Multi-Agent interactions

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Contents

Interaction mechanisms

Indirect interactions

Direct interactions
- Speech Acts Theory
- Message structure

How does this work ?

Interaction protocols

Conclusion

Asynchronous interactions

Problem

- Agents run asynchronously
- Method invocation is synchronous

Asynchronous interactions

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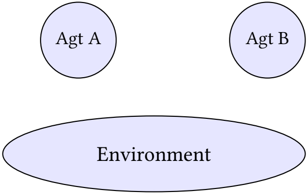
PRS Architecture

- Actions modify the environment
- (Asynchronous) perception of the modification



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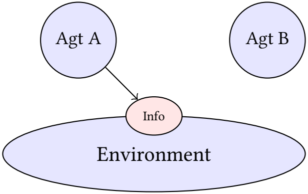

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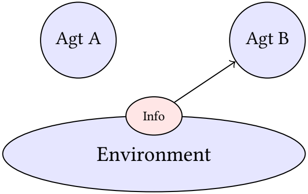

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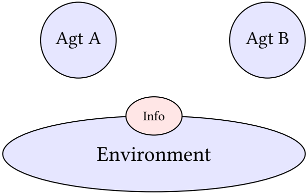

Indirect interactions

Principle

- No intention to communicate to a specific agent
- Modification of the environment perceived by others

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Architectures

- Blackboard : shared centralized ressource, free modification (1990)

Indirect interactions

Principle

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Architectures

- Blackboard : shared centralized ressource, free modification (1990)
- Geographical situatedness (1995)
  - Environment = grid of cells that can be modified
  - Agents move to the positions they need to observe
  - Also used for simulation
- Stigmergy (1997)
  - Cell content modified without agent action
  - Global modification that can use nearby cells
  - Simulation of ant colonies

Agents and artifacts (2003)

Alexandro Ricci

Principle

Indirect interactions through specific objects (artifacts)

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Principle

Indirect interactions through specific objects (artifacts)

Artifact

- Stores data (like agents do…)
- Has a set of invocation methods (like web services…)
- No autonomy ! → No possibilty to refuse a request
- KR-based representation of operations for agents to reason upon
- Process data asynchronously (like agents do…)

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Principle

Indirect interactions through specific objects (artifacts)

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Agents

- Ask for data processing by an artifact
- Register to receive an alert when the operation is done
- Can register to monitor a communication artefact

Direct interactions

Principle

- Intention to communicate to a specific agent
  - Messages with sender, recipient and structured content

Direct interactions

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- Intention to communicate to a specific agent
  - Messages with sender, recipient and structured content

Problem : heterogeneity

Communication layers :

- Transport level → environment
- Syntax level → message structure
- Semantic level → knowledge representation
- Pragmatic level → protocols

⇒ This has to be normalised !

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Speech Acts Theory I

Searle, 1969

Communication is an action

Communicate → change interlocutor's mental state

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Three aspect of a speech act

- Locutory : the act of saying
- Illocutory : the intention of the speech
- Perlocutory : the effect of the speech

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Illocutory act

Performative(Content)

Examples : *Assert(rain), Order(rain), Question(rain)*, . . .

Speech Acts Theory II

Different researchers, different theories…

Searle

- Assertive acts : *Facts*
- Directive acts : *Actions* + *Questions*
  - « Do the action to tell about the Face »
- Promissive acts : *Commitments*
- Expressive acts : *Emotions*
- Declarative acts : *Protocols*

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Sperber & Wilson

- Say that : assertions and promisses
- Say about : orders
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⇒ Need to define the **semantics** of each performative !

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FIPA-ACL standard

`http://www.fipa.org`

Message structure

- Recipient(s) = list of agent IDs
  - *The environment must provide each agent with a unique ID*
- Performative = 1 value in a list of predefined possible acts
- Content expressed in any knowledge representation language
  - *First Order Logics, Lisp syntax, …*

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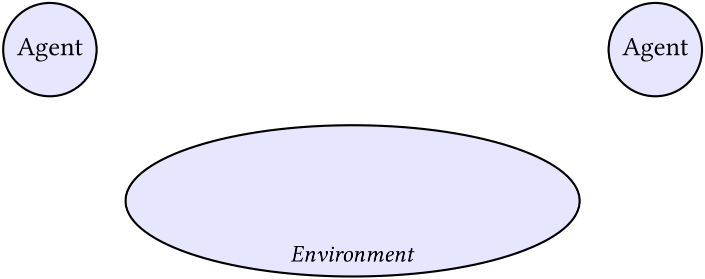
Usual representation : $\langle snd, perf(rcv, content)\rangle$

Communication management elements

- Sender
- Name of the content language
- Ontology referred to for Knowledge Representation
- Conversation ID and number of the message in the conversation

Asynchronous message sending



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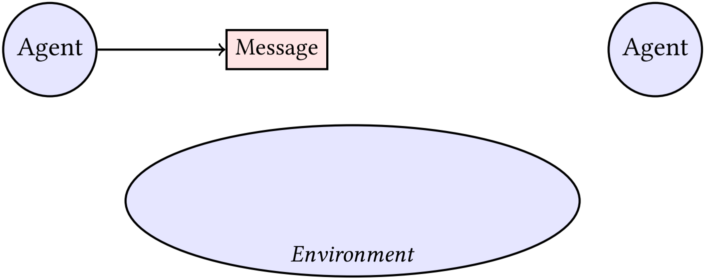

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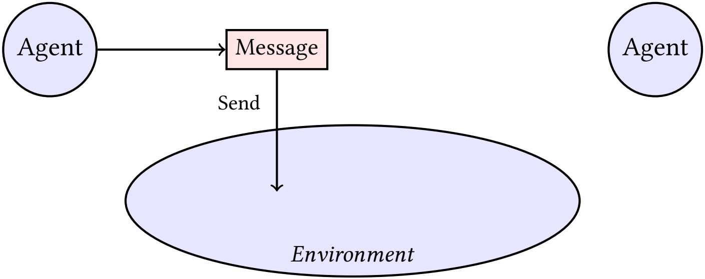

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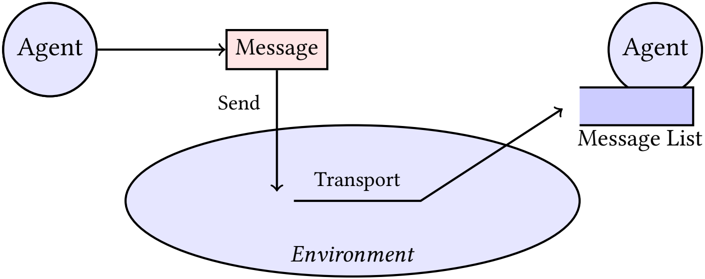

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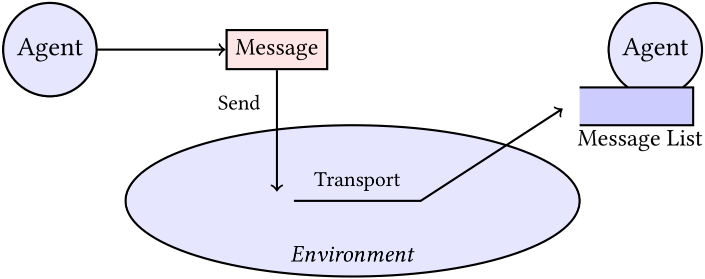
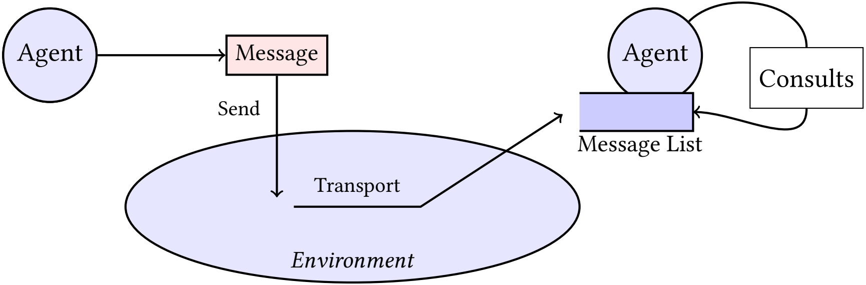


Synchronous method calls

Asynchronous message sending



Synchronous method calls	Asynchronous

Environement's role

Agent Management Service (AMS)

- Loading agents in the MAS
- Allocation of Agent IDs
- Management of the agents' list
- Running threads
- Message sending

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In case of multi-platforms :

- Brokers for message sending
- Mobile agents : threads cloning, starting, ending…

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Directory Facilitator (DF)

Yellow pages...

- Agents register their services and IDs
- Search interface : service → ID

Autonomous agents

Sender agent…

- Can send a message anytime
- Can't know if and when his message is being processed

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  Especially if they are overloaded…
- Can ignore a message

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  Especially if they are overloaded…
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Autonomy

Agents must take into account the autonomy of each other.

- ▶ But they cannot do anything ! → Protocols !

Interaction protocols I

Protocols

Describes how agents can interact in the MAS

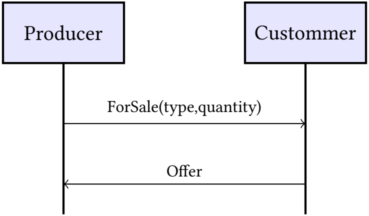
Interaction protocols I

Protocols

Describes how agents can interact in the MAS

AUML standard

- Inspired from UML sequence diagrams
- Describes message exchange between roles
  - An agent can adopt several roles
  - A role can be fulfilled by several different agents



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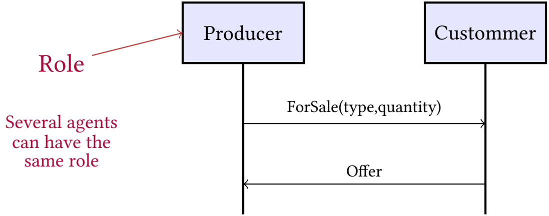

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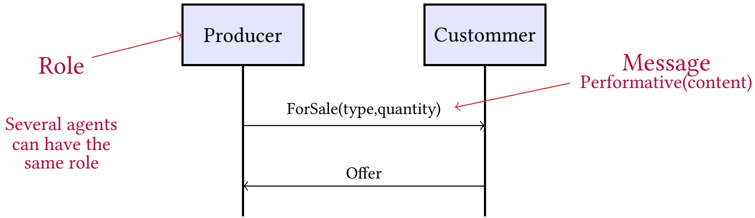

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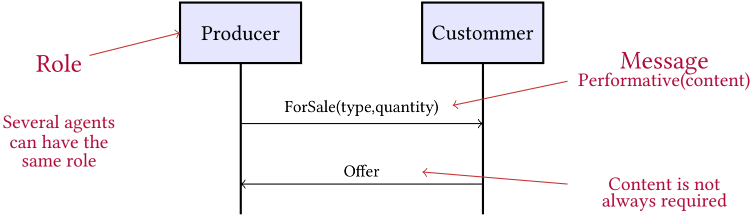


Producer

Custommer

ForSale(type,quantity)

Offer

Role

Several agents can have the same role

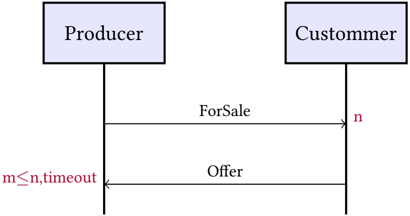
Message
Performative(content)

Content is not always required

Interaction protocols II

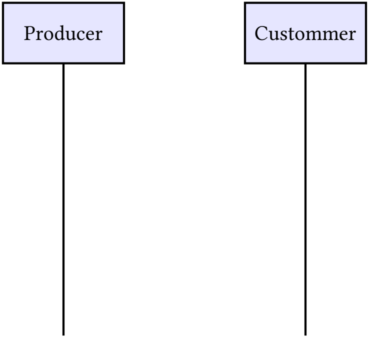
Conditions

- Number of messages sent (arrow end)
- Timeouts
  - Messages received after timeout are considered out of the protocol



Interaction protocols III

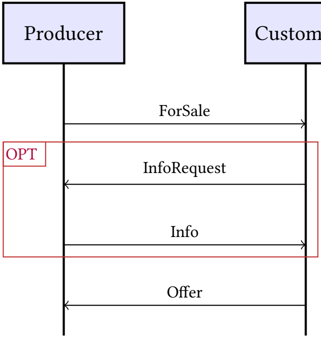
Operators



Interaction protocols III

Operators

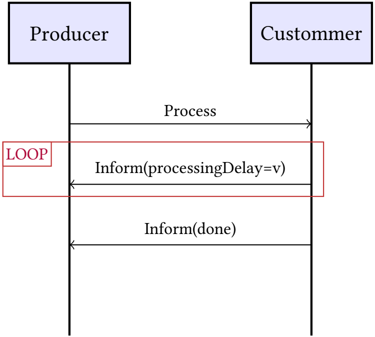
- OPT → some parts can be are optional



Interaction protocols III

Operators

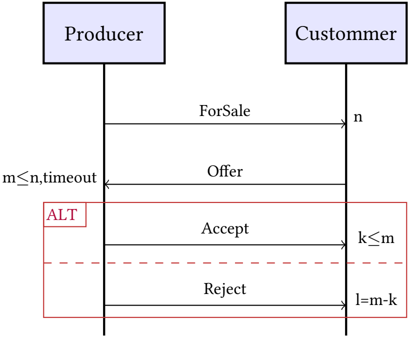
- OPT → some parts can be are optional
- LOOP → some parts can be repeted randomly



Interaction protocols III

Operators

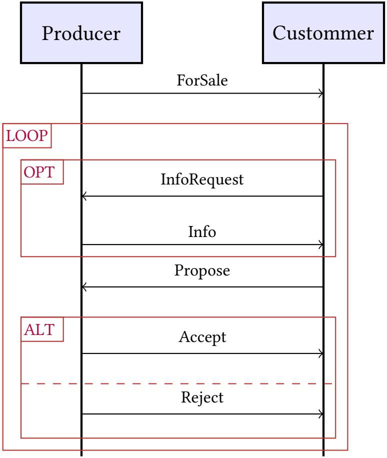
- OPT → some parts can be are optional
- LOOP → some parts can be repeted randomly
- ALT → one or the other



Interaction protocols IV

Operators

- Operators can be **combined**

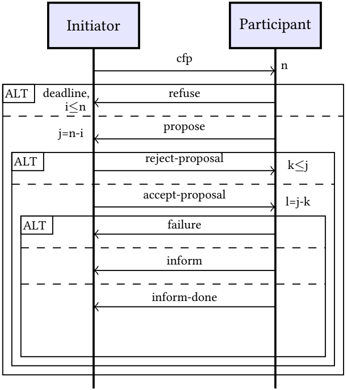


Interaction protocols V

Contract-Net Protocol

Standard for agents to agree on a transaction.

- FIPA standard
- The « must-know » protocol



What's next ?

Tutorial

Using the JADE platform for MAS programming