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# Exploiting the Goal Concept for Agent's Intervention Reasoning

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## ABSTRACT
*Agent's interventions, at social, organizational or system level allow to understand the structure and the behavior of knowledge and information systems. The agent's actions and interactions and the evolution of the involved objects are contained in linguistic expressions composed by a verb and its semantic functions. The goal concept, constituted by a verb and parameters denoting the semantic functions of the verb, is a powerful mechanism for representing the agent's interventions. A pertinent organizational information technology involves the interdependence of actors, teams and organizations in a changing environment. The organizations are compelled today to adopt flexible structures and to adapt dynamically their business relationships. The formal and informal goal discovering and reasoning is supported, in this work, on a verbs/goals ontology and on the variations of the parameters composing the goals. Goal reasoning and the development of alternative solutions are illustrated with a business agent's intervention.*

## INTRODUCTION
The organizations are today submitted to frequent changes in their environments, which demand them to adopt flexible structures and dynamic adaptation of their business relationships. The ongoing trend towards an organizational information technology rather than a technology centered in the automation of well-established processes, Lamweerde (2001), Yu (2001), involves the interdependence of actors, teams and organizations and the permanent interaction between the organizations and their environments. Beyond the requirements elicitation, the system's technologies need to support the analysis of alternatives taking into consideration the user's needs and the stakeholders' interests.

Yu (1997) claims for more support to reasoning in the early-phase of requirements engineering considering the stakeholders interests and puts emphasis on understanding the "whys" rather than on detailed specification of the "what" the system should do. Focusing on the "whys" is a not new concept, the "context analysis" introduced by Ross et al. (1977) determines the reasons why a system has to be developed.

An actor is an entity taking an active part in an action, an activity or a process. The agent is an actor responsible for the execution of an action, an activity or a process. The actor affected by the execution of an activity, a process or interacting with the agent is considered a cooperative agent.

The Goal concept, widely used in Requirements Engineering has been applied in many disciplines, such as: management, human-computer interaction and strategic planning. Ross et al. (1977), Rolland et al. (1999) use the goals to express the rationale used for accomplishing the contextual objectives. Aiming to requirement derivation, the goal concept is used by Anton et al. (1994), Rolland et al. (1999), Dardenne et al. (1993). System goals, in our work, are derived from goals expressing agent's relationships.

Yu (1997) arranges and evaluates alternative solutions using goals. Anton (1996) views the goals as a mechanism for identifying and justifying software requirements. A requirements engineering framework based on the notions of actor, goal and intentional dependency is presented by Donzelli et al, (2003) in the field of Information systems for e-Government.

The referred current approaches aim to support the reasoning used for adapting the organizations and their systems to the change and for analyzing alternative solutions in knowledge and information systems. These approaches are constrained to particular aspects or models to conduct the reasoning and they do not have criteria to validate and formalize the informal contributions. In this article systematic formal and informal reasoning is supported on the verbs/goals ontology and on the variations of goal's parameters. Our work introduces a frame for goal representation and a verbs/goals ontology to support the goal's treatments.

In this paper, the interest is focused on exploiting the goal concepts and a verbs/goals ontology for agent's interventions reasoning at social, organizational and system levels. Interventions are *interactions* among the principal and the cooperative agent, or *actions* executed by autonomous agents. The reasoning may be formally or informally conducted, but it may be always validated, modified or confirmed with the intervention of organization's analysts and system's engineer, using verbs/goals ontology. These practitioners are supported for reasoning.

Section 2 presents the concept and frame for goal representation. A short description of the verbs/goals ontology is included in section 3. The reasoning involving the agent's intervention is described in section 4. In Section 5, future and related works are presented. Last section includes the references.

## 2. GOAL REPRESENTATION
The formalism for goal representation and classification contains a verb and its associated semantic functions, which are represented by parameters. The parameters taken in account are: Agent, Target, Stage1, Stage2, Means, Method and Cooperative Agent. Each goal adopts the frame of its verb.

In an hypothetical organization, it is considered, for example, the organizational agent's intervention where the "Engineering Section" as principal agent designs a product for the "Production Section" acting as cooperative agent. The assumed general frame (verb+parameters), Figure 1, is illustrated with the goal S1. The seven stages for accomplishing this goal are indicated, in the columns stage 1 an stage2, by the verbs announce, activate, ask, apply, valid, work, gives, which give birth to seven stationary goals as it will be explained in section 4.2. That the stationary goal S1 is a component of a discovered goal P1is also explained in that section. The target of S1 is a derivation of the target of P1.In our example only the interaction among the organizational agents "engineering section" and " production section" is considered

The parameters represent the verb's semantic functions agreeing with the case grammar. The one that executes the verb's action is the *principal agent* and the agent affected or interacted by the agent is a *Cooperative agent*.

The grammatical constituent that is acted upon is the Target. *Means* and *Method* are, respectively, the instrument and the way to achieve a goal. Phenomena denoting the stages of a process, directed by the principal agent, arrange the stage1; the stages controlled by the cooperative agent correspond to stage2.

Each sense of a verb is identified for an exclusive frame composed by a verb and the specification of its valid semantic functions. The verbs *keep(1)* and *Keep(2)*, for example, have different sense and they take different place in the ontology.

| Goal | Principal agent | verb | target | stages1 (pl. agent) | stages 2 (coop. agent) | means | method | Cooperative agent |
|---|---|---|---|---|---|---|---|---|
| S1 | Engineering | Designs | Product | Signal Put up Judge operate put | Turn on Put | computer | Graphic | production |
| P1 | Corporate management | Defines | Product line | Announce Offer valid work Give) | Activate Apply | engineering | Decision techniques | production |

Figure 2.Goal represnting ame

| Abstraction levels | Verbs/Goals | | | | Agent's interaction patterns | |
|---|---|---|---|---|---|---|
| | Causative | | Descriptive | | Composed verbs | |
| | Object treatment | | Agent Manifestations | | Principal agent | Cooperative agent |
| | Evolution | Abstraction | Concrete | Abstract | | |
| Service verbs | Compile, keep track manage(1) | | | | | |
| Process verbs | Create, construct, fabricate, grow, evolve, exchange, adapt Promote, Deploy, Evaluate, Treat, remit, Start up, Present Credit, entrust, provide, furnish, obtain, affect, calculate, manage(2) modify, translate Achieve, treat | Discuss, justify, confirm, , Compare | Become, deal, | Argue, diverge | Promote Show Evaluate Treat Remit | Start up bring |
| Activity verbs | Treat(2), cancel, activate,create,ask give avoid, maximize, demand,confirm minimize, verify, apply, pass, evaluate,keep(1),Associate, connect complete, | offer, decide, realize, reach describe determine | | | Announce Offer Valid Work Give | Activate Apply |
| Action/states verbs | Protect, preserve, set, put, keep(2) | Exonerate, absolve, Realize(2), imagine, | Remain | | Signal Put up Judge Operate Put | Turn on Put |

Figure 2. Fragment of Verbs/Goals Ontology with composed agent's interaction

| Conceptualization pattern | | | |
|---|---|---|---|
| | Structured verbs | Composed verbs | Elementary verbs |
| Service | reason | **conceive** | **represent delimit** |
| | | think | |
| Process | conceptualize | **define** | **present limit** |
| | | understand | |
| Activity | analyze | **identify** | **describe determine** |
| | | relate | |
| Action/State | formalize | **characterize** | **symbolize quantify** |
| | | specify | |

## 3. VERBS/GOALS ONTOLOGY

The verbs/goals ontology developed in this paper, represents and organizes goals relating the agents, the cooperative agents and the domain objects. These elements may be expressed by the goal's parameters Agent, Target, Stage1, Stage2, Means, Manner, Cooperative agent and Non Functional Features. Goals are represented in the verbs/goals ontology in accordance with their possible parameters.

A partition of the English verbs allows the classification of the verbs/goals in two high branches: *Causative* verbs/goals, acting upon the target and *Descriptive*, verbs/goals, expressing the agent's manifestation. The first branch contains the sub-branches: *Object Evolution* verbs/goals, Figure 2, and *Object Abstraction* verbs/goals. The second one includes the sub-branches *Agent Concrete Manifestation Goals* and *Agent Abstract Manifestation Goals*. The first level categories in the four branches are *Service* verbs/goals. *Process* verbs/goals arrange the second level. The third level corresponds to *Activity* verbs/goals. The fourth level represents *Actions/States* verbs/goals. All four categories in the verbs/goal ontology contain verbs/goals of three composition degrees: structured, composed and elementary verbs/goals. Structured verbs/goal are composed of composed ones and these, in turn, are composed of elementary verbs/goals. The semantic concepts constituting the verbs/goals ontology represent the structured, composed and elementary service, processes, activities and actions/states that each group of verbs can express. Only the composed verbs/goals and reduced semantic concepts are included in our example, Figures 3 and 4.

Next section explains the agent's intervention reasoning.

## 4 AGENT'S INTERVENTION (GOALS) REASONING

The proposed goal S1, Figure 1, comes from the business process although it ought to have

been *created* by the user or the Systems Engineer. In the same way the goal may be modified, eliminated, composed, decomposed, refined, integrated, generalized, specialized, adjusted or converted from descriptive goals. Previously to these treatments, two reasoning steps must be conducted on the goals. The first step, *agent conceptualization*, is conducted to determine de principal and the cooperative agent, thus the intervention level and its associated object domain is established. The second step, goal *conceptualization*, is conducted to define the abstraction level of the goal in accordance with the goal's verb, supported on the verbs/goals ontology. This last step finds the other cooperative agents, the quality features and the other objects involved in a goal.

### 4.1 Agent and Goal Conceptualization

Performing the reasoning steps to the goal S1, the agent's conceptualization identifies *engineering section* as the principal agent, which indicates the initial *processor* type of this agent. *Production section* is identified as cooperative agent with *requester* type. The direction for the agent's interventions is always *processor-requester*. Principal and Cooperative agents alternate the *processor* and *requester* role in the goals expressing the agent's interactions to achieve a convolutive or a progressive goal, in accordance with the interaction refinement patterns expressed in stage1 and stage2 columns in Figure 1. The refinement of goals representing the agent's interventions finally conduces to instant goals, expressed with action verbs and specifying the responsibilities of the autonomous agents. Thus, the pertinence and efficacy of the agents, with different abilities, may be evaluated.

It is the task of the goal conceptualization step: a) to find the causative *service* or *process* verb. Service and process verbs capture contextual information and more general parameters for developing fruitful and pertinent goal refinements. The sense of the verb *design* in the related context is a *composed activity verb*. That means that it is an activity verb that may be composed of several activities developed at the same time. This verb takes the place of the verb *identify* in the fragment of the ontology and it may be refined from the composed process verb *define* (2) in the verbs/goals ontology. The number (2) indicates the second sense of the verb in the ontology. *Define* (2) is a composed process verb, because it may be decomposed in process verbs. The composed activity verb *design* is a refinement from the composed process verb *define*(2), and it is refined, in turn, in the composed action verb *characterize*. These refinements are represented in Figures 3 and 4, but system's users and engineers may use another valid refinements and decompositions. The selection of the verbs/goals ontology, in Figure 3, illustrates verb's refinement and decomposition used to support the system's users and engineer in goal reasoning. That selection constitutes a pattern for goal decomposition and refinement, which is beyond of the scope of this article. b) to arrange the *target* parameter. In accordance with the principal agent "engineering service" and the verb *define(2)*, *Product line* is the compatible target of the introduced composed progressive goal P1. Consequently *Product* as a derivation of *Product line* remains the target of the original composed stationary goal S1, Figures 1 and 4. This goal refinement involves the refinement of the verb and the derivation of the parameters. c) to determine the goal's components. d) to identify other eventual cooperative agents. e) to integrate the Non-functional features.

### 4.2 Goal treatments

Among the previewed goal treatments: refinement, integration, conversion, creation, modification, composition, decomposition, generalization, specialization, adjustment, only the refinement, integration, composition, decomposition, modification and adjustment are considered in this work. The goal treatments generate the goals and the goal's relationships to enrich the system's specifications.

For sake of simplicity, in this article, the textual goal's expressions contain only the agents, the verb and the target.

### 4.2.1 Refinement/Integration

The refinement of the goals involves the refinement of the their verbs, in fact the transit from a abstraction level to the next lower one. In Figure 4, the goal "define product line" is an integration of the original "design product". Thus the later is a refinement of the former. The integration/refinement reasoning for the composed activity verb "design" is set in Figure 4. These fragments of the verbs/goals ontology, in figures 2 and 3 may a future aid for the verbs/goals integration/ refinement, but the system's users and engineers may always introduce other verbs respecting the proposed abstraction levels. The goal of the upper level keeps the goal's target, while its refinement takes as target a derivation of that goal's target. The parameter's derivations (inheritance, composition, characterization, etc.) are based on the *domain object derivation structures*, which are not considered in this work. Indeed, we refer, in our example, the targets as *product*, *product's features* and *product's subordinated features*. The verbs are refined in accordance with the verbs/goals ontology and the parameters are refined following these same abstraction levels considered in the *domain object derivation structures*. The goal "characterize product's features" refines, in Figure 4, "design product ". *Service*, *process*, *activity* and *action/ state* verbs constitute the four abstraction levels considered in this work. Verbs/goals ontology supports the identification of *service*, *process*, *activity* and *action* verbs. Here only one refined goal from each level is depicted. The proposed refinement patterns, represented by verbs in the stage columns in Figure 1, lead to more goal discoveries. The composed process verb *define*(2), in the progressive goal P1, has the refinement pattern expressed, in the stage parameters, by the activity verbs: *announce*, *activate*, *offer*, *apply*, *valid*, *work* and *give*. The verb *design* is a composed activity verb, in the ontology in Figure 2, or it may be characterized as composed activity verb by the system's users and engineers considering the possible accomplishment of the verb "design" in only one stage and composed by various activities (with activity verbs). This verb substitutes the verb *work* in the pattern. For simplicity's sake the goals expressed by the other verbs in the pattern, are not included.

### 4.2.2 Composition/Decomposition:

In each abstraction level the *structured verbs* are constituted of *composed verbs* and these are, in turn, constituted of *elementary verbs*. These are the three composition degrees. In our example, depicted in Figure 4, we consider only the composed verbs. The reflection on the goal "design product'" allows us to understand that the activity verb *design* is a composed verb. That means that the actions expressed by the verb *design* may compose the actions of a structured activity verb. Thus "design product" may be a component of "reason product" joined with the goal "relate product", which constitutes another component of that goal. The actions expressed by the verbs *design* and *relate* are expressed by the verb *reason*. This way of decomposing the structured activity verb is presented in figure 3, but the system's users and engineers may propose another decomposition respecting the degree of decomposition of the verbs. At the same time, following the previous reasoning expressed in Figure 3 or by new reasoning the system's users and engineers may find that the actions of the verb *design*, at the place of the verb *identify*, are composed by the actions of the elementary activity verbs *describe* and *determinate*. These verbs are activity verbs composing the actions of the verb *design* in only one stage. The parameters of the new goal are derived from the *domain object derivation structures* at the same abstraction level. These structures consider the intervention levels, the abstraction levels and all type of relationships among the objects. The *abstraction levels* and the *degrees of composition* of the verbs determine particular categories in the verbs/goals ontology, which contains the classes of verbs fitting these characteristics. The system's users may use different criteria to conduct the integration/refinement and the composition/decomposition of goals using the verbs that they find more pertinent. These verbs are taken from the ontology or they are validated there. The verbs not previously included in the ontology are stored and then they are confirmed or modified by the system's engineer. For example, the verbs *describe* and *determine* were not originally in the ontology, the system's users have used them and then the system's engineer has confirmed these verbs in the ontology, Figure 2.

### 4.2.3 Modification

The modification of parameters leads to discover alternative goals supporting alternative solutions. In this work only the change of *means* and *methods* parameters is introduced for obtaining goal's alternatives.

Performing the reasoning to the *means* to achieve the stationary goal "determines product", in Figure 4, two alternative *means* are used: *by simulation* of the product's life cycle and *by calculation* of limit values of product's features. These alternative means give place to a pair of alternative goals using the verbs *simulate* and *calculate*, which express a precise way to determine the product. This reasoning directs the assessment of different technologies. The new verbs are, in turn, submitted to goal treatments. Reasoning out the agent's modifications leads to assign the responsibilities to the more pertinent agents.

### 4.2.4 Adjustment

The transit from an agent's intervention level to another level involves the adjustment of a goal at an agent's intervention level to express a pertinent goal at other level. *Social*, *organizational* and *system* levels are the three agent's intervention levels, considered in this work. The new goal is a *strategic goal* and constitutes the beginning of the process of a goal, with all possible treatments. The start goal is marked with the name of the agent's intervention level. Thus de goal "define product line" carries the name "organizational". In our example, Figure 4, the goal "describe product" is going to be adjusted by the new strategic goal "treats product", which reformulates the precedent goal aiming to conduce its achievement at the "system" level. The new goal has the label "system" and may take the verb *treat* from the ontology's fragment, Figure 2, as a composed process verb acting upon the same target than that of the adjusted goal. The verb ought to be any verb to be validated in the ontology or confirmed by the system's engineer. These adjustment goals are *strategic goals* that support the reengineering of the business process as well as the change propagation throughout the agent's intervention levels: social, organizational and system level.

The refinement of this adjusting goal "treat product" uses the *composed stationary* and the *composed instant patterns*, Figure 2, sequentially. For space's sake only the stationary composed verb "work" and the composed instant verb "operate" of the patterns are used to express the goal refining the adjusting goal. The target's parameters are derivation of the target's parameters of the precedent goals. The target of the goal "operate product's subordinate features" is a derivation of the target of the goal "works product's features".

The contribution of this work and the future works are discussed in next section.

## 5. DISCUSSION AND FUTURE WORKS

The level of analysis of actor interactions in terms of ability, workability, viability and believability considered in i*, Yu (1994), Yu (1997) may be reached in our reasoning approach about the different Means and Methods for goal achievements, and the progression stages of the goals. In this way our approach offers many viewpoints for understanding the agent's relationships beyond the above proposed analysis levels. Ongoing works are centered in the analysis and formalization of goal relationships, structures and relationships among domain objects and the integral management of functional and non-functional requirements.

The concept of cooperative agent, in our goals, determines the goal operationalization and fixes the agent's responsibilities, among many alternatives, to accomplish the tasks asked by the users and the other stakeholders in the system.

The elements used to present formal viewpoints for reasoning about the goals and the agent's interactions considered in our goal structure is a contribution to understand the "whys" that underlie system requirements proposed in Yu (1994).

The reasoning centered on the goal's parameters, supported on the verbs/goals ontology is used for modeling the formal, informal, established or potential agent's interactions. They relate the system's decision to business objectives and agents' capacities and interests. The tool Crews-L'Ecritoire establishes a base for assessing our requirements elicitation. Structure of goals and improving the semantic of verbs/goals ontology will be in future works discussed. The notions of actor, goal, actor´s relationships, as considered by Yu (1997) and Donzelli et al: (2003), and the assessment of ontologies, Chisholm (1996), Roseman et al. (2002), Wand (2002), are included in ongoing works.

Anton (1996) searches the goal as high level objectives and assigns them to the agents as ultimately responsible for the goal achievement or maintenance. In this paper the agent's roles and the relationships among them are first identified from formal or informal problem descriptions. The goals represent the interaction among agents, which will be operationalized in actions under responsibilities of a particular agent, using the verbs/goals ontology.

The relationships among principal and cooperative agents are expressed as *convolutive*, *progressive* or *stationary* goals.

The proposed agent-centered goal-based approach uses the goals to determine the more adequate alternative for the assignation of responsibilities to agents, in the same sense was in precognition by Dardenne et al. (1993). The goals are effectively used to define which agent should be best to perform a certain action fitting the concerned constraints.

The five patterns of goals (achieve, cease, maintain, avoid, optimize) introduced by Dardenne et al. (1993) are important for understanding the goal's relationships and their influence in the behavior of the systems. They are completed in our domain-independent verbs/goals ontology where the different categories determine the possible goal relationships using appropriate verbs. In a future work the goal's relationships will be included.

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