Sharing the Local Knowledge of Water Technologies Through Multi-Agent Indexing Systems

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Abstract[1]

Many research debates are recently facing the role of technologies in boosting community development through the raising of the knowledge of agents. As a matter of fact, only capital-intensive technologies have increasingly dominated throughout centuries with wide and large impacts over populated areas. However, during the last couple of decades, many social, financial, environmental concerns have spread dramatically worldwide. Consequently, a new interest has been placed on low-impact, local and small-scale technologies, challenging large technologies with significant outcomes.

The abilities and knowledge of local populations represent the critical added value of such small technologies. Being local-based, intrinsically they are not provided with formal methodologies and technical language, so fatally inducing poor levels of knowledge sharing and generalization. Yet, the usefulness of local-based technologies is increasingly coming out often succeeding where more formal technologies had previously failed. ANTINOMOS project aims at creating a real learning environment for the mutual, shared generation of knowledge. This subject is discussed in the present paper with a cross-disciplinary, cross-scale, multi-agent approach, considering the different forms of local knowledge and language involved.

Keywords: Water resource, Technological memory, Learning architecture, Semantic navigation, Ontological indexing.

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1. Introduction

Mutual relationships can be a highlight today, linking engineering technologies and educational technologies in both production and research environments. In particular, debate is growing about roles of new and traditional technologies in raising community development and the knowledge of involved agents.

Traditionally, structures and infrastructures have heavily relied on capital-intensive technologies, with impacts over large and populated areas. However, during the last couple of decades, social, financial and environmental concerns have boosted small-scale technology initiatives, challenging large technologies at the local level with interesting results.

The importance of such experiences is connected to the local populations' abilities and knowledge, even when they show little or no technological innovations as such. This means that it is always intrinsically difficult to draw out formal methodologies, recognizable levels of generalization and valuable outreach. However, that does not involve the ineffectiveness of local-based technologies, which are contrariwise increasingly reported, often replacing formal technologies previously failed.

Governments have shown mixed attitudes towards such informal experiences, ranging from unenthusiastic or even adverse actions, to more fostering support. European Union financial programs belong to the most proactive supporting institutions, aiming at contextual results by research initiatives such as the ANTINOMOS project, funded by FP6.

Particularly, ANTINOMOS project largely focuses on knowledge management, aiming at providing stakeholders with (i) the access to pertinent, prompt and understandable information, (ii) the skill of making use of that information toward efficient and efficacious project execution, and (iii) an actual learning milieu, allowing (passive) knowledge sharing as well as (active) synergetic knowledge generation. The DAU's role deals with knowledge management which raises through an interaction among partners, stakeholders and interested agents. It aims at building up multi-agent systems to elicit, collect, share and foster local-based technologies among distributed agents worldwide.

As a matter of fact, the gathering of pertinent knowledge from local and global technological initiatives involves a complex learning environment which is realized through a multi-user, cross-scale, cross-disciplinary and multiple-source approach, supposedly to promote the generation of knowledge in the involved agents . This position entails that different local languages knowledge forms , either expert and/or commonsense, need to be decoded, reorganized and adjusted to different agents' needs. Research is scarce in this context, since the intrinsic complexity of large formal and informal knowledge languages is hard to be managed by system architectures. The DAU research approach stems from computer-science multi-agent studies on setting up and managing platforms to support learning interactions.

After the present introduction, this paper shows chapter 2, in which a short description on the knowledge facets of water technologies is carried out, particularly in ANTINOMOS. Multi-agent cognition and learning system architectures are discussed in chapter 3, with an ontological approach. Chapter 4 deals with the concept of technological memory, with some emphasis on the formal building up of efficient indexed search. Features, potentials and follow-ups of the learning system architecture are discussed in chapter 5, followed by final notes in chapter 6.

2. Global and local water knowledge and technologies

ANTINOMOS project strategy stems from the awareness of an inadequate knowledge management in water issues, as obstacle to solve daily water problems in developing countries. Although the inherent complexity of social/technological relationships in water domains was recognised very recently indeed, present practices in those domains still suffer from continuing divisions and sectorial approaches (Bijker, 1997; Latour, 1987). In this condition, border lines across different knowledge forms and sectorial domain approaches hinder a more holistic comprehension of water issues as well as the ability to connect knowledge and action in real contexts.

This occurrence is evident in the modern/traditional technologies' conflict, as part of a greater antagonism between knowledge systems. Mainstream international policies are still mostly dedicated to 'modernize' developing countries through western technology transfer (Kloppenburg, 1991). Hence, local-based activities are generally seen as obstacles to easy exogenous solutions, rather than useful knowledge sources to tackle water problems. Consequently, traditional technologies and practices (TTPs) are often considered as based on irrational beliefs, subjective, context-specific, and with no cause-effect grounding (Millar and Curtis, 1999).
Several researches reacted to such positions at the end of last century's decades, highlighting the significance of local knowledge as a thinking system embedded in the scientific basis of TTPs[2]. Also, activists and researchers tried to rehabilitate TTPs as a plausible alternative to modern, socio-ecologically expensive technologies (Escobar, 1995; Guha, 2000; McCully, 1996; Postel, 1998). Important theoretical and practical repercussions come from that point. On the theoretical side, it helped to demystify modernist rationality, maintaining that similarly valid 'native' viewpoints are legitimate. Politically, it helped to assume that rural poors are the active originators of their own development patterns and boosted political ecology literature (Braun and Castree, 1998; Escobar, 1996; Peet and Watts, 1996). Yet, an idealistic picture of indigenous people (Baviskar, 1997) and an excessive critique to technological modernization came out from that point, which ended up reinforcing the paradigmatic conflict rather than decreasing it.
ANTINOMOS project investigates on possible ways to bridge antinomies and to characterize a learning space in between. Basically, it looks for possible ways of reframing water problems so as to generate novel knowledge and open new solution spaces. Hence, knowledge would not simply summed up across

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[2] Agrawal says that no relevant difference exists between the substantive and epistemological foundations of indigenous vs. western knowledge, because indigenous knowledge is not about the mere livelihood of people, but owns abstract and philosophical systems too, being also based on trial-and-error, scientific experimental approaches (Agrawal, 1995).

discipline boundaries, but will become the input of a wider process of knowledge development. It would result from synergetic interactions of distributed "knowledge workers" in new learning spaces (Drucker, 1999). In line with open source philosophy, knowledge would be successfully shared to boost its generation and improvement through the interaction of agents.

Actually, the possibility of synergies depends on the structuring of appropriate learning spaces of meaningful interaction. The hard difficulty of such task is due to knowledge being embedded in diverse knowledge systems and disciplinary backgrounds (different taxonomies and knowledge frames), diverse geographical locations (different knowledge labels and languages) and diverse scales (different ontology levels). Agents may belong to different "knowledge communities" (Nonaka, 1999), with proprietary jargon and rules to share information and raising knowledge with.

Therefore, real learning spaces require appropriate cognitive architectures to bridge gaps between formal and informal knowledge as well as global and local contexts which have been practically often separated so far. Knowledge workers and knowledge areas need to be singled out appropriately, within an appropriate gap-bridging architecture, in an action-research perspective.

In the system architecture described below, modern and traditional technologies for water supply/sanitation constitute a knowledge base to assess critical factors for their success or malfunctioning. Amongst them, institutional, organizational, social, economic, cultural issues are investigated, in a perspective of health and environmental risk. This investigation is carried out starting from partners' contribution on India, Mexico and South Africa.

3. Knowledge indexing in multi-agent interactions: an ontological approach

Creating and managing social facilities to develop local communities is even more depending on a multi-scale level of infrastructure technologies. From large-scale projects for wide settlements to small-scale plants for villages, infrastructure supply seems to be more and more suited to diverse and frequently disjointed use levels. Yet, large projects leave formal knowledge traceability of used technologies, whereas small-technology project outcomes are frequently unshared, no matter how successful they are. Furthermore, local communities remain largely dependent on TTPs, because of frequent physical/economical difficulties of setting up large-scale infrastructures.

In small and/or mutually disjointed communities, particularly in developing Countries, technologies have difficult outreach. Behind that situation, some literature on water supply and sanitation recognizes technological knowledge/expertise gaps, both in building up and in managing technologies (Torregrosa Armentia et al., 2006; Unver, 1997). The acknowledgement of such complex problems boosts research on bridging gaps through learning environments in order to share technology knowledge and to generate new knowledge in a synergic way.

Making reference to IT-based knowledge-sharing approaches, is rather relevant in this context. In fact, it stems from a long number of IT-supported local development initiatives over the last few decades, with an increasing number of positive results in literature, even with some criticalities (Borri et al., 2005; Borri et al., 2010c). Beyond technical and literacy constraints, the use of large-scale information technologies faces political and demagogical constraints in Developing Countries, with informational asymmetries that are detrimental to local communities themselves (Greenwald and Stiglitz, 1986, 1990). Yet, a real-time, multi-agent, multisource interactive approach can foster effective learning environments for technology knowledge.

Case studies have shown critical aspects that should be taken into account, when setting up operational environments (Borri et al., 2006a; Khakee et al., 2002). Some important aspects can be outlined as follows.

(i) In poor communities, agents may have low possibilities to join an interaction so that they delegate access and feedback to intermediate agents. This may raise problems of legitimization and representativeness of agents with reference to the community. Intermediate agents may even unconsciously report wrong interaction outcomes to the community, so inducing poor levels of knowledge delivery (Forester, 1988, 1999). Therefore, ad-hoc methodologies and architectural features could be used to facilitate and extend interaction potentials of all community agents in order to enhance the effectiveness of cognitive interactions.

In our IT-based water-technology learning environment, a preliminary knowledge basis has been set up by partners to be shared among and enriched by further participating agents. Structured as an hypertext, the knowledge basis will be navigated, integrated and learned by agents by a web-based self-evolving learning environment.

(ii) The question of idioms and access languages is important too, particularly when indexing knowledge is to facilitate search and navigation tasks (Khaled and Mohamed, 2004). As a matter of fact, some kinds of expert agents make use of domain languages in web searching tasks, so needing only plain formalized search tags and a simple straightforward search made up of simple queries (King and Munson, 2004). Yet, less expert agents rely on commonsense, informal approach based on concepts and periphrases –a more complex searching feature, needing articulated document indexing for effective contributions to the learning environment.

(iii) Another important question faced by the IT-based interaction system concerns the cognitive frames of the agents performing search tasks, which are differently patterned and organized in carrying out interactive reasoning activities (Shanahan, 1997). The frame problem seems to influence the agents' cognitive ability to avoid getting lost in huge 'problem spaces', such as web-based multi-agent web spaces. In this case, framing is used to perform context-based and case-based pruning of problem areas and depends on agents' cognitions (Borri et al., 2004). The search of tasks is impacted by the frame problem, entailing different indexing approaches on knowledge memories for effective navigation. A more flexible and semantic-oriented search indexing can better address the different cognitive frames of agents' involved.

(iv) When searching, agents may draw out suggestions for new search indexing criteria by interacting with other agents and by reflecting on navigation results themselves. New concepts may come out from navigation that can be used to access new aspects of technology knowledge. If new navigation criteria highlighted a structure of concept relations, then the searching task would lead to ontological structures of criteria, that can be used as dynamic indexing frameworks for further navigations. The ontology-based indexing can be considered as 'dynamic' if it developed during the navigation task: if the system could keep the trace, the memory and the progressive update of the indexing would change, then a self-learning ontology-based indexing system would result, in the same way as other self-feeding intelligent systems, with an ontological approach (Abraham and Grosan, 2008).

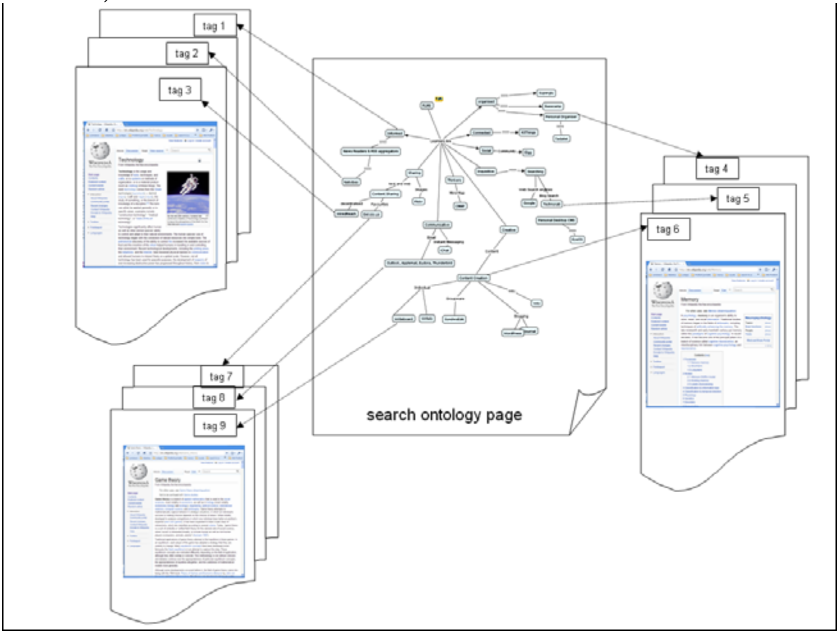

Fig. 1 – An exemplary scheme of the ontologically indexed search

It could be concluded that ontology is useful to set up indexing systems to support searching tasks in learning-oriented environments. However, many of the features which have been proposed require large relying on ICT-based platforms and computer-science approaches that are far form our study scope. The study purpose aims at setting up a web-based interactive learning environment that will be shown in next chapters, particularly dealing with semantic-based search indexing according to the ontological approach.

4. Indexing technological memory efficiently

We can suppose the existence of a given multifaceted and multi-agent problem of Technological Memory (TM) (Borri et al., 2010a). A community of technologically active [3], spatially distributed agents needs to build and make use of the Semantic Web (SW), because they want to manage technological instances dealing with water supply/sanitation (WSS). In order to accomplish the task, they have to (i) keep memory of previously unknown technical solutions to WSS instances, for private use or future advice to others, (ii) find out existent technical solutions to WSS instances already in their memory for private use or future advice to others, and (iii) modify the SW so as to make it more robust and performing.

We can also suppose that keeping memory of a new technological instance can involve retrieving a respective and previously memorized technological instance, aiming at deleting, modifying or confirming it: this would mean that (i) and (ii) are not disjointed. Further, we can suppose that operations in (i) and (ii) are not simple, implying arguing on technological instances for evaluation, classification, making analogies. Also, before (i) and (ii) the agent needs to recognize his/her/its facing a technological solution to a given problem, and to recognize the structure, the organization and the way of navigating the SW space in order to meaningfully navigate it. A SW is considered by Guber as based upon the main following systems: ontology, concepts, relations, instances (Gruber, 1993).

[3] An active agent is an agent who/which is able to change relevantly the environment in which he/she/it is immersed. In turn, an environmental change is relevant if psychically and/or physically perceivable by the agent.

The existence of TM as a process-oriented sectorial memory is hypothesized so as to explain a number of intriguing characters of technological change (TC) in the domain of water engineering technologies (Borri et al., 2010a).
Ontologies for an operational SW on WSS can be identified by making reference to the conceptualization of WSS techniques as embedded in socio-economic systems elementarily modelled by the *Technique/Problem-Cost* Couple. Each Couple element is associated to an operational (individual, social, human, artificial) agent carrying out conceptualization and execution in an integrated way. Costs can be economic, temporal, social, cultural, institutional etc., and techniques can be carried out in that system space with no significant restriction.

$$T = T\ (P, C)$$

Considering a Triplet, instead of a Couple, it becomes:

$$T = T\ (P, C, T)$$

meaning that the ontology needs to be defined in a space defined by the T Triplet, i.e., it is not given once for all (an architecture of a dynamic exploratory WS). However, this also occurs since memory is not a *tabula rasa*: our searching for problem-solving techniques starts from an innate frame of potentially useful memorized techniques.
Local/traditional and exogenous/innovative techniques result from ANTINOMOS research on WSS in Mexico, India and South-Africa[4].
We can define WSa (or Water Sanitation), WSu (or Water Supply). Hence, we derive (WSa)en (or endogenous WSa), (WSa)ex (or exogenous WSa) , (WSu)en (or endogenous WSu), (WSu)ex (or exogenous WSu), each of which we can call Main Ontology Element (MOE). Each MOE is qualified on a dual space: a S1 space where the relations of each MOE with its environment in terms of matching problems and costs is done; a S2 space where a class of attributes of each MOE is set up. Such attributes can be Pl (or operational places), O (or operational

[4] Tradition and innovation is a distinction derived from a panel of expert (builders) and non-expert (users) agents. It is incorporated in the knowledge base (KB) of the WS and needs to be reconsidered at each KB modification

details), S (or stories), Pe (or stored performances, i.e., successes or failures), M (or maintenance), etc. We can define S1 as primary operational space and S2 as secondary operational space. Therefore, MOE can be defined in spaces S1 (P, C) and S2 (Pl, O, S, Pe, M).

This duality cannot be considered as structural, since S2 can be intended as a shadow space (SS) of S1 which can be activated on request from S1 or any other functional mind-body space (MBS) of the agent. This is a characteristic of structural fluidity (SF) that is postulated following Dennett's research, as a convenient tool used when reasoning about human intelligence tasks (Dennett, 1995).

In the scope of the present paper, S1 and S2 exist within a conceptual-operational S space, defining the relation of each agent's MBS with the world. In conditions of sanity for any individual agent, we assume that, generally, there is a temporal precedence from any conceptual space (CS) to any corresponding operational space (OS), even if the working of any OS is to send information (and knowledge) to and modifies any CS.

The memorization of technological solutions

The process of taking memory of a technological solution by an agent can be described by using some major steps made by the same agent which are the following: (i) the creation of a linkage to the source of knowledge, (ii) the identification of a new (total or partial) piece of knowledge as being relevant, at different levels of consciousness (iii) the memorization of the piece of knowledge, previously identified, and its entire set of conveyed attributes (name included) with a parallel or final evaluation about to what extent memorizing according to the relevance of the knowledge piece including its attributes is convenient. The above steps are conceptualized in an indicative way: they can be aggregated or further disaggregated according to the need (and/or intention and/or fortuity) that temporal distances in the process may depend on functional abilities of the agent, even if they may tend to zero because of owned particular psycho-physical skills.

The phase of evaluation is an anticipation of the mechanism of reinforcement which is preliminary because it initially addresses a particular weight to the knowledge bit, although the reinforcement mechanism will represent the final judge in such evaluation (a judging agent within the human agent, in the mind-body mechanism conceptualization) (Minsky, 1987).
As it is known, memorizing is a functional ability whose reinforcement relies on repetition. This feature is presumably innate and natural since it tends to prevent mind from being filled up with excessive quantities of useless knowledge bits as well as feelings and to keep mind capacity limited for more essential memories, like those concerning recursive events. Focusing on TM, this means that domain experts as well as local experts will have both higher levels to memorize a given technique. As far as domain experts are concerned, they make a hard selection of their memory, by devoting it to a particular domain, i.e., to a limited set of events, and therefore they need less reinforcement to memorize a knowledge bit in that specific domain. On the other hand, local experts are continually exposed to the same experience. As a matter of fact, domain and local experts can both represent sources of that knowledge.
However, the quest for TM efficient indexing is particularly addressed to generic agents, neither domain nor local experts, aiming at finding a suitable technique to solve a problem. Because of a lower reinforcement level, agents need manifold reasons to keep memory of knowledge bits [5] meaning that attributes and causal relations need to be multiple, various and numerous. It is evident that the living memory of a generic agent is not affected by the problem of selecting a small set of reality pieces for memorization in a larger amount of pieces (selection problem). A living memory keeps record of all perceptions and selects them naturally having based them on the memorizing and reinforcing capacity in a process during a given period[6]. Domain experts superimpose a special process of selection to the above

[5] Manifold hints result in more reinforcement, coming from manifold events.
[6] That is the reason of the need to postulate a dual memory architecture, namely short and long term memory (Minsky, 1987).

natural process whereas they can evaluate memorization 'candidates' through a variety of cost functions. Their memory is then selective, qualified and can be managed faster.
Therefore, carrying out an efficient TM indexing, it becomes easier when dealing with a multimedia environment, which may contain different means of knowledge communication. Verbal, visual, other sensorial descriptions are useful to activate the various components of the memory architecture.
The classification of TM-relevant reality pieces is made according to typical predicate classifiers of rational logic[7] but also according to some atypical predicate classifiers of emotional logic[8]. Such a classification determines processes of ontology that are founded on concepts, relations, instances. Therefore, memorization is carried out by ontologies represented by the triplet

$$O > (C, R, I)$$

where C represents the abstraction, R represents the abstractions environment, and I represents reality either resulting from that abstraction (idealism) or creating that abstraction (realism).
We must say that ontologies cannot be fixed since they are created by human beings' evolutionary life. This means that human beings' life time should be included in the triplet as a vector of states, in which each element is important for the ontology but unessential, as the knowledge of other elements (context intelligence) can challenge problems caused by missing knowledge pieces. In the sight system, for example, ontologies can be considered as micro-ontologies that are could be grouped in a TM super-ontology. Human mind-body process flows can easily manage such aggregation-disaggregation feature and hierarchical game, due to their peculiar structure and organization, and therefore cope efficiently with complex, changing life environments. This natural architecture is represented by isomorphism, such as designed artificial systems made up with pieces of TM.

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[7] Such as "is a", "interacts with", "is placed in", "is going to" etc.
[8] Such as "it imposes", "I feel it as", "I belief that it", "I trust in it", "I foresee that", etc.

The identification of technological solutions

The process of identifying a technological solution by an agent can be described by some major steps made by the same agent. They are: (i) The perception and conceptualization of a problem, i.e., the objective of a exploration[9] (psycho-physical step), (ii) the exploration of his/her/its TM, so as to find out a solution to the given problem with a specific technique (in this stage, we can make use of problem analogies and technique analogies in order to facilitate the retrieving task) (psychological step), and (iii) understanding whether the found technological solution was or was not a real-world solution (psycho-physical step: the reinforcement mechanisms runs through this retrieving stage). Also in this case, the three steps are conceptualized in an indicative way: they can be aggregated or further disaggregated according to the need (and/or intention and/or fortuity) that temporal distances in the process may depend on the functional abilities of the agent, even if they may tend to zero because of particular psycho-physical skills.

Retrieving is facilitated in natural life because of improving the perception of the problem, then, refining its conceptualization consequently (and vice-versa), then making use of all possible hints to facilitate the search through the memory space[10]. However, supporting frames can be made up continuously in the retrieving process in order to facilitate the process itself and recreate the memorizing condition.

We said we can postulate the existence of a TM, that is a memory architecture shaped also by sectorial classification, as a mechanism allowing the pruning of the search space. Also, we know that it is always possible to go over the limits of that

[9] Similarly to the *beacon-driven* search in path finding (Borri et al., 2010b)

[10] E.g., see the search through literals/numerals, or through frames, or memorizing events, or conjectures concerning the existence of technological solutions in different spaces (different agents' memories), that is able to help searching through the agent memory space like an analogically conjecturing that can create memory spaces transiently. There is a variety of further possible hints, depending on the multi-indexed organization of memories created by life needs (Borri et al., 2006b)

reduced space after a failing search, so as to find additional memories in the global memory space[11]. In some cases, this process of retrieval can be supported by a searching extension when we have only scant ideas of the object searched: a potentially productive space for the retrieving task is navigated step by step in order to find out the searched knowledge piece. If this space was a network of search spaces, then, the search would be more rapid but a resulting labyrinth effect would be able to hamper the search so heavily in as much as simple (e.g., linear) search may be preferred.

Therefore, SW focused on TM ontologies would support the searching task, because it would provide an enriched cognitive environment for the detailed evaluation of the nature of any potential support, preventing agents from moving to another item because of an excessively superficial consideration of an item.

The modification of the SW

When looking at real life, there is no need to change, intentionally, TMs that had been unsuccessful or unusable, as these would progressively and naturally disappear since no reinforcement is applied. In addition, there is an argument even against the deletion of a marginal TM, because in particular cases a human agent could usefully go back to a marginal and sleeping TM, perhaps if he/she thought that there is no alternative to it. In fact, this memory architecture ensures ecological resiliency to the human agent who faces innumerable life cases.

In real life, a modification of TM means continuously building up hierarchies of use convenience in the set of TMs stored by the human agent in his/her mind repository. Because memories are stored in frames which make them significant (and indexed accordingly in the multi-indexing mechanism), then, negative judgments about the successfulness or the usability of a given TM are expressed by human agents within the application frames of that TM. Therefore, the concept of the TM modification is

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[11] Such exploration uses hints, too, so as to facilitate the search: see, for example, the use of analogies.

related to a wider concept of modification, implying a range of modifications of that TM (Levesque et al., 1998) occurring according to specific situations.

TMs are conceptualized and correlated in real life as well as instantiated (as ontology instances) in terms of direct reference to their real-world existence. In this way, human agents continuously memorize the knowledge related to TMs (for example dealing with success, usability, portability, etc.) aiming at making the retrieval of those techniques possible and significant for her/him. This leads to a continuous molecular modification of TM ontologies and, in fact, the historical backtracking of an ontology is only possible by the support of an external agent, who is less involved in the modification and more able to examine it from the outside.

In artificial life, the changing of TMs needs to be conceived in an analogous way, and therefore a SW which is oriented to technological ontologies must include abilities as follows.

Mechanisms of reinforcement need to operate in order to make ontology hierarchies and enhance the operational intelligence of the SW. TM repositories must be designed accordingly and reinforcement should be carried out according to different dimensions (i.e., nominal, ordinal, cardinal). The SW must be exposed to the feedback coming from the observation of the existence of any TM ontology in the world once it is about being modified. In artificial life this problem is very important since in real life each agent is responsible for him/herself so that any unmotivated TM modification may have consequences only upon him/her. This is not the case of SW containing multi-agent TMs: in order to solve this problem the architecture of TM (continuously changing through its experiencing the world) needs to be operated by adding new experiential knowledge even though this induces computational troubles and intelligence loss. In order to reduce inconsistencies and failures, modifications need to be carried out through a quality argumentation and evidence verification.

Eventually, a problem of technological portability of culture and language leads to other problems.

5. The interactive internet-based learning environment

When creating the knowledge management system (KMS), the issues which are dealt with in the abovementioned sections are integrated with some needs linked more directly to the research project at hand. A first phase of the project has followed mainly research as well as academic aims. Now, a second phase is being carried out aiming at collecting knowledge of local communities in developing Countries.

In the first phase, the group of system users is mostly constituted by agents identified as authors and it is rather not great. The system should fulfil needs which are particularly linked to the fact that partners belong to diverse disciplinary domains and Countries.

In the second phase, the user group is much greater and is mostly made up of agents considered as readers. Agents need to register to access the system while a board of controlling agents is to control new and/or changed information. The supporting prerequisites of the system are particularly referred to the connection between global and local networks. They are also related to the possibility of bridging knowledge gaps and to the capability of enhancing solutions of possible differences about visions made over subjects dealt with.

Crosswise the initial and the second phases of the project, other features are demanded to the KMS. Namely, they are (i) access to relevant, real-time and understandable knowledge, (ii) the option of making use of such information for decision-making, (iii) actual learning environment allowing for new and active knowledge generation beyond classical passive learning. From an architectural viewpoint, the solution stack used was the typical LAMP (Linux, Apache, MySQL, PHP). This choice was due to the existence of such well known advantages, such as the open source code, the large user-community support, the easy-to-code, the easy-to-deploy and to locally developed features, cheap and ubiquitous hosting (Gerner et al., 2006).

The final choice was about making use of a collaborative internet-based knowledge-sharing platform of the 'wiki' category. In fact, there had been the choice of the "MediaWiki" software to be integrated with the 'semantic MediaWiki' extension. The selection of that platform stemmed from the existence of useful features, such as the facility of creating/editing a large amount of pages through a web browser, using a simple mark-up language as well as WYSIWIG text editor. Most of the processing cost (which is very low, being a wiki platform) is supported almost completely by the server: because of that, a standard, not even up-to-date web browser, is enough (Ebersbach et al., 2008).

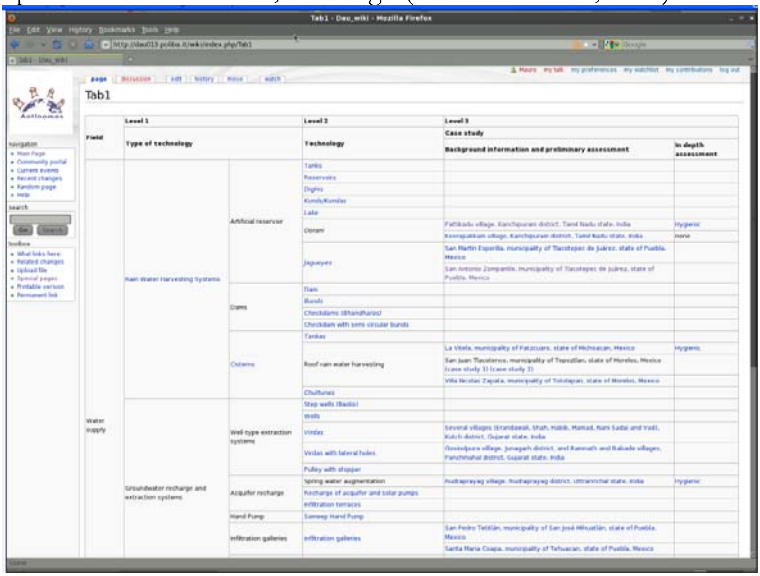

Fig. 2 – The ANTINOMOS wiki portal

The project main idea is to set up a KMS which is strongly oriented to collaboration and community support. However, because the system has to deal with particular subjects. Also the publishing-rights feature should be supported in order to control off-topics, and/or to safeguard authors' intellectual rights.

In order to cope with the need of arranging databases on different significant topics, partially at least, there is the possibility of associating different web pages through hyperlinks and through the mark-up system of the installed semantic extensions. The semantic idea is to build up an ongoing creation/collaboration process which can modify the website 'cognitive landscape' based on both the raw stored records and the classified knowledge in its entire complexity. The general attempt is to make a cooperative system of knowledge management that is able to facilitate creation, navigation, search and attribution of meanings.

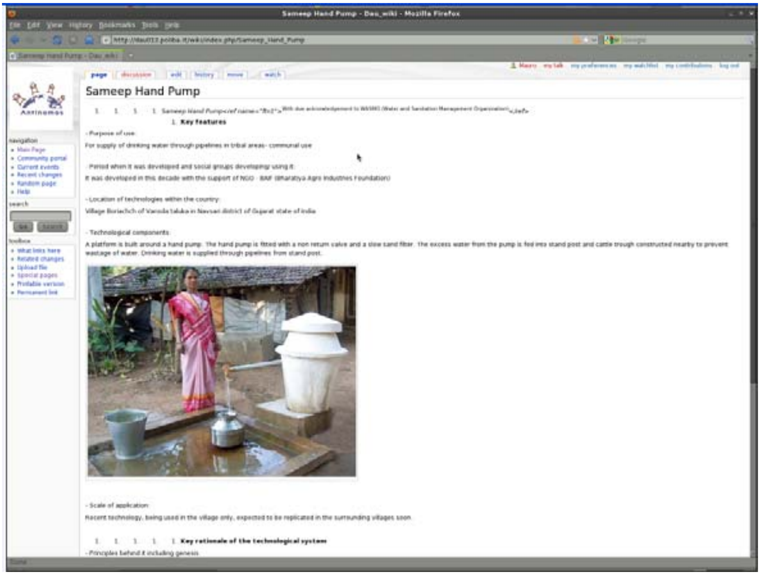

Fig. 3 – A page showing an example of water supply technology

A number of characteristics of the web portal are native features of the non-linear searching support of wiki platforms. In that framework, agents may set up links, tables, indexes with any form of knowledge organization they choose. Yet, a more structured form of content organization has been implemented, framed on SW and ontological approaches. Far from being an essential task of the research project, this structure represents a remarkable research perspective to develop multi-agent-based technology-learning system architectures in informal environments.

6. Brief conclusions

This paper has dealt with the significance and perspectives of the multi-agent learning/sharing of water technologies in informal environments, framed in the EU ANTINOMOS project. The study has investigated on the setting up of system architectures to support learning and knowledge exchanges among agent spread across different spaces, through internet-based modelling and techniques. Knowledge trade-offs and technology learning have been dealt with, considering them as being highly dependent on the interaction environment quality. Therefore, the study has been particularly mindful to the structuration of system searching and navigation features, heavily emphasizing the pursuit of efficient indexing approaches.

For this purpose, the significance of semantic searching has been highlighted, and the quest for navigation features has been directed to the ontological indexing potentials, as a foundation for allowing semantic tasks.

The present paper has shown aspects of some current features while presenting the basic rationale fuelled by some potentials and criticalities coming out of the semantic-based learning architecture. The further development of that system architecture represents part of the remaining research activities of the ANTINOMOS research project.

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