Semantic Alignment of Context-Goal Ontologies

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Abstract. Several distributed systems need to inter-operate and exchange information. Ontologies are gained the popularity in AI community as a means for enriching the description of information and make their context more explicit. Thus, to enable Interoperability between systems, it is necessary to align ontologies describing them in a sound manner. Our main interest is focused on ontologies describing systems functionalities. We treat these lasts as goals to achieve. In general, a goal is related to the realization of an action in a particular context. Therefore, we call ontologies describing goals and their context Context-Goal [4] Ontologies. Most of the methodologies proposed to reach interoperability are semi automatic, they are based on probabilities or statistics and not on mathematical models. The purpose of this paper is to investigate an approach where the alignment of C-G Ontologies achieves an automatic and semantic interoperability between distributed systems based on a mathematical model "Information Flow".

1 Background and Outlines

The exponential growth of information and resources exchanged between different systems increases the rate of heterogeneous information and makes their understanding and analysis very difficult. A crucial problem arising from this heterogeneity concerns the preservation of the meaning (sense) of the exchanged information. This is what we call the *Semantic Interoperability*. A definition is commonly accepted for semantic interoperability: *it gives meaning to the exchanged information and ensures that this sense is common in all systems between which exchanges must be done* [9] [18]. Therefore, distributed systems may combine the received information with the local one and treat the whole in a consistent way.

To ensure semantic interoperability, the exchanged information between systems must be described in a formal structure preserving its semantics. The great challenge is omnipresent in the knowledge Engineering field, where the proposed methodologies and techniques collect, identify, analyze, organize and share knowledge between different organizations. Among these techniques, *ontologies* are gained the popularity in AI community as a means for enriching the description of information and make their context more explicit. They represent an efficient and promising way to implement this is through the use of Ontologies, an explicit specification of conceptualization [8].

The semantic interoperability needs the use of methodologies which establish semantically links between the services provided by the communicating entities of the distributed system. In literature, discovering these links is called *ontologies alignment* , it aims to find connections between concepts belonging to different ontologies within a single application.

After a careful look at the different theories related to these topics, such as the MAFRA framework developed for the mapping of distributed ontologies [14]. Using the Bridge notion, MAFRA allows to create semantic relations between two (source and target) ontologies and apply such relations in translating source ontology instances into target ontology instances.

GLUE is another framework. It is a system that employs learning techniques to semi-automatically create semantic mappings between ontologies[7]. PROMPT is a tool for merging ontologies.

In [11], the approach mainly builds on the IF-Map method to map ontologies in the domain of computer science departments from five UK universities. Their method is also complemented by harvesting mechanisms for acquiring ontologies, translators for processing different ontology representation formalisms and APIs for web enabled access of the generated mappings. In [16], first-order model theory are investigated to formalize and automatize the issues arising with semantic interoperability for which they focused on particular understandings of semantics. But it would be desirable to provide a theoretical framework that accommodates various different understandings of semantics depending on the semantic interoperability. Authors made the first step towards semantic integration by proposing a mathematically sound application of channel theory to enable semantic interoperability of separate ontologies representing similar domains. In general, these works present some insufficiencies. They are semi-automatic (MAFRA, IF-MAP), or centered on probabilities (GLUE) or based on syntactic similarities (PROMPT). For that, it is useful to develop applications in order to automat the ontology alignment.

In the context of distributed systems, the communicating subsystems differ, generally, by a set of services that each one provides to the other, in order to realize global goals. These goals are directly related to the provided services : accomplish a service is done with an objective and achieve a goal is also performing a particular service. In this spirit, several researches are interested in goal notion and in its representation [5], [19], [10], [17] and [2]. These works have proved the effectiveness of system modeling using goals. For this reason, we are interested in our research to the goal oriented modeling. The majority of these works are centered on the description of the functionalities of systems and their components. They have denoted a functionality of a component as a " verb+noun " style for representing the component's activities (or actions) and its operands which needs an ontological schema for functional knowledge which specifies not only the data structure but also the conceptual viewpoint for capturing the target world [12]. Following this approach, we associate with each goal some possible actions (at least one) in order to fulfill the intended goal. At this level, there is a lack of formal terminology [13]. To remedy this problem and represent goal semantics

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[4] we abbreviate Context-Goal as C-G

formally, our approach uses the linguistical aspect based on the principle of linking names to verbs via lexical relations. For example, the structure associated with the name *Temperature* can contain verbs: to measure, to reduce, to increase .. These verbs express the intention or the function related to this name. More precisely, if we analyze two goals "to measure the temperature of a room " or "to measure the temperature of a human being ", we note that the action is always the same but its context is different. This brings us to introduce the concept *Context of a goal*. Our work is focused around two issues that are, on the one hand, the representation and reasoning on goals and, on the other hand, the resolution of semantic interoperability.

The present paper is divided into five sections. In the first one, we present a short background on the existing researches in our domain. The second section introduces a case study to illustrate our approach. In the third section, the C-G ontology construction is defined. The fourth section presents the appropriate part of IF model. The fifth section is centered on the principle of the C-G ontologies alignment.

2 Case Study

To illustrate our different definitions, we propose a case study which concerns an open channel hydraulic system composed of three subsystems (S1, S2, S3) connected with a CAN network. The first system is situated upriver. It performs two pressure measurements from a Pitot sensor: dynamic and static pressure. The measurement of velocity depends on these two pressures. S1 provides, also, the value of the water level in its area. S2 is similar to S1. It has, in addition, an actuator able to regulate the water level. The actuator is a sort of gate activated by the difference of two values of velocity (local velocity and received velocity from distant system-S1 or S3-) and modifies its position with the help of a brushless motor. The actuator is activated only if the velocity comes from a remote upstream system. S3 is the downstream system, it is similar to S1

S2 plays a central role. It must satisfy the global goal which is the regulation of the level by activating the gate according to the velocity information received from the upstream system. The problem appears very simple, but if we consider that a system identical to S2 is a downstream system from S3, then things become less trivial. Indeed, S2 may receive a velocity information from S1, but also from S3. It is then necessary to select the good information. On an other hand, S1 may send two identical information, but from two sequences of different actions. Again, it is necessary to discern the sequence of actions in order to choose the right connection to S2. To solve this problem, we base, on one hand, on a formal representation of goals and their contexts, and on the other hand, on the semantic coordination mechanism of systems using the Information Flow (IF).

3 Context-Goal Ontologies

3.1 Formalization of Context-Goal pairs

We will see in this section how to formalize the knowledge of a given system in terms of C-G Ontologies. We have introduced the context notion which is related to a goal, where this last is the result of an action on a given context (see figure 1). The pairs C-G will be related to form plans in order to satisfy goals.

The context is employed in different disciplines : computer science (mainly the Artificial Intelligence), cognitive science, linguistics, philosophy, psychology or yet in the application areas such as medicine or legislation. In the applications of "Context-Aware" field, the context is considered as an information which characterizes a situation: “ *By context, we refer to any information that characterizes a situation related to the interaction between humans, applications, and the surrounding environment. Context-aware applications*

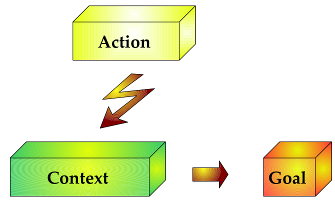

Figure 1. Context-Goal pair

promise richer and easier interaction” [6]. According to Brézillon, the context is always relative to some thing : state, time, object, situation .. " *Le contexte sert de guide au focus, c'est-à-dire au sous-ensemble d'éléments qui sont pertinents pour la tâche en cours* " [3].

In [4], a context is expressed in record of dependent types based on an intuitionist logic. This record is a sequence fields in which labels l_i correspond to certain types T_i, ie, every field may depend to values of precedent fields. We use a simplified version of this approach where a First Order Logic is employed. Contexts are modeled by a structure of knowledge including entities, constraints and proposals. These lasts are extracted from a domain ontology. Based on this idea, we formalize contexts distinguishing two categories:

- **Context Type** : a context type C is constructed from a set of types of objects $\{T_1, T_2, ..T_m\}$ describing entities, properties and/or constraints. We formalize context by the following tuple:
- **Context Token** : a context token c introduce the objects (instantiated types) called tokens which represent an instance sequence of types $\{t_1, t_2, ..t_n\}$. A context token is defined by the tuple:

$$C = \left[\begin{array}{ll} l_1 & : T_1 \\ l_2 & : T_2 \\ & \dots \\ example & \\ Z & : Zone \\ \kappa_1 & : Static(Z) \end{array}\right] \qquad c = \left[\begin{array}{ll} l_1 & : t_1 \\ l_2 & : t_2 \\ & \dots \\ example & \\ z_1 & : Zone1 \\ \kappa_1 & : Static(z_1) \end{array}\right]$$

l_i are labels.
We say that a context (token or type) is valid if and only if the conjunction of the tuple elements are valid.

A goal is defined by the result of an action associated to a particular context. When the context is a type context, we speak about a " *Goal type*" and in the other case we say " *Goal token*". Each pair "C-G" is associated with a real action corresponding generally to the execution of a function within the computational meaning.

The functional aspect of the association C-G is preserved adopting the following rules:

Rule 1 : At a given context, a single action is associated.
Rule 2 : several contexts may correspond to one action because the action can be carried out in several contexts of execution.

In a given system, we denote the C-G pair by $(C_i, \gamma_j)^{(k)}$, such as : C_i is a given context, γ_j is goal and k is a system.

According to our case study, we give the following example extracted from the thesis [15]. The context $C_5^{(1)}$ corresponds to an action " *receive* " where the result is a velocity value received from another system. The basic constraint is the good functioning of the network ($\kappa_1 : Online(R)$). The result is the goal type $\gamma_4^{(2)}$.

$$C_5^{(2)} = \left[\begin{array}{ll} R & : Network \\ \kappa_1 & : Online(R) \\ V & : Velocity \\ Pos & : Distance \\ \kappa_2 & : Sent(V, Pos) \end{array}\right. \rightarrow \gamma_4^{(2)} = \left[\; g \; : Received(V, Pos)\right.$$

3.2 Relations between C-G pairs

In general, an ontology should satisfy an explicit definition of concepts and relations among them. In our approach, the pairs Context-Goal are the ontology concepts and the relations between them are the causal order of goals achievement. We define two relations between the pairs : Causal Dependency and Subsumption Dependency.

3.3 Causal Dependency

We define the inherent causality in systems by dependance relations which base on the inclusion of types.

If a goal associated to a given context is realized, then it is possible to find another context in which this but appears. In other words, if this goal is included in the structure of another but it becomes possible to connect the two pairs. This result may be generalized to several contexts. We can formalize this in the following way:

Definition 1 *Contextual Inclusion*
Let (C, γ) and (C', γ') be two pairs of context types and goals (resp. tokens) such as γ be a goal type representing the result of a given action on C. If C' contain γ, then we say that γ is included in C' and we write:

$$\gamma \subseteq C'$$

Example: $\gamma_2^{(1)} \subseteq C_5^{(1)}$, where $\gamma_2^{(1)}$ is the goal type corresponding to the action of measuring the velocity value.

We define the causal dependency by:

Definition 2 *Causality*
A pair C-G $(C_l, \gamma_m)^{i(k)}$ of abstraction level i in a system k is in causal relation with the pair $(C_{l+1}, \gamma_{m+1})^{i(k)}$ in the same level and system if $\gamma_m^{i(k)} \subseteq C_{l+1}$ and we denote:

$$(C_l, \gamma_m)^{i(k)} \preceq (C_{l+1}, \gamma_{m+1})^{i(k)}$$

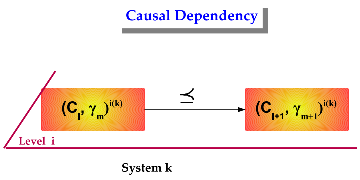

Figure 2. Causal Dependency between C-G pairs

The validity of a pair Context-Goal (C', γ') depends on the completion of the goal γ. This means that the pair (C, γ) "*causes*" the occurrence of (C', γ').

When the pairs are not of the same level, we propose for that the relation *Subsumption Dependency*:

3.4 Subsumption Dependency

Definition 3 *Subsumption of pairs Context-Goal*
A pair Context-Goal $(C_q, \gamma_r)^{i+1(k)}$ of level $i+1$ on a system k subsumes a plan $(C_l, \gamma_m)^{i(k)}, ..., (C_{l+p}, \gamma_{m+p})^{i(k)}$ of level i on the same system if the realization of $\gamma_r^{i+1(k)}$ depends to the realization of all the goals in the types sequence $(\gamma_m, ..., \gamma_{m+p})^{i(k)}$ which we note:

$$(C_l, \gamma_m)^{i(k)}, \ldots, (C_{l+p}, \gamma_{m+p})^{i(k)} \sqsubseteq (C_q, \gamma_r)^{i+1(k)}$$

Example: $(C_1, \gamma_1)^{1(1)}, (C_2, \gamma_1)^{1(1)}, (C_3, \gamma_2)^{1(1)}, (C_5, \gamma_4)^{1(1)} \sqsubseteq (C_1, \gamma_1)^{2(1)}$ where $\gamma_1^{2(1)}$ goal type of level 2 which corresponds to the measurement of the velocity in system S1.

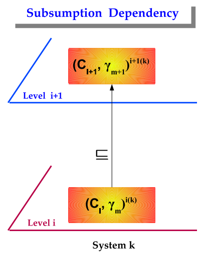

Figure 3. Subsumption Dependency between Context-Goal pairs

3.5 C-G Ontologies Formalization

The C-G ontology $\mathcal{O}$ obeys to the following formal structure:
Definition 4 *C-G ontology*

$$\mathcal{O} = (\mathcal{G}, \preceq, \sqsubseteq)$$

Where $\mathcal{G}$ is the set of Context-Goal types pairs, $\preceq$, the relation of causal dependency between Context-Goal types pairs and $\sqsubseteq$, the subsumption dependency relation.

We have established a knowledge representation (goals) by defining an intentional ontology. This ontology includes pairs of Context-Goal types, allows firstly the representation knowledge and, secondly, provides a conceptual basis to use the IF model in order to link the subsystems of a distributed system. We recall the posed problem in the case study where the system S2 must regulate the level of water in the channel. To solve the problem, we use a mathematical model (IF) which connects Context-Goal ontologies automatically, so connects distributed systems.This model is summarized in the following section.

4 Summary of IF-Model

The IF model is proposed by J.Barwise and J.Seligman [1] to define a logic for distributed systems. In our approach, we define by the model a formal framework in order to implement the ontology alignment process. Let A be a distributed system, each component of A may be described by entities of some types. The types are related by constraints and represent the local behavior of these entities. This is called in IF model by *Local Logic*. To connect entities of different components in a distributed system, the *Information Channel* is used, a tool characterized by the *distributed logic* which expresses formally the links between entities.

When we specify the problem of the alignment in terms of IF model, ontologies are described by local logics and the distributed logic models the alignment.

4.1 Local Logic

Definition 5 *"Classification"*
A classification A is a triple $< tok(A), typ(A), \models_A >$, which consists of:

1. *a set $tok(A)$ of objects to be classified known as the instances or particulars of A that carry information,*
2. *a set $typ(A)$ of objects used to classify the instances, the types of A,*
3. *a binary classification relation $\models_A$ between $tok(A)$ and $typ(A)$ that tells one which tokens are classified as being of which types.*

The notation $a \models_A \alpha$ must be understood as "instance a is of type α in A". IF classifications are related through infomorphisms.

Definition 6 *"Infomorphism"*
Let A and B be classifications. An infomorphism denoted $f =< f^\wedge, f^\vee >$*:* $A \Leftrightarrow B$ *is a contravariant pair of functions* $f^\wedge : typ(A) \rightarrow typ(B)$ *and* $f^\vee : tok(B) \rightarrow tok(A)$ *which satisfies the fundamental property:*

$$f^\vee(b) \models_A \alpha \text{ iff } b \models_B f^\wedge(\alpha) \tag{1}$$

for each $\alpha \in typ(A)$ *and* $b \in tok(B)$

Definition 7 *"Theory"*
We call $Th(A) = \langle typ(A), \vdash_A \rangle$ *a theory generated by from the classification A where the constraints on the set of sequents are satisfied by every token in A.*

Let $\alpha \in typ(A) : \Gamma \subseteq typ(A), \Gamma' \subseteq typ(A), \Delta \subseteq typ(A), \Delta' \subseteq typ(A), \Sigma' \subseteq typ(A)$,
$\Sigma_0 \subseteq typ(A), \Sigma_1 \subseteq typ(A)$, the theory $Th(A)$ generated from a classification A is called regular if it satisfies the following conditions:
Property 1 • *The Identity:* $\alpha \vdash_T \alpha$
- *The Weakening: if* $\Gamma \vdash_T \Delta$ *then* $\Gamma, \Gamma' \vdash_T \Delta, \Delta'$
- *The Global cut: if* $\Gamma, \Sigma_0 \vdash_T \Delta, \Sigma_1$ *for any partition* $\langle \Sigma_0, \Sigma_1 \rangle$ *of subsets* Σ'*, then* $\Gamma \vdash_T \Delta$

Definition 8 *Local logic*
Let $A =< tok(A), typ(A), \models_A >$ *a classification,* $Th(A) =< typ(A), \vdash_A >$ *a theory generated from A. The local logic* $\mathcal{L}_A$ *is defined as:*

$$\mathcal{L}_A =< A, Th(A), N_A >$$

such as: : $\forall a \in N_A \subseteq tok(A)$*, a satisfies the constraints of* $Th(A)$*.* N_A *is called the set of normal tokens.*

The local logic posses the following characteristics:

Property 2 *Let* $\mathcal{L}_A$ *be a local logic generated from a classification*
• *A.* $\mathcal{L}_A$ *is valid if* $N_A = tok(A)$ *;*
- $\mathcal{L}_A$ *is complete if every sequent satisfied by every normal token is a constraint in* $\mathcal{L}_A$*.*

Property 3 *Inverse image of a local logic*
Let $\mathcal{L}_A$ *and* $\mathcal{L}_B$ *be two local logics, such as :*
$\mathcal{L}_A =< A, Th(A), N_A >$
$\mathcal{L}_B =< B, Th(B), N_B >$
f is an infomorphism connecting A and B, such, $(f : A \rightarrow B)$*.*
The inverse image of $\mathcal{L}_B$ *by* f*, denoted* $f^{-1}[\mathcal{L}_B]$*, is the local logic generated from a classification A, the theory* $f^{-1}[Th(A)]$ *and the set of normal tokens :*

$$\{a \in tok(A) | a = f(b) \, for \, some \, b \in \mathrm{N}_A\}$$

Property 4 *Let A and B be two classifications, f an infomorphism connecting A and B (* $f : A \rightarrow B$ *) and* $\mathcal{L}_B$ *a local logic generated from the classification B,*

- *If* $\mathcal{L}_B$ *is complete, then* $f^{-1}[\mathcal{L}_B]$ *is complete.*
- *If f is surjective on tokens (*$f^\vee$*) and* $\mathcal{L}_B$ *is valid, then* $f^{-1}[\mathcal{L}_B]$ *is valid.*

4.2 Information Channel

A distributed system is modeled in IF model by a set of classifications connected by infomorphisms.

An information channel $\mathcal{C}$ consists in the connection of different classifications $A_{i \in I}$ with a core classification C through infomorphisms h_i. The infomorphisms are defined in the domain of A_i and the codomain in C.

Definition 9 *" Information Channel "*
Let $\{A_{i \in \mathrm{I}}\}$ *be an indexed family of classifications and let C be a classification. Having a set of infomorphisms* $\{h_i\}$*, an information channel which formalize the connections between* $\{A_{i \in \mathrm{I}}\}$ *and C is defined by:*

$$\mathcal{C} = \{h_i : A_{i \in \mathrm{I}} \Leftrightarrow C\}$$

Definition 10 *Distributed Logic*
The distributed logic of an information channel $\mathcal{C}$ *is the local logic on the sum* $\sum_{i \in \mathrm{I}} A_i$ *mentioned by* $\mathcal{L}_C$*. The distributed logic is denoted* $DLog_{\mathcal{C}}(\mathcal{L}_C)$*.*

The distributed logic is justified by the local logic of the core classification. We presented in this section the main algebraic tools of the IF model.

5 Aligning C-G Ontologies

We will show in this section, how to succeed an automatic alignment of C-G ontologies using the IF model which aims to connect entities of different systems in terms of information channel. In these systems, types serve to classify objects and obey specific relations. The set defines a distributed logic.

As mentioned in the previous section, the IF model introduces a consequence relationship $\vdash$ on a set of types. This relation can find from a given type t_1, the corresponding type t_2 through the relation $\vdash$ (where t_1 and t_2 belong to different sets of types).

According to the IF model, these entities are related via the information channel which preserves the information during its transmission between systems. The IF model is a good mean to achieve the alignment of ontologies since it can provide a theory and a logic which links entities belonging to different systems.

The process steps are summarized as follows:

1. **Identification of possible classifications in each system according to their associated ontologies:** For every goal of level 2, we identify a classification. The types of the classification are the pairs C-G. The tokens are the goal types included in these pairs. The binary relation expresses the inclusion of a goal in a pair C-G. Let us take the example of classification according to our example :

Table 1. Classification B_1 associated to goal of level 2 $\gamma_1^{2(2)}$

$\models_{B_1}$	B_1 $(C_1, \gamma_1)^{1(2)}$	$(C_2, \gamma_1)^{1(2)}$	$(C_3, \gamma_2)^{1(2)}$	$(C_4, \gamma_3)^{1(2)}$	$(C_1, \gamma_1)^{2(2)}$
γ_1^2	1	1	1	1	1
γ_2^2	0	0	1	1	1
γ_3^2	0	0	0	1	1

2. **Generation of their possible theories:** from every classification, we identify the corresponding theory (see definition 7).
3. **Construction of the Information Channel:** the important step in the process. To identify the distributed logic, we introduce a case where a pair C-G, in a given ontology, is not valid. According to our case study, the pair $(C_5, \gamma_4)^{1(2)}$ is not valid because the action *receive* does not happened in the S2 system, so the constraint $\kappa_2 : Sent(V, Pos)$ is not satisfied. Then it is important to connect this pair to the corresponding pair $(C_i, \gamma_j)^{k(l)}$ in distant systems. It is clear that is not possible to connect it with all pairs, because a combinatorial explosion may be produced when the number of pair is very high. For that we propose two filtering(s):

(a) First Filtering: we assume a partial alignment of pairs C-G of initial classifications via a key classification K. The goal $\gamma_4^{1(2)}$ is the type of K and the tokens are a and b. We observe that the goal is appeared in K as a type but in the initial classifications it appears as a token. Then, it is useful to introduce the flip of classifications by transposing rows and columns. These classifications are connected via infomorphisms. In our case, the condition of infomorphisms aims to identify the candidate classifications by searching goals which are identical semantically to $\gamma_4^{1(2)}$ or included in its context.

(b) Second Filtering: To choose the corresponding classification (the corresponding pair C-G) from the candidates and connect them through the information channel, the core classification C must be generated. The types of C are the disjoint union of goals. The tokens are the cartesian product of pairs C-G. Its binary relation expresses the fact that goals are part of one set of types or not. We generate from C the relevant theory $Th(C)$. According to our case study, $Th(C)$ introduces three sequent(s) :

$\{\gamma_1^1, \gamma_2^1, \gamma_4^1\} \vdash_C \{\gamma_1^2, \gamma_2^2, \gamma_4^2\}$
$\{\gamma_2^1, \gamma_4^1\} \vdash_C \{\gamma_1^2\gamma_2^2, \gamma_4^2\}$
$\{\gamma_1^3, \gamma_2^3, \gamma_4^3\} \vdash_C \{\gamma_1^2, \gamma_2^2, \gamma_4^2\}$

To choose the relevant sequent, we propose an elimination rule: "*We eliminate a sequence of goals if at least one of these goals do not verify the contexts in the C-G ontology*"

Applying this rule, only the first sequent is satisfied, because all constraints are satisfied. For example in the pair $(C_6, \gamma_5)^{1(2)}$ the sequence $\{\gamma_1^1, \gamma_2^1, \gamma_4^1\}$ coming from the S1 system verifies all the constraints. The central constraints are κ_1 and κ_2, where κ_1 means that the received velocity must be sent from an upstream system, so S1. But as we have reported, S1 may send two values of velocity (real and estimated velocity), to choose the relevant one, we have introduced in C_6 the κ_2 which is satisfied by the first sequent.

$$\left[\begin{array}{ll} V_1 & : Velocity \\ Pos_1 & : Distance \\ V_2 & : Velocity \\ Pos_2 & : Distance \\ p_1 & : Calculated(V_1, Pos_1) \\ p_2 & : Received(V_2, Pos_2) \\ \kappa_1 & : More-Than(Pos_1, Pos_2) \\ \kappa_2 & : Not-Estimated(V_2) \end{array}\right. \rightarrow \gamma_5^{(2)} = [g \ : Calculated(V_1 - V_2, Pos_1)$$

From C classification and $Th(C)$, we generate the local logic $LL(C)$ on C. This allows to generate the distributed logic $DL(C)$. It is the inverse image of $LL(C)$ (see definition 10) which expresses the links between different classifications. We succeed an automatic and semantic alignment of C-G ontologies.

6 Conclusion

We have analyzed the dual problem of knowledge representation and the alignment of ontologies. For that we have proposed a methodology addressing two fundamental axes. The first runs around the representation of knowledge where the goals of each system must be formally represented preserving their semantic aspect. These goals are related to their contexts. We have used ontologies which are an effective means for this aspect. The second axis is the achievement of semantic inter-operability of systems, our methodology allows a semantic and automatic alignment of C-G Ontologies. For that, we base on the mathematical IF model to success this alignment formalize connections between C-G ontologies in terms of information channel.

Concerning ongoing work, we investigate the application of Information Channel theory in industrial environments where goal structures generalize the role concept to the industrial or business framework and where the context is replaced by a business context.

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