Système Multi-Agent

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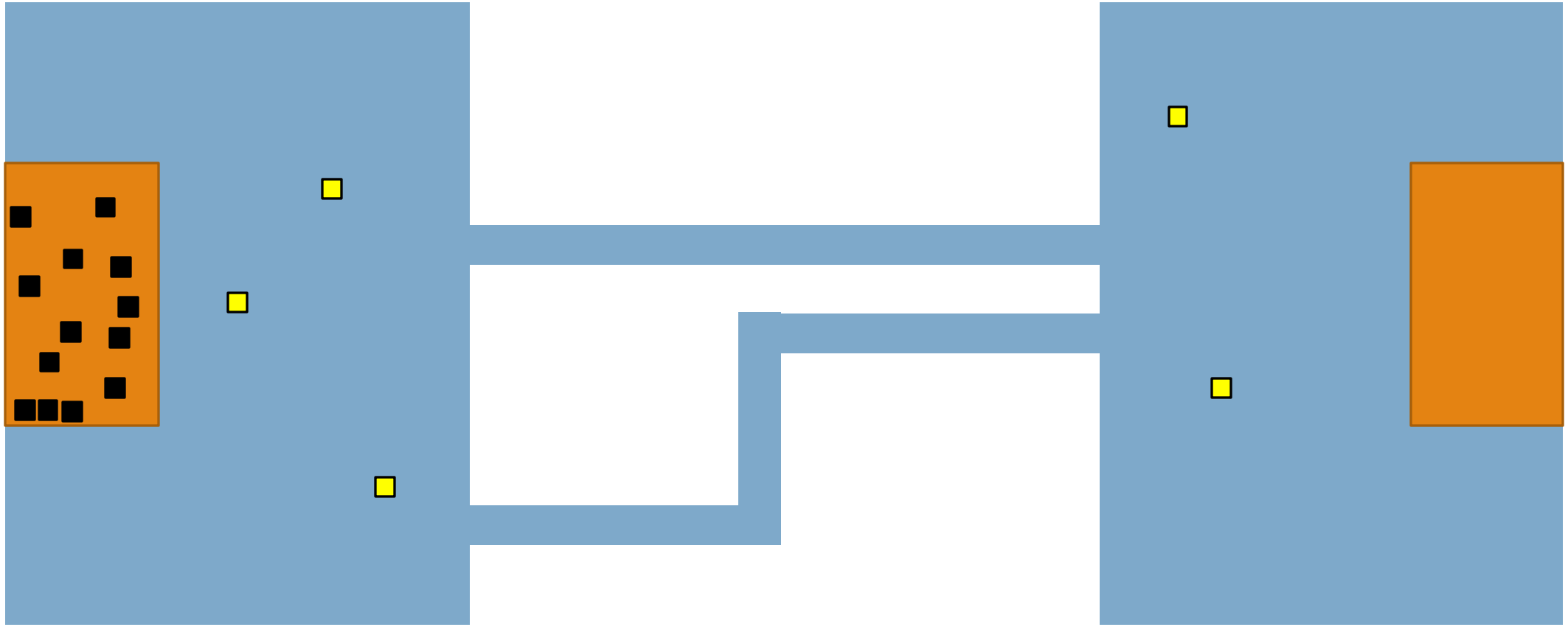
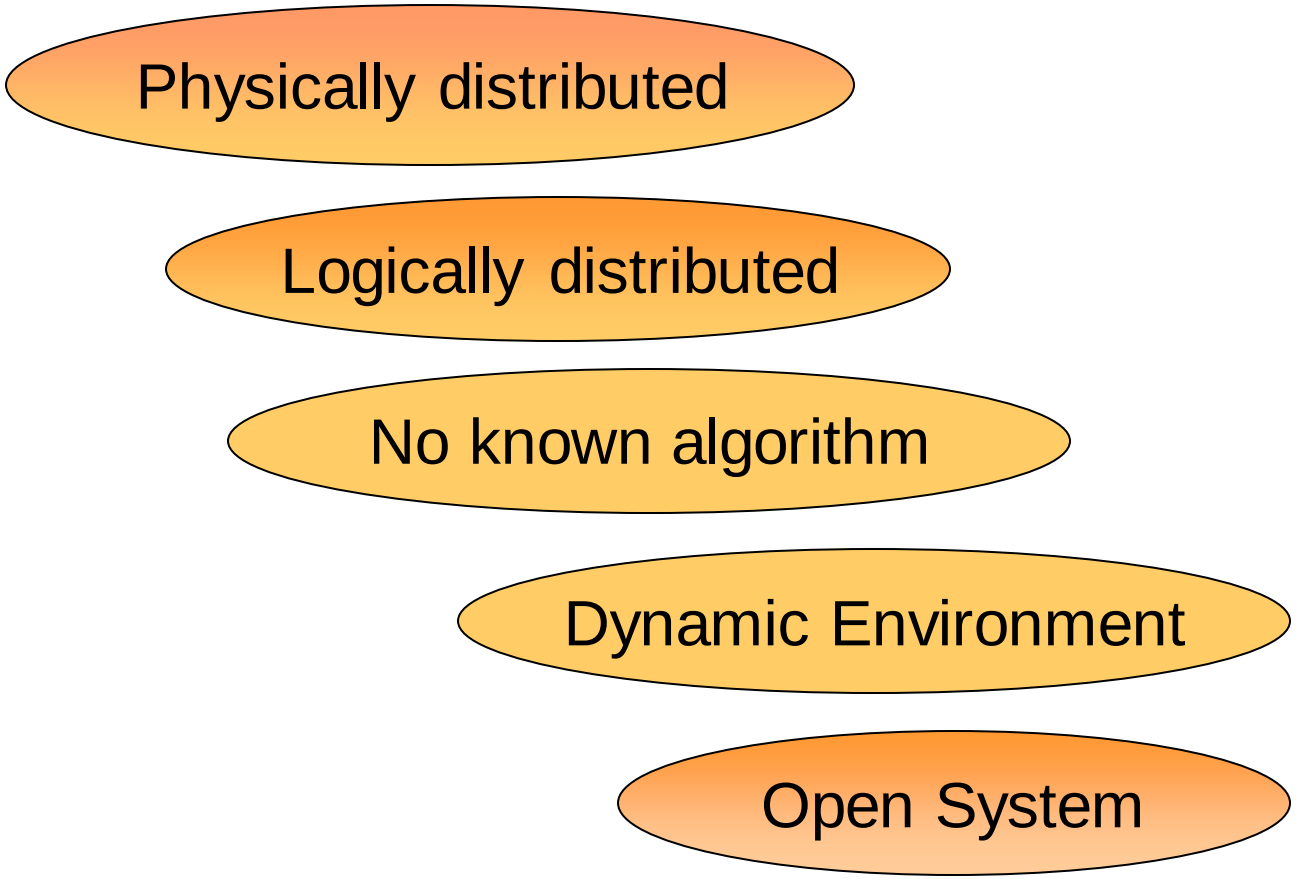
Transport de boites – 1 robot

Transport de boites – X robots

Transport de boites – Environnement dynamique



Main Characteristics of the Problems



SMA

Système multi-agent: Système composé d'agents qui interagissent les uns avec les autres et avec leur environnement

Agent: Entité intelligente autonome ayant une perception limitée

Agent→Autonomy

Intelligent→But, tache à accomplir

Interaction→prise en compte des autres

Agent - Definitions

Agent [Russel&Norvig,95]

- An agent is all which can be understood as perceiving its environment through sensors and as acting on this environment through effectors

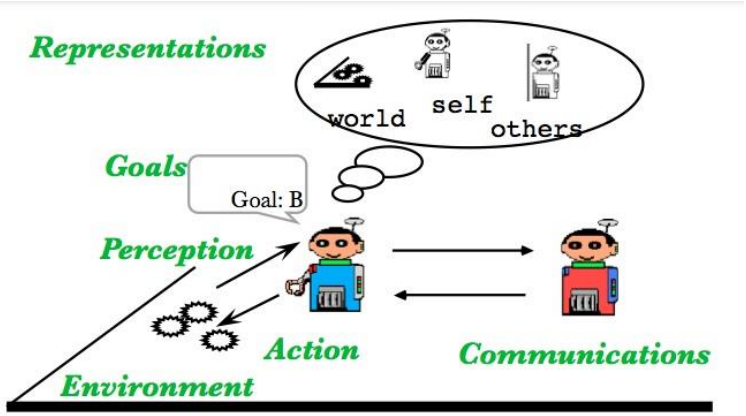
Agent [Wooldridge, 98]

- An agent is a computer system situated in an environment which it can perceive and capable of autonomous action to satisfy its objectives

Agent - Definitions

Agent [Ferber, 95]

- Physical or virtual entity
- Autonomous
- Situated in an environment and capable of acting in an environment
- Capable of communicating directly with the other agents
- Having an individual objective / function of satisfaction
- Having resources
- Capable of perceiving (in a limited way) its environment
- Having a partial representation of the environment
- Having skills and offering services
- Possibly capable of reproducing



Agents and Objects

Common points

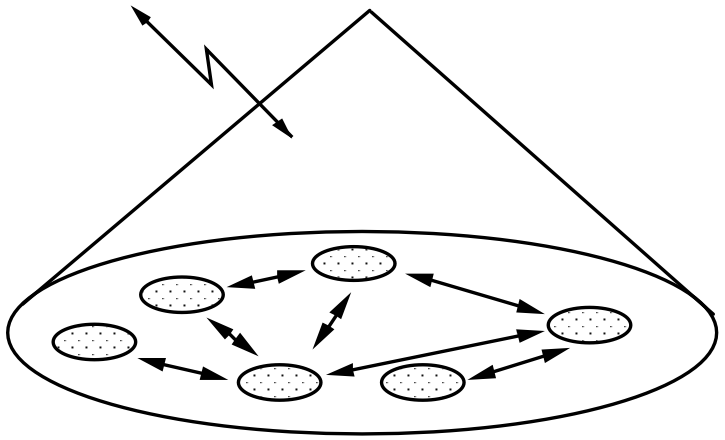
- Internal state
- Can behave on their state
- Modular behaviours units
- Message passing communication

ACTORS AND OBJECTS = techniques for agent implementation

- ✓ Differences
  - Control autonomy : call of internal methods
    - ✓ Actors and objects = execution units It is those who call that decide
    - ✓ Agents = behaviour units. It is those who receive that decide to execute the action
  - CONTROL = agent is a source of control
  - Collective behaviour – social component, introduction protocol…
  - Interactions and communications richer
  - Environment notions

Its specificity

COLLECTIVE BEHAVIOUR



SYSTEM

=

several entities + interactions

Society of animals: ants, bees

Activity inside an enterprise

Activity of several robots

Activity of several experts

- Social Psychology
- Sociology,
- Groups Dynamic
- Economy,
- Philosophy,
- Systemic,
- Biology,
- Ethology,
- Ergonomy,
- Computer Science

Objectives

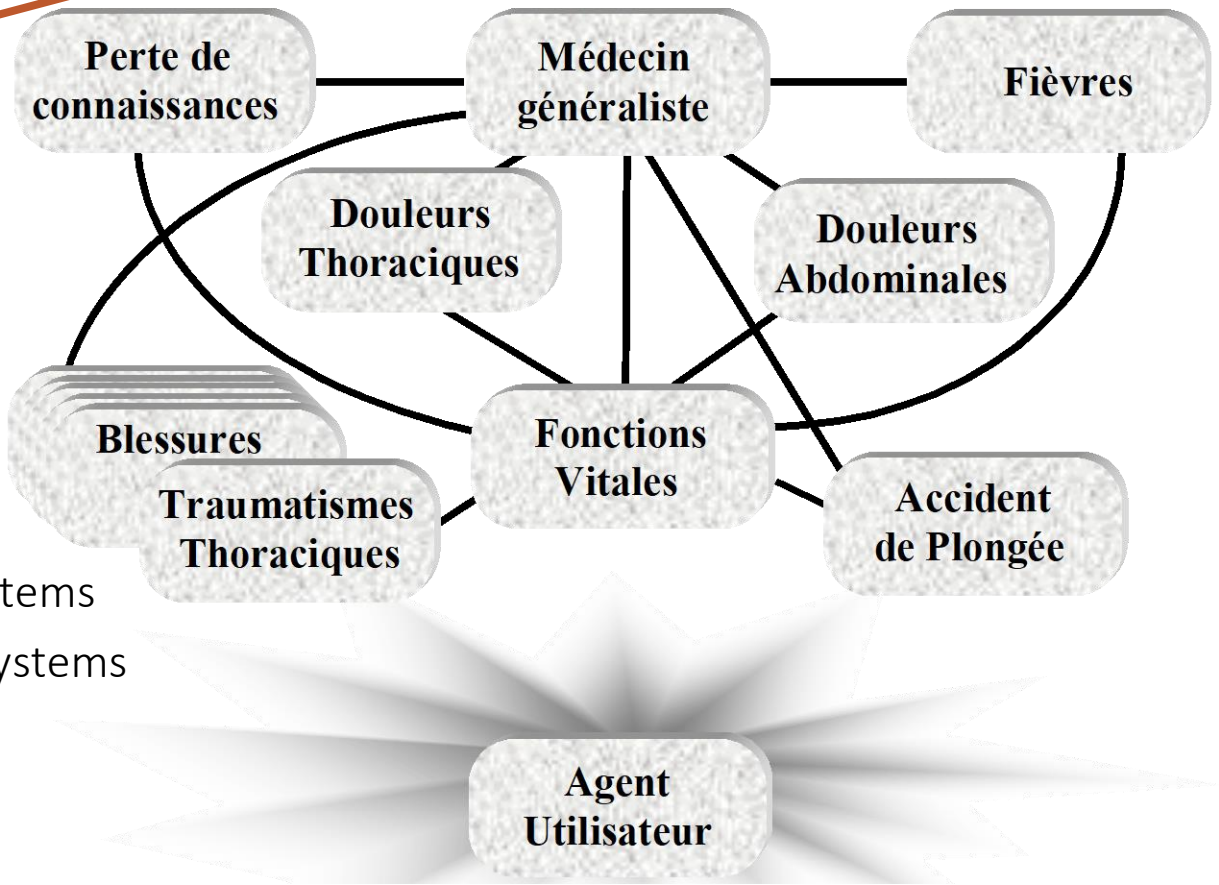
Help designers to design large, complex, open and distributed systems

Face the complexity inerent to multi-expert applications

Get autonomous and robust systems with self-* capacities

Distribution

FONCTIONNAL



- ✓ Medical Diagnosis Systems
- ✓ Speech Recognition Systems

Distribution

Trafic

Air trafic

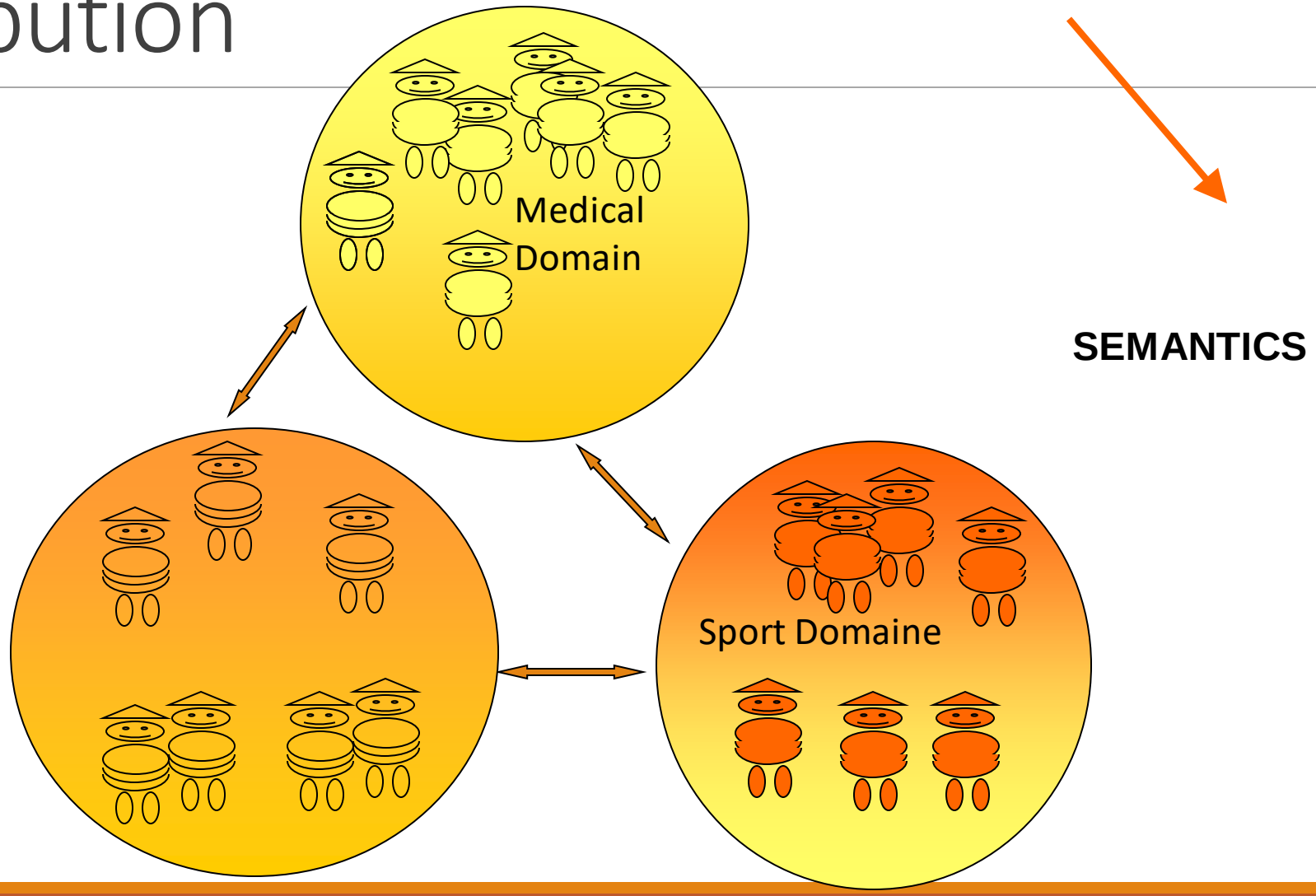
Collective Robotics

Ecosystems

(preys/predators)

SPATIAL

Distribution



Distribution

TEMPORAL

Application Domains

Diagnosis Tasks

- Medical diagnosis at several levels, sick person monitoring

Control tasks
trafic control, air trafic control, aérien, power distribution

Interpretation tasks

signal recognition, speech recognition,

Management Production
workshops scheduling, industrial processes management

Decision aid
entreprise management

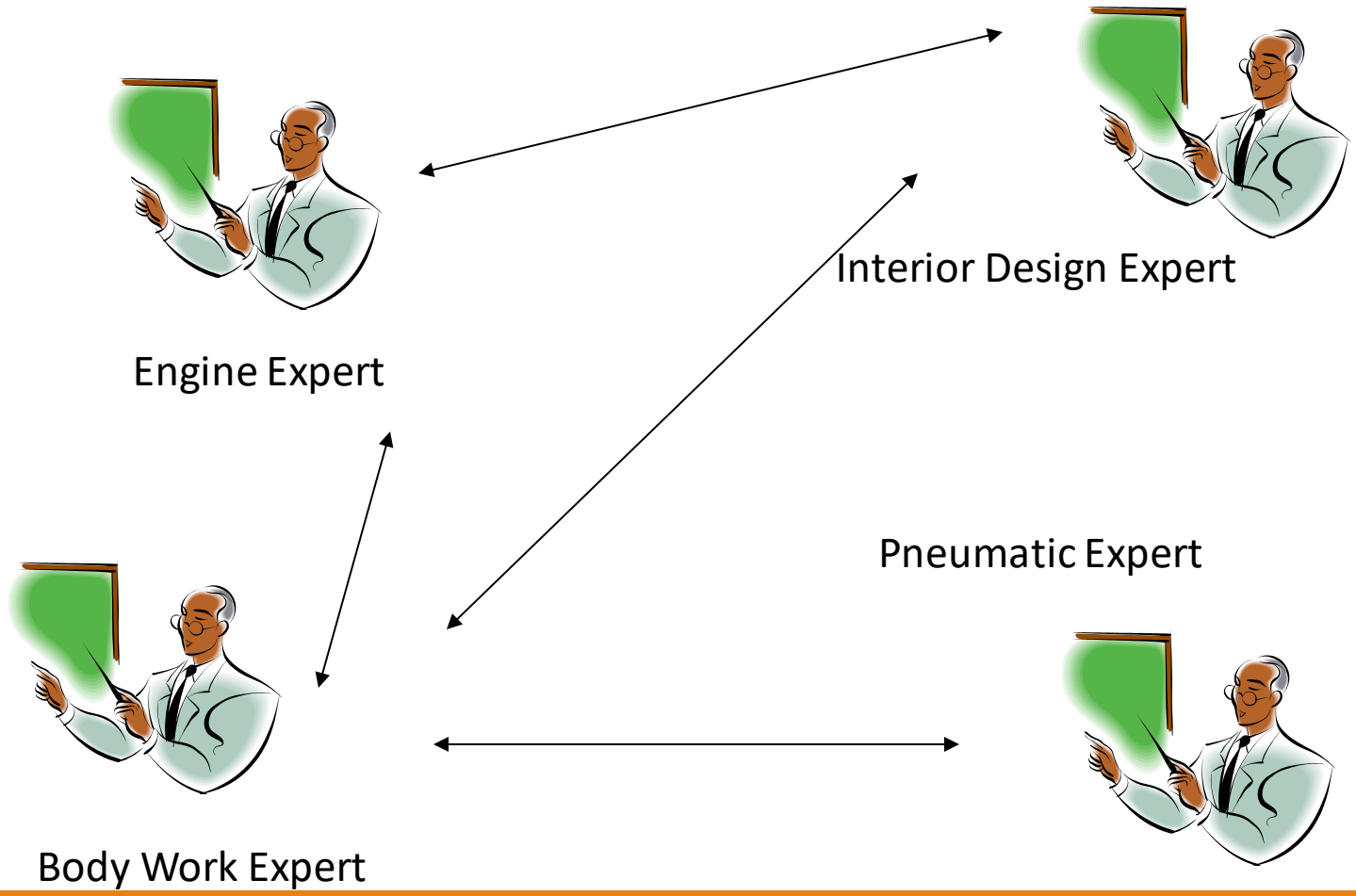
Distributed Robotic
multi-robot planification, Robocup

Optimisation

Telecommunications

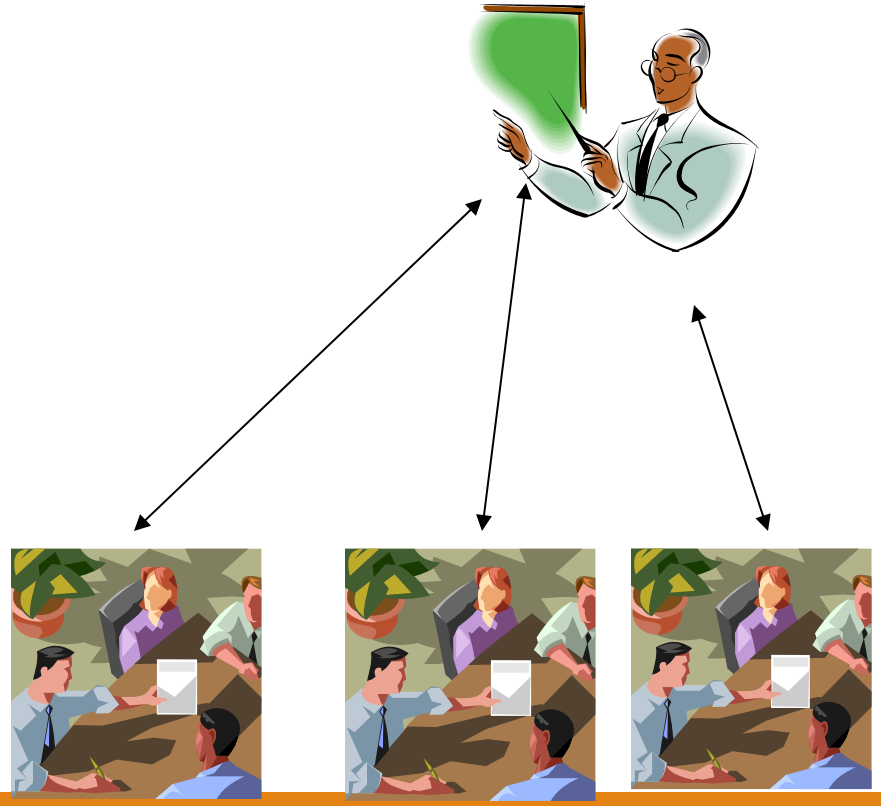
sorting, load balancing, errors recovery,
networks supervision

Example: car design



Example: auction

AUCTIONEER



BUYERS

Some definitions

Collaborative solutions to global problems by a group of distributed entities

The agent can be range from simple execution elements to complex entities providing rational behaviour

The solving problem is collaborative because mutual shared information is needed to reach a solution. The agent group is logically and sometimes physically decentralized at the data and control levels (Huhns, 87)

DAI consists in sharing the representation of the real in independant and communicating agents enable to act on themselve and on the environment (Erceau, 1991)

Agent - Properties

[Jennings, 95]

Reactive

- Maintain interactions with its environment
- Answer the changes of the environment to satisfy its purposes

Pro-active (teleonomy)

- Behavior not only managed by the events
- Generate and reach purposes
- Take initiatives to satisfy its purposes

Social capabilities

- Capacity to interact with the other agents via languages of communication to satisfy its purposes via it
  - Cooperation: work together in team to reach a shared goal
  - Coordination: manage the interdependences between activities
  - Negotiation: capacity to reach agreements on questions of public interest

Agent – Properties

[Sansonnet, 10]

Proactivity <> Reactivity

- An object is reactive
  - An object is a passive entity (or reactive)
  - If nobody asks for the value of an attribute or activates a method of the object, then there is nothing
- An agent is proactive
  - An agent possesses, besides the attributes and the methods, internal processes which work even in the absence of external requests
  - An agent can thus act **even if nobody asks it for anything**

Agent – Properties

Persistence and Adaptability

Persistance et Adaptabilité

- Persistent agent
  - If an agent is proactive it is at first because it is provided with at least a goal for which it tries to satisfy in a persistent way as long as
    - It thinks that it is still possible (logical pre condition)
    - It possesses the resources to make it (physical precondition)

- Adaptive agent
  - In front of an environment perpetually changing (openness), an agent constantly has to modify the plan which it pursues to reach a goal
    - Perceive and estimate the situation of its action
    - Build representations in the course of functioning (learning)
    - Elaborate dynamic plans which launch internal processes or on the contrary stop them

Agent – Properties

Autonomy

- Autonomous agent
  - Its existence is appropriate for it, independently of the existence of the others
  - He can maintain its viability in dynamic environments, without outside control
  - The internal decision-making on its behavior to be had is only a function of its perceptions, knowledge and representations of the world
- The agents can be dependent and autonomous

Agent - Typology

Reactive Agent

- Biological metaphor (ants)
- No symbolic model representing the environment
- No explicit purpose, not (few) memory
- Communication via the environment
- Interaction by tracks put down in the environment (pheromones)
- Behavior reflex (stimulus-answer)

Cognitive Agent

- Social metaphor / psychological (human beings)
- Representation of the explicit knowledge on the other agents
- Notion of purpose, memory
- Direct communication by sending of messages
- Interaction implemented by means of languages of interaction based on the theory of the speech acts
- Deliberative behavior

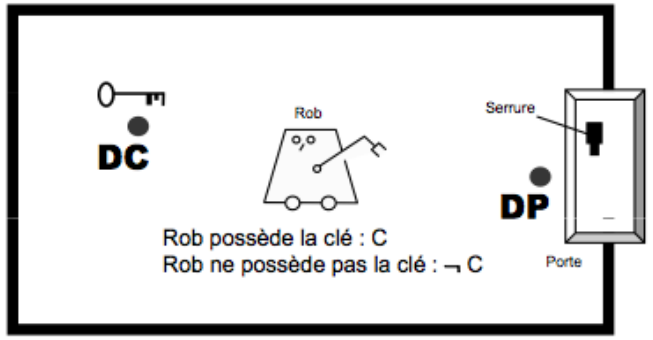
Qu’est-ce que l’agent?

Fourmis
Chaise
Fenêtre
Thermostat
Robot
Gravier
Etudiant
Voiture
Poisson
Flocon de neige
Salle
Université

Agent: reactive / cognitive agent

- Proposer un algorithme réactif permettant de résoudre le problème ci-dessous puis un algorithme cognitif permettant de résoudre le même problème. Dans les deux cas, le robot "Rob" cherche à sortir d'une pièce (vous vous placerez dans un cadre général, c'est-à-dire que vous ne savez pas si la porte est ouverte, fermée, ou fermée à clef, vous ne connaissez pas la position de Rob et vous ne savez pas si Rob possède ou non la clé permettant d'ouvrir la porte)
- Dans la figure ci-dessous est répertorié l'ensemble des variables que Rob peut manipuler au cours de son raisonnement (DC, DP, …)
- L'ensemble des actions que Rob peut mettre en œuvre est
  - ALLER_A_DC, ALLER_A_DP, DEVEROUILLER, MARCHER_ALEATOIREMENT, OUVRIR, PRENDRE_CLE, SORTIR
- Vous utiliserez les actions cognitives lorsque vous construirez la solution cognitive et les actions réactives lorsque vous construirez la solution réactive

Problème :
« Rob le robot doit sortir de la pièce ».

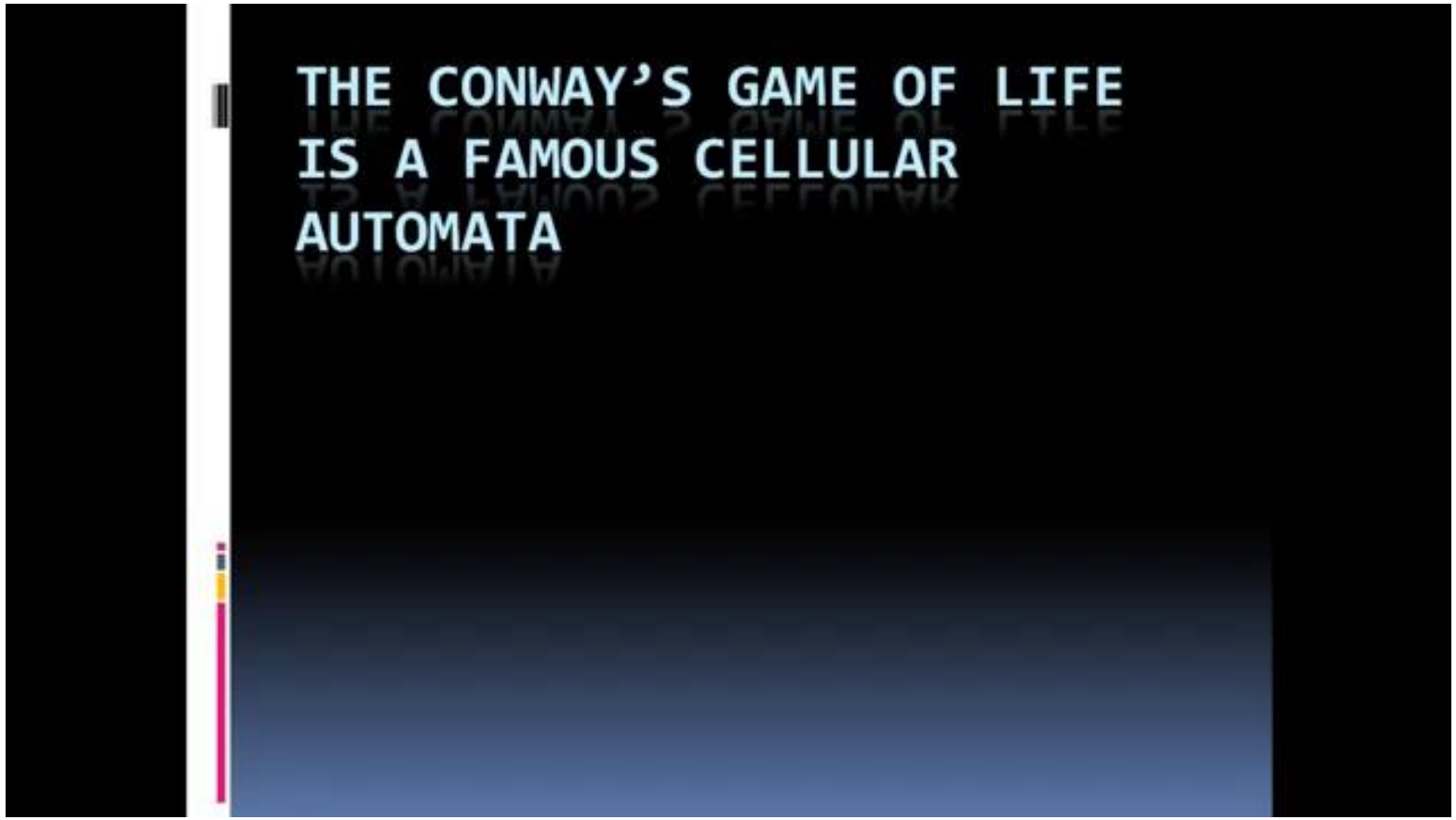


Porte ouverte : PO
Porte Fermée : PF
Porte Fermée à clé : PFC

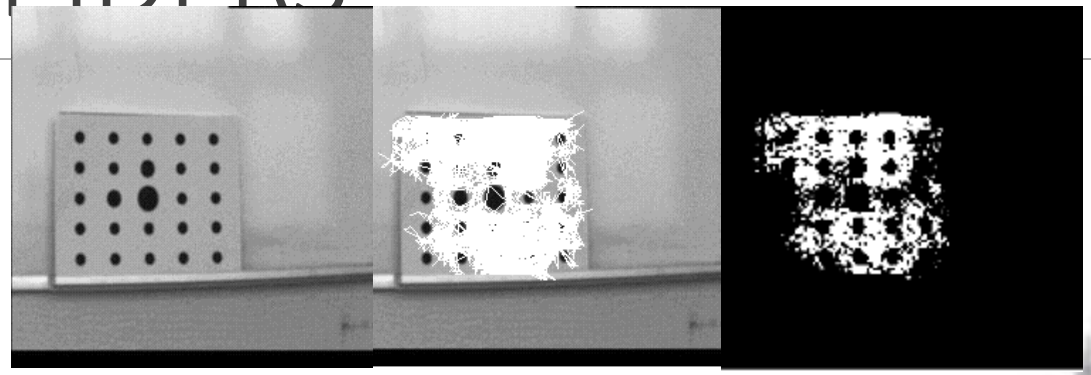
Position DP = Devant la Porte
Position DC = Devant la Clé

BOIDS

Game of Life



SPIDERS

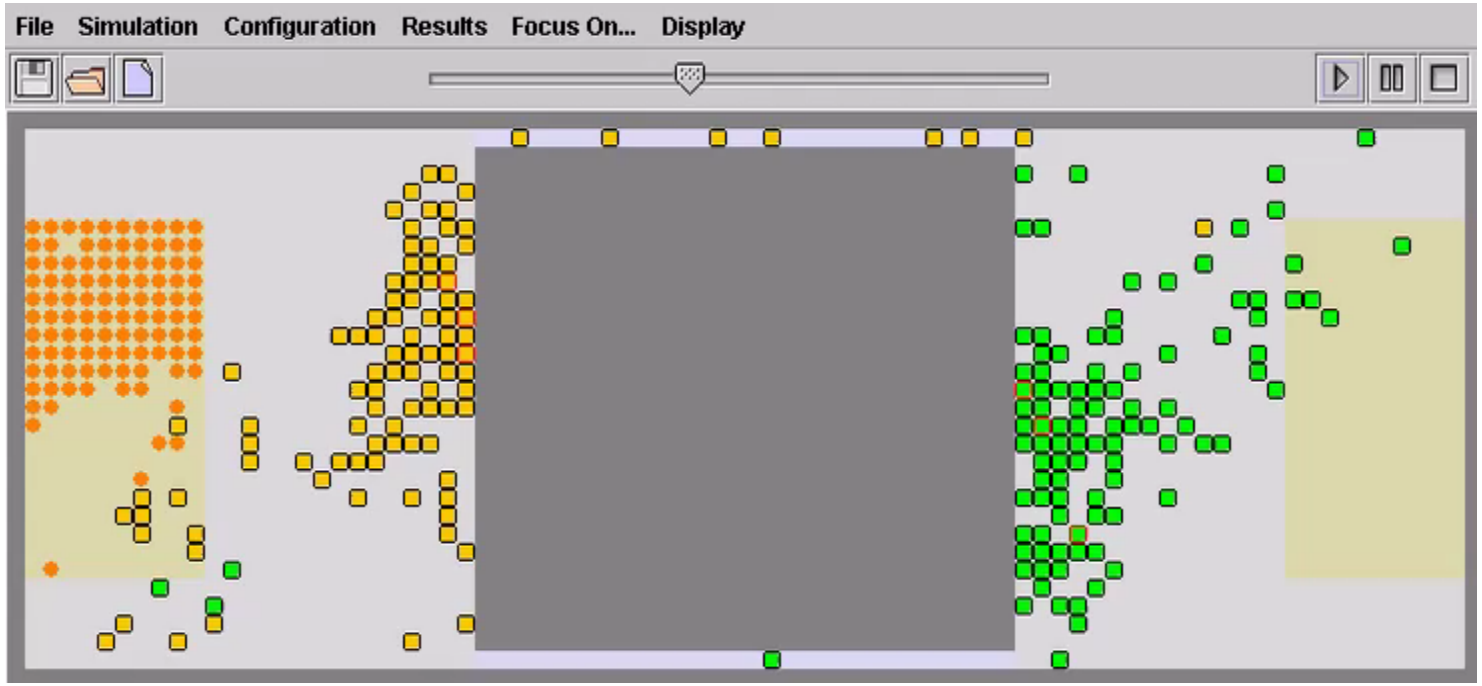


FISHES

CHOREGRAPHY

ANTS – 1 et 2

ROBOTS



Properties [Russel, 95]

- Accessible/ inaccessible
  - The obtained information about the state of the environment can be complete, valid and up to date
- Determinist / Indeterminist
  - An action = a single effect
- Statics / Dynamics
  - Unchanged while the agent deliberates (except by the actions of the agent)
- Discrete / continuous
  - Finished number fixed by actions and by perceptions of the agent