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MECHANIZED CULTURAL REASONING AS A TOOL TO ASSESS TRUST IN VIRTUAL ENTERPRISES

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The globalized knowledge society generates virtual enterprises that are usually set up and managed on the web, and the new trend is to make the relevant technologies available on intelligent portable devices. The existence of trust is a mandatory condition to make such enterprises successful. Trust has many facets ranging from very theoretical ones to fully heuristic features. One point is that trust can arise when one understands the behavior of the other. In this paper we outline a new technology leading to the possibility to include inter-cultural issues among the factors having a strong impact on trust. This technology is called Abstraction-Based Information Technology. Its goal is to enable to design tools in artificial intelligence to perform so-called cultural reasoning that ensures better trust among inter-cultural communities. An argument in favor of our approach is that it relies on a bottom-up approach, particularly suitable for the web technology and for intelligent wearable devices.

Keywords: trust, culture, knowledge, virtual knowledge, reasoning, inter-cultural differences

1. Introduction

Trust is a concept central to any human or technological activity. As noticed many years ago by [Misztal (1996)] social interactions depend on the level of trust which is always silently present. She also outlines that trust is not an objective but a subjective property of an agent. Trust has many facets. The simplest one is a two-valued logic expressing: I trust or I don't. Modal logics with several possible truth values (for instance in temporal logic: was-, will be-, has been trustworthy) can also

be considered. Another approach amounts to base trust on beliefs or reputation. Reputation is a form of implicit reasoning. However, implicit reasoning may have unforeseen effects, which may create some trouble. Trust does depend obviously on the level of security available in a given system. Thus, there is a dimension that addresses cryptography and security protocols issues that is always necessary. Also, trust depends on the laws and regulations that set a framework to business relationship for instance. Trust decisions are made routinely in our daily duties, also embedded into information systems. Experts in legal software agents are investigating relevant problems in this area as demonstrated by the proceedings of the ICAIL or Jurix conferences. The literature on trust is much too extensive to be summarized in the scope of this paper. A meaningful comment is that virtual communities or enterprises are no exception. A second comment is that the impact of trust on virtual communities has been investigated by [Abdu-Rahman and Hailes (2000)] in a much cited paper. More recent antecedents and effects of trust in virtual communities can be found in [Burauskas and Aldama (2008)]. There is however a facet of trust that, to the best of our knowledge, has not been studied in the context of information technology (IT): The impact of intercultural differences on trust. This is usually assumed to be specialized to humanities. But, we are already in the age of virtual enterprises being set up and operating on the web. On one side, it is obvious that different cultures often lead to implicit or explicit misinterpretations of facts or knowledge. Another timely remark is that we are at a stage when artificial intelligence (AI) technology enables to substitute artifacts to human. This is well-known in robotics where several examples are popularized (autonomous robots are driving a car without driver for instance). This is less known in the mechanization of mathematics where systems like Maple or Mathematica carry out mathematician's tasks. This later example is (also with the ability to automatically prove theorems - ATP) at the root of our approach since such works gave rise to the so-called open mechanized reasoning of [Giunchiglia et al (1994)]. The question at the heart of our approach is to investigate whether it is possible to define a concept of mechanized cultural reasoning, and thus to treat intercultural differences with tools from AI. This would be a way to introduce trust into intercultural virtual communities.

Such an approach is expected to be repulsive for traditional professionals of Culture. Indeed, culture is usually understood as a concept belonging to various branches of the humanities and thus foreign to information technology. We know however that virtual enterprises are set up routinely using web-based techniques. We know by simply looking at proceedings of conferences devoted to virtual organizations, that intercultural differences are affecting drastically such global and virtual enterprises.

The purpose of this paper is to outline what a possible approach to mechanized reasoning can be. The following sections provide a summary of the AI methodologies that are being set up to design and implement the techniques upon which we base our approach: Abstraction-based information technology at the upper level

and then virtual knowledge communities and corporate knowledge modeling at the implementation level. We then proceed with some examples of intercultural troubles that were witnessed either in the industrial world or in academia. The last section is devoted to some conclusions and presentation of works in progress. A last word of caution is that culture has such an implicit meaning that we will need to outline precisely what we mean when using this word or, in other words, to define what is the context of mechanized cultural reasoning. Along the same line of caution, we outline that we do not touch the concept of computability (a facet of which is given by [Longo (2001)]). We are well aware of such limitations and it is sufficient to claim that we are only interested in a first approximation.

2. Abstraction-based Information Technology

Culture spans different fields of science and humanities. To design and implement a computer based approach enabling to solve intercultural differences troubles, we need to abstract cultural problems to have a chance to model them. We have designed such a framework that we call abstraction-based information technology. A description can be found in [Calmet (2009)]. The abstraction we do propose is not restricted to cultural problems but is generic for any field of human reasoning. The search for a 'model of everything' is an old quest that can be found either in the philosophy of sciences centuries ago or in artificial intelligence or computer science more recently. We differ from such approaches since we restrict 'everything' to simple cases as we will see later.

If culture has many different meanings, this is also true with the concept of abstraction. Philosophers would refer to some logics, while mathematicians or computer scientists would refer to category theory or algorithms among many very different abstraction mechanisms. We simply start from an abstraction that was proven suitable to demonstrate that open mechanized reasoning is a right abstraction in theorem proving and in symbolic computation (see [Giunchiglia et al (1994)]). It turns out that this abstraction can be expressed generally in simple terms. An abstraction consists in three components.

- A theory,
- A control on this theory,
- The interaction with the universe in which the controlled theory is embedded.

Then, open mechanized reasoning means that once a theory is defined and a control on this theory is specified, a complete understanding of the interaction of this controlled theory with its environment is required. It is this latter part which is often difficult to specify. It must be noted that such abstractions are not generic in the sense that a given field of application may accept different theories.

We list some examples of abstractions that apply to this approach to be found in computer science, law or sociology. In some areas of computing, we have the

following three components:

- A theory is a module of algorithms solving a specific computational problem.
- The control consists of a programming language.
- The environment is the computing environment, i.e. the overall support for leveraging the algorithms using the programming language.

Research on software or AI-based law is very advanced. The concept of legal reasoning is well established and documented. Many conferences are devoted to legal agents for instance. Our abstraction goes however beyond what is investigated today. It is as follows.

- A theory is a set of laws (as voted by legislators).
- The control consists in application decrees.
- The environment consists in the enforcement of these laws and decrees by tribunals (and this defines jurisprudence and litigation procedures).

The third example is from sociology and has two possible facets in the third level. A first one is to introduce political science as a way to define how a society is governed, while the second one relies on simulation to check how a government would emerge.

- A theory is a set of agents with well defined actions.
- The control consists in defining a society arising from the available actions.
- The environment is defined by how this society is governed.

3. Virtual Knowledge Communities

Our approach to agent-based knowledge communities is built upon the concept of virtual knowledge communities which is reviewed in [Maret and Calmet (2009)]. This reference also explains why our methodology is particularly well suited to the web 2.0, to wearable devices and the handling of small, simple cases.

Open Cultural Mechanized Reasoning is built upon reasoning on knowledge bases. We do not favor huge knowledge bases and mediator systems that lead to large and complex systems. Such systems are difficult to manage by users lacking expertise in IT. Also, we want to avoid the old quest of the 'model of everything'. So, we adopt a bottom-up approach and investigate only small and simple cases for feasibility studies.

A virtual enterprise is usually defined as the temporary or permanent alliance of organizations for the accomplishment of a task by way of information and communication technology, also called a virtual environment ([Rajiv *et al.* (2002); Sieber *et al.* (1997)]). A virtual team is accomplishing a given goal ([Palmer *et al.* (1997)]).

A Virtual Community can be defined as a group of people sharing common interests and making use of electronic forms of communication for exchanges. Thus,

a Virtual Community is not necessarily related to a task, rather to a topic and to some knowledge. We have proposed the Virtual Knowledge Community (VKC) abstraction to model and support the objects and processes related to these exchanges ([Maret *et al.* (2004); Maret *et al.* (2005)]). The main basic concepts of VKCs are the Agents, Knowledge Items, Commmunities and Messages.

Agents represent real or mechanized actors in the system. They are autonomous entities that have their own task and knowledge, and can act and communicate with each other.

Knowledge Items are detained by agents. Agent's knowledge is stored in the personal repository of the agent, which contains the relations between the concepts, the properties associated to these concepts, and the different instances of concepts and properties. The concept of knowledge cluster is introduced to represent a piece of knowledge from the agent's repository. Agents share and exchange knowledge clusters.

Communities are virtual places where agents exchange knowledge. A community consists of a domain of interest (a knowledge cluster), a leader (an agent), a policy and an unspecified number of agents. An agent can create and manage or simply join a community. It must exist at less one specific community which is called Community of communities and plays the role of a yellow page. It allows agents to declare communities, check existing communities and to join them according to their centers of interest.

Messages are exchanged among agents conforming to the community policy. Messages contain knowledge items and performatives (communicative act) such as INFORM, REQUEST, SUBSCRIBE, etc...

VKC is the building stone of our knowledge-based approach. In the next section, we describe our framework for cultural reasoning, which is convenient to assess trust. Our approach is strongly linked to knowledge exchange and sharing within a group, i.e. corporate knowledge modelled with VKC.

4. Corporate Knowledge, Culture and Trust

The knowledge detained by people belonging to an organization is part of the corporate knowledge. Additional knowledge is detained within the IT system. Moreover, corporate knowledge is composed of (or associated to) some communication means for exchanging information. Considering the definition of the VKC abstraction, we claim that it is a convenient abstraction for Corporate Knowledge. Indeed, VKC strongly supports the principle of autonomy of actors (individuals as well as artifacts, no central repository imposed). Actors hold knowledge and decision ability (algorithm). Thus, VKC allows building Corporate Knowledge in a bottom-up approach, which is fully compliant with real world processes and which can be implemented for fuzzy but effective knowledge exchanges and management. In [Maret *et al.* (2004); Maret *et al.* (2005)] we showed how to model corporate knowledge using VKCs.

A first step forwards is to claim that cultural background belongs to the corporate knowledge of a nation (Germany, Brazil) or an international grouping of countries (South-American countries), or a company. We assume the very different approaches to culture that are investigating inter-cultural issues in various areas nowadays. If we refer simply to existing consulting companies specializing in solving intercultural differences simply for German-French enterprises, we may list a few different frameworks leading to such approaches. Linguistic is a distinct one assuming that most troubles arise for an imperfect mastering of the languages. Economists do identify some criteria that are gathered in models and then assessed for a better accurancy. Sociologists are right to suggest that societal organizational features are at the origin of such troubles. Philosophers will tend to put more weight on the native way of thinking of cultural groups, taking into account history and geography. Engineers with a solid background in management may identify meaningful differences in the decision making process. We do not claim that we have a new approach to what culture is. We simply claim that our approach enables the adoption of any of these approaches, transform it into a knowledge management process that can be abstracted as an Abstraction-Based Information Technology.

A second step forwards is to considere trust and culture. This topic did attract much attention in Sociology. A very rich book by [Plateau (1998)] is restricted to French-German cooperation but displays a large collection of intercultural troubles that are easy to find and difficult to solve, because they mix up cultural backgrounds and trust. [Grudzewski et al. (2008)] reports on trust and culture in virtual organizations. It is only one among many reports devoted to this topic. These documents are written by sociologists and set in the framework of sociology. Our purposes here is to solve similar conflicts but with tools from Artificial Intelligence. A project by [Subrahmanian (2007)] also belongs to Computer Science. It outlines computer models being developed that can help policy-makers predict the behavior of political, economic, and social groups. However, the methodologies are fully different.

Our approach can be abstracted as an Abstraction-Based Information Technology along the following lines (Fig. 1):

- A theory is an ontology. It describes a given domain.
- The control consists of processes related to this domain. It can be abstracted as the description of decision making processes.
- The environment consists in specializing these processes to a specific cultural group, providing additionnel sub-processes, facts and actions.

Before exploring some examples, we sum up our approach: Our aim is to investigate AI tools to encompass culture in the assessment of trust within multicultural communities. We propose Virtual Knowledge Communities associated to Abstration-based Information Technology to consider culture in small scale knowledge bases to share and exchange among participants. In this approach, knowledge is composed of a set of facts (possibly inconsistent facts, eventually with lack of

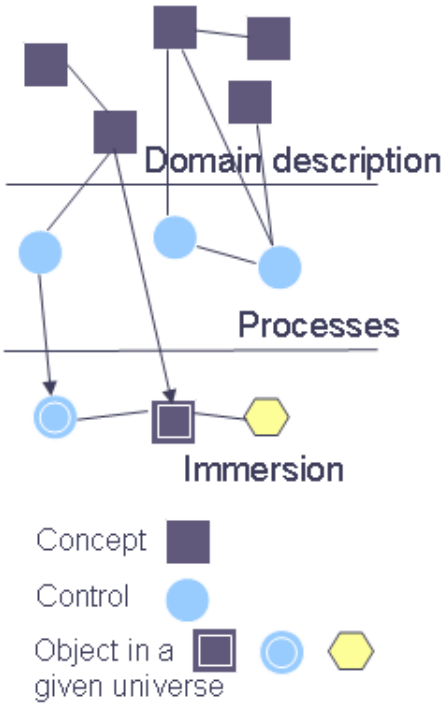

Fig. 1. Schema of the ABIT Model

common semantics, etc.). In order to improve the level of trust when dealing with intercultural communities one must identify conflicts arising from the sharing of knowledge lacking apparently a semantic consistency.

Knowledge management offers several methodologies to identify and to solve such conflicts: metarules, ontology alignment or mapping, negotiation based, etc. Our previous experience with mediator systems ([Calmet et al. (1997)]) shows that such a task is fairly simple. These tools also enable to base the solutions of intercultural conflicts on the knowledge possessed by the actors whenever possible.

5. Examples of inter-cultural troubles in international enterprises

What we want to do now at this stage is to select and describe a few very practical intercultural troubles. We review two troubles that did arise in French-German companies but can easily be generalized to any international venture: health insurance contracts upon hiring engineers and the process of decision making. The third example concerns the experience of a south-amercian crew of a ship forced to stay in a hotel in German port. A generic remark is that the management of international projects involving multicultural differences has received much attention for a long time such as shown in [Vonsild (1996)]. Very often the interest is on what

issues can or must be left at the local level while the others will be managed at the international level. How cultures shape a project is usually not addressed. This is exactly the aim of this section and of this work.

5.1. *Health insurance*

French-German ventures do exist for a long time. They range from very large companies to small enterprises. Such companies hire engineers or managers. Among the benefits linked to the hiring contract there is always some sort of health insurance coverage for the person and his/her family. In fact, a non-German staying in Germany may not know that above a given salary level only private health insurance is allowed. This means that this person will pay for his/her medical expenses upon receiving a bill from any practitioner (sometimes once every trimester). S/he will pay the full amount and then be reimbursed. The same process takes place also in case of hospitalization for instance. In such a circumstance s/he will get several bills: one from the hospital covering the location of the room and nursing costs and one from each of the medical staff providing any medical treatment. S/he will be fully reimbursed but must pay bills that are possibly very high. For lower salaries only public health insurance is allowed. This means no advance of funds but only a partial coverage (however rather large) of the costs. In large company, the DHS (director of human resources) is aware of such facts and, hopefully, provides the relevant information. But actually, in most companies or institutions no one is bothering to provide such information. A German engineer employed in France will face a totally new health system. They will have to pay the doctor each time they visit him and the daily cost in an hospital covers both the hotel and the medical bills. Another cultural shock occurs when visiting doctors. In Germany, the waiting time in the doctor's office is much shorter than in France but the duration of the meeting with a doctor is very short, usually arround two to three minutes. Any doctor has at least one assistant in the waiting room while in France this normally does not exist. Then, the French doctor will keep a patient 10 to 20 minutes. It follows that after a first visit to a German doctor a French patient will assess that the doctor is not taking him seriously while in the parallel situation, the German patient will not understand why he met the doctor for such a long time. When an engineer is married and has young children, the fluency in a host language is having a large impact since German doctors usually do speak only German. This is surprising in a country where the use of English is largely spread. Similarly, French doctors are very reluctant to speak another language than French.

5.2. *Decision making in French-German Enterprise*

Some enterprises do exhibit a parallel structure: German on one side and French on the other one. Since the goal is that these two components do collaborate, there must be a communication channel open at any level of the hierarchical managerial

structure. It was already noted by [Plateau (1998)] that these communication channels are not very efficient. The main reason lies in the way French and German top managers are educated. In Germany, professors do check that graduating student have acquired all of the relevant expertise available in their domain of specialization. This is why the duration of studies was never an evaluation criterion in Germany since what matters is the amount of acquired knowledge. On the French side, the elitist organization of studies leads to identify the brightest minds able to solve as quickly as possible the most challenging problems. The consequence is that a German engineer will not always check whether his boss has changed his/her mind on a given question while this is required on the French side. In other words, on the German side the decision process is almost static once the main decisions have been taken while on the French side the system remains dynamic since any decision can be changed anytime. This is a possible lecture of some recent troubles that did surface recently at different managerial levels of a large aircraft company, and this is an example of the lack of trust in-between two partners due to inter-cultural issues.

5.3. *South-American Crew in German Port*

On a voyage from Brazil to Germany, a shipping crew had to stay in a hotel in Germany while waiting for a new assignment. They were around 20 men including the captain, mainly from Brazil as well as from other South-American countries. South-Americans are known to be lively and festive people and they indeed devoted much time to celebrate their stay. Frequently the crew gathered in the common areas of the hotel, had drinks and told jokes the way they used to do it at home. The hotel management protested in a quiet, polite and mild German way that was not taken seriously by the crew. Therefore, no one in the crew was ever thinking doing something wrong. It was a total surprise when the hotel management asked the crew to move out of the hotel. Being extremely confused about the situation, the captain called up the German local company office and asked for help. The local manager explained the situation in plain words to the hotel and to the crew and offered the hotel guarantees to have the behavior changed. The crew could move back into the hotel where it kept quiet for the rest of the stay. The results were that members of the crew rated the German people as very unfriendly while the hotel management and the neighbors of the hotel rated the South-Americans as uneducated. This shipping company was aware of cultural differences and had published previously a booklet giving some basic information to its employee on how to adapt to local cultures in different parts of the world. But, it is covering very elementary facts. For instance, it is mentioned that Brazilians greets usually people with their first names and seldom with surnames, while in Germany a surname always follows "Frau" or "Herr" or "Dr." and greetings are kept conservatively impersonal. Such basic greetings codes are listed for the numerous countries that the ships of this company do visit but, they are much too simple to be useful. Trust in relations would be improved if the crew could easily identify and take into account some

cultural differences.

5.4. *Modeling of a solution*

We sketch very briefly our solution for the health insurance problem through VKCs. Implementation of VKCs is presented in [Maret and Calmet (2009)]. The *ontology* (= theory) which describes the universe in which the system is embedded is the ontology for health insurance. It is represented as a VKC, since it is a virtual place composed of knowledge items and contributing actors. The ontology represents the different risks, or medical domains that are possibly covered by the health insurance. They range from medical care to care for elderly people suffering from diseases affecting their autonomy, dentistry and vision correction, etc. The list hereafter give a very simplified view:

Ontology : Heath Insurance
Contract
-Private insurance
-Public insurance
Risks
-Professional risk
-Private risk
Medical domains
-Medical care
-Vision correction
-Dentistery

Among possible so-called *controls* that can be related to the ontology are hints on urgencies, visits to doctors, billing system and many more such facets of the domain. Each control corresponds also to a VKC with links to theory (the domain ontology). Hereafter we give a simplied list of some controls. Links with the concepts of the ontology are obvious.

Controls on Heath Insurance
Contract
-Premiums
-Register
-Salary class
Visiting a doctor
-Appointment
-Waiting time
-Consultation
-Payment
Reimbursement

-Bills
-Fiscal status

Specializing the latter controls consists of describing possible controls available for different specific contexts for each country or land or grouping of administrative entities. We give hereafter some hints of specialized controls.

Controls on Health Insurance *for Germany*
Visiting a doctor
-Doctor or specialist or hospital (urgency) or house call
-Make appointment by phone or go to the doctor's office
-Mention private or public insurance (insurance card)
Buying medicaments
Payment
...in case of private insurance: pay for bills by bank transfert
...in case of public insurance: no payment to the doctor (except a token every semester)

The resulting architecture for the system is suitable for a query-based system (automated or involving users). A query asks the system whether there is any available information on the topic of the query. This is a feature of VKCs allowing to access easily any piece of available information. If the query is not answered, it is possible to define a VKC on the topic of the query and to enter (or wait for) the relevant knowledge. This is consistent with the previously made statement that we have a bottom-up approach.

Technically, we simply use the capabilities provided by virtual knowledge communities. We can query the system from the upper level (the health insurance description in a given country) or from the lower end (the ontology). In this first design, the feature of mechanized reasoning arises from the interplay among virtual knowledge communities, the feature of culture is linked to the contents of the knowledge bases, and the trust feature derives from the lack of conflict on the knowledge represented in the system, at least in a first approximation. An advantage is that VKCs can be ported to intelligent wearable devices and are also particularly suitable for the web technology.

6. Conclusion

The have outlined a methodology to introduce and implement a concept of abstraction suitable as well for humanities. We have shown that it can be adapted to assess trust based upon culture. This idea is very familiar to sociologists or economists specializing in trust, culture and management. Our contribution is to demonstrate that we can approach it within AI and design a mechanized cultural reasoning for trust related tasks. With the possible exception of [Subrahmanian (2007)], there is

no similar attempted approach towards such a goal.

The implementation relies strongly on our previous work on virtual knowledge communities. This methodology enables to design easily some of the features we do require. We have provided only an outline of the methodology since the required format of the paper does not permit to get into details. Similarly we do not present some on-going work dealing with more theoretical attempts to quantify culture by using entropy and distance concepts. Another line of research deals with the coupling of social networks to the concept of trust. Sociologically, social networks enable to enforce some sort of social pressure among its users. It is possible to link VKCs to knowledge available in social networks. A technical challenge is to query several different social/cultural networks. This is sometimes defined as the idea of friends of friends but interoperability among several of them is never straightforward. Finally, the trans-disciplinary features of mechanized cultural reasoning must be better defined and assessed. This is a work in progress.

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