University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SPRING TRIMESTER 2023-2024 EXAMINATIONS

Multi-Agent Systems

COMP41400 - RESIT

Module Coordinator:

Assoc. Prof. R. Collier

Time allowed: 2 hours

Instructions for candidates

Answer Question 1 and two other questions

Question 1 (compulsory): Answer All Parts **50 marks in total**

(a) Define what is meant by the term **agent**?

(8 marks).

(b) The **Belief-Desire-Intention (BDI)** architecture is a well-known model of decision making. Explain each component and describe the interplay between them.

(10 marks).

(c) Discuss the relationship between **Goals** and **Desires**.

(4 marks).

(d) What is **Agent-Based Modelling (ABM)**? Illustrate your answer with an example of an application of ABM.

(8 marks).

(e) Draw a sequence diagram illustrating how agents interact with entities in the Environment Interface Standard (EIS).

(10 marks).

(f) Explain in detail the concept of a plan and how it works in AgentSpeak(L). Give and explain an example of a plan to illustrate your answer.

(10 marks).

Question 2. **25 marks in total**

(a) Negotiation is the process by which several agents reach agreement. One approach to implementing negotiation is to use an *auction*. What are the main parameters that underpin an auction and what possible values exist for each parameter?

(8 marks).

(a) One of the FIPA standard Interaction Protocols is the FIPA Contract Net Protocol. Draw the Agent UML Interaction Diagram for this protocol.

(8 marks).

(b) WorkForYou.com is a startup that wants to launch a service that handymen can use to search for commercial maintenance contracts. A feature of the service is that individual handymen can enter a set of prices for services they offer. Companies are then able to create contracts on the system that are automatically matched to the handyman that offers the best value for money. In their initial version of the software, they identify 3 core services that handymen could provide: General Maintenance Services, Plumbing Services, and Window Repair Services. Companies can specify which services they want for a given contract, and the system automatically identifies the best handyman for the job.

The implementation of this service is achieved through the creation of a set of handyman agents (representing the handymen) and a set of company agents (representing the companies). When a company decides to issue a new contract, the details of the contract are passed to their company agent. This agent then contracts a broker to get a filtered list of agents representing handymen in their area. The company agent then uses the Contract Net protocol to interact with the handyman agents to get the best deal for the company.

Given the following agents below, show (in order) the set of messages that will be passed between the company agent and the handyman agents.

Handyman Agent: Joe
Price List: General Maintenance (€50), Plumbing (€100), Window Repair (€50).

Handyman Agent: Andy
Price List: General Maintenance (€80), Plumbing (€50), Window Repair (€60).

Company Agent: HouseMan
Contract (required services): General Maintenance & Window Repair

NOTE: The messages should be specified in FIPA ACL with the content language being either ASTRA or Jason.

(9 marks).

Question 3. **25 marks in total**

This question is concerned with the GAIA analysis and design methodology.

(a) Draw a diagram outlining the main process that underpins GAIA. Include in your diagram the models that are generated and their relationship. Indicate which models are part of the design phase, and which are part of the analysis phase.

(7 marks).

(b) Explain how the GAIA permissions model works. Describe the various access rights provided as part of the model.

(6 marks).

(c) Define what is meant by a **safety property**. Illustrate your answer with an example.

(4 marks).

(d) Give a detailed explanation of the following GAIA Liveness property:

$$\text{COFFEEFILLER} = (\text{Fill} \,.\, \text{InformWorkers} \,.\, \underline{\text{CheckStock}} \,.\, \text{AwaitEmpty})^{w}$$

(8 marks).

Question 4. **25 marks in total**

In the module, we explored the idea of **Practical Reasoning**. This question focuses on the concept and its realisation within AgentSpeak(L).

(a) Give a definition of practical reasoning. List and describe the two main activities associated with Practical Reasoning. What is the relationship of **intentions** to these activities?

(9 marks).

(b) Reasoning using intentions is susceptible to the **side-effect/package deal** problem. What is this? Illustrate your answer with an example.

(6 marks).

(c) Explain how the practical reasoning concept can be realised in the AgentSpeak(L) programming language. Illustrate your answer with through a simple example program.

(10 marks).

Question 5. **25 marks in total**

(a) Two basic approaches to coordination are *task sharing* and *result sharing*. Describe, using examples, both approaches.

(10 marks)

(b) One issue that is increasingly seen as core to coordination is the underlying *organizational structure* through which coordination occurs. Dignum and Dignum introduced three organizational patterns: *market*, *network*, and *hierarchy*. Give a detailed description of the *Network Pattern*. Include in your answer, the objectives underpinning the design of the pattern, and the main roles in the pattern. Additionally, illustrate your answer by explaining how an agent is admitted to this organizational structure and how it would engage other member agents in achieving a required task. Include in your answer details of any interaction between agents playing key roles and the agent that is joining the structure.

(15 marks)

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