

# On Personal and Role Mental Attitudes: A Preliminary Dependence-Based Analysis

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**Abstract.** In this paper, we present some preliminary results concerning the extension of dependence theory [2] and social reasoning [9] to cope with the notion of *organizational roles*. In order to accomplish this task, we first present a rather informal definition of organization and roles, showing how this additional dimension can be represented within a 3-layered architecture of mental states. We then restrict our analysis to the domain level, by extending our original notions of unilateral and bilateral dependence, as well as that of goal situation, to show that just by representing explicitly the input source of some mental attitudes one can easily explain some interesting social phenomena, like agents' adequacy to roles and vice-versa. For methodological reasons, we divide this analysis along two main axes, i.e., the inter-agent and the intra-agent dimensions.

## 1 Organizations, Roles and Autonomy

The task of proposing a complete, formal and rather universal representation of *organizations* and their associated roles is a very difficult one. Indeed, several different dimensions are used by researchers in social sciences [3, 5], distributed AI and multi-agent systems [4, 7], and distributed computing [1, 6] to characterize what an organization is and what its main components are. In a certain sense, quite all of these proposed descriptions comprise both a *factual* and a *procedural* dimension.

By factual we mean a mere observable behavior, despite its internal functioning: an organization has its high level goals, its observable inputs and outputs.

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On the other hand, the procedural dimension has more to do with how this behavior is obtained: division of labor into roles, establishment of authority and communication links between roles etc.

We do not intend in this paper to propose an alternative formal definition for either of these dimensions. Rather than that, we intend to propose a rather *informal* description for what an organization means for us, sufficient enough to enable us to depict further some interesting phenomena associated with it.

In order to do so, let us consider Wooldrige's and Jennings model of cooperative problem solving [11]. This rather generic theoretical model expresses the main phases involved in a multi- agent approach for problem solving. According to this model, a cooperative problem solving is composed by four different phases: *(i)* recognition of a cooperation potential; *(ii)* coalition formation; *(iii)* plan formation; *(iv)* coalition action.

The first phase is carried on when an autonomous agent infers that he cannot achieve a goal alone (complementarity-based interaction, like in [2, 9]) or when he prefers to cooperate with the others (utility-based interaction, like in [8]). The next step is to propose to one or more possible partners a coalition to achieve the goal. If these partners accept to take part into the coalition, then a phase of plan negotiation starts. Finally, the coalition partners may start to act, which may lead to a successful goal accomplishment.

In this work, we consider an organization as being intuitively the *result* of the 3 first phases mentioned above. In the case of pre-established organizations, these phases are carried on off-line, i.e., agents just engage them, not being responsible for their definition. On the other hand, this is not the case of dynamical organizations (like the so-called communities of practice [5]). Anyway, regarding our problem, the fact of being the organizations either dynamically or statically defined does not have any major influence.

Like stated above, we consider an organization as an entity with both a factual and a procedural dimension. The factual dimension can be represented by a set of goals to be fulfilled. The procedural dimension can be captured by a set of plans to achieve these goals, a set of actions that should be performed in order to carry on the plans, and a set of resources which are used when these plans are carried on.

For performance reasons, certainly due to Simon's principle of bounded rationality [10], these goals, plans, actions and resources are splitted into several *roles*. The notion of role, therefore, comprises several notions like cooperation (roles cooperate with one another in order to achieve organizational goals) and coordination (there is pre-established control and communication flow between the roles).

In practice, however, roles are played by autonomous agents. Interestingly, we have proposed in our social reasoning model [9] a similar description of autonomous agents, where they have a subjective representation of each other's goals, plans, actions and resources. A question then arises: using this description framework, how can we merge the notion of organizational role with the model of an *autonomous* agent?

## 2 Personal and Role Mental Attitudes

We propose to merge these notions by representing explicitly the *input source* of these attitudes. In order to do so, let us first consider the following three-layered architecture, represented in Fig. 1.

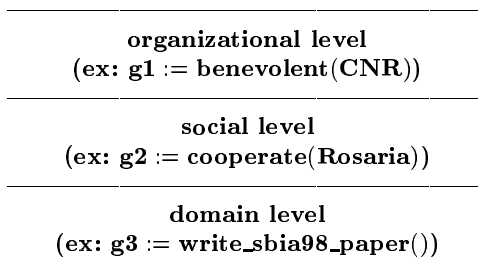


Fig. 1. Architecture layers.

In our previous work [2, 9], autonomous agents decided to cooperate with one another based on their complementarity, i.e., their dependence and power relations. Regarding their mental attitudes, we could consider that a goal to cooperate would be generated at a social level, and this upper level goal would drive the agents to effectively cooperate at a domain level, for instance by performing needed actions or by releasing needed resources. We could then consider that a *personal* domain level goal is a goal whose origin is related to a social level goal derived by the agents' own internal mechanisms, like social reasoning [9], or BDI architectures [7].

By considering the organizational dimension, we can simply add another upper layer, where there is a pre-established goal, i.e., the one of being benevolent within the organization. It must be stated that in this work, we do not analyze the problem of engaging in/trying to modify the organizational structure, i.e., their roles and plans. We just consider that this choice has already been made, and cannot be changed. In fact, we could also propose a dependence based explanation for this process, i.e., a kind of reciprocal dependence between the player of the role (who could offer his *savoir-faire* to the organization) and the organization itself, considered as a single agent (who could offer to the player something in exchange, like prestige or money).

So, we propose to use the same mental attitudes (goals, plans, actions and resources) to characterize the agent endogenous mental attitudes (which we call personal mental attitudes) and the ones which he is endowed with by playing the role (which we call role mental attitudes).

A fundamental difference is expressed by a *long-term, non revisable* commitment to the role mental attitudes. Obviously, an agent may decide to stop to play the role or even to quit the organization, but these situations are not treated here. This long term commitment in a certain sense *reduces* the agent's auton-

omy: he must play the role assigned to him in the organization. Interestingly, this reduction of autonomy is the result of the agent's deliberation, although at a higher level: it is a result of his decision to take part into the organization.

In practice, considering the domain level, this reduction of autonomy means that:

1. Whenever another agent proposes a cooperation or exchange regarding a role goal, the agent who receives this proposal *will always accept to participate*. In other words, the problem of reciprocation regarding reciprocal dependence [9] disappears. This is represented by the benevolence assumption in the upper level of Fig. 1;
2. Whenever there is a role plan to achieve a goal, it *must be used*. It is not a question of the agent's option anymore, even if he may have an alternative better plan in his personal repertoire. When there is no role plan, the agent who plays the role may use whatever plan he likes. This latter difference was already noticed and represented in an alternative way by Yu's model of hard of soft dependence within a context of business process re-engineering [12].

Regarding actions and resources, there is an interesting phenomena: by using some intrinsic resources, the *semantic meaning* of an action may change. Basically, role resources may be differentiated in 2 levels: *extendible* and *intrinsic* ones. Extendible resources may be used by an agent when trying to achieve personal or role goals. For instance, it may be the case that for the role of a secretary, an organization may supply her with a computer, that can be used to type either a letter to his boss or a new recipe of Italian food for her husband. Intrinsic resources, however, are used only to change the semantic meaning of an action which belongs to the agent who plays the role. As an example, we can consider what we call the *Achtung Problem*: when uttered by a policeman, this phrase means something different than when said by anyone else. Moreover, the meaning of the utterance also changes whether the policeman is playing his role (policeman) in the organization (society) or not (for instance, when dressed in civilian).

These latter phenomena are very interesting per se and merit a more detailed analysis, which we do not intend to do in this work. What we want to show is that the very fact of just adding two modalities,  $P$  and  $R$ , denoting respectively personal and role mental attitudes, allows us to explain several interesting phenomena, both in an inter-agent and intra-agent context, as described next.

### 3 The Inter-Agent Dimension

In this section, we try to explain some phenomena related to the fact that the dependence and power relations between agents may have different input sources for their goals, namely personal and role inputted ones.

Let us remind the core notions of dependence theory [2] and social reasoning [9]. Supposing that  $i$ ,  $j$  and  $k$  are variables that denote agents and  $g$  and  $g'$  are variables that denote goals, we have defined the following three basic dependence relations:

- *Bilateral relations*: when two agents depend on one another to accomplish their goals. This case can be splitted in two-sub-cases:
  - $MD(i, j, g, k)$ : agents  $i$  and  $j$  have a *mutual dependence* if they are dependent on one another for the same goal  $g$ ;
  - $RD(i, j, g, g', k)$ : agents  $i$  and  $j$  have a *reciprocal dependence* if they are dependent on one another for different goals  $g$  and  $g'$ ;
- *Unilateral relations*: when one agents depends on another but the converse situation is not true:
  - $UD(i, j, g)$ : agent  $i$  depends on agent  $j$  for his goal  $g$ , but the latter does not depend on him for any of his goals.

In the case of bilateral relations, the letter  $k$  designates the agent  $k$  whose plans are used in order to infer the dependence relations. Even if an agent is always supposed to use his own plans<sup>1</sup> when reasoning about the others, we have shown in [9] that in some cases, specifically those involving bilateral relations, it may be interesting for an agent to use his beliefs about his possible partners' plans in order to evaluate if these latter are also aware of the dependence relations<sup>2</sup>. Regarding this work, this subtlety is not important, and therefore in the rest of the paper we will use a shorter notation, i.e.,  $MD(i, j, g)$  and  $RD(i, j, g, g')$ .

In the next subsections, we will analyze how these relations can be extended by adding the input source to the agents' mental attitudes. In a first attempt, we will limit ourselves to analyze the agents' goals, except in the case of unilateral relations, as shown just below. In order to do this, we introduce the predicates  $P-is_g(i, g)$  and  $R-is_g(i, g)$  to denote that agent  $i$  has the goal  $g$  whose input source is respectively personal and role. However, for the unilateral dependence analysis, we will use also the predicates  $P-is_a(i, a)$  and  $R-is_a(i, a)$  to denote actions whose input source is respectively personal and role.

### 3.1 Mutual Dependence

Considering that a mutual dependence requires a common goal, if we have two different input sources for our agents' common goal, at least three different situations may arise:

$$NEG\_COOP(i, j, g) \equiv MD(i, j, g) \wedge P-is_g(i, g) \wedge P-is_g(j, g) \quad (1)$$

$$ASS\_COOP(i, j, g) \equiv MD(i, j, g) \wedge P-is_g(i, g) \wedge R-is_g(j, g) \quad (2)$$

$$ORC\_COOP(i, j, g) \equiv MD(i, j, g) \wedge R-is_g(i, g) \wedge R-is_g(j, g) \quad (3)$$

**Negotiated cooperation** (1) corresponds to the situation analyzed in [2, 9], i.e., two autonomous agents decide to cooperate because they are interdependent. However, this decision is inferred by the agents themselves, being a result of a deliberative procedure. Some negotiation about the common plan to be used (phase *iii* presented in section 1) may arise, but at the end the agents are effectively going to cooperate.

<sup>1</sup> This means that if the reasoning agent is  $i$ ,  $k$  is instantiated to  $i$ .

<sup>2</sup> In this case, if the reasoning agent is  $i$  who depends on  $j$ ,  $k$  is instantiated both to  $i$  and  $j$ .

**Assisted cooperation** (2) is quite an interesting situation, as it reflects a special kind of assisted relation. As the input source of agent's  $j$  goal  $g$  is role, he does not deliberate about the cooperation. Agent  $i$  may take advantage from  $j$ 's role. Consider for example, the *mother/teacher relationship*, where the former finds in the teacher a sort of accomplice with regard to her child.

**Orchestrated cooperation** (3) is similar to negotiated cooperation (1), but there is no real deliberative procedure of the agents. The cooperation is *pre-established*, in the moment of the design of the roles and common plans in the organization. Regarding the common plan to be used, there is no negotiation, as it is usually predefined too. A nice example of this situation is the *doctor/nurse relationship*.

### 3.2 Reciprocal Dependence

As in the previous case, considering our two different input sources, we may have also at least three different situations:

$$NEG\_EXCH(i, j, g, g') \equiv RD(i, j, g, g') \wedge P-is_g(i, g) \wedge P-is_g(j, g') \quad (4)$$

$$PRO\_EXCH(i, j, g, g') \equiv RD(i, j, g, g') \wedge P-is_g(i, g) \wedge R-is_g(j, g') \quad (5)$$

$$ORC\_EXCH(i, j, g, g') \equiv RD(i, j, g, g') \wedge R-is_g(i, g) \wedge R-is_g(j, g') \quad (6)$$

**Negotiated exchange** (4) corresponds to the situation analyzed in [2, 9], i.e., two autonomous agents decide to do a social exchange because they are interdependent for their different goals  $g$  and  $g'$ . This social goal is autonomously generated. Like the mutual dependence case (1), some negotiation about the common plans to be used (one for each goal) may arise. Moreover, the problem of reciprocation is taken into account: the agents must try to ensure that after doing their part of the deal, the other agent will do his part.

**Protected exchange** (5) is similar to assisted cooperation (2). As agent  $j$  has  $g'$  as a goal whose input source was role, he just accepts the exchange with agent  $i$ . Regarding agent  $i$ , the problem of reciprocation does not arise. Interestingly, from the point of view of agent  $i$ , this situation is as good as a mutual dependence, because agent  $j$  is due by role reasons to effectively help him to achieve  $g$ . A good example of this case is the *policeman/collaborator relationship*, where the former helps the latter in order to obtain information relevant to capture other burglars, while the latter provides information in order to be released.

**Orchestrated exchange** (6) is similar to orchestrated cooperation (3). Here we have a pre-established social exchange, with no real deliberative procedure by the agents. Regarding the common plans to be used, there is no negotiation either, as they are usually predefined too. An important example of this case is the *incentive provision*, where one partner provides an external reinforcement for the other to perform a given activity.

### 3.3 Unilateral Dependence

Considering the case of unilateral dependence, we will take into account for our analysis both the goal the dependent agent needs to be accomplished and

the action that he wants the other agent to perform in order to achieve this goal. Therefore, once more we have two mental attitudes, each of them with two different input sources, which may lead to at least three different situations, described below.

$$END\_BENV(i, j, g) \equiv UD(i, j, g) \wedge P-is_g(i, g) \wedge P-is_a(j, a) \quad (7)$$

$$IMP\_BNVL(i, j, g) \equiv UD(i, j, g) \wedge P-is_g(i, g) \wedge R-is_a(j, a) \quad (8)$$

$$ORC\_BNVL(i, j, g) \equiv UD(i, j, g) \wedge R-is_g(i, g) \wedge R-is_a(j, a) \quad (9)$$

**Endogenous benevolence** (7) corresponds to the situation analyzed in [2, 9], i.e., an autonomous agent depends on the benevolence of the other to obtain what he needs to achieve his own goal. Benevolence can arise by several means, as stated in [9], for instance out of personal reasons (as a mother regarding her child) or for organizational reasons, as shown in (9) below.

**Exogenous or imposed benevolence** (8) is the case where, once more, as in (2) and (5), we have a kind of “master-slave” relation. As agent  $j$  has  $a$  as an action whose input source is role, he just accepts to perform it, in whatever plan, despite of the goal being achieved. Regarding agent  $i$ , here we have the most classical “master-slave” architecture, when the execution of a service is demanded without explaining reasons associated with it. As examples, we can cite the so well known *client-server architectures* in distributed systems, or the *defendant/defender* relationship from the natural domain of professionals. From the point of view of agent  $i$ , this situation is the best possible one: he does not need to offer anything in return and he is assured that agent  $j$  will reciprocate by role imposition.

**Orchestrated benevolence** (9) is similar to the previous cases of bilateral relations shown in (3) and (6), here we have a pre-established benevolence, with no real deliberative procedure by the agents. Agent  $j$  is simply *constrained to act*, because his role imposes him this situation. In a certain sense, this situation corresponds to the imposition of a certain internal structure (procedural dimension) of the organization. This situation can be illustrated by the typical *secretary/boss relationship*.

## 4 The Intra-Agent Dimension

In this section, we want to analyze some interesting phenomena regarding the *adequacy* of agents when playing some organizational roles. This analysis can now be carried on, since we are explicitly representing the input sources of the agents’ mental attitudes.

In order to that, let us remind the notion of *goal situation* [9], which relates an agent to a certain goal. Supposing that  $i$  denotes an agent and  $g$  a certain goal, four different goal situations may hold:

1.  $NG(i, g)$ : the agent  $i$  doesn’t have the goal  $g$ ;
2.  $NP(i, g)$ : the agent  $i$  has the goal  $g$  but has not any plan to achieve it;
3.  $AUT(i, g)$ : the agent  $i$  has the goal  $g$  and at least one autonomous plan which achieves this goal; an autonomous plan is a plan where an agent may perform all its needed actions;

4.  $DEP(i, g)$ : the agent  $i$  has the goal  $g$  and all plans he has to achieve this goal are dependent plans; a dependent plan is a plan where an agent needs the help of the others to perform at least one of its actions.

This goal situation is represented subjectively within the agents' minds, and helps them to deliberate whether they should propose or accept to take part in coalitions, as shown in [9]. Let us now consider which interesting phenomena can be described just by adding to this notion our two modalities,  $P$  and  $R$ . Some very interesting situations regarding the adequacy of agents to roles may be described, which we have initially grouped into six different cases, as described next.

$$ROLE\_ADPT(i, g) \equiv P-NG(i, g) \wedge (R-NP(i, g) \vee R-AUT(i, g) \vee R-DEP(i, g)) \quad (10)$$

$$PERS\_ADPT(i, g) \equiv R-NG(i, g) \wedge (P-NP(i, g) \vee P-AUT(i, g) \vee P-DEP(i, g)) \quad (11)$$

$$ROLE\_ENRC(i, g) \equiv R-NP(i, g) \wedge (P-AUT(i, g) \vee P-DEP(i, g)) \quad (12)$$

$$PERS\_ENRC(i, g) \equiv P-NP(i, g) \wedge (R-AUT(i, g) \vee R-DEP(i, g)) \quad (13)$$

$$INCR\_POWR(i, g) \equiv R-AUT(i, g) \wedge P-DEP(i, g) \quad (14)$$

$$DIMN\_POWR(i, g) \equiv P-AUT(i, g) \wedge R-DEP(i, g) \quad (15)$$

**Role goal adoption** (10) corresponds to the case where an agent adopts a new goal by role playing, as this goal was not previously a personal one. This situation is quite common when considering the domain level, shown in Fig. 1. In fact, the pre-established cooperation is represented in the two upper levels of this figure, as explained earlier. Nevertheless, one situation is worth meaning, i.e., the one when *negative* goals, whose input source is role, are considered. In such a scenario, the fact of playing the role *restricts* the possible goals an agent is supposed to have. A classical example is what we call the *Priest Dilemma*: a priest can not have the goal of marrying a woman he is in love with. Stated differently, while marrying may be a personal goal, not marrying is a goal imposed by his role. Interestingly, it is exactly this situation which lead to eventual conflicts which can not be solved unless the agent decides not to play the role anymore, or even eventually to leave the organization<sup>3</sup>.

In **personal goal adoption** (11), the agent has personal goals that are not supposed to be achieved by his role. Once again, this situation is also quite common when considering the domain level. However, *negative* personal goals may also be in conflict with the role the agent is supposed to play. One example could be that of the *Pacifist Dilemma*: a pacifist who refuses, for conscientious objection, to work in a research project financed by the Army. Indeed, it is quite unreasonable to think that a situation where all agents' role goals could also be personal goals and vice versa could occur. This optimal case, both from an organizational and personal point of view, would mean a perfect adequacy between the agent who effectively plays the role and the motivational requirements that the organization expects from the role player.

<sup>3</sup> We do not consider in this work, as stated before, the problem of trying to modify the organizational structure.

**Role enrichment by personal plans** (12) arises when a role goal does not prescribe any plan, and the agent who is playing the role has a plan, either autonomous or dependent, in order to achieve this goal. This situation corresponds to a good adequacy, from the organizational viewpoint, of the role player: he is someone who can effectively decide what to do in the absence of predefined plans. The organization therefore profits from the fact that the role player has alternative ways to fulfill his goals. This situation illustrates exactly what some expressions, like the following job announcement, mean: “Candidates who are interested, motivated and *able to solve problems with their own initiative* will be preferred”.

**Personal enrichment by role playing** (13) is dual to the previous case. It arises when a role goal prescribes a plan to achieve a goal, and the agent who is playing the role had not any previous idea of how this goal could be fulfilled. This situation corresponds to the *Apprentice Advantage*: an agent profits from playing a role to learn how to achieve a certain goal, and this plan may be used in the future even in a scenario of non-role playing. Now it is the agent who profits from the fact of playing a role within the organization.

In **increasing power by role playing** (14), the role prescribes to an agent an autonomous plan, whereas this latter only has dependent plans to achieve the goal. This situation may be viewed as a special case of the previous one (13), where the *quality* of a possible plan to achieve the goal is enhanced. This statement means that we are assuming that autonomous plans are always better than dependent ones, due to coordination and communication overhead costs [9].

In **diminishing power by role playing** (15), the organization limits the role player, in the sense that there is a predefined *orchestrated* cooperation, whereas the agent could possibly achieve the goal by himself. In a certain sense, the agent is sub-utilized when playing the role. We can call this the *Team Paradox*. On the other hand, a more strategic view of the whole organization may explain why not to let a certain important goal in the hands of a sole agent. For instance, an organization may wish not to be vulnerable to a possible decision of the agent of leaving the organization.

## 5 Conclusions

In this paper, we have presented some preliminary results concerning the extension of dependence theory [2] and social reasoning [9] to cope with the notion of *organizational roles*. We have extended our original notions of unilateral and bilateral dependence, as well as that of goal situation, with two modalities, *P* and *R*, to denote respectively personal and role mental attitudes. We have analyzed some phenomena in both inter-agent and intra-agent dimensions.

In a certain sense, we believe that the role playing dimension *quite extinguishes* the autonomy of the agents. However, this autonomy is played earlier, in the moment when an agent has chosen whether it was interesting or not to join an organization or to play certain roles within an organization he was already engaged to. As a consequence of this fact, the fundamental differences between

mutual, reciprocal and unilateral dependences, as discussed in [2, 9] *lose* their importance: agents simply cooperate, exchange or perform actions (UD case) because they are supposed to do so by role imposition.

Finally, we can consider that the differences between bilateral and unilateral relations, when expressed in a scenario of a role input source, can consist of a first step towards an idea of *role structure*. For instance, the case of mutual dependence could be desirable for the same/similar hierarchical role degrees (for instance, two researchers in a research laboratory) while a unilateral dependence could be used to express a “master-slave” scenario (for instance, one researcher and one photocopist).

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