Implementing a purpose model of status-functions through ontologies to support the social reasoning of agents

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Abstract. *In multi-agent systems (MAS), the agents may have goals that depend on others and on shared interpretation about the facts that occur in the system. These goals are thus social goals. Artificial institutions provide such a social interpretation by assigning statuses to the concrete elements that compose the system. These statuses enable the assignee element to perform functions that are not exclusively inherent to their design features. However, the enabled functions are not explicit in the existing models of artificial institutions. This limits the agents in reasoning to achieve their social goals in institutional contexts. Considering this problem, this paper proposes a model based on ontologies to express the functions associated with status-functions. We illustrate the model through some examples implemented in the JaCaMo framework, highlighting the benefits that agents acquire when using purposes for reasoning about the satisfaction of their social goals.*

1. Introduction

Consider a scenario where (i) the agent *Bob* has the goal of having a book and (ii) the agent *Tom* has the goal of selling a book. To this end, (i) *Bob* needs to execute an action that means *giving a value in exchange for a good*, and (ii) *Tom* waits for such action to then deliver the book. Both goals are *social goals* because they can not be achieved alone and depend on a *common interpretation* involving certain facts. Without such common interpretation, *Bob* might not know which action to perform to give a value in exchange for the book. Even this would not be the case, *Tom* might not acknowledge the action of *Bob*, refusing thus to deliver the book.

Inspired by human societies, some proposed models and tools provide this kind of interpretation to computer systems and, in particular, to MAS [Fornara 2011]. They usually consider that the elements involved in the interaction among the agents *constitute* (or *count as*) institutional concepts, that are the common interpretation of those concrete elements [Cliffe et al. 2006a, Cardoso and Oliveira 2007, De Brito et al. 2018, Fornara 2011]). These institutional concepts are referred in the literature as *status-functions*: they are *status* that assign *functions* to the concrete elements [Searle 1995, Searle 2010]. For example, the status *buyer* assigns to an agent some functions such as perform payments, take loans, etc. Artificial Institutions are the component of the MAS that is responsible for defining the conditions for an agent to become a *buyer*, or an action to become a *payment* [De Brito et al. 2018].

The existing work on Artificial Institutions is more concerned about (i) specifying and managing the constitution of status-functions and (ii) supporting the regulation of the system. They focus more on the status than the function. While the status is explicit, *the function is usually implicit*. The current proposals, as far as we know, *do not provide the means for the institution to explicitly express the functions of the status*. The main disadvantage of this limitation on the agents' perspective is that they cannot reason about the functions performed by the elements that carry the status. This limitation has some implications. First, agents may not exploit the functions enabled by the institutions to achieve their social goals. For example, in the *Book store* scenario, *Bob* has the goal of *having the book*. *Bob* can execute an action (e.g., transfer) that is interpreted by an institution such as *payment*. However, if *Bob* does not know the functions associated with *payment*, he does not know that an action that counts as a *payment* leads the system to a state where his social goal is achieved. Second, the agents may not reach their social goal in institutions where different status-functions have the same function. For example, consider a *library* scenario where agents obtain books by constituting status-functions other than *payment*. Consider that *Bob* is coded to achieve his social goal exclusively by performing actions that are institutionally interpreted as *payment*. When *Bob* enters this new scenario (i.e., library), *Bob* is unable to achieve his social goal, because it is unable to exploit the functions associated with status-functions and there is no status-function *payment* in this institution.

Considering the difficulties discussed previously, the main contribution of this paper is the specification through an ontology of a *purpose model* that makes the functions of status-functions explicit, simplifying the agent reasoning towards the achievement of their social goals in the institution. It is inspired by the philosophical theories called "Construction of the Social Reality" by John Searle [Searle 1995, Searle 2010] and "Documentality" by Maurizio Ferraris [Condello 2018, Condello et al. 2019]. Both theories help to understand the concepts of social reality used in this work.

This paper is organized as follows. Sec. 2 introduces the main background concepts necessary to understanding our proposal and its position in the literature. It includes philosophical theories, related work and ontologies. Sec. 3 presents the proposed model and its interfaces. Sec. 4 presents a generic algorithm for agents to find ways to achieve social goals and the specification of the model through an ontology. Sec. 5 illustrate the proposal based on some examples that allow us to identify some limitations and advantages that the model offers on the agent perspective. Finally, Sec. 6 presents some conclusions about this work and suggests future work.

2. Background

This section presents the essential background of this work, which includes philosophical concepts (Sec. 2.1), artificial institutions (Sec. 2.2) and ontologies (Sec 2.3).

2.1. Institutions according to philosophical theories

An institution is composed of institutional facts [Searle 1995, Searle 2010]. These are based on status-functions and constitutive rules. Status-functions are statuses that have associated functions. These statuses enable concrete elements to perform functions (associated with the statuses) that cannot be explained through their physical virtues. Constitutive rules specify the assignment of status-functions to concrete elements with the following formula: *X* count-as *Y* in *C*, where X represents the concrete element, Y the status-function and C the context where that attribute is valid. For example, a piece of paper (X) count-as money (Y) in a bank (C).

Statuses are imposed on objects when the status-related functions meet some *Purpose*. The functions are called *agentive functions* because they are assigned from *practical interests of the agents* [Searle 1995, p.20]. These practical interests of agents are called *Purposes*. Since the institution is formed by people (i.e., agents) and their collective agreements [Searle 1995], it is possible to say that the agents themselves (through their purposes) assign meaning to the status-functions. In other words, a purpose is the interpretation of a function performed by an element that carries a status from the agents' perspective. For example, someone has the purpose of winning a chess game when it leads the chessboard to a circumstance that count-as a checkmate. This purpose does not occur naturally. It is attributed through the practical interests of the agents playing the game (i.e., under that context). Fundamentally, both agents involved in the game must have the same understanding of these facts (i.e., about the function and their purpose). Otherwise, none of them achieve their social goal. Searle asserts that someone must be *capable of understanding what the thing is for*, or the function could never be assigned [Searle 1995, p.22]. Understanding a function requires to understand for what it serves (i.e., its purpose). In the case of chess game, the purpose of moving the piece to a checkmating position is to win the game. This purpose is in line with the interests of the agents who are playing the game (i.e., its is understood by the people involved in the institution).

While Searle suggests that status-functions are a consequence of collective intentionality, their origin remains, at least in part, unexplained. For example, throughout history, human societies agreed on assigning the function of money to a piece of paper, a shell or a portion of salt. However, the function seems not having a genesis. It is hard to establish when money or any other social objects were invented. It is also even more difficult to explain the nature of the collective intentionality that motivates people to act in different ways when they have contact with a concrete element constituted with a status. Indeed, Searle considers status-functions as a unique abstraction whose function depends on the individual interpretation of each individual, without worrying about how these functions are represented and shared.

To address the mentioned issues, Ferraris [Condello 2018, Condello et al. 2019] proposes to ground the social reality on structures called Documentality. These structures of documents store informations that not only describe or prescribe, but they actually build social objects. Such a structure makes it possible to explain the staying and persistence of functions (and his purposes) associated with status over time. The speech acts that gave origin to functions and status were written and stored in documents that run through time. These documents allow people to learn theses structures through study, perception, etc. For example, the money exercises its functions in the individual intentions only based in the memory (and consequently in the set of functions) that the social objects recover of the individuals with the base on the recording.

To summarize, social objects are used to externalize the set of recordings that allow individuals to remember the functionalities that a *status* (e.g., money) makes available by being assigned to a social object (e.g., paper note). From these theories, it is possible to conclude that an additional system of elements is required so that functions and status can persist and have value recognized over time within the social reality [Condello 2018].

A similar system can be applied to MAS to make explicit the functionalities of the status-functions that compose the institutions. It will permit to improve the agents' reasoning about the satisfaction of their social goals and overcome the difficulties that motivate the realization of this work.

2.2. Institutions in MAS

The main idea of using artificial institutions as a counterpart of human institutions in computer systems has inspired work in MAS. In different ways, these work use the *count-as* relationship, established through the constitutive rules proposed by Searle, to support the regulation of the system [De Brito et al. 2018]. The purpose of this section is to review state of the art on artificial institutions with respect of the explicit representation of the functions associated with the institutional concepts.

Works on Artificial Institutions are usually inspired by the theory of John Searle [Searle 1995, Searle 2010]. Some works present functional approaches, relating brute facts to normative states (e.g., a given action counts as a violation of a norm). These works do not address ontological issues, and, therefore, it becomes even more difficult to support the meaning of abstract concepts present in the institutional reality. Other works have ontological approaches, where brute facts are related to concepts used in the specification of norms (e.g., sending a message counts as a bid in an auction). However, these works have some limitations that are discussed below.

Some approaches allow the agents to reason about the constitutive rules [Cliffe et al. 2006b, Fornara 2011, De Brito et al. 2018, Cardoso and Oliveira 2007, Viganò and Colombetti 2008, Aldewereld et al. 2010]. However, generally the *status-function* (*Y*) is just a *label* assigned to the concrete element (*X*) and used in the specification of the regulative norms. Therefore, *Y* does not seem to have any other purpose than to serve as a basis for the specification of stable regulative norms [Vázquez-Salceda et al. 2008, Aldewereld et al. 2010]. Some exceptions are (i) in [Fornara and Colombetti 2009, Fornara 2011] where *Y* represents a class formed with some properties as roles responsible for executing actions, time to execute them, condition for execution, etc.; (ii) in [Vázquez-Salceda et al. 2008] where *Y* is a general concept, and *X* is a sub-concept that can be used to explain *Y*. Although the exceptions contain more information than just a label in the *Y* element, these data are somehow associated with regulative norms. There are no models that make explicit what the constituted elements (i.e., the status-functions) perform in the institution. From the perspective of agents, this can be made explicit through the purposes associated with status-functions. Thus, the status-functions' name would be less relevant to the system's correct functioning. Also, new agents could enter the system and understand the purposes of carrying out some functions that have institutional interpretation, resolving themselves to satisfy their social goals. [Rodriguez-Aguilar et al. 2015] corroborate this conclusion by stating that institutions have not yet considered how to help agents in decision-making, helping them to achieve their own goals.

2.3. Web Ontology Language

Web Ontology Language (OWL) 2 is a practical realization of a Description Logic (DL) system known as SROIQ(D). It allows one to define classes, properties, and individuals. Classes can be viewed as formal descriptions of sets of objects, and individuals can be viewed as names of objects of the universe [Fornara and Colombetti 2009]. Properties can be either object properties or data properties. The former describe binary relations between objects of the universe; the latter, binary relationships between objects and data values. An OWL ontology consists of: (i) a set of class to describe the modeled domain, which constitute the Terminological Box (TBox); (ii) a set of properties to describe relationships, which constitute a Role Box (RBox); and (iii) a collection of assertions to describe individuals, which constitute an Assertion Box (ABox).

Inspired by the simplified proposal to represent ontologies (available in [Fornara and Colombetti 2009]), the following notation is used to define classes, properties and individuals: $p : C \rightarrow_o D$ to specify an object property named *p*, indicating a relationship between the class *C* and the class *D*. The notation contains the class *C* as the point of origin and the class *D* as the point of destination. It is important to be clear that *p* in this formalism is a property and not a function. We use capital initials for classes, and lower case initials for properties and individuals.

3. The purpose of status-functions

The model proposed in this work is composed of *agents*, *institutions*, and *purposes* (see Figure 1). *Agents* are autonomous entities that pursue their goals in the system [Boissier et al. 2020]. Through MAS definition (cf. Sec. 1), we can see that *goal* is a fundamental concept to understand and program MAS. The literature presents several definitions of *goal* that are different but complementary to each other. In this work, *goals* are something that agents aim to achieve (e.g. the holding of a certain state, the performance of an action, etc.).

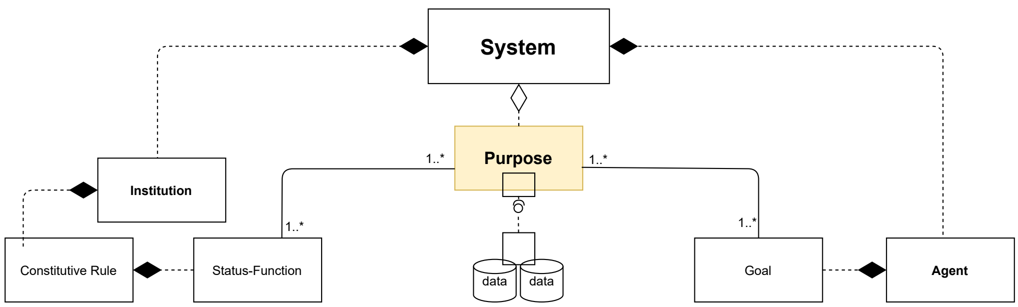

Figure 1. Overview of the model.

Institutions provide the social interpretation of the environmental elements of the system. The several models of artificial institutions consider that constitutive rules specify the assignment of status to those elements, enabling them to perform functions in a certain social context. These statuses with their associated functions are then called status-functions. The assignment of status-functions to the environmental elements is specified through constitutive rules. These rules are generally expressed as *X count-as Y in C* where *X* represents an environmental element (i.e., a brute fact), *Y* represents a status-function to be assigned to X, and *C* represents the context under which the constitution takes place. It is beyond the scope of this paper to propose a model of artificial institution. Rather, it considers this general notion of institution as the entity that constitutes status-functions, that is adopted by several models in the field of MAS.

While *agents* and *institutions* are known concepts, *purposes* are introduced in the proposed model. The *purposes* are an external representation of the practical interests of the agents that can be satisfied by the functions associated with the status-functions (cf. Sec. 2.1). If a goal is something *desirable* by the agent and a purpose of a status-function is a external representation of the practical interests of the agents, then we propose to link them. In this work, we are focusing on *agent's social goals that are satisfied by the purposes of the status-functions*. Therefore, the purpose can be seen as the consequence of the constitution of a status-function (e.g., a state of world) that is aligned with the agent's social goals. For example, the purpose of having a book (i.e., a state of the world reached by the constitution of some status-function) may be associated with agents' social goals such as having a library, having a beautiful bookshelf, having a door weight, etc. In other words, the social goals of the agents can match with the purposes of the status-functions.

In the model, (A) the purpose is connected with the institution through the concept of status-function and (B) the connection between purposes and agents, on the other hand, occurs through the purposes themselves. Shortly, *we are stipulating a relationship between functions of status-functions and purposes and between these purposes and social goals of agents*. Thus, if (i) an agent has a social goal with an assigned purpose, (ii) this purpose is associated with a status-function, and (iii) a constitutive rule specifies how a status-function is constituted, then it is explicit how the agent should act to achieve its social goal (i.e., acting to constitute the status-function that is associated with the same purpose as the social goal). In the previous example, Bob can know that he satisfies his social goal consulting the purpose of *payment* status-function and subsequently consulting the institutional specification to understand what concrete action is constituting the *payment* status-function.

4. A model for purposes of status-functions

This section presents the implementation of the model using ontologies (Sec. 4.1) and an algorithm (Sec. 4.2) to find concrete actions that satisfy social goals.

4.1. Ontology of the model

We specify the proposed model in an OWL 2 ontology. The model represents the *Tbox* and *Rbox* parts discussed in Sec. 2.3. The choice to implement the model using ontologies is justified by the ease of finding and coupling other ontologies available on the web that can represent the *Abox* (domain) part of the application.

The two main classes of the model are *Status-Functions* and *Purposes* (see Figure 2). The first represents the status-functions that may exist in the institution. Each status-function is represented by an individual that pertains to the status-function class. For example, the assertion *pay* $\in \mathrm{status\text{-}function}$ indicates an individual called *pay* that belongs to the *Status-Function* class. The second class (Purpose) generalizes the interests of the agents that are represented through subclasses of that class. For example, *haveBook* is a specialization of class *have*. It can be represented by a axiom $HaveBook \subset Have$. To represent a specific purpose, the developer can create an individual belonging to a class. For example, the assertion $haveBook1 \in HaveBook$ indicates that the individual called *haveBook1* belongs to the *HaveBook* class. When new purposes will exist in the

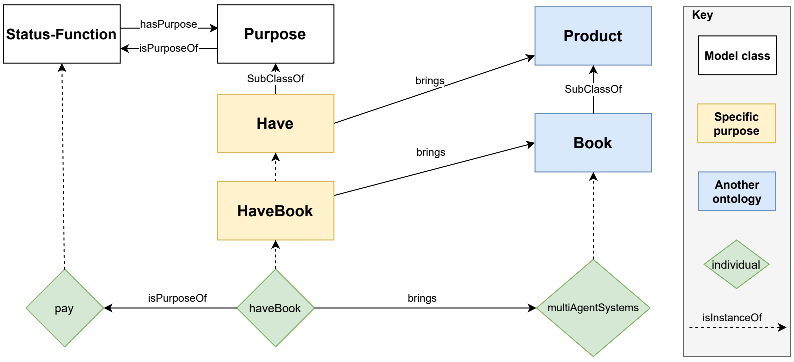

Figure 2. Ontology implementing the model.

system, it is enough to create new individuals to represent them. In this way, the taxonomy of classes and relations are reused. If necessary, the institution's ontology can be related to the ontology of the application domain.

There is a relationship between the classes *Purpose* and *Status-Function* in the model. This relation supports the step 2 of the algorithm 1. The relation is represented through the *hasPurpose* property. The property axiom used to represent this relationship is: $hasPurpose : Status-Function \rightarrow_o Purpose$. These relations have an individual (i.e., a domain) that belongs to the *Status-Function* class and an individual (i.e., a range) that belongs to the *Purpose* class. This relationship means that through the constitution of the status-function, it is possible to change the institution where the purpose is satisfied. We can define a relationship between two individuals belonging to these two classes through assertion: $hasPurpose : pay \rightarrow_o haveBook1$. The example of this relationship means that through the *pay* status-function, the *havebook1* purpose is satisfied.

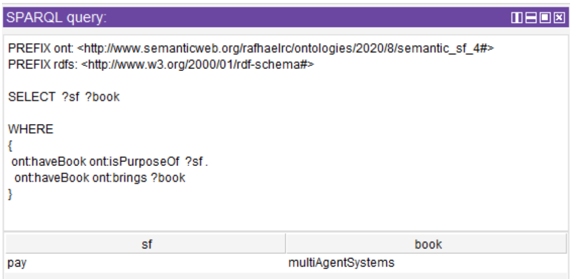

Figure 3. SPARQL query.

The relation *isPurposeOf* is the inverse of the property axiom *hasPurpose*. This relationship is necessary when someone wants to find out the status-functions associated with a particular purpose (i.e., someone doesn't know the status-function name, but someone already knows the purposes). Through this relationship, considering the purpose of *haveBook1*, the *pay* status-function can be obtained. From these definitions, we can specify purposes and relate them to status-functions. This represents the social knowledge that is present in an environment where agents can interact.

From the specification of the model through an ontology and through a language for querying ontologies (e.g., SPARQL), we can obtain answers regarding step 2 of the algorithm (see Figure 3). This query seeks (i) which status-function is associated with the *haveBook* purpose through the *isPurposeOf* relationship and (ii) which concrete element the *haveBook* purpose is associated with through the *brings* property. The results obtained are *pay* for the first query and *multiAgentSystems* for the second query. The queries carried out in SPARQL allow us to observe that the ontology can represent the model's concepts.

4.2. Algorithm to reach agent's social goal

The algorithm 1 can be summarized in three steps: (1) Find a purpose associated with the agent's social goal (line 4); (2) find a status-function associated with that purpose (line 5); and finally (3) find a concrete action that can constitute this status-function (lines 6-7). It is assumed that the actions performed by the agents are taken as events by the institution.

Algorithm 1 Find a concrete action that satisfies a social objective

1: **Input:** agent's social goal
2: **Output:** concrete action'
3: $L \leftarrow \{\}$ ▷ starts the empty set.
4: **if** there is a purpose associated with agent's goal **then**
5:     **for each** status-function σ associated with that purpose **do**
6:         **if** there is a concrete action α that count-as σ **then**
7:             $L \leftarrow L \cup (\sigma, \alpha)$ ▷ add the pair in set L.
8:         **end if**
9:     **end for**
10: **end if**
11: **return** L

Regarding the first step of the algorithm, the specification of the relationship between these two concepts is outside of the scope of this work. The step 2 requires a representation of the social knowledge of the context in which the agent is inserted (cf. Sec. 4.1). Finally, in the step 3 of the algorithm, we assume that there are works that implement the institutional reality and maintain a constitutive specification that the institution must explain [Cliffe et al. 2006b, Fornara 2011, De Brito et al. 2018]. This specification contains rules that allow the agent to understand what concrete actions (i.e., events in the system) it can use to constitute status-function.

5. Using the model in a Multi-Agent System

To exploit the proposed ontology and the algorithm 1, consider an open Multi-Agent System composed of agents, environment and institution. The agents Bob, Alice, François, and João aim to have a book. Different programmers have developed the different agents' specifications, that are slightly different from each other. The goal of agent *Bob* is identified by the term *have a book*. Alice has the goal of *get a book*. François has the goal of *obtenir a book* and João has the goal of *ter a book*. The intended outcome of all these goals is the same. We consider an environment where all agents are located in a book store (Figure 4). This system is instrumented with an institution that contains a constitutive rule stating that the concrete action *transfer count-as pay*. We focus only on this constitutive rule to illustrate the main features of the model proposed (cf. Sec. 3).

The example is implemented with the JaCaMo framework[1] [Boissier et al. 2020] (see Figure 5). The agents (*Bob*, *Alice*, *François* and *João* in Figure 4) are coded in Jason and the environment in CArtAgO. To implement the artificial institution (*Institutional*

[1]https://github.com/rafhaelrc/psf_model

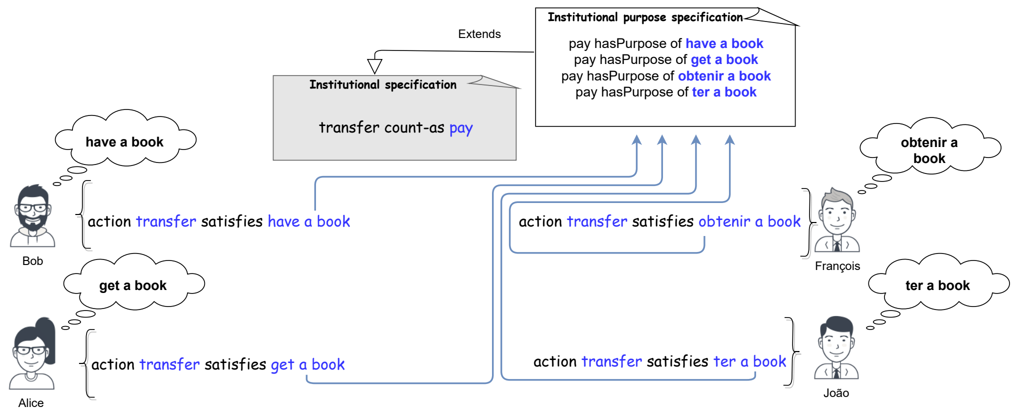

Figure 4. Use of the proposed model in an institutional specification.

specification in the Figure 4), we used an implementation of the Situated Artificial Institution (SAI) model [De Brito et al. 2018]. In SAI, the institutional reality is composed of *status-functions* attributed to concrete elements through the interpretation of *constitutive rules*. To implement the model proposed in this work (*Institutional purpose specification* in the Figure 4), we use ontologies (cf. Sec. 4.1). Finally, to make the model accessible to agents, we encapsulated it in a CartAgO artifact. The query and persistence of data in the ontology was possible because we used MasOntology[2], a set of tools developed in CArtAgO to interact with ontologies.

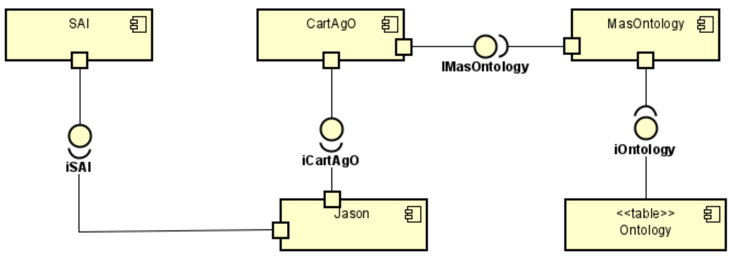

Figure 5. Component diagram with the systems used to compose the example.

Considering the focus of the article, which are (i) the specification through an ontology of a purpose model that explains the functions of status-functions (already specified in Sec. 4.1) and (ii) the relationship of these functions to the social goals of agents, the rest of this section shows how agents can benefit from the proposed model. The other components used in the system (SAI, CartAgO, etc.) are not detailed due to space.

Figure 6 depicts the agents program. The program of all agents are similar, varying only the term they use to refer to their social goals. The agents' social goals can be satisfied by the plans illustrated in lines 4 of each piece of code in Figure 6. In these plans, agents acquire a new goal called *commonPurpose*, that includes all the required actions to find the action that satisfies the purposed related to such social goal in the institution. These goals can be met through the plan detailed in Figure 6 (E). In this excerpt, first the agent consults the ontology (which is a representation of the model) using the *isPurposeOfStatusFunction* operation encoded in a CartAgO artifact (line 10). This

[2]https://github.com/smart-pucrs/MasOntology

```
// agent's goal
!haveBook("MultiAgentSytem").

+!haveBook(Product) <-
   // step 1 of the algorithm
  !commonPurpose("haveBook", Product).
```

(A)

```
// agent's goal
!getBook("MultiAgentSytem").

+!getBook(Product) <-
   // step 1 of the algorithm
  !commonPurpose("getBook", Product).
```

(B)

```
// agent's goal
!obtenirBook("MultiAgentSytem").

+!obtenirBook(Product) <-
   // step 1 of the algorithm
  !commonPurpose("obtenirBook", Product).
```

(C)

```
// agent's goal
!terBook("MultiAgentSytem").

+!terBook(Product) <-
   // step 1 of the algorithm
  !commonPurpose("terBook", Product).
```

(D)

```
8  +!commonPurpose(Purpose, Product)
9    <-
10     isPurposeOfStatusFunction(Purpose, Product, NameStatusFunction);    // step 2 of the algorithm
11     ?constitutive_rule(Action, NameStatusFunction,_,_);                 // step 3 of the algorithm
12     Action.
```

(E)

Figure 6. Plans of the agents Bob (A), Alice (B), François (C), João (D) to satisfy a social goal. These agents include the plan commonPurpose (E).

operation has as its first parameter the term used by the agent to refer to its social goal and the second parameter (if any) is the concrete elements that are related to the purpose (for example, the name of a book). When performing this operation, the agent obtains in the third parameter the status-function that satisfies the purpose. Second, the agent consults which concrete action may constitute the found status-function (line 11). Finally, the agent executes the action, eventually satisfying the social goal (line 12). Table 1 briefly shows the execution of agent *Bob* in the example. The other agents are executed similarly, varying only the time 0 and 1 according to their social goals. From these steps, all agents are able to achieve their different social goals in the same institution.

Table 1. Simulation of the execution of the example.

Time	Agents' actions
T=0	Goal: *!haveBook("MultiAgentSystem")*; Plan: *+!haveBook(Product)*.
T=1	Bob executes the *+!haveBook(Product)* plan and acquires the *commonPurpose("haveBook", Product)* goal.
T=2	Bob starts the execution of the *+!commonPurpose(Purpose, Product)* plan.
T=3	Bob executes *isPurposeOfStatusFunction* method (line 10). The result of this execution is the name of the status-function associated with its purpose (e.g., *pay*).
T=4	Bob queries which concrete action might constitute the status-function (line 11). The result is the name of the action (e.g., *transfer*).
T=5	Bob executes the *transfer* action (line 12), Tom receives the value, he achieves his social goal and hands the book to Bob.
T=6	Bob receives the book and achieved his social goal.

6. Results and future works

The problem motivating this paper is the difficulty of the agents to reason about the functions associated with status-functions representing the institutional interpretation of certain facts that occur in the environment. This problem is partially solved by computational models that implement artificial institutions. However, these models do not represent the purpose of this interpretation from an agent perspective. Agents have to be hard-coded to know which status-functions can be useful for them to achieve their social goals. Considering this problem, we propose the specification of a purpose model using an ontology to express the purposes of status-functions and allow agents to reason about them.

There are some advantages of such conception that we discuss below. The first one is related to the implementation of the model using OWL. Engineers can use the ontology to create representations of purposes based on the core of the proposed model. The ontology can then be extended with domain and application-specific modules. According to [Fornara 2011], Semantic Web technologies are increasingly becoming a standard for internet applications, and thus allow for a high degree of interoperability of data and applications, which is a crucial precondition for the development of open systems. The second is related to the *flexibility* for the agents, that can achieve their social goals even though it is specified with different nomenclatures. For example, the Sec. 5 illustrates a scenario where all agents are located in the same institution (e.g., book store). In this example, specified agents with vocabularies other than the institutional vocabulary can be specified considering the purposes related to the status-functions rather than the status nomenclature. The advantages are (a) the agents can reason about these purposes and adapt their behavior for different scenarios to satisfy their social goals and (b) by reasoning about the purposes of the status-functions, the agent can realise that these purposes are similar to their interests and therefore they can help the agents to reach their social goals. The agent's capability to reason about the purposes and adapt to different scenarios is an important advance in open systems' flexibility [Aldewereld et al. 2010]. The third is related to the *autonomy* of the agents. In this case, the agent can reason about the actions in the plans and the regulative rules that govern the system. In both cases, the agent has greater autonomy and flexibility in deciding whether a particular action will help him reach his social goal. There are also some advantages from an institutional perspective (see [Cunha et al. 2021] for more details).

As future work, we plan to explore additional theoretical aspects related to the model, such as (i) investigations about how other proposed institutional abstractions fit on the model, (ii) the verification of the consistency among status-functions' purposes and agents' social goals, and (iii) study the relationship between purposes and social functions in addition to artificial institutions as defined in other works (e.g., [da Rocha Costa and Dimuro 2012]). We plan to also address more practical points such as (i) the integration of this model in other models that implement artificial institutions, (ii) the implementation of a library that generalizes the use of the model and (iii) the use of the model in real scenarios.

7. Acknowledgements

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