Coordination and Organization

Definitions, Examples and Future Research Directions

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Abstract

Coordination languages and models like Linda and Reo have been developed in computer science to coordinate the interaction among components and objects, and are nowadays used to model and analyze organizations too. Moreover, organizational concepts are used to enrich the existing coordination languages and models. We describe this research area of "organization and coordination" by presenting definitions, examples, and future research directions. We highlight two issues. First, we argue for a study of value-based rather than information-based coordination languages to model the coordination of autonomous agents and organizations. Second, we argue for a study of the balance between enforced control and trust-based anticipation to deal with security aspects in the coordination of organizations.

Key words: Coordination, organization, electronic commerce, normative systems, multi-agent systems, secure systems.

1 Introduction

In human society, organizations embody a powerful way to coordinate complex behavior. Various models of organizations exist, from bureaucratic systems based on norms to competitive systems based on markets. Moreover, organizational concepts structure the behavior of complex entities in a hierarchy of encapsulated entities. For example, roles structure departments, which in turn structure organizations. Moreover, organizations structure inter-organizational virtual organizations. Organizations specify also the interaction

and communication possibilities of each of these entities, abstracting from the implementation of their behavior.

In agent theory and computer science, organizational models in which organizations are autonomous entities have become popular to model coordination in open systems, and practical applications to organizational modeling are being widely developed. This is due also to the need to ensure social order within applications like Web Services, Grid Computing, and Ubiquitous Computing. In these settings, openness, heterogeneity, and scalability pose new challenges for traditional organizational models. For example, organizational and individual perspectives must be integrated and the models must dynamically adapt to organizational and environmental change.

In particular, organizational concepts are used to enrich coordination languages and models developed in computer science to coordinate the interaction among components and objects, like Linda [13] and Reo [1]. Moreover, these languages and models are nowadays used to model and analyze human organizations too. In this survey paper we raise the following questions:

(i) What are "coordination" and "organization" in the context of the first workshop on coordination and organization?

(ii) What are typical examples of research topics concerning both coordination and organization?

(iii) Which results have been obtained thus far in this research area, and what are the future research directions?

An example in electronic commerce illustrates the use of coordination techniques for modeling, analyzing and simulating human organizations, and an example in object oriented programming languages illustrates the use of roles for coordination. We raise the questions which properties a coordination language should have to model organizations, how such a coordination language can be used, which organizational concepts can be used in coordination languages and models, and how these concepts should be used.

We highlight two future research directions. First, coordination in computer science is concerned with information, whereas organizations are concerned with values. Values have properties information does not have, since, for example, it cannot be duplicated, or it can perish. Coordination languages have to be developed that deal with these properties. Second, security aspects play an important role in coordination and organization. Whereas traditional security concerns have focussed on building control mechanisms such as cryptographic methods, organizational coordination focusses on incentives to motivate agents, and trust and anticipation play a central role too.

The layout of this paper follows the research questions. In Section 2 we present some definitions, in Section 3 the two examples from electronic commerce and object oriented programming languages, and in Section 4 the future research directions including value-based and secure coordination.

2 Definitions

2.1 Coordination

For completeness, Figure 1 presents the dictionary description of the noun 'coordination' and the verb 'to coordinate', and Figure 2 presents the various uses of 'to coordinate' in the lexical reference system Wordnet [16]. Here we focus on the use of 'coordination' in computer science.

Main Entry: coordination

Function: noun

1 : the act or action of coordinating

2 : the harmonious functioning of parts for effective results

Main Entry: 2 coordinate

Function: verb

transitive senses

1 : to put in the same order or rank

2 : to bring into a common action, movement, or condition : HARMONIZE

3 : to attach so as to form a coordination complex

intransitive senses

1 : to be or become coordinate especially so as to act together in a smooth concerted way

2 : to combine by means of a coordinate bond

Fig. 1. Merriam Webster: 'coordination' and 'to coordinate'

An often used definition due to Malone defines coordination as the "management of dependencies among independent activities" [28]. This definition is used in particular in business and economic contexts. It emphasizes that instead of the activities themselves the interaction among these activities are central, and that the activities are autonomous.

In agent theory coordination has been defined as "the process by which an agent reasons about its local actions and the (anticipated) actions of others to try to ensure the community acts in a coherent manner [22], "the activity that involves the selection ordering and communication of the results of agent activities as that an agent works effectively in a group setting" [27], as "a process in which agents engage in order to ensure a community of individual agents acts in a coherent manner" [30], and in computational intelligence as "a way of adapting to the environment" [35].

Finally, a more technical definition in computer science due to Arbab defines coordination as "the study of the dynamic topologies of interactions among Interaction Machines, and the construction of protocols to realize such topologies that ensure well-behavedness" [2].

- the skillful and effective interaction of movements
- the regulation of diverse elements into an integrated and harmonious operation
- the grammatical relation of two constituents having the same grammatical form

Fig. 2. WordNet: S: (n) coordination

Main Entry: 1 organization

Function: noun

1 a : the act or process of organizing or of being organized

   b : the condition or manner of being organized

2 a : ASSOCIATION, SOCIETY <charitable organizations>

   b : an administrative and functional structure (as a business or a political party); also : the personnel of such a structure

Main Entry: 2 organization

Function: adjective

1 : characterized by complete conformity to the standards and requirements of an organization <an organization man>

Fig. 3. Merriam Webster: 'organization'

2.2   Organization

An organization is a formal group of people with one or more shared goals. In sociology 'organization' is understood as planned, coordinated and purposeful action of human beings in order to construct or compile a common tangible or intangible product or service. This action is usually framed by formal membership and form (institutional rules). Sociology distinguishes the term organization into planned formal and unplanned informal (i.e., spontaneously formed) organizations.

Management is interested in organization mainly from an instrumental point of view. For a company organization is a means to an end in order to achieve its goals. In this sense organizations can be distinguished into two fundamentally different sets: Organizations whose goal is to generate certain services and/or to produce goods (factories, service enterprises, etc.) or to bring about certain effects in its surrounding world (e.g., authorities, police, political parties, interest groups, trade unions, etc.), and organizations whose goal is to change individuals (e.g., schools, universities, hospitals, prisons).

- a group of people who work together
- (also arrangement, system) an organized structure for arranging or classifying; "he changed the arrangement of the topics"; "the facts were familiar but it was in the organization of them that he was original"; "he tried to understand their system of classification"
- (also administration, governance, governing body, establishment, brass) the persons (or committees or departments etc.) who make up a body for the purpose of administering something; "he claims that the present administration is corrupt"; "the governance of an association is responsible to its members"; "he quickly became recognized as a member of the establishment"
- (also constitution, establishment, formation) the act of forming something; "the constitution of a PTA group last year"; "it was the establishment of his reputation"; "he still remembers the organization of the club"
- the act of organizing a business or an activity related to a business) "he was brought in to supervise the organization of a new department"
- the activity or result of distributing or disposing persons or things properly or methodically; "his organization of the work force was very efficient"
- (also system) an ordered manner; orderliness by virtue of being methodical and well organized; "his compulsive organization was not an endearing quality"; "we can't do it unless we establish some system around here"

Fig. 4. WordNet: S: (n) organization

3 Examples

In this section we present two examples of research on coordination and organization. On the one hand we illustrate how research on coordination can be used within research on human organizations, by illustrating the use of coordination languages in electronic commerce. On the other hand we illustrate how research on organizations in multi-agent systems can be used within research on coordination, by discussing the use of roles for coordination in object.

3.1 Electronic commerce

Many social and economic constructs can be seen as mechanisms for coordination, for example marriage can be seen as a mechanism to coordinate selection, and money can be seen as a mechanism to coordinate the exchange of goods among three parties (known as Wicksell triangle). When someone wants to buy a pack of milk, he takes his cash and goes to the store. The shop-keeper and the buyer directly inspect and exchange our goods and cash, and that is the end of the story. If he wants to buy the next season's entire milk production of a dairy farm, or purchase a house, although the principle is the same as buying a pack of milk, we need to use constructs such as an escrow service, because the transaction now involves multiple steps and spans over time. All activities involved need to be coordinated such that in the end we still get the all-or-nothing effect of a transaction.

Therefore these social and economic constructs can be modeled or formalized using coordination languages developed in computer science. Using a more precise mathematical language forces one to better understand what is going on with constructs such as escrow, Letter of Credit, or other trust instruments. Moreover, formal descriptions and analysis can be used to support the design of coordination mechanisms in electronic commerce. As an example we consider here mechanisms for the coordination of value exchanges in economic and business contexts. As a running example we consider the well known documentary credit procedure of a Letter of Credit [10,26,24].

Suppose we have a potential transaction between a customer and a supplier which is located in a remote and unfamiliar part of the world. Hence there are no common conventions or trade procedures. In such circumstances a lack of trust is warranted. The supplier does not want to ship the goods without first receiving payment, but the customer does not want to pay before the goods have been shipped. To solve this deadlock situation banks introduced the letter of credit procedure. A letter of credit is an agreement that the bank of the customer, called the issuing bank, will arrange a credit to guarantee payment as soon as the supplier can prove that the goods have been shipped. The supplier can prove this by presenting the shipping documents, such as a bill of lading, to his own bank, the corresponding bank. The shipping documents are issued by the carrier of the goods, as soon as the goods have in fact been shipped. The corresponding bank transfers the shipping documents to

the issuing bank, which only delivers the shipping documents to the customer after payment. With the shipping documents the customer can then reclaim the goods from the carrier.

A possible way of modeling the procedure is depicted in Figure 5, adapted from [26]. This figure should be read as follows. It indicates the order in which documents must be exchanged, which provides information about the dependencies among actions: which actions should occur only provided some other actions have occurred. For example, the objective of step 4 is to let the supplier know that a credit has been secured, and that he can safely start shipping the goods. Similarly, the objective of the shipping documents, is to provide evidence that the goods have been transferred.
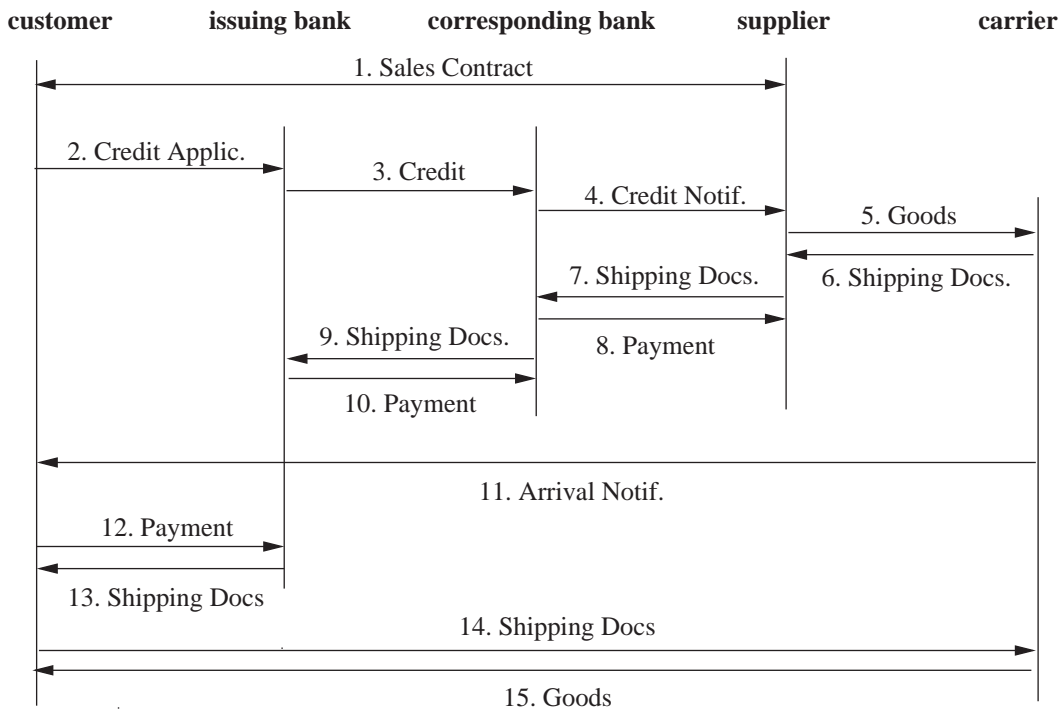

Fig. 5. Interaction Diagram of the Letter of Credit Procedure

One aspect that is not covered by this diagram is the amount of value that is transferred. For example, payment 12 by the buyer should be large enough to cover payment 10, as well as the fees of the issuing bank for supplying the service. Such issues are better addressed in the *value perspective*. Gordijn *et al.* [18,19] have been advocating the value perspective for requirements engineering in electronic commerce. They developed the e^3-value tool, which makes it possible to calculate the respective values of exchanges for different scenarios. The central idea is the *principle of reciprocity*: whatever happens, the net value of all exchanges must be equal to zero. Kartseva *et al.* [24] give a value-based account of the Letter of Credit procedure.

Consider a value based analysis of the trading practice of a Letter of Credit in Figure 6. The Bill of Lading is issued by the carrier, as soon as the goods

are shipped. The supplier's bank transfers the Bill of Lading to the customer's bank, which only gives the Bill of Lading to the customer after payment. The customer's bank receives a fee for the letter of credit service (*LoC fee*), part of which goes to the supplier's bank for handling the payment (*P fee*). The Bill of Lading is an example of a multi-modal transport document that has an evidentiary effect. Compared to the interaction diagram, we also consider a shipping fee the supplier pays to the carrier, and an extension with a merchant role. The customer can claim the shipped goods from the carrier in return for the Bill of Lading, or sell the Bill of Lading to some other company, which can then claim the shipped goods.
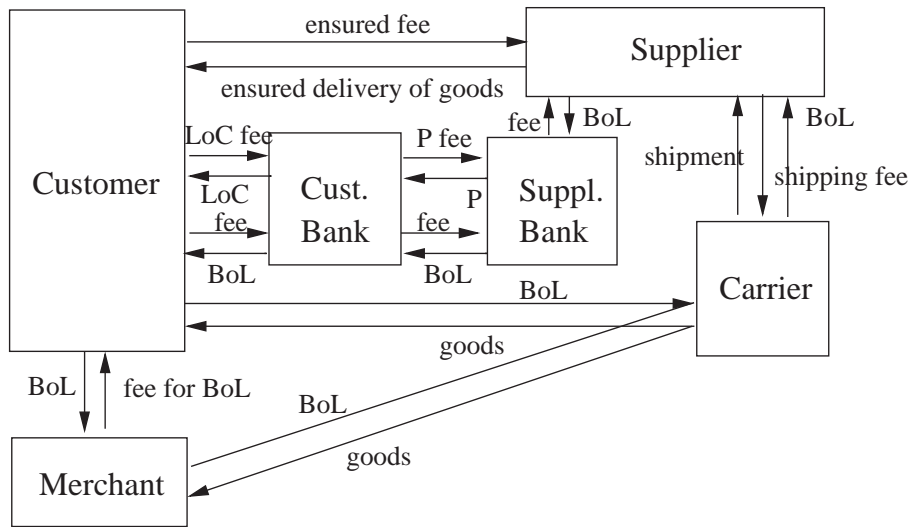

Fig. 6. Value network

Depending on what it is that you want to model with a multi-agent-system, it may or may not make sense to insist on having explicit agents representing letter of credit or escrow companies. Recognizing that their role is simply to coordinate, one can simplify the complexity of what a buyer and seller has to deal with in the real world, and simply present a view to them as if buying a house is the same as buying a pack of milk: everything needed by each party must be present and verified before the actual exchange takes place; i.e, we have an atomic transaction. We can leave it to be the responsibility of the exogenous coordination mechanism to ensure that the integrity of this complex transaction is preserved. However, if the intention is to model what happens in the real world, then we will not see an explicit role or agent for banks in this case. The atomic transaction implicitly does the same job, but eliminates their role. So, we want to have another model that includes some explicit construct representing the letter of credit company. Comparing what buyers and sellers must do in their blissfully ignorant versions versus their real-life models, clarifies the exact role of letter of credit in coordination and conduct of these transactions, as well as what exactly needs to become endogenous.

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3.2   Roles for coordination of objects

In order to constrain the autonomy of agents and to control their emergent behavior in multiagent systems, the notion of organization has been applied [17,37]. According to Zambonelli *et al.* [37] "a multiagent system can be conceived in terms of an organized society of individuals in which each agent plays specific roles and interacts with other agents".

The notion of role refers to the structure of social entities like institutions, organizations, normative systems, or groups [6,17,37]. Roles are usually considered as a means to distribute the responsibilities necessary for the functioning of the organization. Moreover, roles allow the uncoupling of the features of the individuals playing roles from those of their roles. Finally, roles are used to define common interaction patterns, and embed information and capabilities needed to communication and coordination [11]. E.g., the roles of auctioneer and bidder are defined in an auction, each with their possible moves.

The use of roles in multi-agent systems has not only been beneficial to the construction of multi-agent systems. It has also led to a better understanding of what is a role, which are its properties and how to formalize them.

Baldoni *et al.* [4,5] propose to use the notion of role as it has been developed in multi-agent systems to coordinate objects and components in the traditional object oriented paradigm rather than agents in multi-agent systems. As object orientation is a way to handle the complexity arising from the large number of interactions in a system, roles can be a further representation mechanism to achieve the same purpose in environments which are more varied and dynamic, and need to accommodate more local freedom and initiative, scenarios common in multi-agent systems [23,36]. Introducing roles in object oriented languages is a way to bring back to object orientation the fruits of applying organizational concepts to agents.

Baldoni *et al.* [4] propose to introduce roles in an extension of Java. The distinguishing features of roles in their model are the foundation of roles, their definitional dependence from the institution they belong to, and the powers attributed to the role by the institution. Baldoni *et al.* [4], thus, call powerJava their extension of Java.

To understand these issues they propose the following example. Consider the roles student and professor. Roles are always roles of some institution. A student and a professor are always roles of some university. Without the university the roles do not exist anymore: e.g., if the university goes bankrupt, the actors (e.g. a person) of the roles cannot be called professor and students anymore. The institution (the university) also specifies the properties of the student, which extend the properties of the person playing the role of student: the university specifies its enrolment number, its email address, its scores at past examinations, and also how the student can behave. For example, the student can give an exam by submitting some written examination. A student can make the professor evaluate its examination and register the mark

because the university defines both the student role and the professor role: the university specifies how an examination is evaluated by a professor, and how it maintains the official records of the examinations. Otherwise the student could not have an effect on the professor. But in defining such actions the university *empowers* the person who is playing the role of student: without being a student the person has no possibility to give an examination and make the professor evaluate it.

This example highlights the following properties that roles have in the model of [8,9]:

Foundation: a (instance of) role must always be associated with an instance of the institution it belongs to (see Guarino and Welty [21]), besides being associated with an instance of its player.

Definitional dependence: the definition of the role must be given inside the definition of the institution it belongs to. This is a stronger version of the definitional dependence notion proposed by Masolo *et al.* [29], where the definition of a role must use the concept of the institution.

Institutional empowerment: the actions defined for the role in the definition of the institution have access to the state and actions of the institution and of the other roles: they are powers.

To introduce this view of roles in Java is necessary to address the following issues:

 (i) A construct defining the role with its name, who can play it and its powers in the institution.

 (ii) The implementation of a role, inside an institution and according to the specification of its powers, so to make the role definitionally dependent on the institution.

(iii) How an object playing a role can exercise the powers its role gives to it in the institution to which the role belongs.

Figure 3.2 shows by mean of the above example the use of roles in powerJava. First of all, a role is specified (`role` - left column) by indicating who can play the role (`playedby`) and which are the powers acquired by playing the role (`exam()`, giving an exam in this case). Second, a role is implemented inside an institution as a sort of inner class which realizes the role specification (`definerole`). The inner class implements all the methods required by the role specification as it were an interface.

In the right column of Figure 3.2 the use of powerJava is depicted. First, the candidate player `p` of the role is created. Its type must be compatible with the requirements of the role (`Person`). Before the player can play the role, however, an instance of the institution hosting the role must be created first (a `University u`). Once the `University` is created, the player `p` can become a `Student` too. Note that the `Student` is created inside the `University u` (`u.new Student(p)`) and that the player `p` is an argument of the constructor

```
role Student playedby Person
   { int exam(); }

class University {                  p = new Person();
  private int[][] marks;
                                    u = new University();

  definerole Student {
                                    u.new Student(p);

    int exam(){ ...
      marks[i,j]=x; ... }           ((u.Student) p).exam();

  }

}
```

Fig. 7. A role `Student` inside an *University.*

of role `Student`.

The player `p` maintains its identity and if it has to act as a `Student` it must first be classified as a `Student` by means of a so-called *role casting* (`(u.Student) p`). Note that `p` is not classified as a generic `Student` but as a `Student` of `University` `u`. Once `p` is casted to its `Student` role, it can exercise its powers, in this example, giving an exam (`exam()`). Such method is called a power since, in contrast with usual methods, it can access the state of other objects, since its namespace shares the one of the institution defining the role. Thus it can access the state of the institution it belongs to and of the other roles in the institution. In the example, the method `exam()` can access the private state of the `University` and assign a value to the private variable `marks`: giving an exam successfully counts as the `University` assigning a mark to the `Student` in the registry of exams.

Powers are used to coordinate objects. In Baldoni *et al.* [5] it is shown how roles can be used for coordination purposes. First, the interaction among objects is dealt with only inside the institution which specifies how they coordinate with each other. This is possible since powers allow roles to access the state of the institution and of the other roles. In our example, the coordination between a `Student` and a `Professor` can be made inside the institution. This allows to achieve a separation of concerns between the core behavior of an object (which is given inside its class) and its interaction capabilities, which depend on the context of the interaction and, thus, are specified in the institution.

Second, the player of the role does not need to know which is the identity of the other players it must coordinate with, but it has to refer only to the roles. In our example, a `Student` does not need to know the identity of player of the `Professor` role it has to interact with, but it needs only to know which is the `Professor` of the course it attends.

4 Directions for future research

We distinguish four directions for future research. The first direction concerns research questions concerning the gap between computer science where the coordination languages and models have been developed, and the social sciences where organizations are being studied. The second kind of questions concerns the use of coordination languages for human organizations, and the third kind concerns the use of organizational concepts for coordination. A separate class of questions concerns security issues for the coordination of organizations.

4.1 Computer science and the social sciences

Coordination as considered in this paper is a concept studied in computer science, whereas organization is a concept borrowed from the social sciences - economics, business administration, and sociology. This gives rise to our first research question.

Question 1 *What are the fundamental distinctions underlying these two concepts?*

Coordination in computer science is concerned with information, whereas the letter of credit example illustrates that organizations are concerned with values. Values have properties information does not have, since, for example, it cannot be duplicated, or it can perish. Coordination languages have to be developed that deal with these properties. Porter, a business scientist who studied the notion of value chains and applied it to strategy [33], defines value as follows. "Economic Value for a company is nothing more than the gap between price and cost, and it is reliably measured only by sustained profitability. To generate revenues, reduce expenses, or simply do something useful by deploying internet technology is not sufficient evidence that value has been created." [34, p.65]

4.2 Coordination languages for organizations

The second research direction concerns the use of coordination languages, tools and models, as developed in the coordination community in computer science, for human organizations. Coordination techniques are used in formal models of organizations to analyze or simulate them.

Question 2 *What kind of properties should a coordination language for organizations have?*

Dastani *et al.* [15] argue that coordination for organizations should be exogenous, in the sense that coordination is defined in terms of interactions rather than agents, because organizations are defined in terms of roles rather than agents. They explain and promote the use of the exogenous coordination language Reo, developed by Arbab at the Center of Mathematics and Computer Science in Amsterdam.

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Groenewegen *et al* [20] argue that the coordination language should be able to describe and relate global and local behaviors, and they promote Paradigm as an organization-oriented coordination language. Global behaviors described in Paradigm provide flexibility in arranging computation as well as coordination. According to the authors, this flexibility is an organizational, organic and human like characteristic, usually absent in system specification.

Omicini *et al* [32] argue that the coordination language should be able to describe artifacts. Human intelligence has evolved along with the use of more and more sophisticated tools, and that therefore agent intelligence should not be considered as separated by the agent ability to perceive and affect the environment. In contrast, agent intelligence is strictly related to the artifacts that enable, mediate and govern any agent (intelligent) activity.

Question 3 *How to use the coordination languages for human organizations?*

An example of a coordination problem is the model integration problem. In enterprise architecture, for example, many distinct models are used to describe an organization, for example using the unified modelling language (UML) or the Zachman framework for enterprise architecture, and it is an open problem how these models can be related [25].

4.3 Organizational concepts for coordination

Organizational concepts are used frequently for coordination purposes in different areas of Computer Science. For example, roles are used in access control, conceptual modelling, programming languages and patterns. Contracts are used in design by contract, and services are used in web services and service level agreements. Message based communication is used in networking. However, most coordination languages refer mostly to different kinds of metaphors, like blackboards, shared dataspaces, component composition and channels.

Question 4 *Which organizational concepts can be used for coordination?*

Argente *et al.* [3] discuss how to go from human to agent organizations, with examples from electronic institutions and virtual organizations. She compared human organizational taxonomies with approaches to coordination of agents, with the aim to employ organizational theory to develop multi-agent systems based on organizational meta models.

Carabelea and Boissier [12] propose to coordinate agents in organizations using social commitments, describing how one can use social commitments to represent the expected behavior of an agent playing a role in an organization. Norms play a central role in many social phenomena such as coordination, cooperation, decision-making, etc.

The example of powerJava [4,5] illustrates the use of roles, which are adopted in agent oriented software methodologies and programming languages like GAIA, TROPOS, 3APL, etc, to define the organizational structure in ob-

ject oriented languages. For example, roles allow to distribute responsibilities and obligations, and to require the suitable know how to their players. However, open problems are how to transform organizational theories of roles in computational theories and exploring mechanisms about how to assign agents to roles, how to design organizations in terms of roles, monitoring of roles, etc.

Colman and Hun [14] explain how to use association aspects to implement organizational contracts. They show how a coordination system can be implemented by a separate concern, and how association aspects can be used to create contracts that bind roles together in an organization. These contracts allow performance to be specified and monitored. They also define organiser roles that control, create, abrogate and reassign contracts.

Question 5 *How to use these concepts in coordination languages and models?*

The above mentioned papers also illustrate how organizational concepts can be used.

4.4   Security

Traditionally research on coordination and organization has been concerned with cooperative agents, but in open systems security concerns must be addressed. Omicini *et al.* [31] argue that security and coordination are in some sense complementary.

Question 6 *How are coordination and organization related to security?*

In electronic commerce, security is concerned with, for example, potential loss of value, sanctions and control systems. Whereas traditional security concerns have focussed on building control mechanisms such as cryptographic methods, organizational coordination focusses on incentives to motivate agents, and trust and anticipation play a central role too. In [7] we raise the question under what circumstances we need to introduce a control system by considering the following three scenarios. For example, when you buy a ticket to the theater, you buy the right to view a performance that will be delivered later on. The buyer trusts the seller concerning the validity of the ticket. It is an open problem how to balance enforced control and trust-based anticipation to deal with security aspects in the coordination of organizations.

5   Summary

Coordination languages and models like Linda and Reo have been developed in computer science to coordinate the interaction among components and objects, and are nowadays used to model and analyze organizations too. Moreover, organizational concepts are used to enrich the existing coordination languages and models.

Coordination is the "management of dependencies among independent activities" [28], which emphasizes the interaction among these activities, and

their autonomy. Various more precise or technical definitions are given in agent theory and computer science. An organization is a formal group of people with one or more shared goals. In sociology 'organization' is understood as planned, coordinated and purposeful action of human beings in order to construct or compile a common tangible or intangible product or service. Management is interested in organization mainly from an instrumental point of view. For a company organization is a means to an end in order to achieve its goals.

We illustrate how research on coordination can be used within research on human organizations, by illustrating the use of coordination languages in electronic commerce. Many social and economic constructs can be seen as mechanisms for coordination, because transaction typically involve multiple steps and span over time, and constructs such as an escrow service coordinate the activities involved such that in the end we still get the all-or-nothing effect of a transaction. Using a more precise mathematical language forces one to better understand what is going on with constructs such as escrow, Letter of Credit, or other trust instruments.

Moreover, we illustrate how research on organizations in multi-agent systems can be used within research on coordination, by discussing the use of roles in object oriented programming languages. The institution roles belong to coordinates the interaction of the players of the roles independently of their core behavior. In this way for the objects to be coordinated it is only necessary that they fulfill the requirements specified by a role.

We raise the questions which properties a coordination language should have to model organizations, how such a coordination language can be used, which organizational concepts can be used in coordination languages and models, and how these concepts should be used. We highlight two issues. First, we argue for a study of value-based rather than information-based coordination languages to model the coordination of autonomous agents and organizations. Second, we argue for a study of the balance between enforced control and trust-based anticipation to deal with security aspects in the coordination of organizations.

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