e3) (and (help' e3 a2 a1 e)(cause e2 e3)))))        (7)
```

That is, if a person `a2` believes person `a1` has a goal `e`, then that will cause `a2` to help `a1` achieve `e`. Assuming agents like help in achieving goals, this is close to a statement of the Golden Rule: "Do unto others as you would have them do unto you."

This rule, however, is eminently defeasible, and the `etc` predication in the antecedent can be expanded in a myriad ways. People have developed a number of devices for reducing the defeasibility of this rule or tightening the rule to improve its reliability. Many types of interpersonal relationships can be viewed as having the effect of reducing the defeasibility of this rule.

We can first of all place conditions on the helping agent `a2`. One person will help another if it is in the person's self-interest. The purpose of an exchange is to make helpful actions be in the self-interest of both parties. A weaker condition on agent `a2` is that `a2` has no conflicting goals. That is, agent `a1`'s achievement of goal `e` does not undercut `a2`'s achievement of `a2`'s goals.

Members of the groups engage in actions which contribute to the group goal but not directly to the individual agent's goals. Among the rules that members are supposed to follow is often the injunction to help other group members. In the above axiom the `etc` predication would be replaced in part by the condition that `a1` and `a2` are both in a group with that principle.

The larger the group that rule operates in, the closer we are to a world characterized by good will. World religions promote the extension of the group to at least those who share the religion, and often its extension to the entire population. They do this, for example, by promoting the Golden Rule or an ethic of hospitality and charity (although there

is a question about the extent to which these precepts carry over to daily life, cf. [13]). It is true that this is sometimes crudely framed as a simple exchange – good behavior for avoidance of eternal punishment – but this is rarely the sole motivation.

There are at least two things an individual can do to promote good will. The first is to persuade others to accept the rule, whether as part of a larger system of beliefs or not. The second is to act in accordance with it. The latter is not exactly an exchange event. The person I help may never be in a position to help me. But I am performing exactly the part in the creation of a general good will that I have direct control over. When I act in accordance with the rule, we are one person closer to the rule being true in general.

This is a rational reconstruction of why one person would help another. It is a very weak kind of exchange. I help others in hopes that others one day will help me. But the reality is of course very much more complicated.

From the perspective of evolution, even though the rule provides no direct advantage to the individual helper, it provides a clear competitive advantage to groups in which it is operative. Evolution happens to groups, not to individuals. It would thus be unsurprising if it were part of the human hardware that we have a desire to help others. This does not invalidate the rule; it is still a high-level abstract characterization of one aspect of human behavior. We would still have to encode something like this in computational agents intended to simulate human actors.

Moreover, we are never simply placed into the world isolated from all ties to others and forced to decide what behaviors are in our own best interests. We are born into groups, and these groups are the primary source of our beliefs about what will cause us to thrive. An ethic of helping others is usually among those beliefs. Even if a desire to help others is not part of our native hardware, it comes very early in the software we are provided with (cf. [14]).

Finally, one of the most powerful ways we experience the desire to help others is as compassion. We identify more or less with other people, and we feel their desires and their potential disappointments as though they were our own, and we help them for that reason [15]. The `etc` predication in the above rule is expanded into a statement that agent a1 is similar to a2 and the situation that gives rise to a1's goal e is a situation a2 could very possibly find himself or herself in. We are very often charitable to those less fortunate than ourselves because of a feeling that "There but for the grace of God go I."

6. The Host-Guest Relationship

The host-guest relationship is important everywhere, but one region where it holds special significance is the Middle East. This means that Americans working in the Middle East need to be very aware of their obligations and privileges both as hosts and as guests.

The host-guest relationship rests on a distinction between "home" and "away". When people are at home, they are generally secure and more able to satisfy their various wants because of local knowledge and a social network of friends and family who can provide help. When people are away, they are much less secure, lacking local knowledge and the supporting social network. Goals are thus more difficult to achieve.

Of course "home" and "away" are extremely complex concepts. But a very crude and preliminary start in characterizing the concepts is to say that there is a set of the agent's goals that are easy to satisfy at home and difficult to satisfy away from home. Difficulty is defined in terms of obstacles that have to be overcome to achieve the desired

state. We use `home` and `away` as properties of agents that say something about the local environment they are in.

It is convenient to give a name to the set of goals that are easy to achieve at home and difficult away; we will call the set the `homeAdvantage`.

```
(forall (s a)
  (iff (homeAdvantage s a)
       (and (set s)(not (null s))
            (forall (e)
              (iff (member e s)
                   (and (goal e a)
                        (if (home a)(easy e a))
                        (if (away a)(difficult e a)))))))))       (8)
```

The concepts of "home" and "away" are very much wrapped up in location. A home is usually thought of as a place. But its significance here is rather in the resources it affords the agent for achieving goals.

The host in a host-guest relationship is at home; the guest is away from home. The host undertakes, or commits, to provide the guest with all, or at least some, of the advantages he or she would enjoy at home.

```
(forall (a1 a2)
  (if (host a1 a2)
      (and (home a1)(away a2)
           (exist (s)
             (and (homeAdvantage s a2)
                  (forall (e)
                    (if (and (member e s)(etc))
                        (exist (e1)
                          (and (committed a1 e1)
                               (help' e1 a1 a2 e)))))))))))       (9)
```

The expression `(host a1 a2)` says that `a1` hosts `a2`. The axiom says that if `a1` hosts `a2` then `a1` is at home, `a2` is away, and defeasibly `a1` is committed to helping `a2` achieve those goals that are normally part of `a2`'s "home advantage".

The advantage of being a guest is getting the help of others. It is more problematic why someone would voluntarily agree to be a host. There is no necessary direct benefit to the host. But most people in their lives will be away from home, with all the attendant disadvantages and insecurities of that situation, and they will want the help of others. They are better off in a world in which good will spreads at least to the host-guest relationship. The host stands to gain from a universal ethic of hospitality, and one way to promote its universality is to act in accordance with it. Or putting it negatively, violating the ethic is a sure way of making it nonuniversal. The above axiom is the Golden Rule applied to the host-guest relationship. If you are a host, you should do unto the guest as you would have the guest do unto you.

The building up of good will in one's community through such actions as being a host can be thought of as a kind of exchange where the reciprocal act in the exchange has not yet happened and we do not yet know what it will be, or in some cases, who it will be with.

The host is obligated to help the guest with at least some of the guest's "home advantage" goals. Exactly which ones depend very much on the particular culture. Also culture-dependent are the conflicting goals of the host that relieve the obligation. The

role of guest also carries obligations to minimize the difficulty to the host caused by the visit. These obligations are also very culture-dependent. To accept too little help is to insult the host's ethic of hospitality; to accept too much is to cause the host hardship.

An offer is a statement that one will be committed to what is offered if the offer is accepted. An invitation is a kind of offer in which what is offered is a host-guest relationship. The so-called hospitality industry – hotels, restaurants, and so forth – offers the advantages of home as their part of a direct exchange.

7. Friendship

Friendship is another interpersonal relationship that is culturally laden and a frequent source of cross-cultural misunderstanding. Some of the principal properties of friendship are that we know a lot about our friends, that we are consequently able to talk about more private matters, that we frequently meet with our friends, that we help them out, and that associating with them makes us happy. We give a preliminary axiomatization of each of these properties. They are general enough that it is possible to specialize them in a variety of culturally dependent ways.

The expression (`friend p1 p2`) says that person p1 is a friend of person p2. This relation is generally but not always symmetric. Friends are acquaintances. Consequently, people know identity properties of their friends. More generally, there is a set of properties of each other that friends know.

```
(forall (p1 p2)
  (if (friend p1 p2)
      (exist (s) (forall (e)
                  (if (member e s)(and (arg* p2 e)(know p1 e)))))))         (10)
```

In this axiom, s is a set of eventualities e in which p2 is somehow involved (`arg*`) and p1 knows e to be the case. Of course, characterizing what this set is likely to contain for different cultures is a very complex issue.

Most of the properties we know about our friends we know because they told us. Telling causes knowing. There are some things we are more likely to tell our friends than we are other people. Rather than attempt to define the private-public distinction, we will here just say that there is a set of things we will tell our friends but will not tell others. (In fact, this is probably one of the chief inferences we would want to use to distinguish public from private.)

```
(forall (p1 p2)
  (if (and (person p1)(person p2))
      (exist (s) (forall (e)
                  (if (member e s)
                      (and (believe p1 e)
                           (if (friend p1 p2)(tell p1 p2 e))
                           (if (not (friend p1 p2))
                               (not (tell p1 p2 e)))))))))         (11)
```

Here s is the set of eventualities or propositions that person p1 believes that he will tell person p2 if they are friends and will not tell p2 if they are not friends.

We frequently meet with those we consider friends. Just how frequently is culture-dependent. In the Middle East, one is expected to meet with one's friends more frequently

than is expected in America. Here again we will only write a very general axiom that says that for every pair of friends there is an associated set of interactions. Tighter characterization of that set, e.g., in terms of frequency, is part of what needs to be encoded for each culture.

```
(forall (p1 p2)
  (if (friend p1 p2)
      (exist (s) (forall (e) (if (member e s)(interaction' e p1 p2)))))) 	(12)
```

Already we have sketched out enough properties of friendship to identify a very common misunderstanding between Americans and people from the Middle East. Americans are much more open about what they will say to someone they've recently met, but they have much lower expectations about how often they should see their friends. Thus someone from the Middle East may assume a greater level of friendship from initial conversations and then be surprised or even offended when that is not followed up by frequent visits.

Next comes the key value of friendship: they help each other out.

```
(forall (p1 p2 e)
  (if (and (friend p1 p2)(goal' e1 e p2)(believe p1 e1)(etc))
      (exist (e2) (and (help' e2 p1 p2 e)(cause e1 e2))))) 	(13)
```

This is the Golden Rule for friends: "Do unto your friends as you would have them do unto you."

Again the defeasibility of this rule is very problematic and culture-dependent. In some cultures, a person is expected to help a friend cheat on a test; you help out your friends in a time of trouble, and a test is a time of trouble. In other cultures, one would be very reluctant to impose on a friend like that.

It is sometimes convenient in reasoning about interpersonal relations to decompose this property of friendship. We help our friends because we want them to achieve their goals and we do things to achieve what we want. The second half of this is just the property that agents develop and execute plans to achieve their goals. The first half deserves to be stated explicitly.

```
(forall (p1 p2 e)
  (if (and (friend p1 p2)(goal' e1 e p2)(believe p1 e1)(etc))
      (exist (e2) (and (goal' e2 e p1)(cause e1 e2))))) 	(14)
```

That is, if a person p1 believes a friend p2 has goal e, then defeasibly this will cause p1 to have e as a goal too. For example, if we are friends and you want to find a good job, then defeasibly I want you to find a good job too.

Finally, friendships connect with our emotional life. Being with friends makes us happy. (The beginning of a formalization of emotions is presented in [16])

```
(forall (p1 p2 e1)
  (if (and (friend p1 p2)(interaction' e1 p1 p2)(etc))
      (exist (e2)(and (happy' e2 p1)(cause e1 e2))))) 	(15)
```

This rule is defeasible because sometimes friends fight or bore each other. We can derive that the interaction normally also causes p2 to be happy because the predicates friend and interaction are both defeasibly symmetric.

Friendship is a scalar notion. Someone can be a good friend, a better friend than someone else, and one's best friend. The scale of friendship of course cannot be defined precisely. But it is influenced by all of the properties of friendship we have axiomatized. The better friends you are with someone, generally the more you know about each other, and the more likely you are to discuss private matters. Good friends are friends that you try to meet with more frequently, and making no efforts to meet is a strong indication of a weaker friendship. The better friends you are the more likely you are to help each other out. And finally, your best friends are the ones seeing whom make you the happiest.

Politeness is a complex concept, but one aspect is that it is a benign pretense of friendship. By acting as if someone is a friend, some of the benefits of friendship may accrue. This idea is developed in the full version of our theory.

8. Ontology in the Instructional System

The microsocial ontology is being used in a project that extends the state of the art for training cross-cultural competency, or the knowledge, skills, and attitudes required to communicate in a foreign environment [17]. These include linguistic and cultural elements. The training system is being adapted from existing software that allows trainees to engage in real-time dialogue with conversational agents in an immersive 3-D environment. These agents recognize and respond to speech, gesture, and other actions taken by a human user of the system. As a result, users are provided with an opportunity to acquire declarative knowledge like vocabulary and to practice procedural skills in real time.

The microsocial ontology is applied in a conversational agent architecture, that employs a variant of the SAIBA framework [18], which separates intent planning (what to communicate) from production of believable behavior (how to express it). A player engages the agent by speaking into a headset microphone. An automatic speech recognition module produces a string representation. This is interpreted into a logical representation based on the ontology, and ultimately it is associated with a Communicative Act, along the lines of [19]

Heuristic rules are applied to formulate a response, also expressed in terms of the ontology. Currently, this output Act is passed to a module that generates behavior by selecting an appropriate pre-recorded sentence or non-verbal action, rendered by animations. In the future we expect to make response generation more flexible by using natural language generation techniques.

In addition to providing a vocabulary for Act-Response rules, the microsocial ontology creates the possibility of applying reasoning to assist in the generation of an output act. Because the ontology has been cross-validated with ethnographic data as described in Section 1, we have confidence that the result will be a believable model of behavior for conversational agents.

9. Future Directions

We are currently working on extending the commonsense theory of microsociology to cover several other sets of key concepts:

- Group structure as reflected in the group's defining shared plan, and the roles of members in that plan.

- The presentation of the social self, or the set of beliefs about an agent that the agent wants others to believe and acts in a way to make them believe.
- Authority within groups and the scope of authority.
- Conflict, negotiation, and compromise.

In addition, we are working on making the natural language processing of the instructional system more sophisticated, so that deeper reasoning will be possible and unanticipated utterances can be handled more appropriately than they are now.

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