ANTHROPOPATHIC AGENTS IN E-LEARNING SYSTEMS APPLIED TO THE AREA OF THE MEDICINE

by

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Abstract

The association of human properties and behaviours to virtual entities, namely to agents or computees, has been made, almost exclusively, by an evaluation function that measures such properties, grading it. In this paper, it is presented an alternative way to analyse intelligence, behind an agent's knowledge, through the use of anthropopathic functions. The enforcement of such attitudes is made via the extensions of the functions or predicates referred to above, which make the agents or computees body of knowledge, and are to be applied in distance learning systems embedded in websites prepared for medical education.

Introduction

The exponential evolution of the Information Technologies in the diverse areas of knowledge developed a myriad of intelligent tools that are now applied to the area of distance education. Technologies as high speed networks, hypermedia, virtual reality and Artificial Intelligence (AI) tools make what is called the next e-learning age. Information and knowledge systems developed as portals and supported by the Web technology have proliferated like mushrooms for the past several years. Indeed, websites that integrate and distribute information to various groups of physicians, patients or students have grown so ubiquitous that they are falling victim to their own popularity. To eliminate the technological shortcomings associated with maintaining a number of heterogeneous single-function portals to serve various users and to streamline the flow of information, knowledge and services, researchers are looking for ways to consolidate or integrate multiple websites into a single entity: *the holding e-learning portal*. By centralizing information, streamlining business or educational processes, and connecting people for meaningful collaboration, holding portals can improve operational efficiency and reduce costs, ranging from e-business, e-procurement, e-health or e-learning systems.

The strengths of a holding portal lie in its potential for integration, for supporting communities of virtual entities, and for collecting, organizing, and dispensing contents. Any good strategy for creating such an engine must capitalize on those strengths. These multiple portals for various departments, schools or business units often have different architectures, different ownership, and duplicative content. Hence, it is desired to collapse the current state of individual sites into a single one (i.e., in terms of a holding).

Medical e-learning is becoming increasingly popular. Delivering e-learning through a holding portal has proven advantageous to universities, allowing them to engage at low costs in expansion processes. Experts can launch a training course or a common set of instructions to their students. The main challenges of medical holding portals are to increase productivity, efficiency and medical services. Learning and training in this context are major strategic goals. The role of Simulation in e-learning, and Information Technology management training are also paramount. Simulation praxis are to be included into the portal's functionalities. In Figure 1 it is presented the holding portal for medical e-learning in use at the University of Minho, Braga, Portugal.

On the other hand, in fields such as Computer Science, Artificial Intelligence and Multi-agent Systems, is felt an approximation with disciplines of the area of Social Sciences, Anthropology, Sociology and Psychology. Much work has been made related with the personification of the behavior of virtual entities, by expressing feelings and emotions. Works like [10][11] detail studies and propose lines of action that consider the treatment of reason and a way to assign emotions to machines. Attitudes like cooperation, competition and socialization of agents [3][13] are explored in fields such as Economy [2] and Physics [6], using known problems as it is the case of the "*El Farol Bar Problem*", the "*Minority Game*" and the "*Iterated Prisoner's Dilemma*". In [4] and [5] is recognized the importance of modeling personalities in agents, in the sense they use characteristics and qualities that are humans' own.

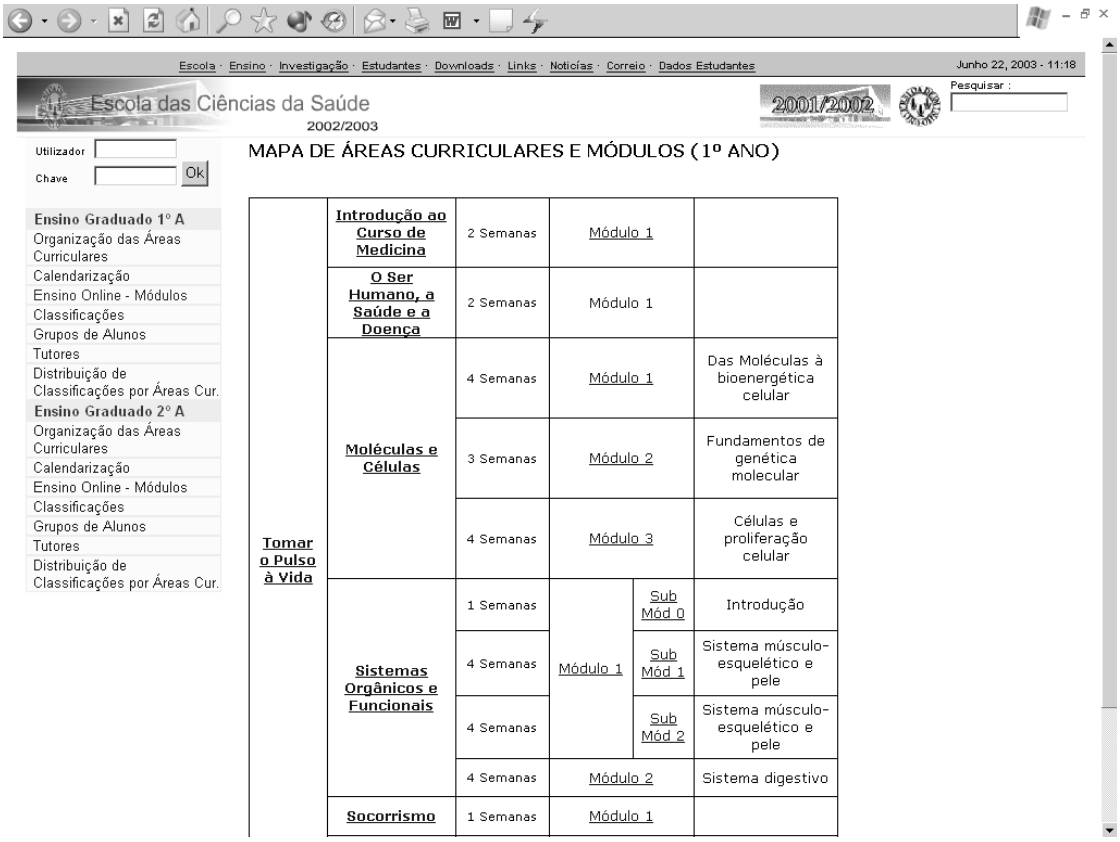

Figure 1 – Holding Portal for medical learning at the University of Minho

An important motivation to the development of this work relates with the ability of knowledge representation and its flexibility regarding the development of solutions, allowed by the Extended Logic Programming language (ELP)[1][9] [12].
The use of null values and their characterization in terms of exceptions to the predicates that drive the system's behavior should be another justification for the adoption of these formalisms for knowledge representation. Intelligent systems described this way, make possible the establishment of forms of behavior that can be expected from its single constituent entities (in this case, such entities will be referred to as agents).

Knowledge Representation

Knowledge representation techniques as a way to describe the real world, based on mechanical, logical or other means, will be, always, a function of the systems ability to describe the existing world. Therefore, in the conception of a knowledge representation system, it must be object of attention:

Existent Information: it may not be known in all its extension.

Observed Information: it is acquired by the experience, and obtained by contact or observation.

Represented Information: with respect to a certain situation, it may be (ir)relevant to represent a given set of information. In spite of all the limitations, it is possible that observations made by different individuals, with distinct education and motivations, show the same set of fundamental data, function of its utility.

Incomplete Information

In a classical logical theory, the proof of a question is made in terms of being true or false, or in terms of representing something about which one could not be conclusive. In spite of that, in a logic program the answers to questions are only of two types: they are ***true*** or ***false***. This is due to the fact that a logic program shows some limitations in terms of knowledge representation (it is not allowed explicit representation of negative information). In addition, in terms of an operational semantics, it is applied the Closed World Assumption (CWA) to all the predicates; i.e., what is not stated as true is false. Indeed, the generality of the programs written in logic represent implicitly negative information, assuming such a presupposition. An extension of a logic program may comprise negative information, as well as directly describing the CWA for some predicates[1][13][9]. Consequently, it is possible to consider three types of conclusions for a given question: ***true***, ***false*** or, when there is no information at all, the answer will be ***unknown***.

Preliminaries

This work is supported by the developments in [1][13], where the representation of incomplete information and the reasoning based on partial assumptions is studied [7].

Null Values

The identification of null values emerges as a strategy for the enumeration of cases, when one intends to distinguish between situations where the answers are ***known*** (true or false) or ***unknown*** [1] [12].

The representation of null values will be scoped by the ELP. In this work, it will be considered two types of null values: the first will allow the representation of unknown values, not necessarily from a given set of values, and the second will represent unknown values, from a given set of possible values.

Interpretation of null values

Consider the meta-predicate demo() to evaluate a question submitted to a knowledge base using an ELP with null values, i.e.:

demo: Question $\times$ Answer

where Question identifies the query to be processed in terms of ELP and Answer denotes a truth value, being one of the three possible terms: True (T), False (F) or Unknown (U).

demo(Q, T) $\leftarrow$ Q
demo(Q, F) $\leftarrow \neg$Q
demo(Q, U) $\leftarrow$ not Q $\wedge$ not $\neg$Q

Program 1: A Meta-predicate for knowledge interpretation in terms of ELP using null values

Anthropopathic Qualities

It is possible to establish mechanisms to express world knowledge in a way that makes possible the behavior study of virtual entities, in terms of its personification. Therefore, situations involving forgetfulness, remembrance, learning or trust will be analyzed.

The description of abnormal situations using formulae, declared as exceptions to the predicate extension, turns feasible such a goal.

Characterization of a problem

Consider the following example, created to configure a practical application in terms of what is the main contribution of this work. The symbol $\neg$ denotes strong negation, defining what should be interpreted to be ***false***, and the term `not` designates negation by failure.

diagnostic(normal,paul)
$\neg$diagnostic(P,S) $\leftarrow$ not diagnostic(P,S) $\wedge$ not exception(diagnostic(P,S))

Program 2: Excert of an extended logic program, representing knowledge in an instant of time t_i

In Program 2 there is an axiom stating that the diagnostic of Paul is normal. Assuming that this is all the knowledge in instant t_i, the second clause of Program 2 impose that it must be considered false all other situations in which it is not given any information and that it cannot be an exception.

Suppose that, in an instant later, t_j, the knowledge evolves in such a way that it must be represented as shown in Program 3.

$\neg$diagnostic(P,S) $\leftarrow$ not diagnostic(P,S) $\wedge$ not exception(diagnostic(P,S))
exception(diagnostic(atrophy,paul))
exception(diagnostic(hemorragy,paul))
exception(diagnostic(tumour,paul))

Program 3: Knowledge base excert, in instant t_j

In a third instant of time, t_k, the knowledge base is as shown in Program 4. Symbol $\perp$ represents a null value of an undefined type, in the sense that it is a representation that assumes that any value is a potential solution but without concluding which value will characterize the knowledge.

diagnostic($\perp$,paul)
$\neg$diagnostic(P,S) $\leftarrow$ not diagnostic(P,S) $\wedge$ not exception(diagnostic(P,S))
exception(diagnostic(P,S)) $\leftarrow$ diagnostic($\perp$,S)

Program 4: Excert of the program that resulted from the evolution of knowledge, between instants t_j and t_k

Looking to the process of knowledge evolution, since instant t_i to t_k, one may say that the information has been loosing specificity, since that, primarily, it was known that the Paul's diagnostic was normal (t_i); after that, it was only known that the paul's diagnostic was out of the three hypothesis, atrophy, hemorragy or tumour (t_j); finally, in a third instant, the system only knows that the Paul's diagnostic was done, but cannot be conclusive about it.

Consequently, in terms of the temporal axis $t_i \rightarrow t_j \rightarrow t_k$, one may say that the knowledge evolution has taken a form of forgetfulness, leading to the emptying of the knowledge base meaning. However, taking the knowledge evolution in the other way around; i.e., $t_k \rightarrow t_j \rightarrow t_i$, a similar analysis will allow concluding that the knowledge base learned something, showing that the evolution of knowledge was in a way that the system was perfecting what it knew.

Leading with human like properties

Now, it is possible to pay attention to the recognition of humans' own qualities represented in an intelligent system, which adopts the ELP as the language to describe its knowledge base. Consequently, the objective is to define mechanisms that allow the formalization of procedures that seek to characterize any knowledge agent in terms of its anthropopathic qualities; i.e., to recognize and to assign, to an intelligent system, humans' features, allowing a certain kind of personification of the computational agents.

Consider, again, Program 2, that describes the state of the system in instant t_i, in which is questioned what is the Paul's diagnostic, `diagnostic(P,paul)?` In terms of the meta-predicate `demo()`, one has:

1st Round:
∀(P): demo(diagnostic(P,paul),T)?
∠ successful
∀(P): demo(diagnostic(P,paul),F)?
∠ unsuccessful
∀(P): demo(diagnostic(P,paul),U)?
∠ unsuccessful

This question only has a solution when interpreted in terms of the positive information, when the diagnostic of Paul is normal. In this way, in a second round, it is possible to determine the quantity and quality of the information that was used to determine the solution for the question in the first round. In other words, one intends to find the set of all the solutions that could contribute to solve the question in the first round:

2nd Round:
∀(P,S): findall(P,demo(diagnostic(P,paul),T),S)?
∠ S = [normal]

Now consider the state defined by Program 3. One may have:

1st Round:
∀(P): demo(diagnostic(P,paul),T)?
∠ unsuccessful
∀(P): demo(diagnostic(P,paul),F)?
∠ unsuccessful
∀(P): demo(diagnostic(P,paul),U)?
∠ successful

i.e., the question is answered, but there is a certain level of noise attached. This means that the second round will produce an empty set of solutions, when invoked in terms of the `demo` meta-predicate:

2nd Round:
∀(P,S): findall(P,demo(diagnostic(P,paul),U),S)?
∠ S = [ ]

This situation denotes that there are exceptions defined, given rise to an unknown solution. One may now turn to the exceptions in order to evaluate the answer, based on this lack of knowledge:

3rd Round:
∀(P,S): findall(P,exception(diagnostic(P,paul)),S)?
∠ S = [atrophy, hemorragy, tumour]
∀(S,N): length(S,N)?
∠ N = 3

In this third round, through a search of the exceptions, a solution's evaluation is made. In this case, due to the fact that there are three exceptions, it may be concluded that each exception contributes with $^1/_3$ to the (eventual) certification of the solution.

Consider, now, the case described by Program 4. By the application of the same mechanisms, one has:

1st Round:
∀(P): demo(diagnostic(P,paul),T)?
∠ unsuccessful
∀(P): demo(diagnostic(P,paul),F)?
∠ unsuccessful
∀(P): demo(diagnostic(P,paul),U)?
∠ successful

i.e., it is given a solution to the question that is understood as being of the undefined type. In this case, the second round produces a specific result:

2nd Round:

$\forall$(P,S): findall(P,demo(diagnostic(P,paul),U),S)?

$\angle$ S = [$\perp$]

$\forall$(S,N): lenght(S,N)?

$\angle$ N = ∞

i.e., the evaluation of the truth value to be assigned to the solution, falls back upon a mechanism that starts from an unlimited set of possible solutions.

An interpretation of the results

At timestamp t_i, the existing knowledge grant a solution to the problem in terms of stating which is Paul's diagnostic. The question has a solution in terms of the extension of the positive part of the predicates that embodies the universe of discourse. At the next timestamp, t_j, it is not possible to state in a conclusive way an answer for the given question, but it has been possible to compute, with a good level of trust, the exceptions to the contribution of the extensions of the predicates, to get a possible solution to the problem. At the last timestamp, t_k, despite the problem solution continues unknown, this situation occurs when a null value is represents an undefined set of possible solutions. One's trust on the solution tends to be null; i.e.:

$$\mathcal{G}_{\texttt{diagnostic(P,paul)}} = \lim_{\perp \to \infty} \frac{1}{\perp} = 0$$

where $\mathcal{G}$ denotes a truth value. Indeed, considering the system evolution in the way $t_i \to t_j \to t_k$, the level of trust for the same question at every timestamp, decreased; i.e., we are in presence of a knowledge emptying process (forgetfulness). On the other hand, if one's have $t_k \to t_j \to t_i$, the level of trust in the question's answer increases; i.e., the system learned to remember facts or past situations.

Conclusions

In this work, it were considered some techniques and mechanisms to endorse the problem of representing emotions. This represents a step forward to get real intelligent systems, with human properties and behaviors, applied in distance learning systems embedded in websites prepared for medical education.

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