Reputation-based Agreement for Agent Organisations*

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Abstract. Reputation mechanisms have been proved to be valid methods to select partners in organisational environments. In order to tackle some well-known problems inherent to both centralised and distributed reputation mechanisms, a hybrid mechanism combining both techniques seems to be a promising approach. In this work firstly we summarise our previous work, a hybrid reputation mechanism, focusing on the distributed part. Then we put forward the centralised module that completes the mechanism, based on a novel concept such as *reputation-based agreement*, that attempts to define reputation aggregation as a global agreement reached amongst a set of participants belonging to an organisation. Besides, some particular properties of this type of agreements are proposed. The rest of the paper deals with the problem of how to present the information related to those agreements to agents in the organisations. For that, we will use *informative mechanisms* supported by some simple examples to better understand their functioning.

1 Introduction

Reputation mechanisms have been proved to be successful methods to build multi-agent systems where agents' decision-making processes to select partners are crucial for the system functioning [1][7][10]. In those systems, agents exchange their opinions about third parties to better select partners to interact with. In organisational environments, those mechanisms may also be useful for agents, since organisational structures, such as *roles* or *norms* can be used in order to estimate other participants' behaviour. Thus, integrating those organisational concepts into reputation mechanisms seems to be a promising approach to improve agents' decision making processes.

To cope with the interchange of opinions, many different reputation mechanisms have been proposed in the literature [7][10][13]. We can distinguish among

* The present work has been partially funded by the Spanish Ministry of Education and Science under project TIN2006-14630-C03-02 (FPI grants program) and by the Spanish project "Agreement Technologies" (CONSOLIDER CSD2007-0022, INGENIO 2010)

two different types, namely: *i)* centralised and *ii)* distributed. Both types have been proved to suffer from some important problems, such as: *newcomers* problems, lack of reliability in information exchanging, etc. [12]. To tackle with these problems, hybrid reputation mechanisms – combining centralised and distributed approaches – might be considered as a convenient technique [6]. In [12] we put forward a hybrid reputation model for organisations with a few strokes of the brush. We claimed, in that paper, that reputation fluctuates by the effect of norm fulfilment and violations, and that reputation values must be justified somehow by including, for instance, the norms that have been previously violated and the facts that have violated the norms. After that, in [5] we focus deeper on the distributed part, dealing with agents' information exchange, exploring the scenario of supply chains' formation. In the present work we present a formalisation of the centralised approach so completing the model.

In this paper we introduce the concept of *reputation-based agreement* as the cornerstone of the centralised module of the hybrid reputation mechanism. An *agreement* is usually defined as a meeting of minds between two or more parties, about their relative duties and rights regarding current or future performance. Around this concept new paradigms have been emerged [2][3] oriented to increase the reliability and performance of agents in organisations by introducing in such communities these well-known human social mechanisms. With this in mind, we propose a novel approach for the meaning of reputation. From a centralised point of view, a *reputation-based agreement* is a meeting point on the behaviour of an agent, participating within an organisation, with regard to its reputation. Agreements are evaluated by aggregating opinions sent by participants about the behaviour of the agents. We also define some interesting properties that describe different types of agreements. Information about reached agreements will be provided to agents by using the concept of informative mechanism [4].

The paper is organised as follows: Section 2 presents the previous work already done and in which the current paper is based on. Section 3 formalises the centralised module of our approach, supported on the idea of reputation-based agreements. In Section 4 we illustrate all concepts introduced by means of a case study. Section 5 discusses some related work and, finally, in Section 6 we summarise the paper and present the future work.

2 Previous Work

Reputation mechanisms are being used to increase the reliability and performance of virtual societies (or organisations) while providing mechanisms for exchanging reputation values. In centralised reputation models, a reputation system receives feedback about the interactions among the agents. Each agent evaluates the behaviour of the agents with whom it interacts and informs the reputation system. The system puts together all evaluations and stores such reputations. In contrast, in distributed reputation models, each agent evaluates and stores the reputations of the agents with whom it has interacted with and is able to provide such information to other agents.

With the aim to cope with the problems of centralised and distributed reputation mechanisms[3], we proposed the use of a hybrid mechanism [12]. In the distributed part of such a mechanism, agents evaluate the behaviour of other agents by exchanging opinions and storing such information. An opinion has to be justified by providing, for instance, the set of violated norms that contribute to that opinion.

This work is framed in organisational environments that provide a minimum set of organisational mechanisms to regulate agents' interactions. Formally, an organisation is defined as a tuple $\langle \mathcal{A}g, \mathcal{A}, \mathcal{X}, \phi, x_0, \varphi, \{\mathcal{ON}^{om}, \mathcal{R}^{om}\}\rangle$ where $\mathcal{A}g$ represents the set of agents participating within the organisation; $\mathcal{A}$ is the set of actions agents can perform; $\mathcal{X}$ stands for the environmental states space; ϕ is a function describing how the system evolves as a result of agents actions; x_0 represents the initial state of the system; φ is the agents' capability function describing the actions agents are able to perform in a given state of the environment; $\mathcal{ON}^{om}$ is an organisational mechanism based on organisational norms; and $\mathcal{R}^{om}$ is an organisational mechanism based on roles that defines the positions agents may enact in the organisation (see [5] for more details).

Agents participating in the field of such organisations are involved in different *situations*. A situation is defined as a tuple $\langle \mathcal{A}g, \mathcal{R}, \mathcal{A}, T\rangle$, that represents an agent $\mathcal{A}g$, playing the role $\mathcal{R}$, while performing the action $\mathcal{A}$, through a time period T. As detailed in [5], different types of situations can be defined following this definition. For instance, situations in which an agent performs an action, regardless of the role it is playing – $\langle \mathcal{A}g, \_, \mathcal{A}, \mathcal{T}\rangle$ –, or situations in which an agent is playing a role along a time period, regardless the action it performs – $\langle \mathcal{A}g, \mathcal{R}, \_, \mathcal{T}\rangle$ – are examples of possible situations.

As we aforementioned, we claim that when agents exchange opinions, those should be justified somehow, in order to allow receivers to reason about them (see [5] for more details) and, what is more important, this justification has to be based on the fulfilment of norms that regulate the different situation in which agents are involved. We consider two different types of norms regarding an organisation and its members. On the one hand, there exists norms that regulate all the participants in the organisation in different situations, known by all of them, which fulfilment could possibly be controlled by some authority entity. We call these norms *organisational norms*. Furthermore, we also define another type of norms – *personal norms* –, that regulate the preferences an agent has, regarding an individual situation. That is, they regulate how an agent wants a particular situation to be carried out. Agents define their own personal norms and they are the only ones that check their fulfilment. Note that, the personal norms defined by an agent regulates the behaviour of its partners and not its own behaviour, of course. As already pointed out, when an agent A sends an opinion to B about C – usually a reputation value –, A has to justify such value by sending the set of organisational norms that C violated when interacted with it, as well as the facts that prompted that reasoning. Moreover, personal norms that also contribute on an agent's reputation evaluation, are sent only when requested on

[3] In Section 5 we detail those problems

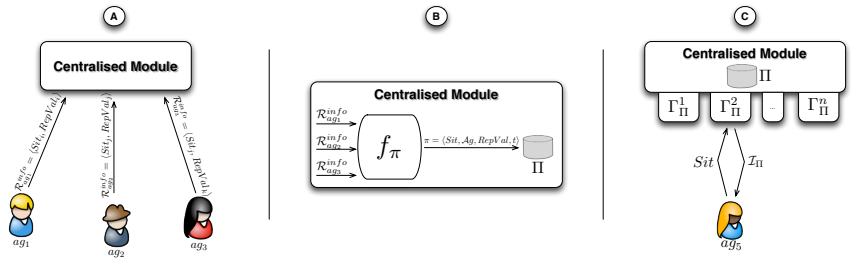

Fig. 1. Dynamics of the centralised module

demand. Starting from this approach, we focus on how to model the centralised part of the mechanism, stressing in the definition of *reputation-based agreement*.

3 Centralised Module based on Reputation-based Agreements

As we have previously pointed out, the current work faces with the task of formalising the centralised module to complete a hybrid reputation approach, working on organisational multiagent systems. The dynamics of such a module is threefold (as illustrated in Figure 1): *i)* agents within an organisation have to send their opinions about situations in which they have been involved; *ii)* the centralised module aggregates all opinions received from agents, creating *reputation-based agreements*; and *iii)* information about the agreements reached within the organisation is provided to agents by using different informative mechanisms [4]. In following sections we explain each task in detail.

3.1 How Agents Send Their Opinions

Along the lifetime of an agent within an organisation, it is involved in several different *situations* [5]. Usually, agents evaluate those situations in order to compile reliable information that allows them to predict the result of future situations. The rationale of the current work is that if agents share their knowledge about the situations they are involved in, this information might be useful when other agents have not enough information to select partners to interact with. This problem becomes hard when new participants join an organisation and they have not formed their own opinions so far.

The centralised module relies on the concept of *situation*. Situations are evaluated from an individual point of view. An evaluation may reflect the experience of the agent performing the evaluation – direct way – or the opinions provided by third parties about the evaluated situation – indirect way. Thus, at any time, an agent can send its opinion about a particular situation to the centralised module. Obviously, an agent can only send an opinion about a situation it has been

involved in: the centralised module could check this. We call this information *reputation information message* and it is formalised as follows:

Definition 1. *A reputation information message* $\mathcal{R}^{info}_{ag_i \in \mathcal{A}g}$ *is a tuple, representing an opinion sent by the agent* ag_i *to the centralised module containing an evaluation about a particular situation,* $\mathcal{R}^{info}_{ag_i} = \langle Sit, RepVal \rangle$,

where ag_i stands for the agent, which sends the opinion; Sit is the situation being evaluated; and $RepVal$ represents the evaluation the agent is sending about the situation (typically a number).

In this work we assume that agents are motivated to collaborate by sending their opinions to the centralised module. It is out of the scope of this paper to deal with the problem of lack of collaboration. In such situations, the centralised module should be coupled with an incentive mechanism that motivates agents to send their opinions. For instance, the module could give some credit to agents when they send an opinion, and later on, they could change that credit by information. Thus, an agent could be motivated to send their messages since it will be able to get useful information later on.

3.2 Creating Reputation-based Agreements

In this section we intend to face the task of giving a novel approach for the meaning of reputation, from a centralised point of view, tackling this concept as a partial agreement about a certain situation. When the centralised module receives reputation information messages from agents, it aggregates them creating what we have called *reputation-based agreements*. That is, the aggregation of all the opinions regarding to a particular situation is '*per se*' what that set of agents – as a whole – actually think about the aforesaid situation. Thus, a reputation-based agreement represents the consensus reached in the reputation opinions space sent by a set of agents about a particular situation. Formally:

Definition 2. *A reputation-based agreement* π *for a particular situation, is a tuple* $\langle Sit, \mathcal{A}g, RepVal, t \rangle$

where Sit stands for the situation about which the agreement is reached; $\mathcal{A}g$ is the set of agents that contributed to the agreement; $RepVal$ represents the reputation value – whatever its representation is (qualitative, quantitative, etc.) – reached as consequences of all opinions sent about the situation; and t stands for the time when the agreement was reached.

Therefore, an agreement means a global opinion that a set of agents have on a certain situation. This agreement, as we put forward in the next section, can be used as a generalist expectation for a situation in which agents have no (or little) previous information about.

As we have claimed, a reputation-based agreement is reached as consequence of the aggregation of all opinions sent about a particular situation. Thus, the centralised module requires a function that is able to aggregate information reputation messages sent by agents. The aim of such a function is to create

reputation-based agreements from reputation opinions that agents send to the module by means of reputation information messages. We formally define the function as follows:

Definition 3. *Let f_π be a function that given all the reputation information messages sent by agents and a particular situation creates a reputation-based agreement for that situation:*

$$f_\pi : |\mathcal{R}^{info}_{ag_i \in \mathcal{A}g}| \times Sit \rightarrow \Pi$$

where:

- $|\mathcal{R}^{info}_{ag_i \in \mathcal{A}g}|$ stands for the set of reputation information messages received by the centralised module;
- Sit is the set of situations;
- Π represents the set of reputation-based agreements.

As aggregation function the module might use any function that is able to aggregate values without any modification. For instance, it is possible to use a simple function to calculate the average of all opinions or a sophisticated function that aggregates the opinions by means of complex calculations (the implementation of this function is out of the scope of this paper). Note that a "good" aggregation function should take into account: i) the temporality of given opinions, since two opinions should not have the same importance if one of them was sent more recently; ii) in addition, the module should recalculate existing agreements when new opinions come.

3.3 Reputation-based Agreements: Properties

From previous definitions – definitions 2 and 3 – it is possible to define some desirable properties about reputation-based agreements. These properties should be taken into account when agreements are created and may also provide useful extra information when informing about different issues.

Property 1 *A reputation-based agreement π is **complete** iff. all agents participating in an organisation, at time t, contribute to reach that agreement:*

$$\pi^* \Leftrightarrow \begin{cases} \mathcal{O} = \langle \mathcal{A}g, \mathcal{A}, \mathcal{X}, \phi, x_0, \varphi, \{\mathcal{ON}^{om}, \mathcal{R}^{om}\}\rangle \ \wedge \\ \pi = \langle Sit, \mathcal{A}g', RepVal, t\rangle \ \wedge \\ (\mathcal{A}g = \mathcal{A}g') \end{cases}$$

That is, given a time t every participant $ag \in \mathcal{A}g$ in the organisation $\mathcal{O}$ has necessarily sent a reputation information message indicating its opinion about the situation concerning the agreement ($\mathcal{A}g = \mathcal{A}g'$). The more complete agreements are in the system, the more reliability the information will be offered.

Property 2 *A reputation-based agreement π is α-**consistent** iff. the reputation value of π differs, at most, α from the reputation value sent by every agent that contributed to reach that agreement:*

$$\pi^{\alpha} \Leftrightarrow \begin{cases} \pi = \langle Sit, \mathcal{A}g, RepVal, t \rangle \ \ \wedge \\ \forall ag \in \mathcal{A}g \ \ [\forall r \in Rep_{ag}^{info}[(r = \langle Sit_i, RepVal_i \rangle) \wedge \\ (Sit_i = Sit) \ \ \wedge \ \ (|RepVal_i - RepVal| \leq \alpha)]] \end{cases}$$

This property represents the monotony on the agents' behaviour, since measures how equals the opinions coming from them are. Therefore, the lower α is, the similar the opinions are.

Property 3 *A reputation-based agreement π is **full** iff it is complete and 0-consistent:* $\pi^{\phi} \Leftrightarrow (\pi^{*} \ \ \wedge \ \ \pi^{\alpha} \ \ \wedge \ \ \alpha = 0)$

In the case α is 0 means that all agents have the same opinion about a given situation. This property is very desirable when seeking reputation-based agreements, because the more agents contribute to the agreement, the stronger validity the latter has. Thus, the likelihood of capturing what is actually happening in the organisation tends to be higher.

Although properties 1 and 3 are desirable, they are not achievable in some types of systems, for example in electronic marketplaces. However, many systems can present those properties, such as closed organisational systems where the number of participants is not huge.

3.4 Providing Information about Reputation-based Agreements

Once we have defined an agreement as a distributed consensus-based expectation for a set of agents on a certain situation, we now present how the centralised model can present the relevant information on the reached agreements. Reputation-based agreements somehow capture the general thinking about a particular situation – when the less α-consistent the agreement is the more the reality captured is. Thus, information about the agreements reached until that moment may be very useful for agents. In particular, when agents have recently joined the organisation, they do not have any clue about situations in which they might be involved in, so if the centralised module provides information about agreements, agents may improve their utility from the very beginning.

With this in mind, we lead with the problem of how the centralised module may provide such an information. To that end, we part from the notion of *informative mechanism* [4]. Those types of mechanisms are in charge of providing some kind of information to agents in order to regulate a multiagent system. Thus, an *informative mechanism* $\Gamma : \mathcal{S}' \times \mathcal{X}' \rightarrow \mathcal{I}$ is a function that given a partial description of an internal state of an agent (S') and, taking into account the partial view that the mechanism has of the current environmental state ($\mathcal{X}'$), provides certain information ($\mathcal{I}$). We adhere this definition to create mechanisms over the agreements for different situations, creating information valuable for participants in the organisation. Thus, all the information about reputation-based agreements reached within an organisation will be provided by means of informative mechanisms, formalised as follows:

Definition 4. *An informative mechanism providing information about reputation-based agreements is:*

$$\Gamma_{\Pi} : Sit \times \mathcal{X}' \rightarrow \mathcal{I}_{\Pi}$$

where:

- Sit is the situation an agent is requesting information about;
- $\mathcal{X}'$ is the environmental state;
- $\mathcal{I}_{\Pi}$ stands for the information provided by the mechanism by using the set of agreements Π reached over the situation Sit.

We have chosen a very general definition about information in order to cover all possible types of information the centralised module could offer taking into account the reputation-based agreements reached. The information provided may consist of a ranking sorting the best agents for a particular situation, such as $\langle \_, \mathcal{R}, \mathcal{A}, \_ \rangle$, created from the agreements reached for that situation, a value representing the reputation value for a situation, reached as consequence of the agreement for that situation, information about the properties of the agreement reached for a particular situation, for instance if it is full, complete, etc.

When we refer to situations as a key aspect when creating and using reputation-based agreements notice that instead of situation we could also follow the same processes to create reputation-based agreements about information related to organisational norms, such as: violation/fulfilment of norms. For instance, there could exist an informative mechanism providing a ranking with participants sorted by their degree of violation of certain norms. For the sake of simplicity we have described the terms of reputation-based agreement using situation, but exactly the same could be applied for organisational norms.

4 Case Study

In this section, we illustrate the proposed model by means of a simple case study. The scenario we use involves five different agents: *Anna*, *John*, *Jessica*, *Albert* and *Harry* participating within an organisation. In this organisation agents can *buy* and *sell* items, so the action space of agents is composed of actions such as, *buy-item-x*, *sell-item-x*, where x is whatever object they want to sell/buy. Besides, agents joined the organisation playing the following roles: *Anna* - *buyer*, *John* - *buyer*, *Jessica* - *buyer*, *Albert* - *seller* and *Harry* - *seller*. The situations in which an agent is involved in that organisation are regulated by organisational norms [5], some examples of such norms are:

- $\mathcal{ON}_1$: *"An agent playing the role seller must deliver the product sold 2 days after the payment, as maximum"*
- $\mathcal{ON}_2$: *"An agent playing the role buyer must pay 2 days after the purchase is performed, as maximum"*

After several interactions among them – performing actions of buying and selling different items – *Anna* decides to make public its opinion about *Albert* and *Harry* as sellers. Thus, she uses the reputation information messages to send to the centralised module its opinion, as follows:

$$\mathcal{R}^{info}_{Anna} = \langle\langle Albert, seller, \_, \_\rangle, 0.2\rangle$$
$$\mathcal{R}^{info}_{Anna} = \langle\langle Harry, seller, \_, \_\rangle, 0.9\rangle$$

This information shows that *Anna* has had bad experiences while she was buying things from *Albert* – 0.2 – maybe because *Albert* violated some organisational norm.[4]. Otherwise, she has had good experiences while she was buying things from *Harry* – 0.9 – maybe because *Harry* never violates organisational norms. Similarly, *John* and *Jessica* send their opinions about *Albert* and *Harry* as seller, by using the following reputation information messages:

$$\mathcal{R}^{info}_{John} = \langle\langle Albert, seller, \_, \_\rangle, 0.2\rangle$$
$$\mathcal{R}^{info}_{John} = \langle\langle Harry, seller, \_, \_\rangle, 0.8\rangle$$
$$\mathcal{R}^{info}_{Jessica} = \langle\langle Albert, seller, \_, \_\rangle, 0.2\rangle$$

It seems that both *John* and *Jessica* agree that *Albert* is bad selling items, however, *Harry* is good as a seller, from the point of view of *John*.

When the centralised module receives this information, it is able to create reputation-based agreements by using a function that aggregates the reputation information messages. Let us suppose that it aggregates the messages by calculating the average of reputation values sent by agents over exactly the same situation:

$$f_\pi(Sit) = \frac{\sum_{i=1}^{n} \mathcal{R}^{info}_{ag_i} = \langle Sit, RepVal_i\rangle}{n}$$

From the set of messages sent by the agents so far, the centralised module can create two reputation-based agreement regarding to two different situations:

$$\pi_1 = \langle\langle Albert, seller, \_, \_\rangle, \{Anna, John, Jessica\}, 0.2, t\rangle$$
$$\pi_2 = \langle\langle Harry, seller, \_, \_\rangle, \{Anna, John\}, 0.85, t\rangle$$

where the first component indicates the situation being evaluated, the second is the set of agents which have participated in the agreement, the third component is the reputation value agreed by the participants – it is calculated by using the function $f_\pi(Sit)$, i. e. it represents the average of all values sent about that situation –, and finally the fourth component is the time in which the agreement is reached.

Taking into account those agreements, the centralised module makes available three different informative mechanisms:

- $\Gamma^1_\Pi(\langle \mathcal{A}g, \mathcal{R}, \_, \_\rangle)$ given a situation where an agent and a role is specified, returns meta-information[5] about the reputation-based agreement reached about that situation;
- $\Gamma^2_\Pi(\langle \mathcal{A}g, \mathcal{R}, \_, \_\rangle)$ given a situation where an agent and a role is specified, returns the reputation-based agreement reached. In particular, it returns the reputation value in the agreement of that situation;

[4] We suppose that reputation values – denoted by $RepVal$ – are in the range [0..1]

[5] with meta-information we mean the α-consistency of the agreement, if it is full or complete

– $\Gamma^3_\Pi(\langle \_, \mathcal{R}, \_, \_\rangle)$ given a situation where a role is specified, returns a ranking of agents playing that role, sorted by the reputation value they have as consequence of the reputation-based agreement reached until the current time t.

Let us suppose that a new agent *Alice* join the organisation playing the role *buyer*. Since she does not know anybody within the organisation and she wants to buy something, she may use the informative mechanisms published to obtain information about other participants. For instance, *Alice* is looking for a *seller* to buy something, so a ranking of sellers will be a great solution to select the best one. Thus, she searches among all informative mechanisms if there exists one which provides that information[6]. She is very lucky finding Γ^3_Π, that returns a ranking when it is queried with a situation specifying a role. So, *Alice* performs the following query to Γ^3_Π:

$$\Gamma^3_\Pi(\langle \_, seller, \_, \_\rangle) \Rightarrow \{Harry, Albert\}$$

the informative mechanism returns a ranking of agents, sorted by the reputation values of all reputation-based agreements, where the situation specified in the query matches with the situation of agreements. In particular, the implementation of this mechanism searches among all agreements reached where the situation has the role *seller*. By using this information *Alice* knows that there exists an agreement within the organisation about *Harry* is better seller than *Albert*. But, how good are they?. To answer this question *Alice* queries the informative mechanism Γ^2_Π as follows:

$$\Gamma^2_\Pi(\langle Harry, seller, \_, \_\rangle) \Rightarrow 0.85$$
$$\Gamma^2_\Pi(\langle Albert, seller, \_, \_\rangle) \Rightarrow 0.2$$

Right now, *Alice* knows that *Harry* is better seller than *Albert* and there exists an agreement within the organisation that *Harry*'s reputation selling goods is 0.85 and another one that says that *Albert* as seller is 0.2 – in the range 0 and 1. However, *Alice* is still doubting about which seller could be the best, because she is wondering how consistent that agreement is. Thus, she wants to answer that question and she queries the informative mechanism that provides meta-information about the agreement reached regarding a situation. Therefore, she performs the following queries:

$$\Gamma^1_\Pi(\langle Harry, seller, \_, \_\rangle) \Rightarrow \pi^{0.05}$$
$$\Gamma^1_\Pi(\langle Albert, seller, \_, \_\rangle) \Rightarrow \pi^0$$

With this information *Alice* clears all her doubts, because now she knows that all opinions sent about *Albert* are coincident because of the reputation-based agreement reached is 0-consistent (π^0). Besides, she knows that the opinions sent by the agents that have interacted with *Harry* are almost the same since their variability is (0.05). With this in mind, *Alice*, finally, selects *Harry* as a seller.

[6] We suppose that informative mechanisms are published by the organisation to all participants

5 Discussion

There are several distributed reputation systems where the agents themselves are able not only to evaluate the behaviour of other agents and associate reputation values but they are able to aggregate different reputations related to different experiences. It is the case of the agents in Regret [11] that can aggregate reputation values created based on their individual experiences and also on reputations values reported by other agents.

As stated before, one of the main advantages of having a centralised reputation mechanism is feasibility for an individual to know a more consistent reputation about another agent based on numeral experiences. In the case of distributed mechanisms, the individual itself would need to participate in several interactions with the given agent and also to ask for other agents about their experience with it. In the case of the centralised mechanism, the agent can easily ask the *informative mechanisms* about the *reputation-based agreement* of the given agent in the desired situation.

In [8] the authors present an approach to create rankings able not only to provide the most trustful agents but also a probabilistic evidence of such reputation values. Those rankings are also computed by a centralised mechanism by aggregating the reputations reported by the agents. This approach and the one presented in our paper are complementary. This paper focuses on defining the ranking algorithms and ours focuses on describing the mechanism used to receive the reputation information and to provide the already evaluated agreements and rankings. Another work that is also complementary to ours is the one presented in [9]. They describe the algorithm *NodeRanking* that creates rankings of reputation ratings.

In order to motivate agents on reporting their experiences to the centralised mechanism several approaches can be used. Points can be provided when agents send reputation information to the mechanism and a given number of points can be required when the agent asks for reputation-based agreements or rankings. We assume that the agents know how important the information stored in the centralised mechanism is in order to them achieve their goals.

6 Conclusions

This work tries to put forward a novel approach of reputation-based agreement concept by supporting on a hybrid reputation model presented in [5]. This approach formalises a centralised module – complementary to the distributed mechanism presented in [5] – that defines reputation-based agreements as aggregations of participants' opinions sent to the module. We also define some properties that can be derived. Furthermore, we also propose to use the agreements reached by using the concept of informative mechanism [4], so providing agents with useful information based on those agreements. Some different examples are also given to clarify the importance of reaching reputation-based agreements and its utility for the participants in the organisation.

In future work we plan to experimentally test our approach by implementing a case of study. We are also interested in how to merge different agreements. Moreover, it would be interesting to study the aggregation of information sent in different periods.

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