Mandatory topics (4 days)

Understand relation btwn practical reasoning (means-end) <-> BDI <-> AgentSpeak PDA Y

2015

Weak notion of agency (4 feature) + Y

Speech Act theory (5 categories) + Y

Shared space communication ( pro and cons) Y

Agents & Artifacts model, relation with environments, workspaces Y

2016 sample

Agent definition, feature + Y

Analisis phase(GAIA?) (week 10) Y

**negotiation phase (auction) between agents + (week7)** \*\*\* Y

Comparison AOP - OOP B Y

BDI architecture + (pdf mio) Y

4 plan operator in AgentSpeak (query, update, primitive, sub-goal) Y

**Iteration and selection in agentspeak (manca)**

2023

Agent-based modelling and use +

Gaia and models and diagrams and relationships between them, design, analisis phase (week10) Y

Liveness and Safety Responsibilities in the GAIA Role Model. Y

2023 resit

Goal, desires (pdf mio)

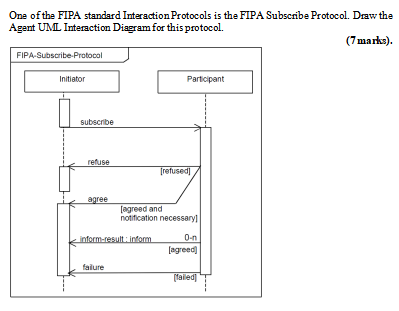
Draw a sequence diagram illustrating how agents interact with entities in the Environment -> **Interface Standard (EIS).**

Plan in AgentSpeak (pdf mio)

Non Mandatory

*market*, *network*, and *hierarchy*. Give a detailed description of the *Network Pattern ? (weeek7)*

**Fipa**



1. The following two example FIPA-ACL conversations relate to a single FIPA protocol. Explain what is happening in each conversation, identify the protocol and draw the corresponding Agent-UML protocol diagram.

|  |  |
| --- | --- |
| **Conversation 1**  (request  :sender rem  :receivers (set robot)  :language ASTRA  :content “get(beer)”  )  (refuse  :sender robot  :receivers (set rem)  :language ASTRA  :content “get(beer)”  ) | **Conversation 2**  (request  :sender rem  :receivers (set robot)  :language ASTRA  :content “get(beer)”  )  (agree  :sender robot  :receivers (set rem)  :language ASTRA  :content “get(beer)”  )  (inform  :sender robot  :receivers (set rem)  :language ASTRA  :content “have(beer)”  ) |

*Conversation 1: (2 marks)*

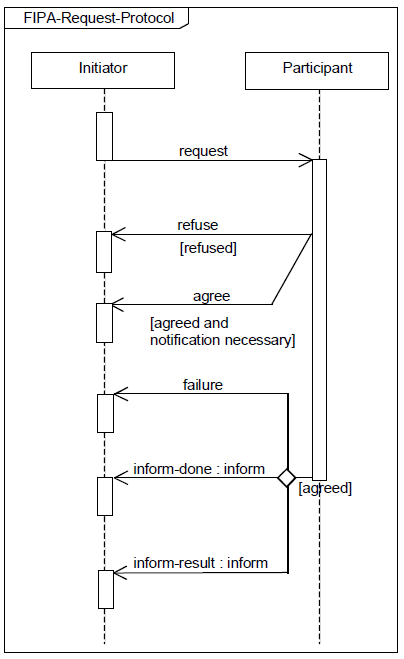
*Rem sends a request message to Robot asking the robot to get him beer. The robot refuses to perform the task.*

*Conversation 2: (2 marks)*

*Rem sends a request message to Robot asking the robot to get him beer. The robot agrees to perform the task, and later informs Rem that he has the beer when the task is completed.*

*The protocol used is the FIPA Request Protocol (2 marks)*

*6 marks for the Agent UML Diagram*



**ACL**

1. What is an *Agent Communication Language (ACL)*? What is the minimum set of features required for a functioning ACL? Why is this insufficient in practice?

**(8 marks)**

* *An Agent Communication Language combines:*
  + *a data format for representing speech acts.*
  + *a (partial) model of the state of the speaker and hearer.*
  + *a formally specified set of speech act types (based on the above model).*
* *Minimal Practical Form: performative, sender, receiver, content*
  + *request ( rem, bob ) “closed(door)”*
* *In theory:*
  + ***speech act*** *=* ***performative verb*** *+* ***propositional content****.*
* *In practice:*
  + *Contextual information, such as: who performed the speech act, and to whom it was directed.*

Communication ?

Practical reasoning (pdf mio)

Prisoner dilemma ?

**Coordination**

Def:  
"The process by which an agent reasons  
about its local actions and the (anticipated)  
actions of others to try and ensure that the  
community acts in a coherent manner

1. reasons why you may need to use coordination.

**(5 marks).**

* *Preventing anarchy or chaos*
* *Dependencies between agents’ actions.*
* *Need to meet global constraints*
* *No individual has sufficient competence, resources or information to solve the entire problem.*
* *Efficiency*

Two basic approaches to coordination are *task sharing* and *result sharing*

*Task Sharing (2 marks):* When a problem is decomposed into subproblems and allocated to different agents.

*Result Sharing (2 marks):* When agents share information that is relevant to their subproblems as they collaboratively develop a solution.

**Task Sharing** and **Result Sharing** are two essential forms of coordination in multi-agent systems. Based on the provided presentation, here’s an explanation of these concepts and examples.

### ****Task Sharing****

**Definition**:  
Task sharing involves decomposing a problem into smaller subproblems and allocating them to different agents. This is dynamic and happens at runtime, where tasks are assigned based on agents’ capabilities.

**Key Features**:

1. **Decomposition**: The main task is broken down into smaller, manageable sub-tasks.
2. **Assignment Mechanisms**:
   1. **Centralized**: A central coordinator assigns tasks to agents (e.g., a manager-worker structure).
   2. **Decentralized**: Agents reach agreements themselves (e.g., through negotiation or distributed planning).

**Example**:

* **Warehouse Robots**:
  + The task of fulfilling customer orders is divided into pick-lists for different warehouse areas.
  + **Robot A**: Assigned to pick items from the east of the warehouse.
  + **Robot B**: Assigned to pick items from the west of the warehouse.

### ****Result Sharing****

**Definition**:  
Result sharing involves agents exchanging information that is relevant to their subproblems as they collaboratively develop a solution.

**Key Features**:

1. **Pre-assigned Tasks**: Tasks are pre-allocated during the design phase.
2. **Information Exchange**:
   * **Proactive Sharing**: An agent voluntarily provides information to another agent.
   * **Reactive Sharing**: An agent shares information in response to a specific request.

**Example**:

* **Warehouse Robots**:
  + As Robot A collects an item (e.g., item A10456), it informs Robot B.
  + Robot B, with this knowledge, independently decides to pick a different item (e.g., item A20987) to avoid redundancy and improve efficiency.

### ****Three Examples****

**Task Sharing** in a Software Development Team:

* + A project is divided into sub-tasks: frontend, backend, and database setup.
  + Each developer is assigned a specific part based on their expertise.

**Result Sharing** in Autonomous Vehicles:

* + Cars on a highway share information about traffic conditions.
  + If Car A detects a traffic jam, it informs Car B, which adjusts its route to avoid delays.

**Task and Result Sharing Combined in Emergency Response**:

* + In a natural disaster scenario, drones are assigned different regions to survey (task sharing).
  + As they find survivors or assess damages, they share results with a central hub or other drones to update the overall rescue plan (result sharing).

EXERCISE TYPE

1. Write an AgentSpeak(L) program to represent the following algorithm:

**Algorithm:** PrintEvens(x, y)

*Print all the numbers in the range [x,y].*

**begin**

count := 0

**for** all i in the range x to y inclusive **do**

**if** i is even **then**

count := count + 1

**endif**

**endfor**

print the message

"There are <count> even numbers in the range <x> to <y> inclusive"

**end**

**(13 marks)**.

*6 marks for the first rule, 3 marks for the 2nd rule and 2 marks for the 3rd and 4th rule*

*+!printEvens(X, Y) <-*

*+count(0);*

*!checkValue(X,Y);*

*?count(Z);*

*-count(Z);*

*print("There are " + Z + " event numbers in the range " +*

*X + " to " + Y + " inclusive").*

*+!checkValue(X,Y) : count(C) & X <= Y & X % 2 == 0 <-*

*-+count(C+1);*

*!checkValue(X+1,Y).*

*+!checkValue(X,Y) : X <= Y <-*

*!checkValue(X+1,Y).*

*+!checkValue(X,Y) <-*

*skip.*

1. A bookstore has decided to launch a FIPA compliant book announcement service. For this service, they expect customer agents to subscribe to the service providing information about the genres the customer likes. The service is managed by a book\_service agent, and customer agents are identified by the customers email address. Give the sequence of messages that would be passed between the customer agent and the book\_service agent for a customer with email address: bob@mail.com, who likes fantasy and cooking. As an example of a book that is announced, the book “Harry Potter and the Philosophers Stone” by J.K. Rowling.

*NOTE: I want the messages to be specified in FIPA ACL with the content language being either ASTRA or Jason.*

**(9 marks).**

*(subscribe*

*:sender bob@mail.com*

*:receiver book\_service*

*:language ASTRA*

*:content “book\_service([\”fantasy\”,\”cooking\”])”)*

*(agree*

*:sender book\_service*

*:receiver bob@mail.com*

*:language ASTRA*

*:content “book\_service([\”fantasy\”,\”cooking\”])”)*

*(inform*

*:sender book\_service3*

*:receiver bob@mail.com*

*:language ASTRA*

*:content*

*“new\_book (\”Harry Potter and the Philosophers Stone\”, \”J.K.Rowling\”)”)*

1. A company has decided to develop a next generation warehouse that is fully automated. In the warehouse, they plan to use 3 self-driving fork-lift trucks to pick up produce and to load delivery lorries. Only one fork lift truck is able to entry a delivery lorry at a time. Also, the isles are only wide enough to fit one fork-lift truck at a time. Produce for a delivery is typically spread all over the warehouse, although there is a small space next to the loading bays that can be used as temporary storage. It is decided that each fork-lift truck will be controlled by a single (onboard) agent and a central schedule agent will be used to notify the truck agents about the next order. The system should be designed to provide minimize the time taken to load the lorry.

Describe how you would get the agents to coordinate their activities in this scenario and identify whether the approach you advocate is *task-oriented* or *result-oriented*. Explain your choice.

**(10 marks).**

*I want the students to think about how they would solve this problem and sketch out a solution. In the solution, they can use task-oriented strategies (where one agent assigns tasks to the other agent(s)) or result-oriented strategies (where each agent is pre-assigned tasks and they inform the other agents of their activities).*

To coordinate the activities of the self-driving fork-lift trucks in the automated warehouse, a **task-oriented strategy** is most appropriate. In this approach, a central scheduling agent dynamically assigns tasks to the fork-lift truck agents, ensuring flexibility and minimizing the total time taken to load the lorry.

The **central scheduling agent** plays a crucial role by maintaining a **global view** of the warehouse. It keeps track of key details such as the current locations of all fork-lift trucks, the locations of produce required for the delivery, and the availability of aisles and loading bays. This global perspective allows the scheduling agent to allocate tasks efficiently and prevent conflicts, such as multiple trucks attempting to use the same aisle or enter the loading bay simultaneously.

Tasks are broken down into smaller, manageable steps, such as navigating to a specific aisle to pick up produce, transporting the produce to temporary storage or the loading bay, and finally loading the lorry. The scheduling agent assigns these tasks dynamically, prioritizing based on factors like proximity, urgency, and efficiency. For example, the truck nearest to a required item may be assigned the task to reduce travel time.

**Coordination protocols** are established to manage communication between the scheduling agent and the truck agents. When a task is assigned, the truck agent acknowledges receipt and begins execution. The truck agents also provide **progress updates**, such as when a task is completed or if there are unexpected delays. This feedback allows the scheduling agent to reassign tasks or adjust the plan to ensure smooth operations.

To prevent bottlenecks, the central agent actively resolves potential conflicts. For instance, if two trucks are assigned to retrieve produce from the same aisle, the agent schedules them sequentially to avoid congestion. Similarly, it ensures that only one truck enters the loading bay at a time.

This **task-oriented approach** is better suited than a result-oriented strategy for this scenario because it allows for **dynamic adaptation** to changes in the environment, such as unexpected delays or new priorities. It also provides **global optimization**, enabling the system to minimize lorry loading time through coordinated task allocation. By contrast, a result-oriented strategy, where each truck is pre-assigned tasks and resolves conflicts independently, lacks the flexibility and centralized oversight needed for optimal performance.

In conclusion, the task-oriented strategy provides a structured and efficient solution for coordinating the agents in the automated warehouse, ensuring that all tasks are executed seamlessly while minimizing overall loading time.

A new manufacturing plant is being built by WidgetWorks that contains a production line for their new product WidgetWare whose assembly points are to be controlled by agents. The production line consists of three assembly points: point one combines widgets A and B, point two takes the product and adds widget C, and point three puts the product in a box for shipping. The widgets and boxes are stored in a warehouse and additional stock can be sent to an assembly point on request. The assembly agents should request more stock from the warehouse agent whenever a reorder level is reached for that stock. The assembly point agents continue to assemble the product until they runs out of widgets / boxes. At this point, they wait for more stock to become available.

Using the GAIA Methodology, write 4 Role Schemas (Warehouse, Point1, Point2, and Point3) that model the production line process described above.

**(25 marks)*.***

*The role schemas should identify the key behaviours of each agent, and highlight any protocols that are required for interaction between the agents playing the roles.*