

## Assignment 1

CSci 5511

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Rahul Ghosh

Student ID: 5476965

## Problem 1

The paper titled "Agent-based software engineering", by M.Woolridge rightly points out that the development of agents based systems is more about software engineering than about other disciplines. The paper then lists out the following properties that an agent must have:

- **Autonomy:** Ability of the system to take decisions on their own based on the state they are in, without the intervention of human beings.
- **Re-activity:** Ability to react according to the perception of the changes that are occurring in the environment
- **Pro-activeness:** Ability to take initiative to achieve the goals set for them.
- **Social ability:** Ability to interact with other agents through some agent communication language to achieve the goals set for them.

The following earlier examples of agent based systems are provided:

- **Agents and AI:** In this section one very important point is made on distinguishing between broad intelligence and the intelligence we seek in agents. It is essential as specifications must be set before the development of agents. For e.g. all agents may not be capable of learning and common sensing.
- **Agents and expert systems:** In this section some expert systems of the past are mentioned along with their specifications and limitations and also how they evolved with time. For e.g. MYCIN, a system assisting the physicians in blood infections treatment and ARCHON, a system for industrial process control.
- **Agents and objects** In this section the agents are analyzed from the point of view of objects. Some light is shed on the single thread control in traditional object oriented programming and how agents work on multiple processes simultaneously.
- **Agents as rational systems:** In this some solutions to the conceptualizing problems is mentioned. Difference between procedural programming and agent oriented programming is explained.

Eventually the software engineering of an agent based system are mentioned and analyzed in the specification, implementation and verification sections.

The paper titled " Intelligent Agents on the Internet: Fact, Fiction, and Forecast", by Etzioni et al focuses on the software engineering and the computer science aspects of the agent based system similar to the above paper. This paper focuses more on forecasts rather on implementation analysis. It lists out similar properties of an agent with the following additions:

- **Autonomy:** ability to take goal oriented, collaborative and flexible actions.
- **Continuity:** ability to run continuously.
- **Communication ability:** similar to that mentioned in the Woolridge paper.

- Adaptability: in this qualities similar to the reactivity quality mentioned by the Woolridge paper is described.
- Mobility: ability to transport from one machine to another and across different systems.

An intelligent agent in the future is forecasted to take various type of roles which may include assisting us in getting information or even getting the information for us. Some examples of agent based systems are also provided in the form of Tour guides, Indexing agents, FAQ finders and Expertise finders.

Next a case study of the Internet Softbot is done with respect to the objectives that are clearly defined in a high level manner. Moreover, certain goals are specified to enable the softbot to achieve its objectives. The Internet Softbot's goal oriented manner and certain nuances like the language, syntax etc are mentioned. Next the architecture is specified in a high level detail with some of its major components being mentioned which include a task planner, XII planner, model manager and some internet domain models.

To conclude some of the research challenges of that time are mentioned which were significant back then but have somewhat been solved nowadays with the vast amount of research being done in Knowledge understanding, natural language understanding and virtual assistants.

## Problem 2

The Etzioni paper mentions a few research challenges that the author feels important:

- Algorithms for planning with incomplete information  
Rule based system will work only when the conditions matches exactly with those mentioned in the rules. If certain condition arises not mentioned in the rules, it leads to the failure of the program. In my opinion rule based system should not be the adopted approach as all conditions cannot be captured in rules. Reinforcement learning based approach suits more in this scenario as the softbot can learn from the human actions and the decisions will be reward based rather than rule based.
- Multiagent communication techniques  
Multiagent communication techniques could have been a research challenge during the 90's. But there has been tremendous development in this area as is evident with the growth of IoT(Internet of Things) field and the advancement in the VA(Virtual Assistants) for e.g. Amazon Alexa. Moreover with the rise in home automation through VAs, I feel this is no longer a research challenge now.
- Learning Algorithms  
Rather than learning algorithms, in my opinion data representation and problem formulation is a research challenge, as in the last few decades there have been a tremendous growth in machine learning algorithms.
- Cyberperception  
This problem has been tackled to an extent with the development of the Knowledge Graphs. Knowledge graphs can store real world data. Entity extraction and relation mapping extracts new information from daily information sources. For ex. Google Knowledge vault which regularly updates the graph through information from reliable news sources.
- Safety systems  
This is one of the areas where work needs to be done as is evident from the recent accidents

which occurred involving the self driving cars. Fail-safe protocols need to be developed which will ensure the safety of the owner.

In the Etzioni paper, the author forecasts that with the development of agent based software, human interaction will be primarily with these agents rather than with the Internet directly. While there has been significant efforts in this direction in the past decade, the disappearance of the Internet is impossible. Virtual Assistants can be thought of such agents as they can get specific information that the user asks for. The problem arises when the search gets complex as a higher-level understanding is required to extract the specific information from the sources. For e.x Searching for an abstract concept results in the display of multiple web pages, deciphering information from which requires human level understanding of the subject.

### Problem 3

Yes I agree with the argument that agents are more of computer science and software engineering than AI. For many decades learning algorithms faced research challenges due to the lack of proper hardware and development platform. Algorithms for Neural Networks have been around since the 1940's but only after the recent advancements in GPU's in the 2012-current period, these algorithms saw extensive use in the research problems. Moreover, numerous tweaks and improvements have been published which adapt Artificial Neural Network algorithms to different domains. Another reason for this recent rise of ML and AI have been the development of numerous frameworks for developing deep learning models, for e.g. Tensorflow, Pytorch, Horovod etc. to name a few. Thus the advancements in deep learning can be credited to computer science and software engineering rather than the algorithms of AI which have existed for quite a while.

### Problem 4

The following analysis is done with respect to an agent which collects data from satellites and performs various tasks which will be mentioned in the following sections.

- Specification:
  - Data Gathering: The agent should be communicate with various satellites to gather the hyper-spectral remote sensing data from them.
  - Data Pre-processing: The agent should be able to call various pre-processing modules before scheduling processing tasks on the clean data. These may include data cleaning, data combining from various sources etc
  - Processing: These may include natural vegetation cover prediction, surface water cover prediction, identification of forest fires, climate changes etc. Ability to select algorithm and apply to the appropriate dataset.
- Implementation:
  - Scheduler: An efficient scheduler is to be implemented which takes into account the run time and importance of tasks to schedule the list of the tasks to execute.
  - Data handler: The handler should be able to handle hyper-spectral images which consists of large number of channels

- Algorithms: The algorithms used to process the images and provide useful insights should be capable of taking into account the spatial as well as the temporal information. A combination of convolutional neural networks(CNN) and recurrent neural networks(RNN) are required. The CNN will act as a feature generator using the spatial information whereas the RNN captures the temporal modifications of those features. Moreover the algorithms should be able to take into account the land water consistencies and make sense of the geographical data(crest and troughs)
- Verification: For verification of the results presented by the agent several error measures are used. There will also be an user interface using which the user can randomly check some of the activities of the agent whether it be data pre-processing or the scheduling of the jobs etc.