Multi-agents system for medical diagnosis

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ABSTRACT

The medicine domain is an enormous environment characterized by its shared and distributed decisional aspect, and its management of care, requiring a communication and a complex coordination of the various clinical forms of information between the various medical departments, doctors and patients. The introduction of multi-agents system into the medical fields facilitates the management of the decisions and the actions, and ensures the communication and coordination by reducing the errors of diagnosis and treatment, and by improving time required to seek the medical resources, and other medical departments. The objective of this paper is to propose a multi-agents system (M.A.S), which distributes the diagnosis on three agents. Each agent is a specialist (ORL, digestive and cardiology) able to decide and communicate with the other agents.

Key Words: artificial intelligence, multi-agents system, medical diagnosis

1. Introduction

The objective of data-processing fusion and medicine quite simply consists in offering a level of medical care more improved. For the patients, that means to obtain more precise diagnoses and more effective options of treatment. The doctors will be able systematically to enrich the traditional procedures of diagnosis with new knowledge. New technologies, the definition of the profile of transcription, the microphone-networks, chips ADN and the mass spectrometry generate enormous quantities of data on genes and the proteins which could inform us about the origin, the prevention and the treatment of multiple diseases, such as cancer, the diabetes, Alzheimer and the cardiopathy. To be able to explore these new data effectively, it is necessary to have powerful information processing systems able to reach this information, to analyze and manage it. These systems will also allow the researchers various parts of the world to collaborate between them [18][23]. The adoption of " agent " approach for the realization of a medical application is founded on the distribution of the data and the environment dynamism [2][4]. The multi-agents systems [21] brought a solution interesting for the realization of an application of assistance to the medical diagnoses. The multi-agents system Approach can be used in the coordination of the hospitals, for the managing organ

transfer between human and other types of services. Another aspect of the use of the M.A.S in medicine, is the simulation of interactions phenomena of genes and of proteins, the results make it possible to simulate the way in which the patients will answer the treatments [22].

2. Artificial intelligence in medicine

Since the first steps of the I.A, scientists and doctors were captivated by the potential of such a technology, which could have in medicine [25]. Intelligent computers are able to store and treat enormous quantities of knowledge, the hope was that they would become "doctors limps about it", helping the doctors in various tasks like the diagnosis [19][8]. With such motivation, a community of data processing specialists and professionals of health start to form a research program for a new discipline called the I.A in medicine [20]. Clancey and Shortliffe [7][26] provided the following definition: " the medical I.A is mainly concerned by the construction of the programs I.A which perform of the diagnoses and make recommendations of therapy. With the difference of the medical applications based on other methods of programming, like purely statistical and probabilistic methods, the medical programs in I.A are based on the models symbolic systems of entities of disease and their report/ratio with the states of the patient and the clinical demonstrations "[23].

3. Multi-agents systems and medicine

The medicine field is an enormous environment characterized by its shared and distributed decisional aspect, and its management of care, requiring a communication and a complex coordination of the various clinical forms of information between the various medical departments, doctors and patients [17][24]. The introduction of the M.A.S into the medical fields facilitates the management of the decisions and the actions, and ensures the communication and coordination by reducing the errors of diagnosis and treatment, and by improving time required to seek the medical resources, and other medical departments. M.A.S approach [12][14] can be used in the coordination of the hospitals, for the managing organ transfer between human and other types of services. Another aspect of the use of the M.A.S in medicine, is the phenomena simulation of interactions of genes and proteins, the results make it possible to simulate the way in which the patients request with the treatments. So that the M.A.S can be deployed in medical applications, surmounted several difficulties are needed. As example of these difficulties we quote:

- the communication: the systems of medical departments are complex, various dispersed. Consequently, the use of a standard of communication, vocabularies and ontologies are important in the development of a medical M.A.S.

- medical data protection: medical information (the medical file of a patient for example) must be confidential in any system of care based on agent. For example, the use of the cryptographic methods to protect the access to the data of transmission between agent (a mechanism of identification by password).

The M.A.S [16] have most important interest in medial field, they can be integrated with existing applications. For example, the agents can access to a data base of of a certain hospital to obtain information on a patient [3].

4. Medical diagnostic

The diagnosis can comprise several operations:

- to recognize the state of disease and to name it,
- to try to determine how it occurred,
- to explain why it is binding to this person suddenly.

During the consultation, the doctor listens patient who describes from which he suffers. Then the doctor examines the consultant to check and gets information. Thus, the diagnosis is the different compiling data of origin:

- symptoms (subjective): signs acquired with the interrogation of the patient. Faintnesses, abnormal feelings, disorders of a function like digestion or the sleep, etc.
- The signs (objective): the doctor seeks demonstrations, anomalies, phenomena by examining the patient.

5. Diagnostic assist systems

The majority of artificial intelligence systems in the medical field were developed to help the doctors in the process of diagnosis. The majority of these first systems were not used, partly because they did not gain the sufficient support doctors. DXPLAIN is one of these computerized decision-making systems private clinics, developed at the hospital of Massachusetts [1][5]. It is used for the assistance with the diagnosis, by taking a whole of facts including the signs, the symptoms, the data of laboratories, it provides then a list classified of diagnostic [6]. The system contains a base of data for more than 4500 clinical signs which are associated with more than 2000 different diseases.

6. System Presentation

Our system models a set of specialists doctors. Each doctor is modeling by an agent which communicates with other agents using blackboard struture. The goal of the system is to arrive at a final medical diagnosis following initial facts thanks to the co-operation, the coordination and the reasoning of the set of the agents. This system consists of:

- a set of agents: who model the specialists doctors by simulating their behaviors;
- a blackboard: a structure of data to ensure the communication between the various agents of the system;
- an interface: to communicate the patient information to the system.

6.1 System architecture

The architecture of the multi-agents system using blackboard control is composed of three elements:

- Agents [13].
- the blackboard [15].
- the mechanism of control [15].

6.1.1 Agent architecture

All the agents system are characterized by their:

- autonomy, each agent has a faculty to control its own behavior without the intervention of a other agents or human [10]. It perceives information of its environment and to react in return by handling the blackboard. Each agent of the system has its own knowledge (its medical field).
- deliberative behaviors, according to its beliefs and its goals the agent is able to reason, cooperate and communicate.
- Capacities to answer in time, the agent must be able to perceive its environment and to work out a response in required time, that requires that the agent must be always in an active state.

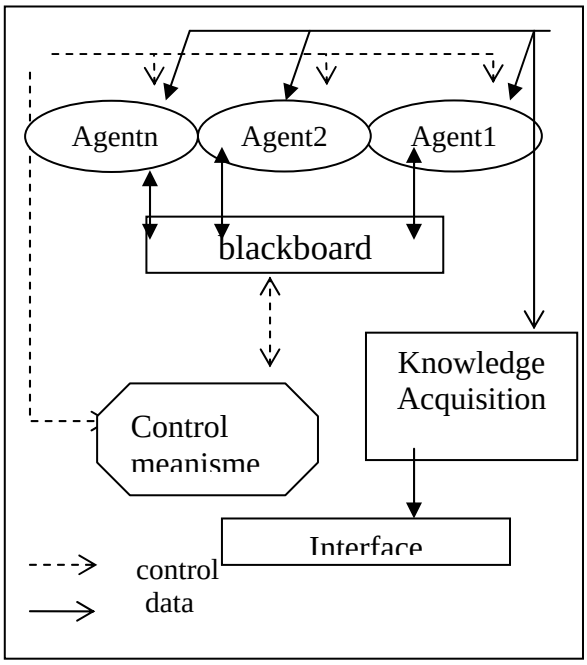


Fig.1. System architecture

So we refer to cognitive agents which are able to plan and make decisions, which permit us to model the doctor operation. Common interns architecture of all agents of the system includes the following components: expertise, beliefs, the arguer, the communication module.

6.1.2 Blackboard architecture

The blackboard is a software structure which ensures the communications between several cognitive agents functioning simultaneously by means of a management of the partial solutions in real time under control. In our system, the blackboard is a structure given to subdivide on the number of agents (a number of specialists), where each level is associate to one agent [11].

6.1.3 Control

Control plays an important part in a multi-agents system for the management of the co-operation and coordination between the agents [9]. In our system we use procedural control. Control is solved by a single program, composed of one:

- Monitor.
- Diary.
- Ordonnansor.

The operation cycle of a controller is as follows:

- According to facts (signs) present in the blackboard, if an agent can be activated, the monitor places it in the diary. This stage is as many repeated once than there are agents whose conditions of activation are carried out.
- the agents, placed in the diary, are ordered according to various strategies of selection, then finally chosen by the ordonnansor.
- the agent selected is started. This results in generally by modifing the blackboard by additions of new facts, destruction of certain facts or modifications of facts already present.

The cycle begins again at the first stage and operation continues as much as there are agents in the diary (fig.2).

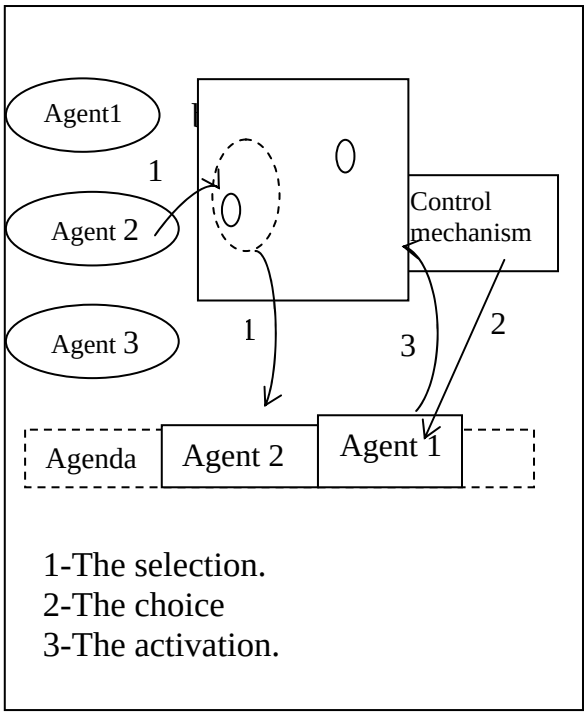


Fig.2 Control functioning cycle

6.1.4 Data acquisition Module

The richness of a multi-agents system comes in fact that it makes it possible to update the knowledge base of each agent.

6.1.5. The interface

The interface has a great importance in the information processing systems. It plays the intermediary role between the user and the system for the acquisition of the data. It provides more convivial, more flexible and more effective system.

In our system, the user introduces the clinical signs using a preset signs list or a suspect disease, then to launch the operation of diagnosis.

6.2 Functioning system

The operation of the system proceeds according to these essential stages:

- data acquisition: this process is carried out in two stages the user (the doctor) communicates the signs, or a suspect disease of the patient to the system. Consequently, the system questions the user, if necessary, to refine certain signs.

- Activation of the control mechanism: after the consultation of the blackboard and according to its state. The controller detects the agents interested by these changes, then activates the priority agent.
- Agent activation: the agent receives the data of the blackboard, then it adopts its own strategy of reasoning to lead to a diagnosis.
- The reasoning: the engine have about it these capacities of reasoning, specific knowledge of the agent (bases rules) and state of the blackboard, can lead to a partial or final diagnosis.
- The blackboard modification : The modification of the blackboard is carried out after each reasoning of an agent (insertion of new facts) for the next cycle.
- Results interpretation : When the blackboard does not contain the conditions of activation of other agents, the controller interprets the results and gives a final medical diagnosis.

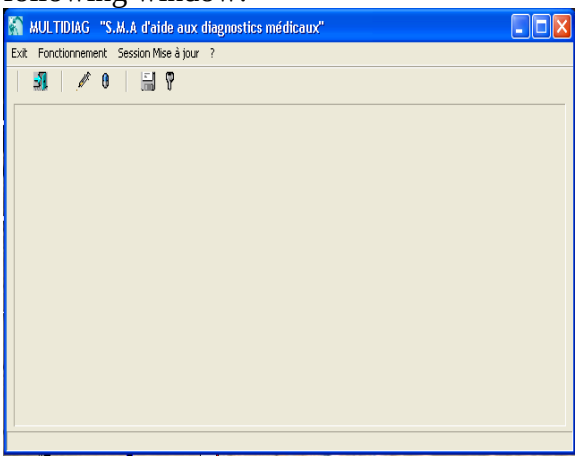
These stages its carried out in the session user to arrive at the end at a final diagnosis for which all the agents took part. For the acquisition of new data (the base of rules for each agent), it is necessary to rock in mode of update by introducing a password to eliminate all risk to seize rules by people not forming part of the medical profession. The session of update proceeds according to these stages:

- To choose agent who is concerned with the update of new rules.
- To handle the base of rules through the interface of acquisition. The operations carried out are:
- Insertion: For the addition of new rules of production. At least a sign
- should be seized (condition), and the action.
- Suppression: To remove the rules of production.
- Modification: To modify the signs (conditions) and the action of the rules of production.

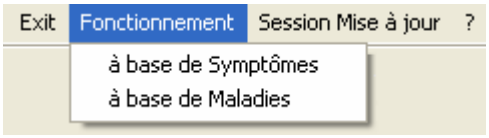
7. Validation

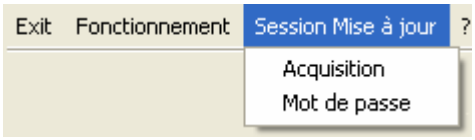
7.1 System presentation

The system interface is represented by the following window:



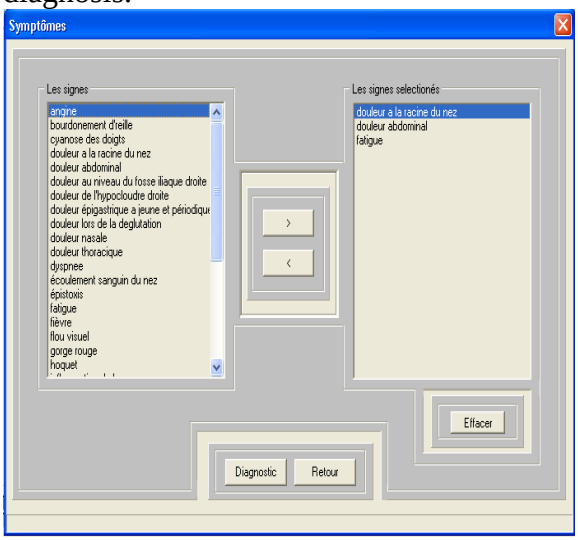
The principal window is made up of menus and a bar of tools. There are four menus to reach all the functions available:





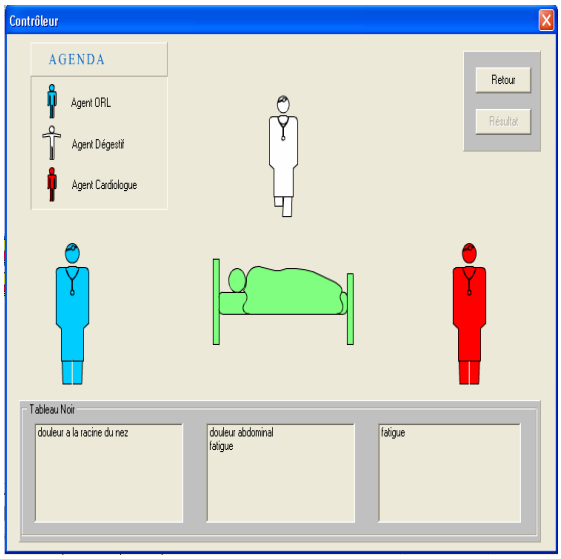
7.2 Operating system

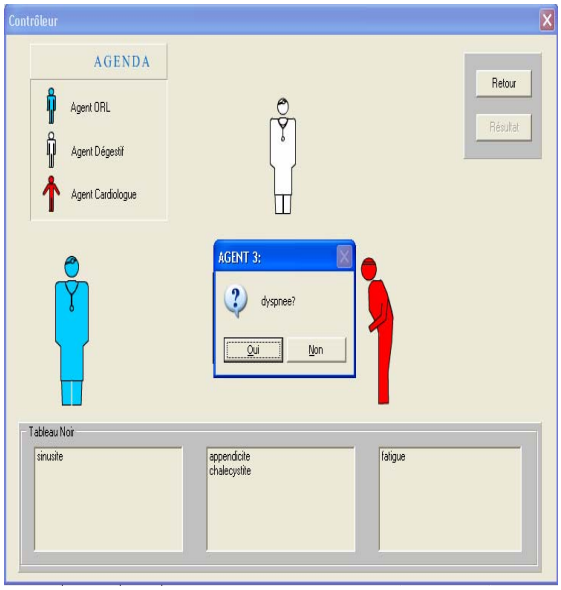
Operating system contains symptoms given by the following window makes it possible to be selected using a list of preset signs. Then the user can begin the diagnosis.



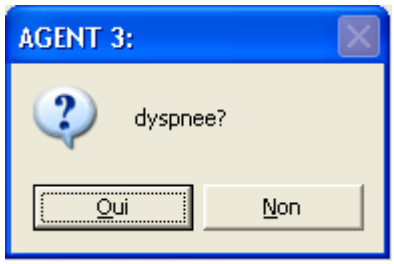
The next windows make it possible to visualize the operation of the system:

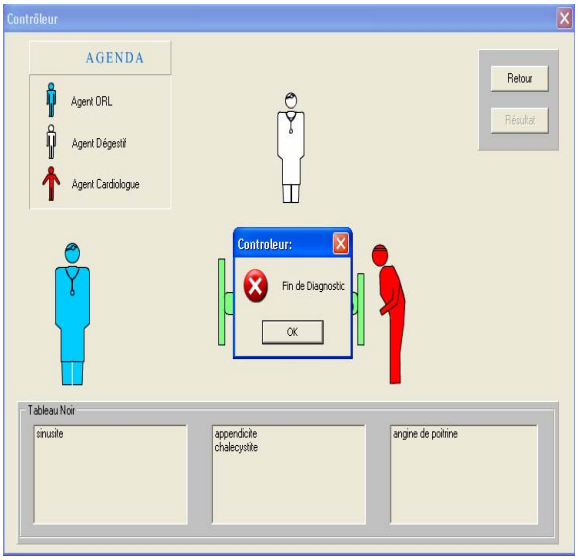
- the cycle of operation of the controller.
- Modifications of the blackboard





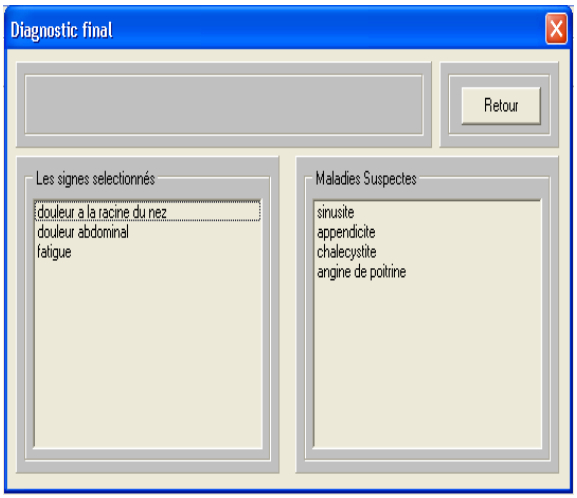
The agent has the possibility of asking questions:





The following message indicates the end of the diagnosis:

The controller interprets the results and gives the final diagnosis in this window.



8. Conclusion and perspectives

The objective of this paper, is to model a multi-agents system of assistance to the medical diagnoses. We used the approach multi-agents which comprises three agents, where each agent with a different specialty. These agents communicate using the blackboard and which cooperate to give to the end a final diagnosis. Us have noted during realization of our system that the multi-agents systems are currently in full rise, which is interested in the individual behaviors, with the interactions between autonomous agents. The possible prospects for our works can be an adaptation so that the system is more flexible for the addition or the removal of an agent. An improvement of the interface allowing to specify the signs or symptoms in laconic free text, and the possibility of adapting the system for a use on Internet.

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