Aiming at Reducing Modelling Complexity-Modelling Information Systems with Agents

Joseph Martin Kavuma
Supervisor: Dr.Th.P.van der Weide

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Abstract

The process of modelling Information System is a complex and tendinous exercise, yet vital in the determination of the final system's quality. Object Role Modelling is the best method for information system modelling especially due to the fact that it gives very detailed models as compared to other methods. In an attempt to overcome complexities involved in the modelling process, this study will evaluate the agent properties that could be used in an implementation of an interactive modelling multi-agent system.
Given the importance of the modelling process in the information system's life cycle, the study through the use of the JADE agent framework, is anticipated to lead to the development of an interactive modelling support tool.

Contents

1 Introduction

The quality of Information Systems in this information age is a very important subject as far as organisational knowledge learning, management and retation is concerned. A very well designed information system enables an organisation to learn from its existing knowledge assets through appropriate exploitation, all with a sole goal to make the organisation more competitive in its industry. But the quality of the information system depends critically on its design or the model (Terry, Overview 1), Terry also argues that the quality can only be improved by use of concepts and a language that is readily understood by humans, when specifying the information system at the conceptual level.
A model could literally be defined as, a simple description of a system used for explaining how something works or calculating what might happen (Oxford, 2006). A slight modification of this definition leads to the view of an information system model as not just a "simple description", but rather a depiction of the actual system with the capability to simulate actual system behaviour, built/developed to guide the actual system development process. Thus information system modelling will consist of all the formal conceptualisation processes of the system into a model.

Quite a number of modelling methods exist among which are Entity Relations (ER), Unified Modelling Language (UML) and Object Role Modelling (ORM). The method of choice for this study is the ORM method especially due to its advantages over the others. In the ORM method, the quality of the model depends on the accuracy of the objects and relationships represented. And as according to (Dinesh and Solomon, 1999), the accuracy in modelling requirements depends on the modeller's experience, characteristics, and the complexity of the task.

1.1 Object Role Modelling

Originally known as the; Nijssen's Information Analysis Method (Nijssen and Halpin, 1989) but later renamed Natural Language Information Analysis Method (NIAM), Object-Role Modelling is a data modelling method in the design and analysis of information systems at the conceptual level(Terry, 1998). It is made up of several procedures for mapping between conceptual and logical levels. With the use of a natural language and intuitive diagrams, Object-Role Modelling is capable of being populated with examples and by expressing the information in terms of elementary relationships, the process of understanding the formal model of the application or the Universe of Discourse (UoD) is eased, enabling analysis and design of the information system.

The ORM method is a composition of objects with roles to play, the ability to work without use of attributes ensures stability, convenient population with multiple instances and uniformity of the ORM models and queries. ORM uses a unique notation and procedures for its two formal languages; the textual specification (used for both models and queries) and the graphical language for diagrammatically representing the formal model. The closeness of the textual language to natural languages makes it more expressive than the graphical language that utilises symbols to aid the modelling process.

After the collection of information (definition of the UoD), the ORM notation is used

to re-define the UoD into a conceptual schema which gives the information structure of the knowledge domain by indicating the types of facts that are of interest, with their constraints and derivation rules for facts from others.
The conceptual schema procedure consists of the steps below;

1. Development and quality checking of elementary facts
2. Development of fact types and applying a population check
3. Checking for possible combination of entity types and note any arithmetic derivations
4. Applying uniqueness constraints and checking facts types arity
5. Applying mandatory role constraints and checking for logical derivations
6. Adding value, set comparison and subtyping constraints
7. Adding other constraints and performing final checks.

Usually the complexity of the modelling process increases with increasing object relationships, redandancy in data objects' specification in all modelling methods is unavoidable with poor models. Complexity in the modelling process mainly occurs due to the fact that many relationships are possible even in presence of few objects. This makes the conceptual and logical modelling phases erroneous because there is always failure to determine if a relationship is ternary or binary.

1.2 Agents

Agents are intelligent software components with special features capable of enabling assistance in the modelling of information systems. Agents have been used in several time critical systems and automated rational systems. This study will extensively examine the Agent potential embedded in their properties like autonomy and rationality, in order to effectively work with a modeller to produce a model of desirable quality.
(Wooldridge and Jennings) view the term agent to denote a hardware or software based computer system exhibiting autonomy, social ability, reactivity and pro-activeness properties that is conceptualised or implemented using concepts that are human like in nature.

An agent is also defined as any entity created with a goal of accomplishing a task(s) and is distinguishable from other agents in the same environment in order to enable its substitution with another when comparing their performance.
According to (Wooldridge and Jennings), agents communicate with their peers by use of a common language and can also be viewed as large entities exhibiting some sort of persistent control.

Software agents are developed with inspiration from human agency and other natural agents' behaviour. So common to all existing agents is the desire to interact and interoperate (Finin,Labrou and Mayfield, 1995). These two requirements together define agent communication but for software agents to communicate, a common language, a common understanding of the knowledge exchanged and the ability to implement the theory

and concepts of the two, are fundamental. Effective interaction is considered to be the exchange of information and knowledge that is mutually understood (Finin,Labrou and Mayfield, 1995)

1.2.1 Agent Properties

Agents exhibit certain distinctive properties that help identify them as agents, in this section these properties are explored through a brief description and objectification.

- Autonomy

  The agent propertty of autonomy defines agents as systems with the ability to act without foreign intervention but with some control over their actions and internal state (Wooldridge and Jennings). This implies that agents practice self instruction to perform actions and are able to go through several states of behaviour but all this is in the boundaries of their expected or defined nature of actions.

  - Mobility

    In relation to autonomy is the agents' ability to move around an electronic network, which movement is self initiated without any foreign assistance.

  - Veracity

    This is a property that states that though agents can be autonomous and mobile, all this actions must be under control to ensure absence of intentional information miscommunication.

- Reactivity

  The notion of reactivity implies that agents are aware of their environment and act responsively in a timely fashion to changes within their environment. Environment is a diversity of some sort in this case because it could mean physical conditional atmosphere or an activity atmosphere. Where the first could be a real world physical phenomenon like temprature change or appearance of light, etc. and the later could mean any form of interaction atmosphere that involves a software agent and other agents (humans, other software agents....).

- Social Ability

  This is the quality of interoperatability and interaction that allows the communication of information messages between agents in a given environment. This requires the interacting agents to use an agent communication language common to both, to aid understanding and development of the meaning of the exchanged messages of information. This property enables agents to learn from each other and also notice the presence of each other in the same environment.

- Pro-Activeness

  This would also be correctly referred to as intelligent reactivity which means that though agents react responsively to environmental changes, their reactions are goal directed.

  - Benevolence

    -In connection to agents being pro-active, is the property of benevolence which is the assumption that agents act to expections, avoiding any possibility of conflicting goals.

- Rationality

  Under this property agents are to act in order to achieve their goals or tasks but not to prevent the achievement of these goals. This makes agents almost as obedient as humans who are expected to be productive and responsible by their society laws and ethics.

2 Thesis Statement

The term Complexity, in this context is used to refer to the level of difficulty encountered by a modeller when faced with the task of designing and developing a model for a given information system specification. This study will attempt to develop a tool composed of sub agent-systems that can be used to make the modelling process more interactive and supportive for the modeller by raising model suggestions and providing correction and guidance throughout the process.

The absence of a step-by-step approach to managing complexities in the modelling process, is blamed for the always developed poor models which have been said to be the sole cause of poor Information Systems. Modellers are faced with the problem of identifying objects and entities, whose attributes and relationships too have to be identified but even in some cases of few entities relationship identification can be such a difficult process which implies that with the present enormous Information Systems the difficulty increases propotionally.

2.1 Objectives

By attaining a deep understanding of the modelling process through studying its involved phases, importance in the systems' life cycle and current short comings, and also understanding the concept of software agents through studying their properties and qualities,implementations and strengths', the main objective of this study is to develop a solution that will attempt to reduce the complexity of the modelling process of information systems by formalising the modelling process as much as possible and integrating agent theory into the process.
To achieve this objective, the study will be based on and guided by the research questions below;

2.2 Research Questions

- What is modelling and why is modelling a vital process in the development of Information Systems?
- What are software agents and why would they have anything to offer in support of the modelling process of information systems?
- How can agents be implemented in the modelling process of Information systems?

Using the first question, i intend to define, explain and describe modelling, and evaluate its role in development of information systems. This will be vital understanding the theme(modelling) of the study and i feel will uncover vital information like model short comings and weaknesses that will be vital in the attempt to develop a solution.

Since i intend to use agents as a possibility of enabling more interaction in the modelling process, the second question will be used to attain a deep understanding of agents and their properties before they are used as part of the solution. In the process of answering this question, an agent framework will be implemented and experimented with on a practical network.

The third question defines the intended contribution of this research and it will be used to integrate knowledge attained using the other to questions in order to come up with a concluding solution.

3 Approaches/Methods

This section briefly describes the different methods and tools that are to be employed for this research for both data collection and analysis, system development and subject familiarisation and internalisation.

3.1 Methods

3.1.1 Literature Study

Literature study/review will be the main knowledge reference method for this study and this will involve various scientific textbooks, articles and other publications about modelling, agents and the tools and methods that will be used for the research and solution development. Likely literature will be about ORM, Formal methods, JAVA programming language, agents, information retrieval and software engineering.

3.1.2 Weekly meeting discussions

Additional to literature study, will be the weekly meetings with my supervisor Dr.Th.P. van der Weide that will involve guidance, correction and approval of the research progress and findings. Also in these meetings formal methods will be discussed to give further enlightment about the topic.

3.1.3 Development Methods

This is a description of the specific methods that will be employed in the solution formulation and development.

- Object Role Modelling: This has been chosen as the modelling method of the study over the so many others and the study and the anticipated solution will built around it. This comes as a result of its advantages over the other methods as earlier mentioned in the introduction.
- Object Oriented Programming: The programming language of choice(JAVA) for the solution development is an Object Oriented Programming language and this is to exploit its strengths especially object-complexity reduction through the re-using mechanism of inheritance.
- Formal Concept Analysis: The FCA will be used mainly to define and identify objects, their attributes and relationships and this is anticipated to make the modelling process more formal and thus more predictable.

3.2 Tools

Among the likely tools for the study, will be the Java Agent Development Environment(JADE) which is an agent framework for implementing network based java agents. Since a java agent framework will be used, the JAVA language will be the language of choice which mainly will be compatibility advantageous. The Eclipse IDE will be main development environment for the proposed solution and in order to ease the formalisation of the process the XML notation will be adopted for the file formats that will be used and processed by the system.

4 Work Plan

Time Table/ Work Plan		
Week(s)	Task(s)	Deliverable(s)
1&2	Proposal, Introduction	Proposal
3,4	Modelling(ORM)	
5,6	Agents(JADE)	Set-up JADE framework
7,8	System requirements definition	System specification
9,10	System Modelling	System Model
11,12,14,15,16,17,18,19,20,21	System development and testing	First Draft paper
22,23	System Implementation	Second Draft paper
24,25,26	Write-up	Third Draft paper
27	Presentation	Final paper

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