Introducing the concept of otherness (alterity) in multi-agent systems cooperation modelling

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**Introduction**

Multi-agents systems (m.a.s) as systems made up of entities in interaction, are not only relevant tools for the modeling and the simulation of social mechanisms (dynamics of populations, evolution of the cultures, group formation, etc.) but also for solving problems for which a cooperative approach is needed because there is no satisfying centralized algorithm (approach). In addition, it is well known that the design of the m.a.s can itself be inspired by concepts resulting from other sciences (social sciences, linguistic, social psychology, anthropology, philosophy, etc).

In this work, we are interested in the mechanisms of the cooperation between heterogeneous agents (each agent has particular competences and specific knowledge representation) in order to interact in synergy for the resolution of a common problem which is beyond individual agent’s capabilities. Multiple points of views are integrated so that the total system which of it is made up can take into account (all) its various components in spite of contradictions and conflicts which can necessarily arise from the various points of view and seem to behave as it was monadic.

For this purpose, we proposed a cooperation model shared by a group of agents to ensure the suited synergy. This model is based on a conceptual level shared by the agents composed by a cooperation expertise, a domain expertise and an engine algorithm which is processes these two expertises to make the agents exhibit a cooperative behaviour.

We present here, an extension with an original way to deal with inevitable conflicts that appear between agents during their cooperative problem solving process. Indeed, we believe that, in such systems, the contradictions and the conflicts are responsible for the hability, for the agents, to be adaptative.

As we will show, the cooperative reasoning emerges because the conflicts and inconsistencies between the agents are managed but not systematically avoided. In the previous version of our system, some cooperative expertise was dedicated to solve the conflicts and a specific method was choosen according to the context and the kind of the conflict.

Many work on cooperation in m.a.s deals management of the conflicts and most of them propose solutions making it possible to solve them either by mechanisms of negotiation, or by anticipation by preventing that they occur.

The intuition that we explored in our present work is that not only the conflicts resulting from the differences are impossible to circumvent, but that it is thanks to the appearance of these conflicts that new solutions can emerge.

On this basis, we can then conceive artificial systems able partly of creativity, in condition to consider these conflicts and to clarify their significance.

More generally the concept of otherness which invites to consider the other in its difference as source in richness contains a component according to which the difference of the other contributes to the construction of oneself. We thus propose to model the otherness like a component of the cooperation activity between agents and we try to show that the simple fact of this consideration not only makes it possible to solve these conflicts, but to transcend them while bringing to the agents new knowledge. The agents deal with the conflicts in their giving
a significance according to their own knowledge on themselves (their competences). For this purpose, they use a set of rules which are a formulation of the awakening that the other is part of oneself and that the conflict is there to enter in resonance with this part to discover and to exploit. These rules are integrated in a process relating to the conflict, which can be declined in five steps: (1) recognition, (2) identification, (3) mirroring, (4) assimilation, (5) going beyond (surpassing).

Cooperation activity in m.a.s

Since the beginnings of work on the m.a.s, the cooperation has been the target of a lot of work, particularly in collective problem-solving applications for which several kinds of knowledge and modes of reasoning are necessary in order to mitigate the insufficiencies of the individual approaches.

The cooperation is modelled by multi-agents community, sometimes as an activity of reasoning, sometimes as a set of attitudes of interaction, or like an exchange of intermediary results and tasks. The limits of these approaches led certain authors to introduce the concept of indices of co-operation (degree of parallelization of the tasks, persistence of the conflicts, resource sharing, coordination, collaboration, …) allowing to quantify the quality of the cooperation. We think that for an effective evaluation of the cooperation, the agents must be equipped with a reasoning on their own manner of cooperating. We were interested initially in the conflicts between agents. We based our approach on the one hand on works synthesized in which argue for some degree of necessary inconsistencies in m.a.s (“some degree of inconsistencies are necessary to improve collective problem solving…”) and in the concept of otherness to model in a specific way management of the conflicts between agents. The last cited concept (alterity) is inspired from psychological and anthropological works. We then explored the assumption according to which the conflicts would be source of the evolution of a system and have to be “well” managed but not avoided.

Otherness and cooperation in m.a.s

It is useless to point out the obviousness which the human being is a social being by definition; many experiments “of wild children” testify some. Let us cite Boris Cyrulnic, “the paradox of the human condition is that one can become oneself only under the influence of the others.”

If we want to design really intelligent systems, it is necessary that they are able to learn. This training is not made in a monadic way (by oneself), but thanks to the interactions with the others. We will tackle the problem of the conflicts resulting from these interactions and we will explain how these conflicts can cause evolution and training for the entities in interaction and consequently for the system which they compose.

In a general way, the otherness is the recognition of the other in its difference. This concept of otherness can be under consideration under various angles. We will focus ourselves on the vision of which looks at the otherness like a structural component of oneself. This author defined three dimensions of the otherness: intercultural, intracultural (within the same culture) and interior (or individual). As we will show later, the introduction of the concept of significance, allows us to add a transcultural dimension.

In the approach described here, the otherness is taken into account at the time of the interactions between agents, with a special focus on the interactions which generate conflicts.
Indeed, the keystone of the suggested approach resides in the mechanism of treatment of the conflicts due to the interactions. On the one hand filters (patterns) of interaction make it possible to identify the interactions likely to generate conflicts with other agents or in-house with the agent. In addition, a set of rules (or heuristics) are employed to give a significance to the conflicts. We propose an approach with five steps:

1. Conflict pattern detection and recognition
   - Identification and classifying the conflict: what is the type of conflict? (sharing resource, dissension on information, refusal to keep to a commitment, …)
2. Mirroring the conflict: is there any bond with internal knowledge of the agent? (the cause of, the consequence of, deals with this conflict…)
3. Assimilation/transformation of the conflict: it consists in applying a set of rules by considering the bonds worked out into 3.
   - Example of used rules:
     
     If the conflict is due to a refusal to keep to a commitment, the agent looks at if itself already refused to keep to a commitment. If it is the case, the agent must seek which is the strategy employed and which generated this lack of engagement.

5. Going beyond (surpassing) the conflict: there is no more conflict, the next time that this kind of interaction will occur, it will not cause more conflict. According to the rule which was employed in 4, the filters of interaction are consequently updated and the rules employed integrated.

Contrary to traditional approaches which consist in launching a process of argumentation/negotiation to deal with conflicts between agents, in our approach, each agent tries to benefit from the conflicts by assigning to each kind of conflict a significance which is specific to itself (agent). From there, the conflict is not any more one since it becomes source of innovation and creativity.

**Conclusion**

We proposed and experimented an original approach to deal with the problems of the occurrence and the management of the conflicts which can occur between several agents during their cooperative problem-solving process. We explored the concept of otherness to make advantage from the conflicts instead of avoiding them or spending resources for their resolution. Of course, we don’t pretend to have solved the whole question of the otherness in m.a.s cooperation, but we have initiated a study and a work whose first results are already conclusive. Indeed, our experimental platform is with double use. On the one hand, it makes it possible to explore various reflections on this concept of otherness which causes so many studies in the fields of social psychology, philosophy or anthropology. In addition, the introduction of the concept of otherness into the modeling of the cooperation in m.a.s makes it possible to conceive gifted systems of creativity and of capacities of training by the interaction. Our s.m.a has been tested on a diagnosis problem-solving case study, and we have improved the number of validated hypothesis compared to our previous version of the system.

Several extensions are considered for our system Mocah. The most important concerns the rules employed by the agents during the five steps of the "miroring" process. In fact, the rules are generic and identical for all the agents. We wish that our system be used to make emerge
and explore new rules. An other extension concerns the domain application of Mocah. It has been tested on a technical field (diagnosis of breakdowns), but it is in the course of application to the intercultural dialog in a project on the dialog of civilizations.

References