ABSTRACT

In today's life, it is a true fact that computerized intelligent health care system can provide better healthcare than the traditional medical system. In the framework of this paper, it is interesting to consider the possibility of deploying agents that provide Health Care-related services. We have made the design and construction of a Multi-Agent System (MAS) that is composed of agents that provide medical diagnosis services. The MAS contains agents that allow the user to have a solution for his/her symptoms. We proposed Very Large-Scale Medical Diagnosis System (VLMDS) using Multi-Agent System (MAS), an advanced scheme of the Large-Scale medical diagnosis system. Using the Communication Improvement Agent (CIA) and collaborative as well as cooperative intelligent agents and residing on a multi-agent platform, that VLMDS provides a communicative task-sharing environment. In this paper, we report the design and construction of a Very Large-Scale Medical Diagnosis System (VLMDS) using Multi-Agent System (MAS) that is composed of agents that provide medical services using JADE.

INTRODUCTION

Diagnosis of diseases is the process of converting observed evidence into the names of diseases. The efficiency with which it is applied is of great economic importance. Applying Artificial Intelligence techniques in the medical field [2] [9] may help not only in improving the accuracy performance of classification but also in saving diagnostics time, cost, and the pain accompanying pathologies tests.

The process of causal diagnosis usually begins with an investigation of patient's symptoms, tracing them back down the chain until the source of the problem is confirmed. Central to the effective delivery of healthcare by the physician is the complex skill of clinical problem solving. The accuracy of this skill is crucial to the life and well-being of his/her patients. The efficiency with which it is applied is of great economic importance.

The process of diagnosis usually starts with an investigation of patients symptoms, tracing them back down the chain until the source of the problem is confirmed. Central to the effective delivery of healthcare by the physician is the difficult task. The Accuracy of this task is crucial to the life and well-being of his/her patients. The efficiency with which it is applied is of great economic importance.

A multi-agent system [1] is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. Intelligence may include some functional, procedural approach, algorithmic search or reinforcement learning. Agent-Based Model tends to be used more often in the sciences, and multi-agent system in engineering and technology. Topics, where multi-agent systems research may deliver an appropriate approach, include online trading, disaster response, and modelling social structures.

Multi-Agent System is a self-organized system, tend to find the best solution for their problems without intervention. There is the high similarity to physical phenomena, such as energy minimizing, where physical objects tend to reach the lowest energy possible within the physically constrained world. Example- Many of the cars entering a metropolis in the morning will be available for leaving that same metropolis in the evening.

The study Multi-Agent System is concerned with the development and analysis of sophisticated Artificial Intelligence problem-solving control architectures for the multi-agent system.

Topics of research in Multi-Agent System include:

- agent-oriented software engineering [5]
- beliefs, desires, and intentions (BDI)
- cooperation and coordination
- distributed constraint optimization (DCOPs)

- organization
- communication
- negotiation
- distributed problem solving
- multi-agent learning
- agent mining

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AGENT

An **agent** is anything that can perceive its environment through **sensors** and acts upon that environment through **effectors.**

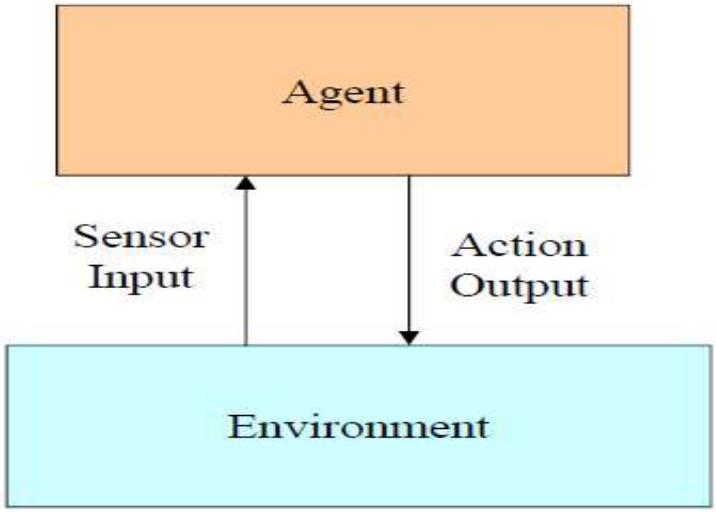

Fig 1: Agent

- A **human agent** has sensory organs such as eyes, ears, nose, tongue and skin parallel to the sensors, and other organs such as hands, legs, mouth, for effectors.
- A **robotic agent** replaces cameras and infrared range finders for the sensors, and various motors and actuators for effectors.
- A **software agent** has encoded bit strings as its programs and actions.

RATIONALITY

- Rationality is nothing but the status of being reasonable, sensible, and having a good sense of judgment.
- Rationality is concerned with expected actions and results depending upon what the agent has perceived. Performing actions with the aim of obtaining useful information is an important part of rationality.

How do agents acquire intelligence?

Cognitive agents

The model of human intelligence and human perspective of the world characterises an intelligent agent using symbolic representations and **mentalistic notions**:

- knowledge - John knows humans are mortal
- beliefs - John took his umbrella because he believed it was going to rain
- desires, goals - John wants to possess a PhD
- intentions - John intends to work hard in order to have a PhD
- choices - John decided to apply for a PhD
- commitments - John will not stop working until getting his PhD
- obligations - John has to work to make a living

INTELLIGENT AGENT

In artificial intelligence, an **intelligent agent** (**IA**) is an autonomous entity which observes through sensors and acts upon an environment using actuators (i.e. it is an agent) and directs its activity towards achieving goals (i.e. it is "rational", as defined in economics). Intelligent agents may also learn or use knowledge to achieve their goals. They may be very simple or very complex. A reflex machine, such as a thermostat, is considered an example of an intelligent agent.

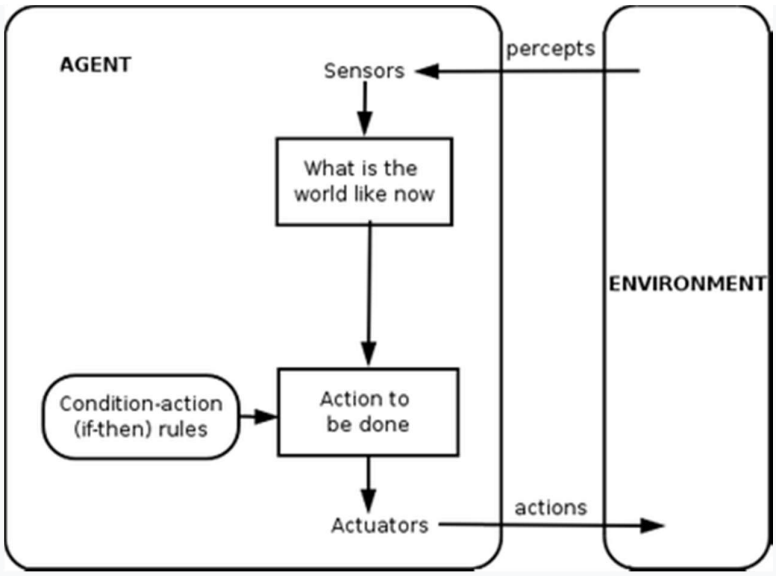

Fig 2: Simple reflex agent

Intelligent agents are often described schematically as an abstract functional system similar to a computer program. For this reason, intelligent agents are sometimes called **abstract intelligent agents** (**AIA**) to distinguish them from their real world implementations as computer systems, biological systems, or organizations.

MULTI-AGENT SYSTEM

Multi-agent systems consist of agents and their environment. Typically multi-agent systems research refers to software agents. However, the agents in a multi-agent system could equally well be robots, humans or human teams. A multi-agent system may contain combined human-agent teams.

Agents can be divided into different types ranging from simple to complex. Some categories suggested to define these types include:

- **Passive agents** or agent without goals (like obstacle, apple or key in any simple simulation)
- **Active agents** with simple goals (like birds in flocking, or wolf–sheep in prey-predator model)
- **Cognitive agents** (which contain complex calculations)

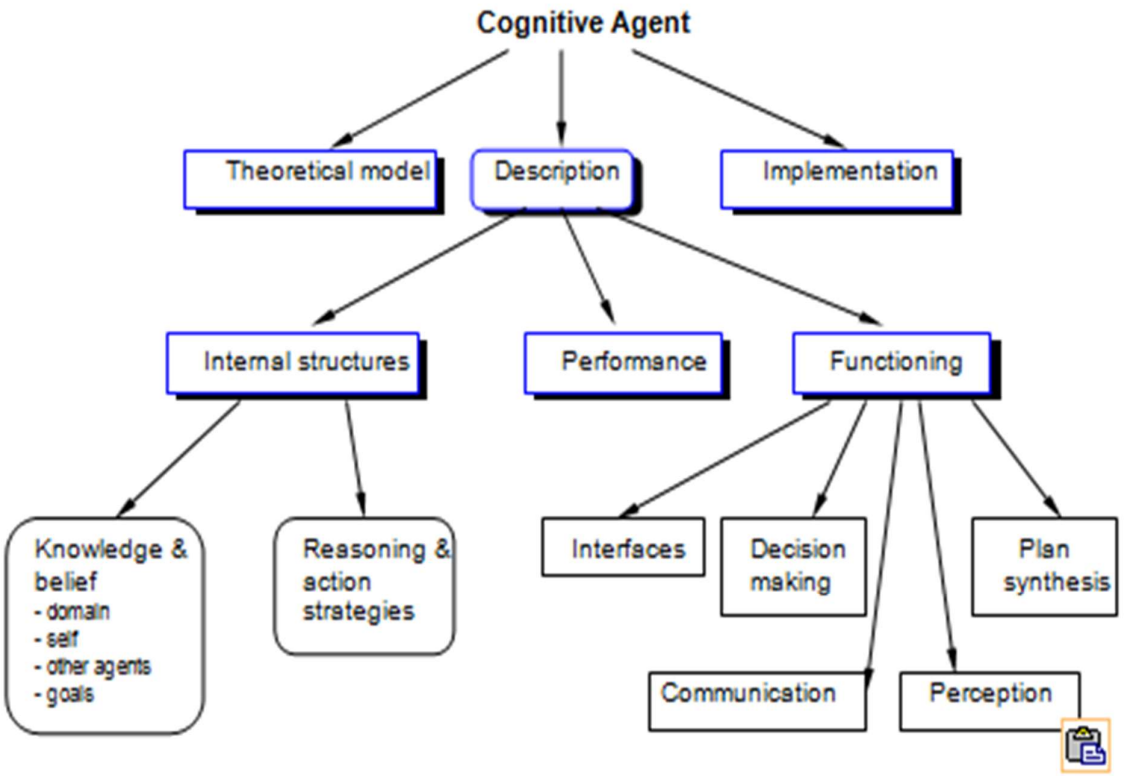

Fig 3: Cognitive agents

Agent environments can be divided into:

- Virtual Environment
- Discrete Environment
- Continuous Environment

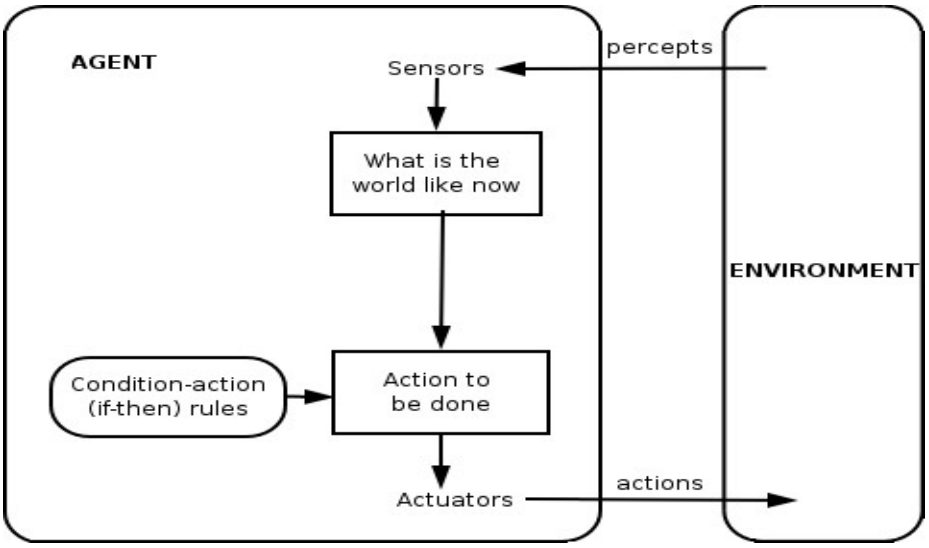

Fig 4: Simplex reflex Agent

Agent environments can also be organized according to various properties like: accessibility(depending on if it is possible to gather complete information about the environment), determinism(if an action performed in the environment causes a definite effect), dynamics (how many entities influence the environment in the moment), discreteness (whether the number of possible actions in the environment is finite), periodicity (whether agent actions in certain time periods influence other periods), and dimensionality (whether spatial characteristics are important factors of the environment and the agent considers space in its decision making).

Agent actions in the environment are typically mediated via an appropriate middleware. This middleware offers a first-class design abstraction for multi-agent systems, providing means to govern resource access and agent coordination.

LMDS DIAGNOSIS SYSTEM

The main novelty of the LMDS system consists in the novel classes of agent members of the system and the manner in which the members of the system contribute to the problems solving. Each diagnostic can be elaborated cooperatively by more members of the system. The diagnosis system can solve difficult medical diagnosis problems whose solving must be discovered cooperatively by the members of the system. Many difficult medical problems solving requires medical knowledge that cannot be detained by a single physician or a medical computational system. Simulations prove the correctness in operation of the LMDS system.

INTELLIGENT COOPERATIVE MOBILE AGENT ARCHITECTURE

- An ICMA agent denoted MA is composed of two parts
  - a static part
  - a mobile part
- Static part can create new mobile subagents and eliminate the inefficient or useless mobile subagent.
- mobile subagents are responsible for the problems solving at the hosts distributed in the network
- The communication between different ICMA agents is realized via the mobile part.
-

ICMA OPERATION

If the static subagent Ss, of a medical ICMA agent MA, cannot solve an over-taken problem (does not have the necessary capability and/or capacity), then the problem must be allocated for solving to another agent with medical knowledge.

The problem can be allocated for solving by a mobile subagent of MA created by Ss. A mobile subagent may migrate in the network with an overtaken problem until the problem is solved. During its migration more agents may contribute to the problem solving, each of them making modifications on the statement of the problem solving.

Drawback of LMDS

LMDS has many advantages but still it suffers from some problems which are:

- Communication between agents is not good.
- Security (Agents can access the other network).

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VERY LARGE-SCALE MEDICAL DIAGNOSIS SYSTEM

Very Large-Scale Medical Diagnosis System (VLMDS) the newly introduced component is Communication Improvement Agent (CIA) [8]. CIA improves the communication between the agents and checks that the network agent are not accessing the data other than its own network

VLMDS consists of following components:

- Physicians
- Medical expert system agents
- Medical ICMA agents [7]
- Communication Improvement agents CIA

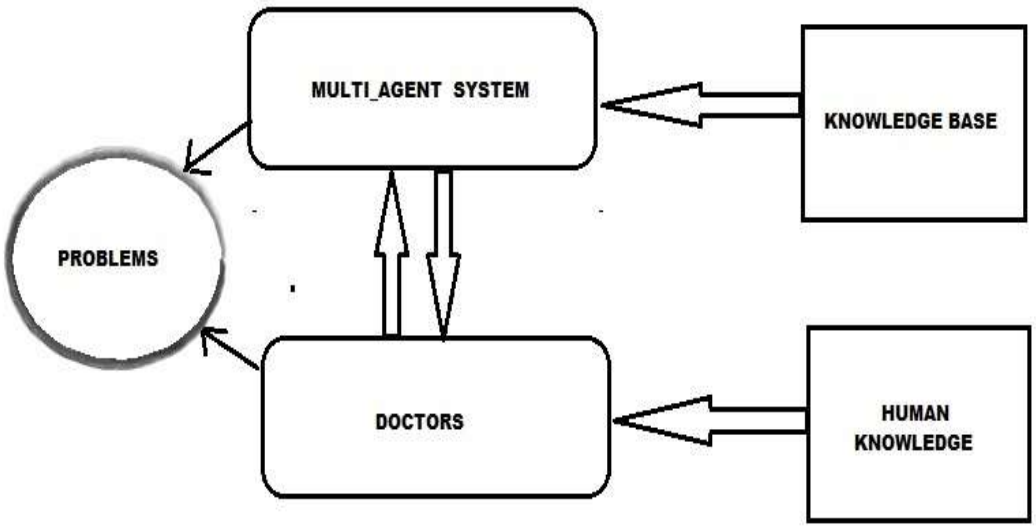


Fig 5: VLMDS Architecture

WORKING MODEL OF THE VLMDS

In Fig host with which Doctor interacts during its operation. The host detains different information from a host (submitted agents to the hosts, submitted agents specializations etc.). Agents (human and artificial) submitted host and ICMA [1] [6] mobile subagents [7] arrived for problems allocation for processing at the host.

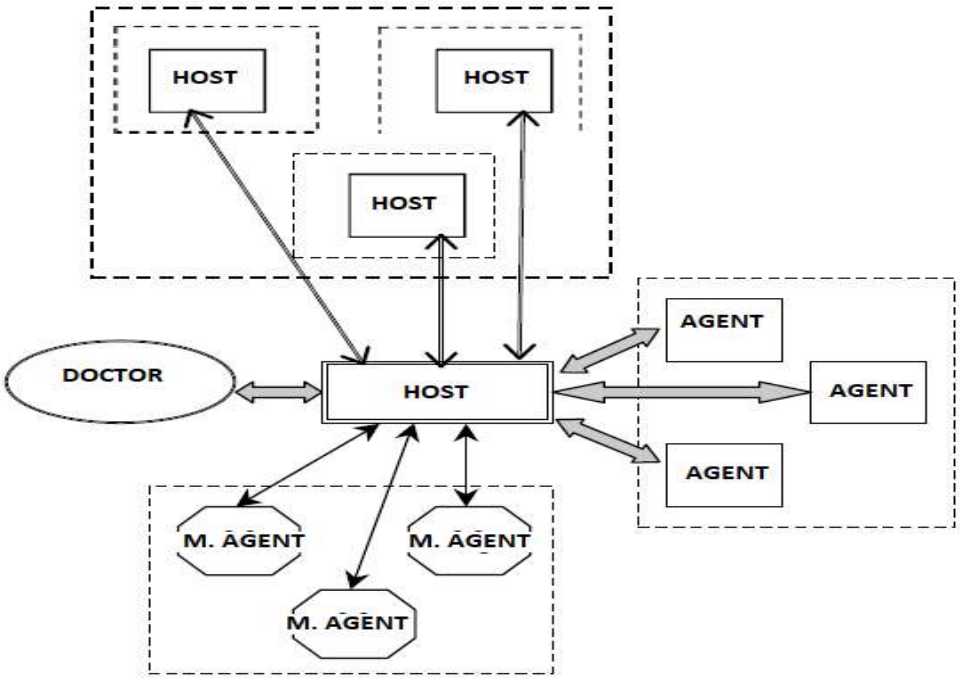


Fig 6: Doctor Relation with the VLMDS system

In the following, an operation of the VLMDS system is described. The problems are transmitted randomly to the medical sub-agents members of the system.

Each medical sub-agent can receive problems transmitted by solving. A problem is solved, when the problem is received for solving and is terminated when the problem solution is obtained

MULTI-AGENT SYSTEM IN VLMDS

An MAS in VLMDS is composed from two parts

- a static agent
- a mobile agent (MA)
- a CIA

Static part can create new mobile subagents mobile subagents are responsible for the problems solving at the hosts distributed in the network. The communication between different Mobile Agent agents is checked by CIA.

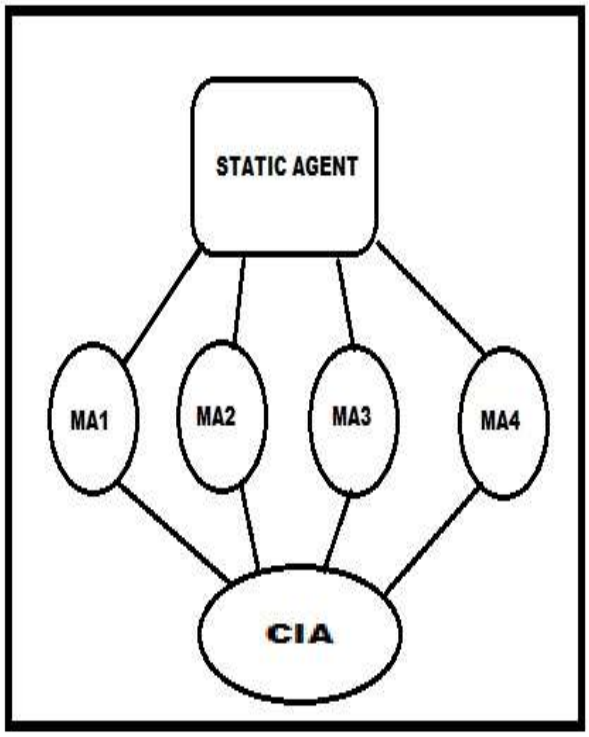
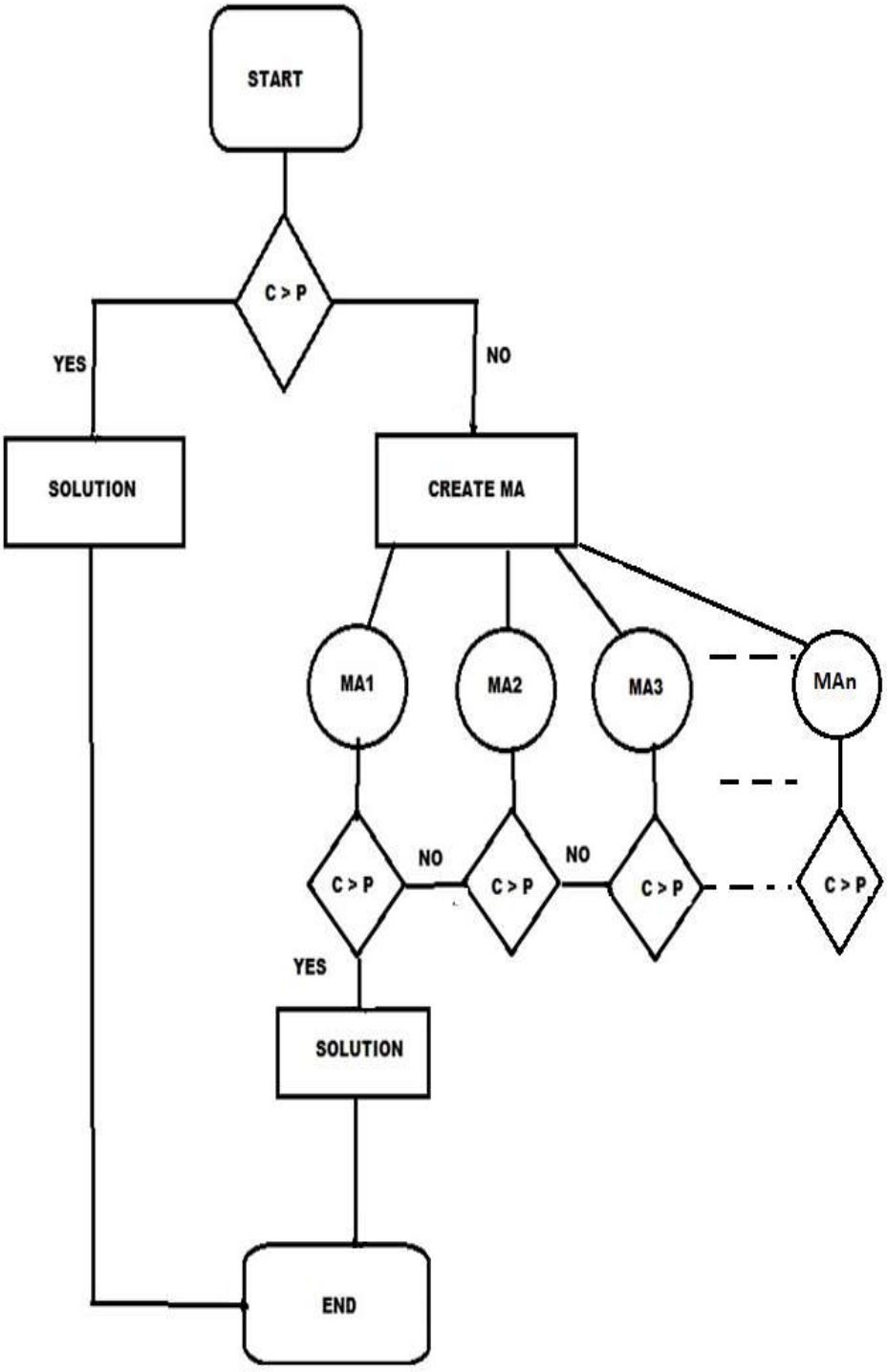


Fig 7: MAS in VLMDS

FLOWCHART


START
C > P
YES
NO
SOLUTION
CREATE MA
MA1
MA2
MA3
MAn
C > P
NO
C > P
NO
C > P
C > P
YES
SOLUTION
END

ALGORITHM

In the following, operation of the VLMDS system is described. The problems are transmitted randomly to the medical ICMA agents' members of the system. A problem solving cycle is beginning, when the problem is received for solving, and is finished when the problem solution is obtained. The Algorithm describes a diagnosis problem solving cycle by the system.

The static subagent [1][6]denoted of a medical ICMA agent denoted overtakes the problem description.

I/P: The Medical Problem(problem)

O/P: Solution of Problem=SOL

```
Static_Subagent(problem)
{
        If (Capacity>problem)
        {
                Process(problem)
                SOL=Solution()
        }
        else
        {
                Create(Mobile_Agent);
                Launch_Mobile_Agent(PRBLM);

                Problem_allocation()
        }
        return(SOL)
}
```

```
Launch_Mobile_Agent(PRBLM)
{
        While(Solution of Problem not obtained)
        {

                        //Host tries to find(Capacity>problem)//

                if(Capacity>problem)
                SOL=Solution()
                else
                {
                        Create(MobileAgent)
                        TransportSolution(problem)
                }
}
```

The static subagent of the agent will solve the diagnosis problem if it has the necessary specialization and capacity. If static subagent cannot solve the problem (don't have the necessary capability and/or capacity), then it will create a mobile subagent, that is endowed with the knowledge (information and data) known about the problem.

Each host included in the itinerary is estimated that have submitted agents "capable" (have the necessary capability and capacity) to processes the problem. After a problem processing, a result is obtained (new knowledge) that can represent the problem solution (the identified illness and the established diagnosis to cure the illness) or may help the agents in following the processing of the problem.

A medical ICMA agent may collect information about the system from the host to which it is submitted. The hosts in the itinerary of a mobile subagent are ordered based on the problem processing capabilities of the agents submitted to the hosts.

The information about a problem-solving statement, detained in a mobile subagent body, is understandable to the physicians and artificial agents (the information is grouped based on the specifics of the information) and the hosts may extract easily the knowledge that must be transmitted to agents.

The knowledge detained in a mobile subagent's body contains different information and data obtained during a diagnosis problem-solving process. As examples of knowledge contained in a mobile subagent body, we mention: the specification of the necessity to use a physician in the problem solving, the maximum allowed time for the problem solving, the necessary problem solving specialization, the illness symptoms descriptions, medical analyses results, different observations related to the illness, supposed illnesses etc. An agent who processes a problem transported by a mobile subagent agent may add, retract or modify the transported knowledge.

Problem Allocation ()

In: The Medical Problem

Out: The Agent Selected For Problem

Step 1. Host extract the knowledge of the problem.

Step 2. Host establishes the problem announcement.

Step 3. Host approves the problem to a set SUB of submitted agent.

Step 4. Host select the Agent capable to process the problem.

Step 5. Return agent

Problem Allocation () describes the process of finding the best-fitted agent by the host, capable of processes the problem carried by an ICMA mobile subagent. To establish the best-fitted agent capable to process the problem, the host announces the problem to a set SUB of submitted agents. In the establishment of the agents to which the announcement should be sent, Host uses its knowledge detained about the submitted agents and the knowledge detained in Mobile subagent [18][19][20]body. As an example of information that can be used in the establishment of the agents to which a problem announcement should be sent, we mention the specification in the body of the mobile subagent of the problem solving by a physician (the problem is considered to be difficult). Based on this information, Host will send the problem announcement Agent to submitted physicians only. More agents that have

received the announcement might answer a problem announcement. Based on the responses parameters values the host will choose the best-fitted agent.

ABOUT JADE

JADE is a proprietary object-oriented software development and deployment platform product from the New Zealand-based Jade Software Corporation, first released in 1996.It consists of the JADE programming language, IDE and debugger, integrated application server and object database management system.

Designed as an end-to-end development environment to allow systems to be coded in one language from the database server down to the clients it also provides APIs for other languages, including .NET Framework, Java, C/C++ and Web services.

Although a free limited license is available for development, using the JADE platform requires per-process fees to be paid.

A KNOWLEDGE BASE AGENT

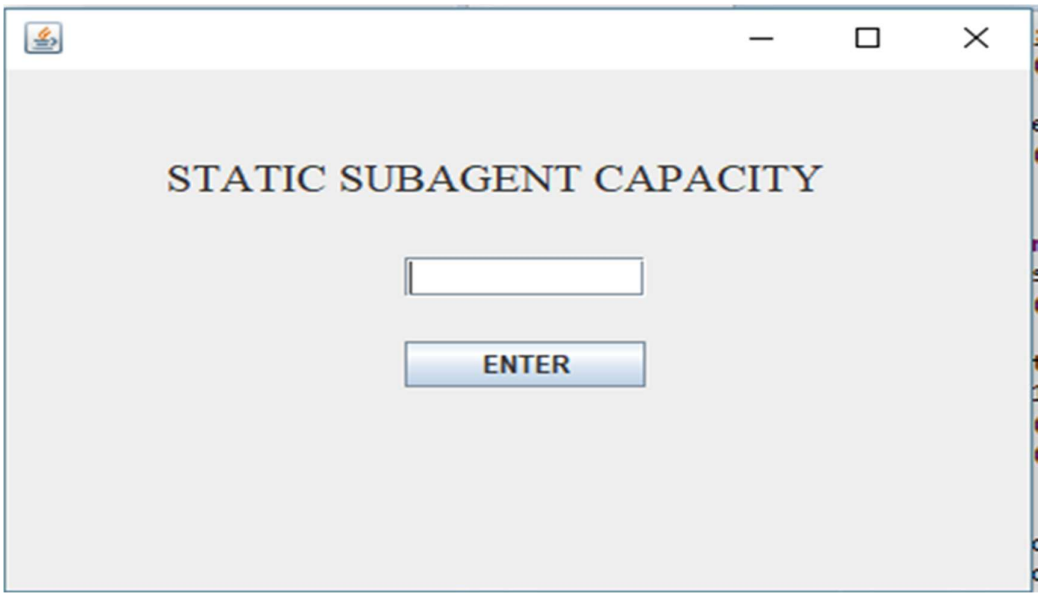
• A knowledge-based agent includes a knowledge base and an inference system.
• A knowledge base is a set of representations of facts of the world.
• Each individual representation is called sentence.
• The sentences are expressed in a knowledge representation language.

The agent operates as follows:

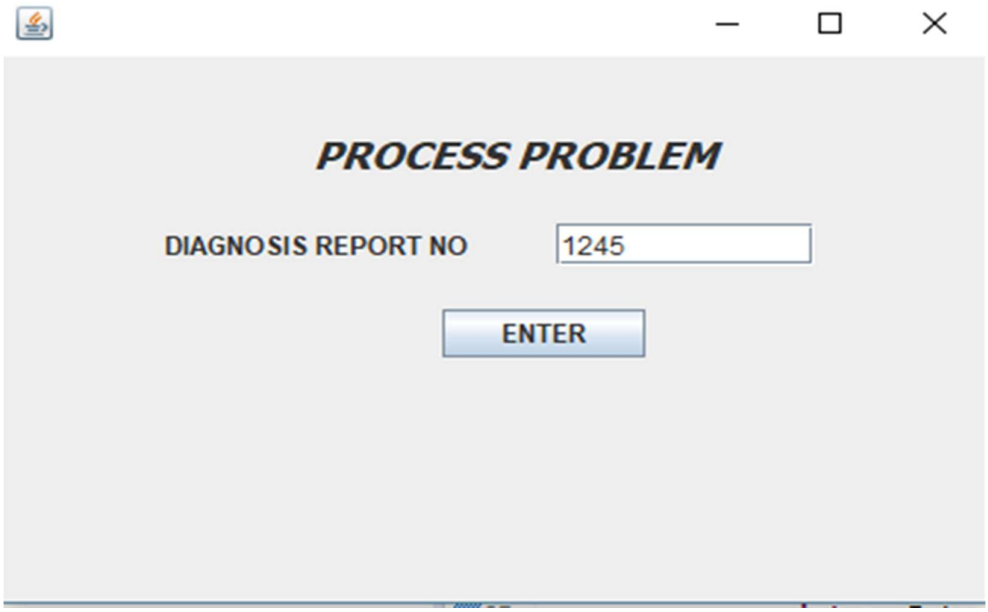
- It TELLS the knowledge base what it perceives.
- It ASKS the knowledge base what action it should perform.
- It PERFORMS the chosen action

SCREENSHOTS AND RESULT

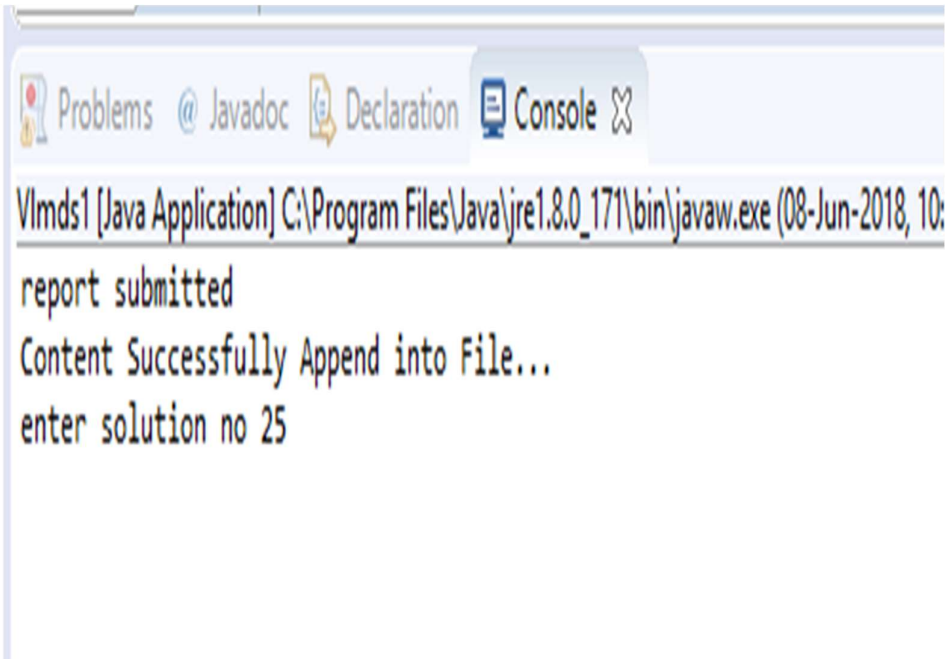
The value of capacity of Static Subagent is enter. If the value is greater than the capacity then the Process Problem interface appear in the screen else another interface for Mobile agent will be appear.



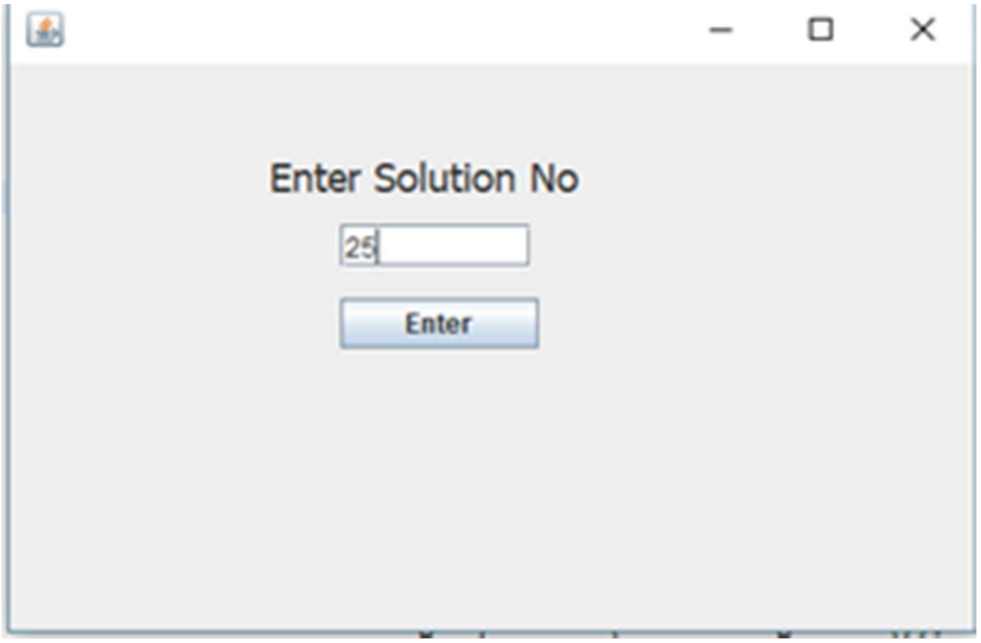
Now as the Capacity is sufficient for the agent to solve the problem so the next step will be the Process Problem. Here the Problem will be enter and passed to the agent.



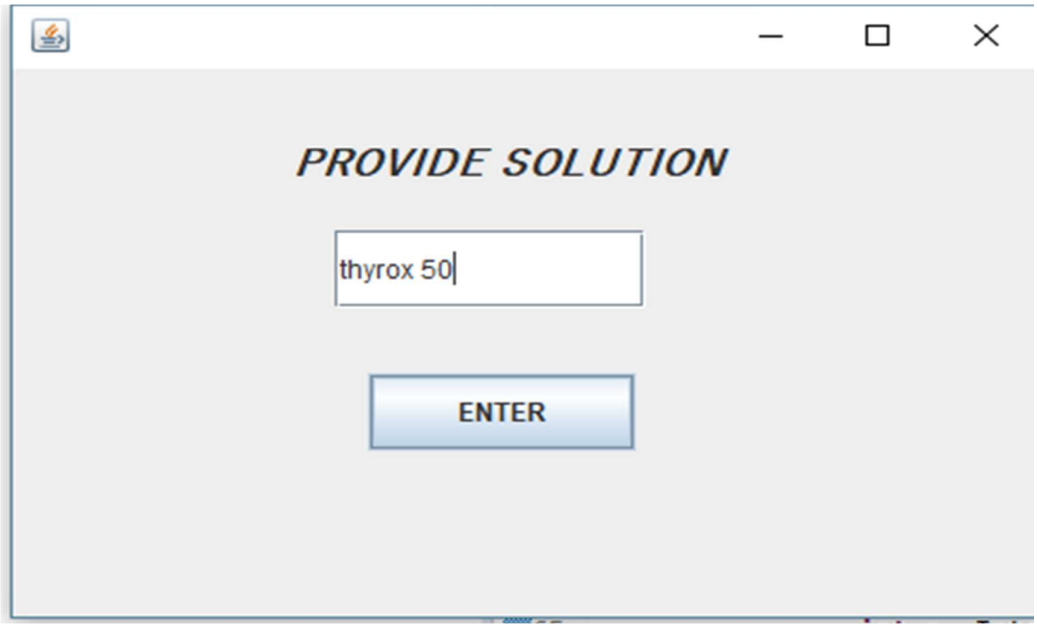
After the problem will be submitted in the form of diagnosis report a Solution will be provide in the console according to the Doctor knowledge.



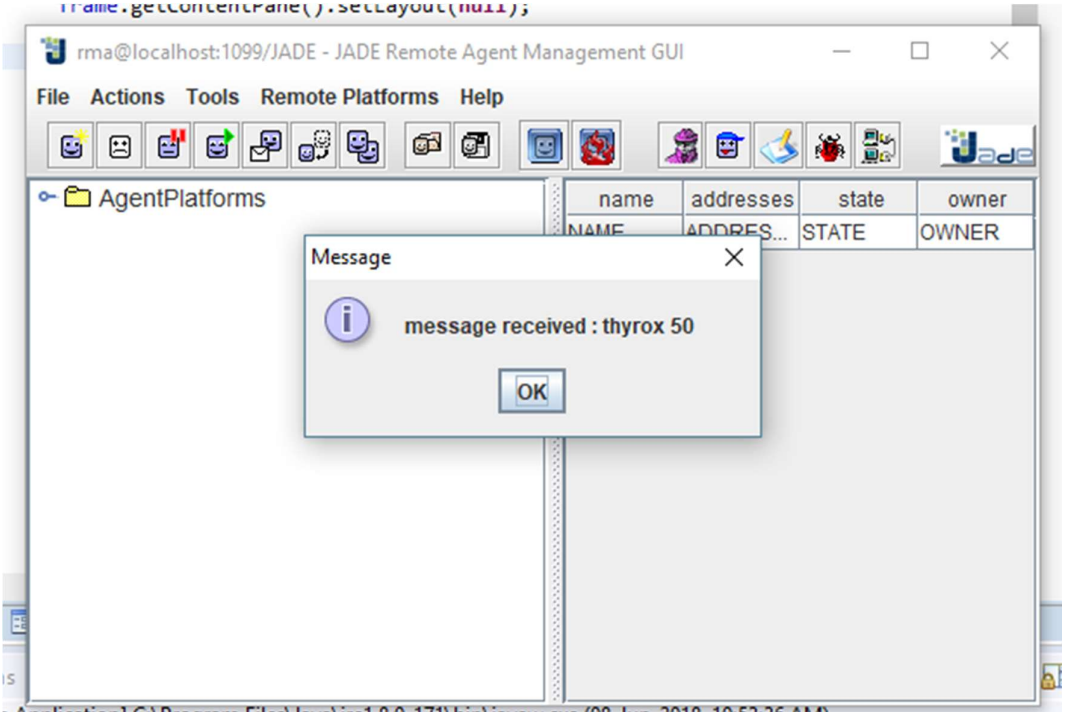
Now Solution Number is to be provided to the Agent.



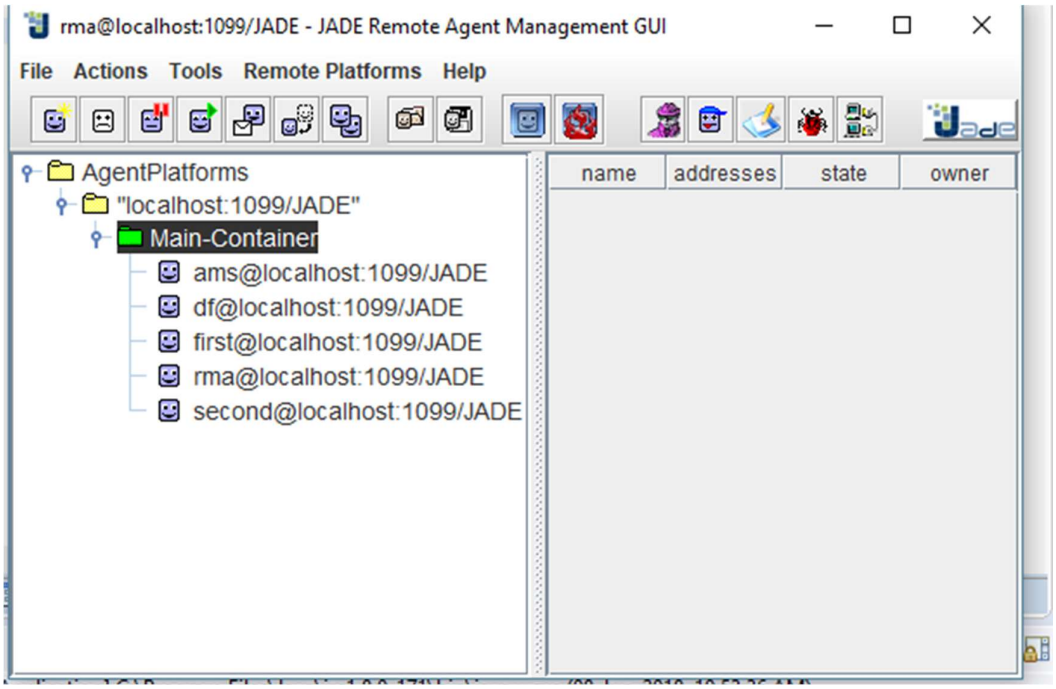
After this the Doctor will provide the necessary treatment or Solution to the Agent.



Once the Solutions is enter by a Doctor the Message is passed through the parameter from first Agent to Second agent.



In the Main container the agent created can been seen. The Agent participated in the communication are also appeared in the RMA.



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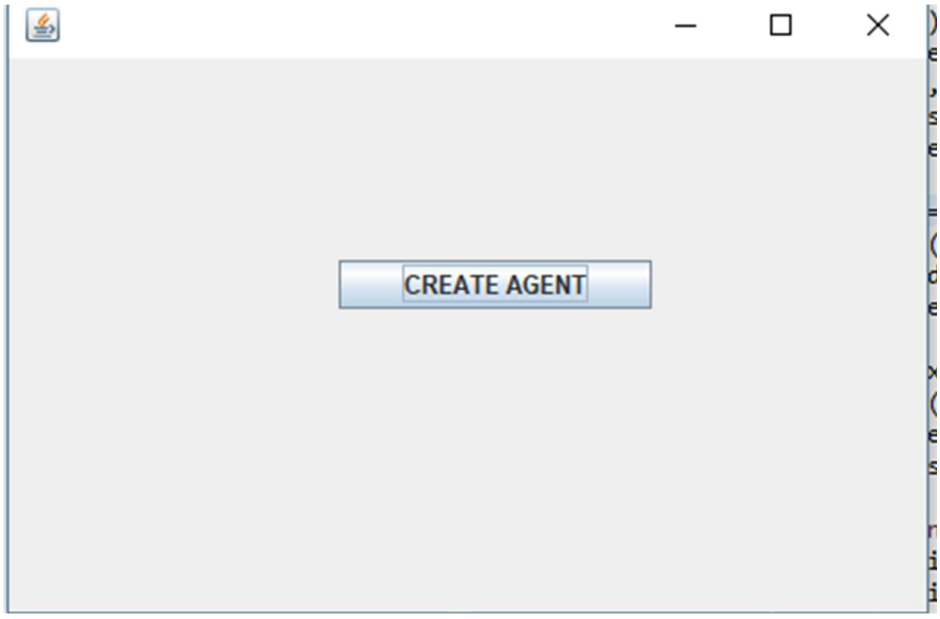
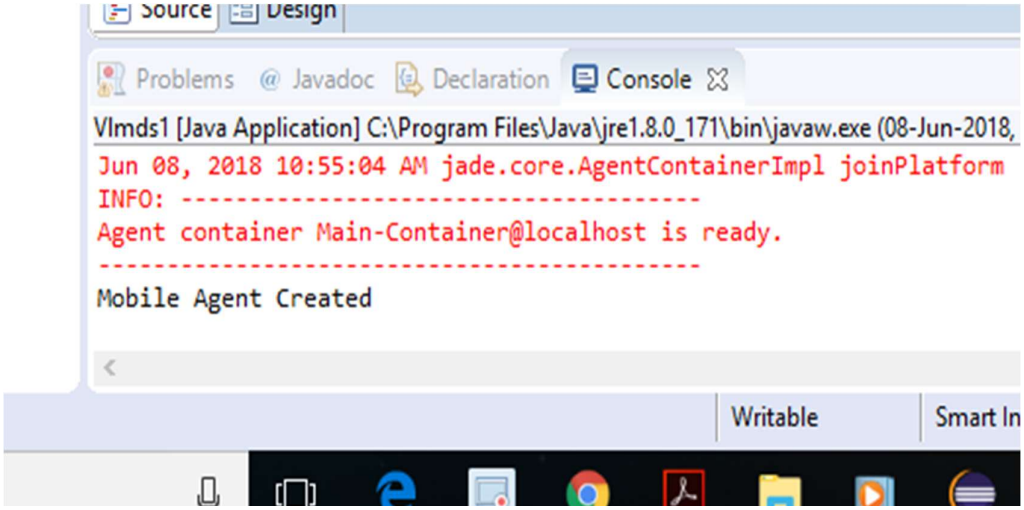
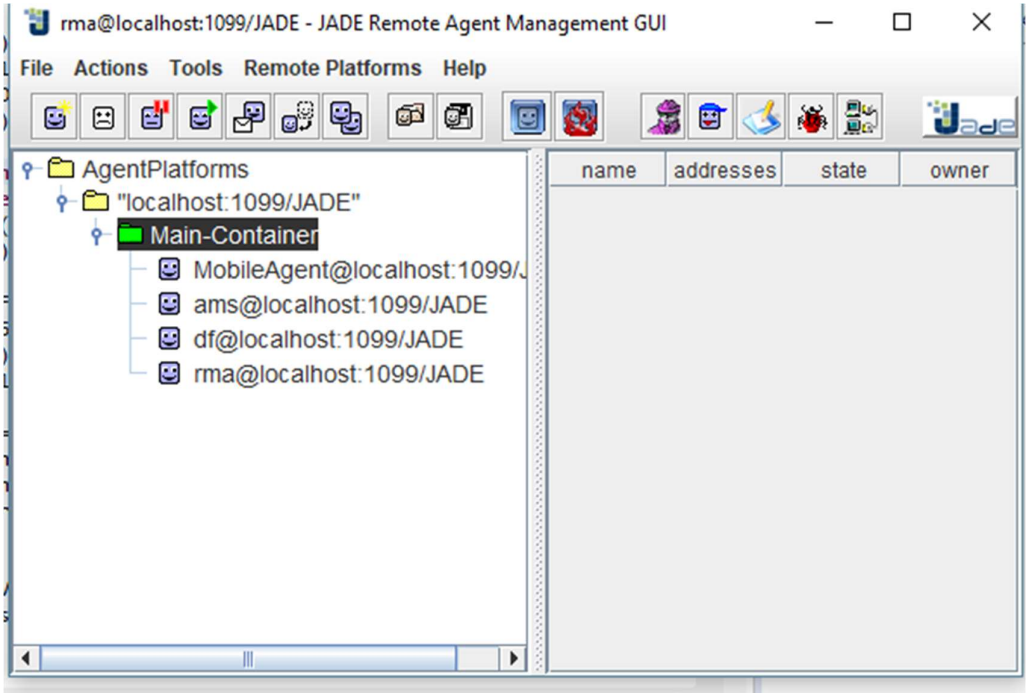


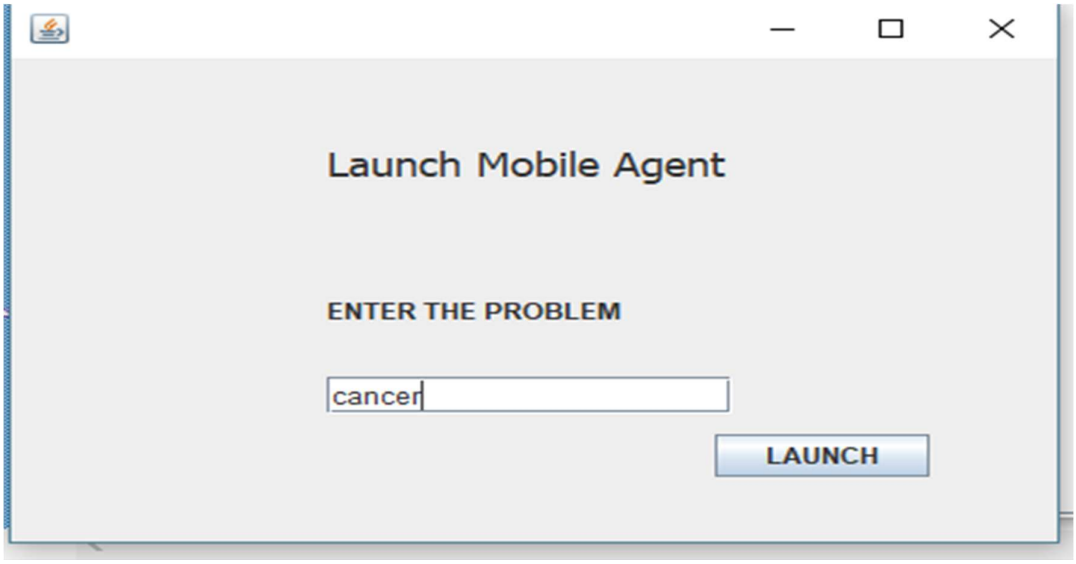
Here Mobile Agent is Created ad message is shown in console.



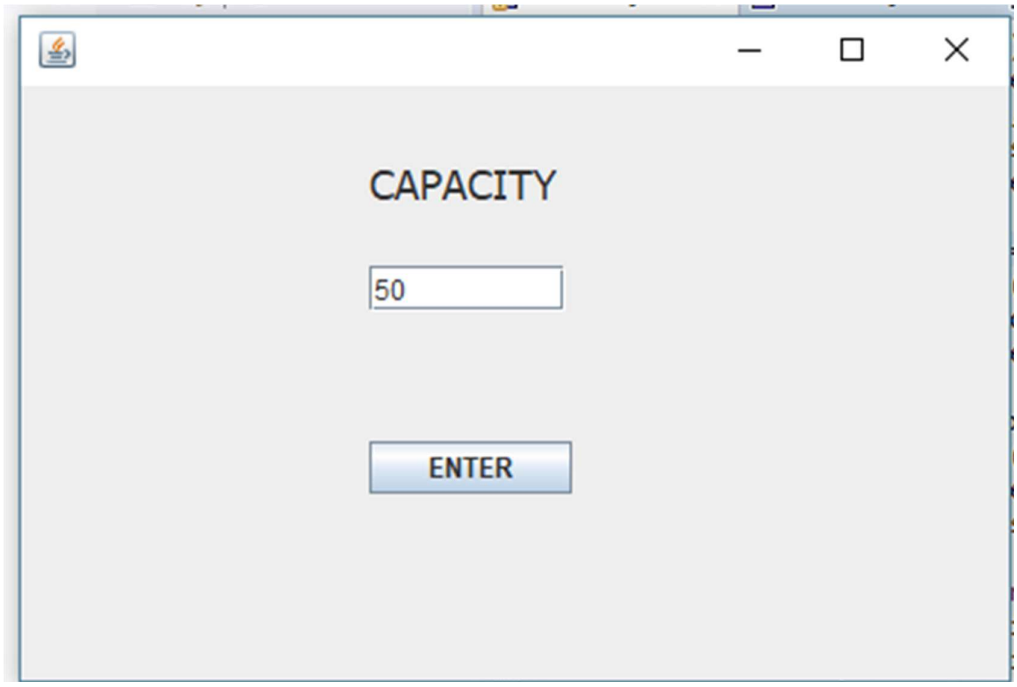
Mobile Agent Created can be seen in the Rma.



After mobile agent is created the problem has to be launch with the mobile agent.



The Capacity of mobile agent is checked. If it is capable of solving the problem then solution will be provide else mobile agent will be created till the problem is solved.



CONCLUSION

Medical diagnostics [10] elaborations often represent a naturally distributed & cooperative processes, which involves human medical doctors and different medical systems. The results described in the literature prove that many medical diagnosis problems can be solved efficiently by Very Large-scale medical multi-agent systems. The development of Very Large-scale medical diagnosis systems represents an important recent research direction.

In this project, we have made a cooperative hybrid Very large-scale medical diagnosis system, called VLMDS (Very Large-Scale Medical Diagnosis System) with physicians and artificial agents [6] (medical expert system agents and medical ICMA [7] agents and communication [8] improvement agents CIA) as members.

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