Self-Extension and Improved Planning in Multi-Agent Systems using Bayesian Techniques and Injected Knowledge Feedback – An Alarm Monitoring Application in Health Care Framework with different Medical Specialization

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Abstract
We Propose a Multi-agent Framework where agents exploit User supplied Knowledge in a domain where the environment is modeled as partially observable markov decision processes (POMDPs) and process situations using a Multi-agent subsumption architecture and handle uncertainty using Bayesian probabilistic inference. Multi-agents systems in this Framework gradually attain self extension in their autonomous actions and help generating Optimal plans at decreased computational cost for achieving goal states. Planner modules typically would consider future uncertainty while generating plans for large problems. This is planned to be tested in large Medical domains in a typical Healthcare system.

Keywords – multiagent systems, Bayesian networks

I. INTRODUCTION

An Agent is a computer system, situated in some environment that is capable of flexible autonomous action in order to meet its design objectives. Multi-agent systems are computational systems in which a collection of loosely coupled autonomous agents interact in order to solve a given problem. Since the problem in hand is usually beyond the individual agent's capabilities, agents exploit their ability to communicate, cooperate, coordinate and negotiate with one another for the advancement of one another and also to accomplish their common goal. During the process, agents constantly monitor the team effort as a whole, help on tasks, and coordinate actions so that they are not repeated but well coordinated with teamwork, through communication mechanisms. Agents have individual beliefs updated about the environment and also a global belief updated about the environment. We expect the agent with the help of its current belief and inputs from the current environment autonomously pick its learning goals and update the global belief. If in a state of incompleteness of information and in a state of uncertainty, agent needs to take probabilistic assumptions and move forward with a known state of variables. This might take the agent to the next level or Self-extension of the autonomous mental development of the agent. Our work describes methods in order to reduce the complexity of the planning within the agent by feeding spatial information or domain information which is user-provided information which in a framework if provided would greatly improve the performance of the agent.

II. ARCHITECTURE DESIGN & PLAN

1) The components are described as follows, - Sensory information processor
- Communication Processor for updating beliefs
- Bayesian inference engine for processing uncertain information.
- Agent control unit with conceptual layer/verification layer/spatial layer/state layer/message passing/belief updating layer/goal processor play/ planner control

Fig 1. Agent Architecture.

Our approach is based on the Subsumption architecture of Multi-agent systems action selection is in the form of layered architectures and that Intelligent behavior arises as a result of an agent’s interaction with its environment.

Fig 2. Multi-agent Subsumption Architecture

If in a Medical domain of uncertain specialization is considered we have determined that Initial medical knowledge is necessary for the Agents to start with initially and then progress through learning. We use Bayesian methods of Probability density function over evidence variables based on the below as there were many imprecise, incomplete, noisy information of quantitative nature resulting from perception that should be intelligently transformed into a qualitative information.

\[ P(A_i | B) = \frac{P(A_i, B)}{P(B)} \]

Agents act only individually; this is the most limited case. However they perform a limited form of cooperation, for example, they work together with different Agents for different medical specialization, or pitch in for other agents when they are unable to perform their share of labor.

Fig 3. Multi-agent Software Architecture.

In terms of Beliefs of agents, we take \( \text{BEL}(i, \phi) \) to have as an intended meaning ‘agent i believes proposition \( \phi \)’. A Kripke model is a tuple \( M = (W, \{B_i : i \in A\}, \text{Val}) \), such that: 1. \( W \) is a non-empty set of possible worlds, or states. 2. For all \( i \in A \), it holds that \( B_i \subseteq W \times W \). They stand for the accessibility relations for each agent with respect to beliefs. (s, t) \( \in B_i \) means that t is an ‘epistemic alternative’ for agent i in state s; 2 henceforth, we often use the notation s\( B_i \) t to abbreviate (s, t) \( \in B_i \). 3. \( \text{Val} : (P \times W) \rightarrow \{0, 1\} \) is the function that assigns truth values to ordered pairs of atomic propositions and states (where 0 stands for false and 1 for true). In the possible worlds semantics above, the accessibility relations \( B_i \) lead from worlds \( w \) to ‘epistemic alternatives’; worlds that are consistent with agent i’s beliefs in \( w \). Thus, the meaning of \( \text{BEL} \) can be defined informally as follows:
agent i believes \( \phi \) (BEL(i, \( \phi \))) in world w, if and only if, \( \phi \) is true in all agent i’s epistemic alternatives with respect to w. BEL(i, \( \phi \)) means Agent I believes \( \phi \), E-BELG(\( \phi \)) means Group G has general belief \( \phi \) and C-BELG(\( \phi \)) means Group G has Common Belief \( \phi \). A traditional way of lifting single-agent concepts to multi-agent ones is through the use of common belief C-BELG(\( \phi \)). The formula E-BELG(\( \phi \)), called ‘general belief in \( \phi \)’, is meant to stand for ‘every agent in group G believes \( \phi \)’. C-BELG(\( \phi \)) is meant to be true if everyone in G believes \( \phi \), everyone in G believes that everyone in G believes \( \phi \). For example for a group of agents involved in teamwork of lifting a heavy object together or a coordinated activity the success of each individual agent and their mutual coordination are vital to the overall result for which a common belief is needed. Further to this common belief we can say that every agent in Group G has the individual intention to achieve goal \( \phi \) or group G has the mutual intention to achieve group goal \( \phi \) or group G has the collective intention to achieve goal \( \phi \). This can not often be collective intention but based on a common belief with the situation on hand to quickly progress towards a goal state with limited time on hand. Suppose for example if in a situation where a person has badly injured by a Car accident during a Cyclone with heavy wind and two of the potential helpers in the neighborhood run towards the person in danger without knowing each other intend to have a common belief about the mutual intention established to make real team work possible. The issues encountered basically in real world implementation are, limited accuracy of sensors, time restrictions on completing measurements, unfortunate combinations and unpredictability of environmental conditions, noise, limited reliability and failure of physical devices.

III. DISCUSSION

We have proposed a method of reducing the Computational complexity of Planner in Agent systems for generating efficient and faster solutions to Problems with minimal amount of knowledge base. We are hoping to improve further and demonstrate performance gains experimentally. For this purpose we are planning to develop a AlarmPoint Monitoring Framework using JADE - Java Agent Development Framework in a Health care Domain with different areas of specialization such as gynecology, Orthopedic, Pediatrics, Surgery, Cardiology and diseases related to them. The Domain Knowledge related to them will be fed into the framework for the Agents to process the Data of Patients and Monitor the fluctuations of health of Critical Patients from time to time. The Diseases for different Specializations are to be understood also using Bayesian Networks framework using the Probabilistic methods based on the findings, initial diagnostic data and Symptoms of the Patient. Large amount of data is required for the processing and modeling initial research activity for implementing and testing this Application and work is in progress for implementing it.

REFERENCES

