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Multi-Agent System Overview: Architectural Designing using Practical Approach

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ABSTRACT

A software agent should be autonomous, flexible, robust and social. The increasing importance of the Multi-Agent System (MAS) has led to the greater availability of tools designed to facilitate their creation and use. To devise agents is considered a real challenge which faces analysts and designers during development of any multi-agent systems. This paper proposes a methodology to determine, clarify and differentiate among agents during development of multi-agent systems using goals and functionalities grouping approach. A step by step case of study is presented to explain the proposed methodology for the creation of an Online Intelligent System (OIS) for Board of Directors guide using Multi-Agent System to facilitate online communication between the board members and their president to monitor the policies and productivity of the company.

KEYWORDS

Software Agent; Board of Directors; agent elicitation; goals grouping; functionalities.

1. INTRODUCTION

For decades, the business industry has been a powerful symbol of an increasingly global market economy, providing innovative software for the stakeholders with a new concept which can take it to a next level. In the past years, global competition and updating customer requirements have further underlined the importance of planning and scheduling according to the market demand. Agents play an important role in the increasing competition in the business market. Multi agent systems are systems composed of multiple interacting computing elements, known as agents. Agents are a software paradigm through which possibilities can be exploited by massive open distributed systems. The role of a Multi-Agent System makes an integrated online system to advance and develop its performance with unique options. Agents represent a similar advance in generalization. They may be used by software developers to more naturally understand, model, and develop an important class of complex distributed systems.

In many ways business intelligence (BI) is a catch-all phrase as it does not refer to one single type of analysis or data, but rather it represents a variety of methodologies, technologies and software applications and tools to organize and analyze all of a business data. BI is the combination of software applications which plays a key role in the strategic planning process of a corporation.

The board of directors in a company is appointed to act on behalf of the shareholders to efficiently run the daily affairs of the business. The board is directly accountable to its shareholders to report the performance of its company along with its future plans and strategies [1]. In order to ensure the company's prosperity by collectively directing its affairs, the board members should deal with different challenges and issues relating to the corporate social responsibility and ethics. To control the company's overall situation, strategy and policy it is important to held board meetings periodically so that directors can discharge their responsibility. A multi-agent system can be used in order to monitor their modus operandi and analyze whether they are achieving their goals. The agenda of the meeting should be conveyed properly and all those entitled individual directors may express their views in the meeting as a whole. The board as a whole is responsible for actions carried out by its authority and should report their opinion to the president of the board.

In order to control the board more effectively by the president, this paper presents an idea to develop an online integrated system for board of director's guide and decision support. This unique system will offer a personalized user friendly interface for all the members of the board by providing a choice to decide their opinion and write their reasons for the decision. With the help of this system the president of the board can access the member's choice and overall approval percentages with an option to allow specific members of the board to see the choices. This system also have an option to store the decisions taken by the board along with the feedback of selected companies and this can be viewed later from the history section. It also provides an option to print the detail reports. The methodology proposed is comprehensive as it deals with a medium level aspect of system design. It represents an advance over previous agent oriented methodologies in which it is neutral with respect to both the target domain and the agent architecture.

Determination, elicitation and deriving of agents are the key point for development of any multi-agent system. in fact there is no clear way to define agents during analysis stage. Easy and new approach is proposed to devise agents from goals and functionalities of the required system.

This paper presents a Multi-agent System Overview: Architectural Design using practical Approach and is divided into five sections. The first section is this introduction. The second section focuses on the related work. The third

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section discusses about the overview of proposed system methodology. In the fourth section the multi-agent architectural design is demonstrated by means of a case study where we show how it was applied to the design of an agent based online system for the company. Finally we conclude our work in the fifth section with some recommendations to the future work.

2. RELATED WORK

Borrajo et.al. talk about the requirement to control Multi agent business for different size of companies. He stressed on developing a tool for the decision support process based on multi agent system that incorporates a case-based reasoning system and automates the business control process [2]. Mangina et.al. discuss how the case-based reasoning system automates the organization of cases and the retrieval stage by means of a Maximum Likelihood Hebbian Learning-based method, an extension of the Principal Component Analysis which groups similar cases by automatically identifying clusters in a data set in an unsupervised mode [3]. Wooldridge discusses on building an agents that are capable of independent, autonomous action in order to successfully carry out the task which is delegated, particularly when the other agents cannot be assumed to share the same interests and goals[4]. The multi agent system field is highly interdisciplinary and takes inspiration from diverse areas as economics, philosophy, logic, ecology and social sciences [5]. Software architectures that contain many dynamically interacting components, each with their own thread of control and engaging in complex, coordinated protocols, are typically orders of magnitude more complex to engineer correctly and efficiently than those that simply compute a function of some input through a single thread of control- Unfortunately, it turns out that many (if not most) real world applications have precisely these characteristics. As a consequence, a major research topic in computer science over at least the past two decades has been the development of tools and techniques to model, understand, and implement systems in which interaction is the norm [6]. Indeed, many researchers now believe that in the future, computation itself will be understood chiefly as a process of interaction. Just as we can understand many systems as being composed of essentially passive objects, which have a state and upon which we can perform operations, so we can understand many others as being made up of interacting, semiautonomous agents. This recognition has led to the growth of interest in agents as a new paradigm for software engineering [7,8,9,10].

Corporate governance and the role of the Board of Directors has become an increasingly important research topic over the past decade [11]. This interest, driven in part by the high profile failures of some notable firms, has focused mainly on how the composition of the board helps or hinders its ability to effectively hire fire, monitor and advise the CEO [12].

Renee et. al. does a survey of the literature of board of directors. The two questions most asked about boards are what determine their makeup and what determines their actions? These questions are fundamentally intertwined, which complicates the study of boards because makeup and actions are jointly endogenous [13]. Given that all corporations have boards, the question of whether boards play a role cannot be answered econometrically as there is no variation in the explanatory variable. Instead, studies look at differences across boards and ask whether these differences explain differences in the way firms function and how they perform[14]. The boards differences that one would most like to capture are differences in behavior. Empirical work in this area has focused on structural differences across boards that are presumed to correlate with differences in behavior [15]. For instance, a common presumption is that outside (non-management) directors will behave differently than inside (management) directors. One can then look at the conduct of boards (e.g., decision to dismiss the CEO when financial performance is poor) with different ratios of outside to inside directors to see whether conduct varies in a statistically significant manner across different ratios. When conduct is not directly observable (e.g., advice to the CEO about strategy), one can look at a firm's financial performance to see whether board structure matters (e.g., the way accounting profits vary with the ratio of outside to inside directors).

Electronic business, or "e-business", is any business process that is empowered by an information system. Today, this is mostly done with Web-based technologies. The term "e-business" was coined by Lou Gerstner, CEO of IBM. Electronic business methods enables companies to link their internal and external processes more efficiently and flexibly, work more closely with suppliers and partners to better satisfy the needs and expectations of their customers.

Current technologies especially communication technologies of our era have been changing the way we live and the way we think thus, the way business operates. On the other hand, the shifts in business paradigms require, hence lead to, new technological innovations. This two-way interaction is leading us to a digital future. This digital era obviously suggests new rules. Different from the technology-management relationship in the past, today firms are not only close followers of technology but inventors of technology too [16].

3. PROPOSED SYSTEM METHODOLOGY

After studying and investigating common methodologies: PROMETHEUS [17], TROPOS [18], MASE [19,20] and MASUP [21], it has been observed that no such methodology exists which explains in clear steps how to extract agents during system development. If agents are to realize their potential as a suitable software system paradigm, then it is necessary to develop the software system techniques that are specifically tailored to them. Our methodology is intended to allow an online system for the board of directors of the company to go systematically from a statement of requirements to a design that is detailed sufficiently in a simple way that it can be implemented directly. This paper will express a combination of all methodologies in a very simple way which is

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suitable for an average system which starts with defining the goals and ends by architectural design including agent extraction.

The architectural design will use the system specification artifacts to build the system architecture. It will be developed in six steps where the systems application agents and its interactions are specified and the system overview is designed.

Prometheus is an agent oriented software engineering methodology which is widely accepted in the agent research community for specifying and designing agent systems. It supports the design of agents that are based on goals and plans by providing guidance on how to perform various steps that form the process of Prometheus. Despite of advancing in Prometheus design needs, analyzing an online system's ability to meet desired quality criteria is still difficult. With the help of the proposed scenario an integrated online system for board of directors is developed with an approach that the members gain online access and information of the company and this depends on the system's ability to meet desired quality attributes. Agents are independent of each other and in order to retrieve information about members, other agents are created to run the system query again for source of data. To develop the multi-agent online intelligent system this paper presents some important concepts for simple system design that is likely to provide a solution for the company to interact online & to monitor all the management activities within the stakeholders which helps the chairman of the company in identifying the loop holes and to planning & implementing the decisions more precisely on time from the information available.

Architectural design consists of the following activities to produce a system level overview diagram describing the overall structure of the system.

3.1 Goal Refinement.

3.2 Goal Rearrangement and grouping.

3.3 Functionalities interactions with databases to extract and define agents.

3.4 Scenario development

3.5 Percepts, actions and protocols.

3.6 System overview diagram including actions, percepts and protocols.

All these activities will be explained step by step in detail in the case study section

4. CASE STUDY - ARCHITECTURAL DESIGN

A fully online intelligent system for board of director's guide and decision support is extracted with the following system goals user requirement.

- Board of Directors guide and decision support.
- Fully online intelligent system.
- Availability for all the members.
- Personalized and user friendly interface.
- Provide options for members
- Gives members an option to comment on the reasons for their decision.
- Allows president to do specific management actions.
- Store history of decisions
- Store feedback of the selected companies.
- Provide detail reports.

4.1 Goal Refinement

Goal refinement starts by studying the main system goals and define the sub goals to depict the connection net between goals and sub goals as figure (1).

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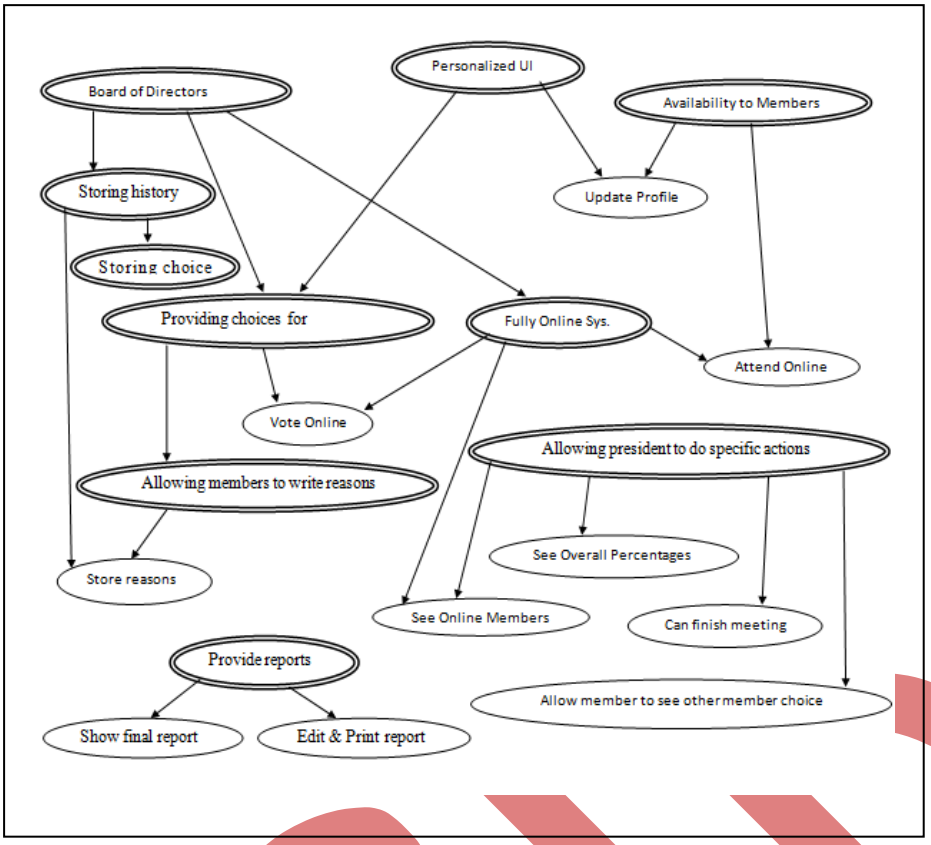

Figure 1 shows network flow of connected goals and sub goals

4.2 Goal Rearrangement & Grouping

From the main initial ten goals (inside double line ovals in figure 2) we rearrange the goals again and put them in a suitable way which helps to group the goals and extract functionalities. We will rearrange the goals as follows:

Goal (1): Decision Support - The boards of director's guide and decision support system helps the board members by giving a priority to make their own choice on the information available according to the history and feedbacks.

Goal (2): Online Interaction - It's a user friendly online interface, where the members can created their own profile, login, view other online members, attend and vote online and can save their personal data.

Goal (3): Member Management – This system is available for all the members. It gives an option for the members to login and participate in vote. Members can create their profile to store personal data.

Goal (4): Welcoming – Personalized user friendly interface with a personalized welcoming feature.

Goal (5): Profile Monitor – Provides recommendations based on the user profile. It gives an option to register and update the member profile.

Goal (6): Choice Management – This feature gives an option to the members with multiple choices and provides information about each choice. Members can vote online, write and store the reasons of choices for further needs.

Goal (7): President Authority - It gives an option for the president to manage and view the members online, see their choices, and to monitor their work remotely at any time. This feature allows the members to write their reasons for their decisions. The president can do specific management actions with an option to allow specific members to see other member's choice and reason and restrict specific member from seeing others choice. He can also see the overall approval and refusing percentages.

Goal (8): Result Management - The system can store the history of its decisions like overall approval and refusing percentages, final decisions made in a meeting, feedback from selected companies about their technical and theoretical performances.

Goal (9): Reporting - Can provide final report review for each meeting with an option to edit and print the reports.

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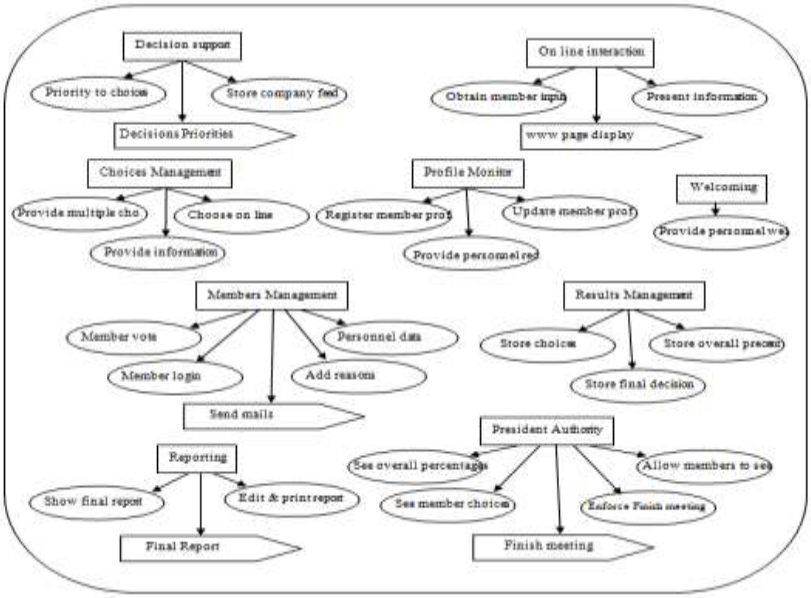
4.3 Functionalities Interactions with Databases to Extract and Define Agents

Functionality is the term used for a chunk of behavior, which includes a grouping of related goals, as well as percepts, actions and data relevant to the behavior. Functionality should be coherent, in that it can be described adequately in one or two sentences, and can be named in a way that captures its essence. Functionalities allow for a mixture of both top-down and bottom-up design. The process of refining and then grouping goals suggests an initial set of functionalities. Further work with scenarios and development of the specification may well suggest additional ones. Figure 2 shows functionalities for the board of directors guide system.



Databases

It is an application that manages data allows fast storage and retrieval of the data. The proposed online system has three databases that stores data in three different sections with the different sort of information.

- Members Database: It contains information about the members along with their personal data, profile and history of decisions.

Figure 2 Functionalities for Board of directors guide system

- Decision Database: It contains presented subjects in the meetings and the available choices with detailed information about each choice.

- History Knowledge Base System: It stores the final decisions for the meetings with the member's comments and also has some external data entered by technical specialists about the feedback of subject choices.

Figure 3 shows how functionalities will be grouped related to data bases in order to define the agents. This step is very important to device agents. As shown in figure 3 after grouping functionalities of figure 2 and link them with the related database we find that we have three groups, each group represents one agent. Then we will have three agents: member's manager agent, decision assistant agent and reporter agent as colored in figure 3

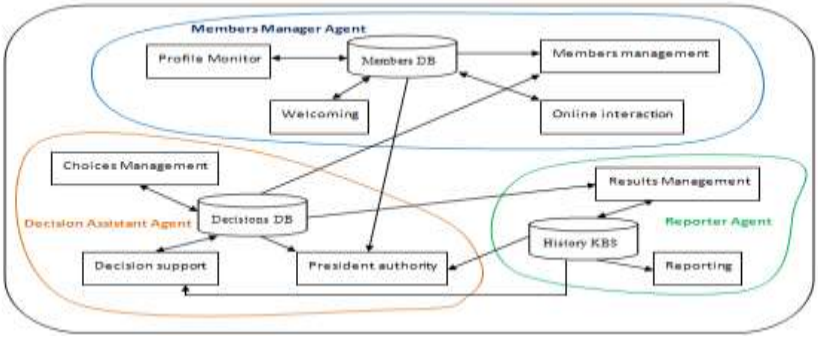


Figure 3 Grouping functionalities with databases

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4.4 Scenario Development

The core of a scenario consists of a sequence of steps. Possible steps are achieving a goal (GOAL), performing an action (ACTION), receiving a percept (PERCEPT), or referring to another use case scenario. Additionally, the steps type OTHER to cover unusual steps such as waiting for something to happen. The list of scenarios developed for the board of directors guide is as follows.

- WWW site arrival scenario.
- Register member scenario.
- Member login scenario.
- Member profile update scenario.
- Decision support scenario.
- Minimum acceptable attendance scenario.
- Member attendance scenario.
- Stop and finish meeting scenario.
- Allowing members to see other member decision scenario.
- New questions scenario.
- Printing report scenario.

Figure 4 shows an example for stop and finish meeting scenario including messages between the three agents

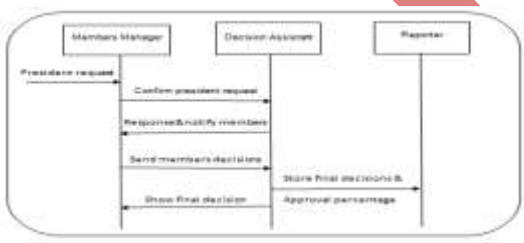

Figure 4 stop and finish meeting scenario

4.5 Percepts, Actions and Protocols

It is the basic component in the formation of the online system concept. Percepts are the input to the system where as actions are the output. A protocol is a definition of legal interaction patterns among agents to satisfy the agent attribute of sociality. System overview diagram show percepts, actions and protocols. Also after the diagram all these components will be mentioned in details.

4.6 System Overview Diagram

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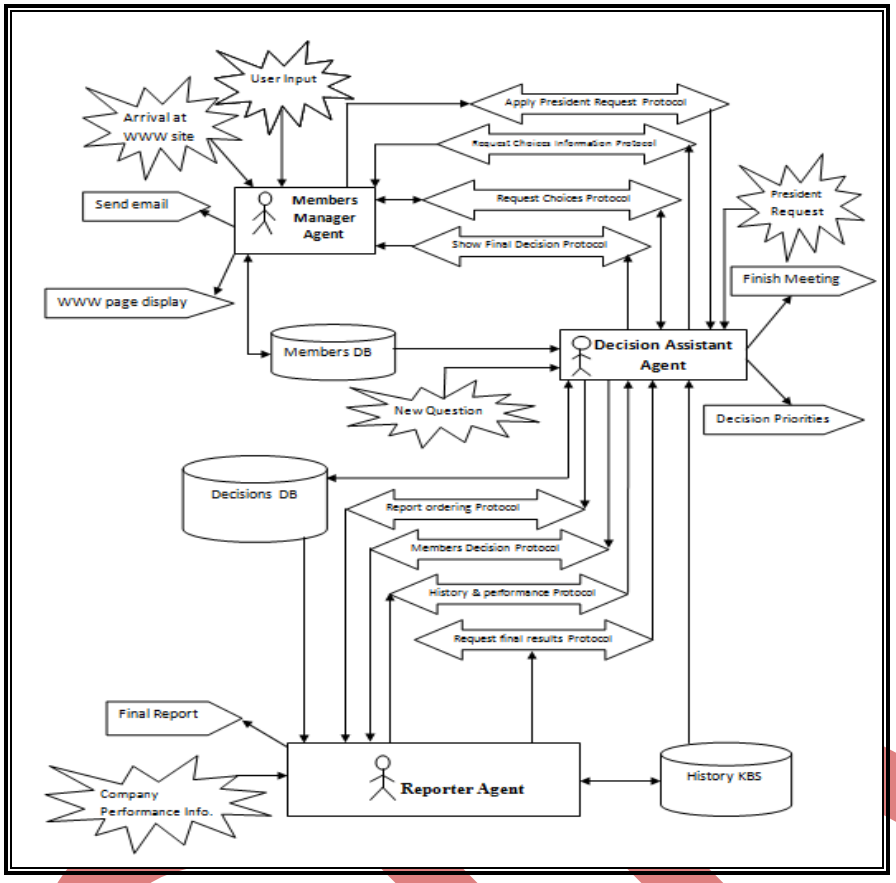

Figure 5 System overview diagram

From the system overview diagram figure 5 we can easily devise agents, percepts, actions and protocols.

Agent (percepts, actions):

Members Manager (percepts: Arrival at the WWW site and user input), (**Actions**: WWW page display and send e-mail)

Decision assistant (percepts: New question and President request),(**Actions**: Finish meeting and Decisions priorities)

Reporter (percepts: company performance info.), (**Actions** : final report)

Protocols between member manager and decision assistant agents:

Apply president request, Request choices information, Request choices and Show final decision.

Protocols between decision assistant and reporter agents :

Report ordering, member decision, history & performance and request final results.

5. CONCLUSION

There are lots of methodologies each of them suitable for special case. When choosing a methodology for a problem, considering the complexity of methodology is important. Methods that propose large and complex models in the development phase may be not suitable for analyzing and designing an online system. In this paper an integrated online system for members of the company is proposed to fit out the system using multi-agents by explaining how to extract agents using proposed methodology through goals and functionality grouping. As a future work the idea is to implement the proposed methodology for more business applications.

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Dr. khozium has published many articles in international journals and conferences in the area of electronic warfare, expert systems, information security and software engineering, he participated in organizing many international conferences, he is an active reviewer for numerous international journals, Khozium works as PI for many international projects. http://www.hajjcore.org/khozium

Dr.khozium has been awarded "doing duties honestly and faithfully award" and "excellent duty medal from the first level" from the president of Arab Republic of Egypt, 1996, 2006 respectfully.

Dr.khozium is an active member in many international computing and electronic warfare associations including ACM and AOC.