Agents and their environment

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Outline

Agents: architecture, interaction... What about their environment?

Environment: Russell – Norvig characterization

Environment responsibilities

Environment and agent interaction

Environment and agent behaviour

Agents, interaction... And the environment

Agent architecture: supports the definition of agent behaviour
◦ Reactive vs. Deliberative agents

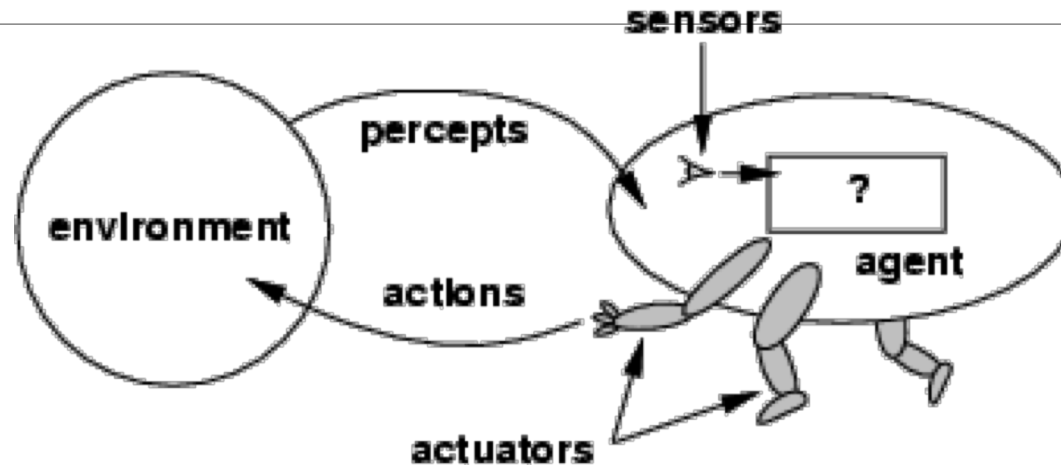Agent interaction model: supports the definition of mechanisms for information exchange between agents
◦ Direct vs. Indirect interaction

Agents "live in an environment"
◦ Relationships among the environment and agent behaviour
◦ Relationships among the environment and agent interaction

Features of environments

Accessible vs. *inaccessible*
Deterministic vs. *non-deterministic*
Episodic vs. *non-episodic*
Static vs. *dynamic*
Discrete vs. *continuous*

(AI: A Modern Approach, S. Russell and P. Norvig)

Environments – *Accessible* vs. *inaccessible*

An accessible environment is one in which the agent can obtain complete, accurate, up-to-date information about the environment's state

Most moderately complex environments (including, for example, the everyday physical world and the Internet) are inaccessible

The more accessible an environment is, the simpler it is to build agents to operate in it

Environments – *Deterministic* vs. *non-deterministic*

A deterministic environment is one in which any action has a single guaranteed effect – there is no uncertainty about the state that will result from performing an action

The physical world can to all intents and purposes be regarded as non-deterministic

Non-deterministic environments present greater problems for the agent designer

Environments – *Episodic* vs. *non-episodic*

In an episodic environment, the performance of an agent is dependent on a number of discrete episodes, with no link between the performance of an agent in different scenarios

Episodic environments are simpler from the agent developer's perspective because the agent can decide what action to perform based only on the current episode - it need not reason about the interactions between this and future episodes

Environments – *Static* vs. *dynamic*

A static environment is one that can be assumed to remain unchanged except by the performance of actions by the agent

A dynamic environment is one that has other processes operating on it, and which hence changes in ways beyond the agent's control

Other processes can interfere with the agent's actions (as in concurrent systems theory)

The physical world is a highly dynamic environment

Environments – *Discrete* vs. *continuous*

An environment is discrete if there are a fixed, finite number of actions and percepts in it

Russell and Norvig give a chess game as an example of a discrete environment, and taxi driving as an example of a continuous one

Continuous environments have a certain level of mismatch with computer systems

Discrete environments could *in principle* be handled by a kind of "lookup table"

Examples of environments

| Environm.	Accessib.	Determ.	Episodic	Static	Discrete
Chess	Yes	Yes	No	Yes	Yes
Backgammon	Yes	No	No	Yes	Yes
Poker	No	No	No	Yes	Yes
Medical Diagnosis	No	No	No	No	No
Taxi driver	No	No	No	No	No

Environment and agent behaviour

In general agent behaviour is influenced by its perception of the environment

But does it mean to perceive for different agent architectures?

◦ Boids' behaviours are essentially determined by perception, which has a clear definition and influence on agent behaviour

◦ 3APL behaviours are mostly focused on analysing the belief base and constructing plans building on basic capabilities according to agent's goals
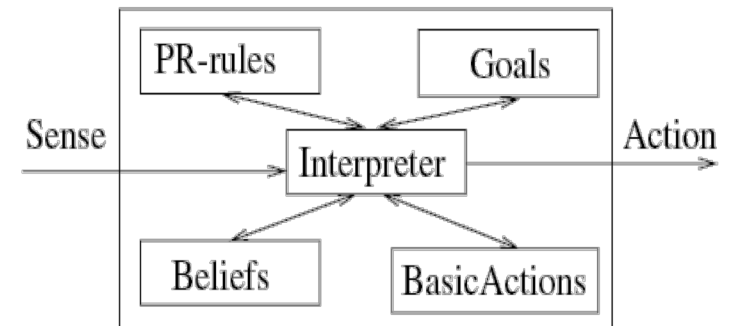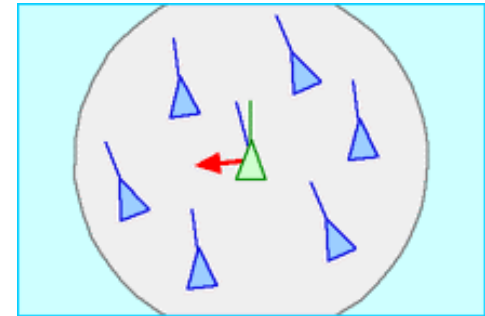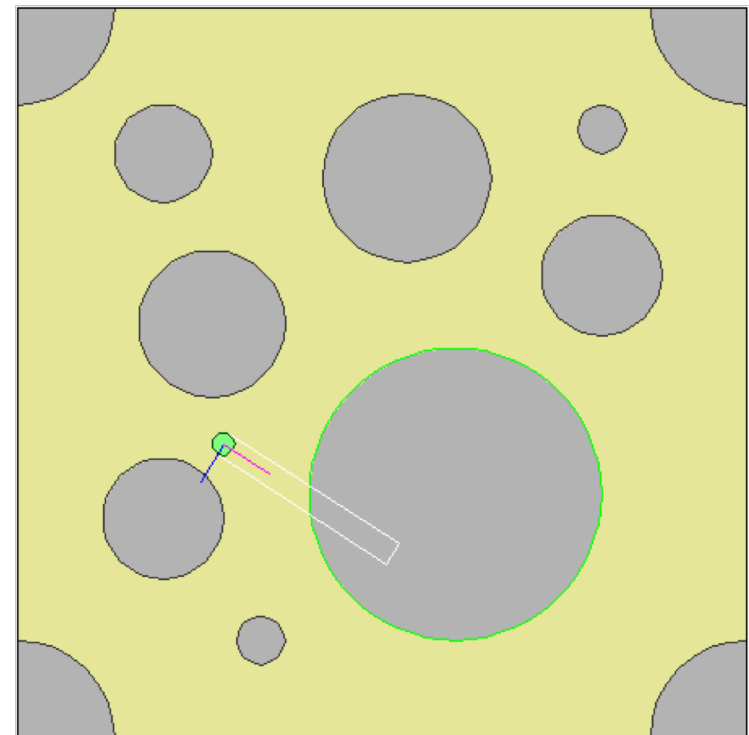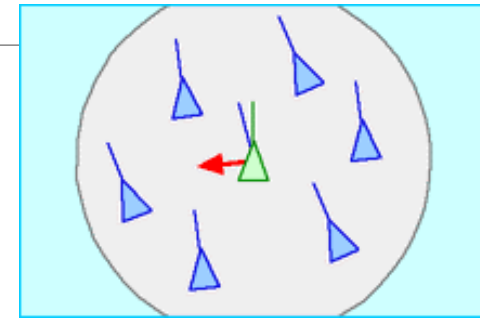
Boids... and reactive agents in general

Agent execution model: focused on reaction

- Deliberation and proactivity are almost absent

Precise notion of perception

Heavily relies on the environment to realize complex behaviours

3APL.. and deliberative agents in general

Agent execution model: focused on proactiveness

◦ The introduction of reactivity is not simple

The diagram indicates a general "Sense" (and 3APL-M architecture includes a sensor module) but its semantics is not clear (belief base update?)
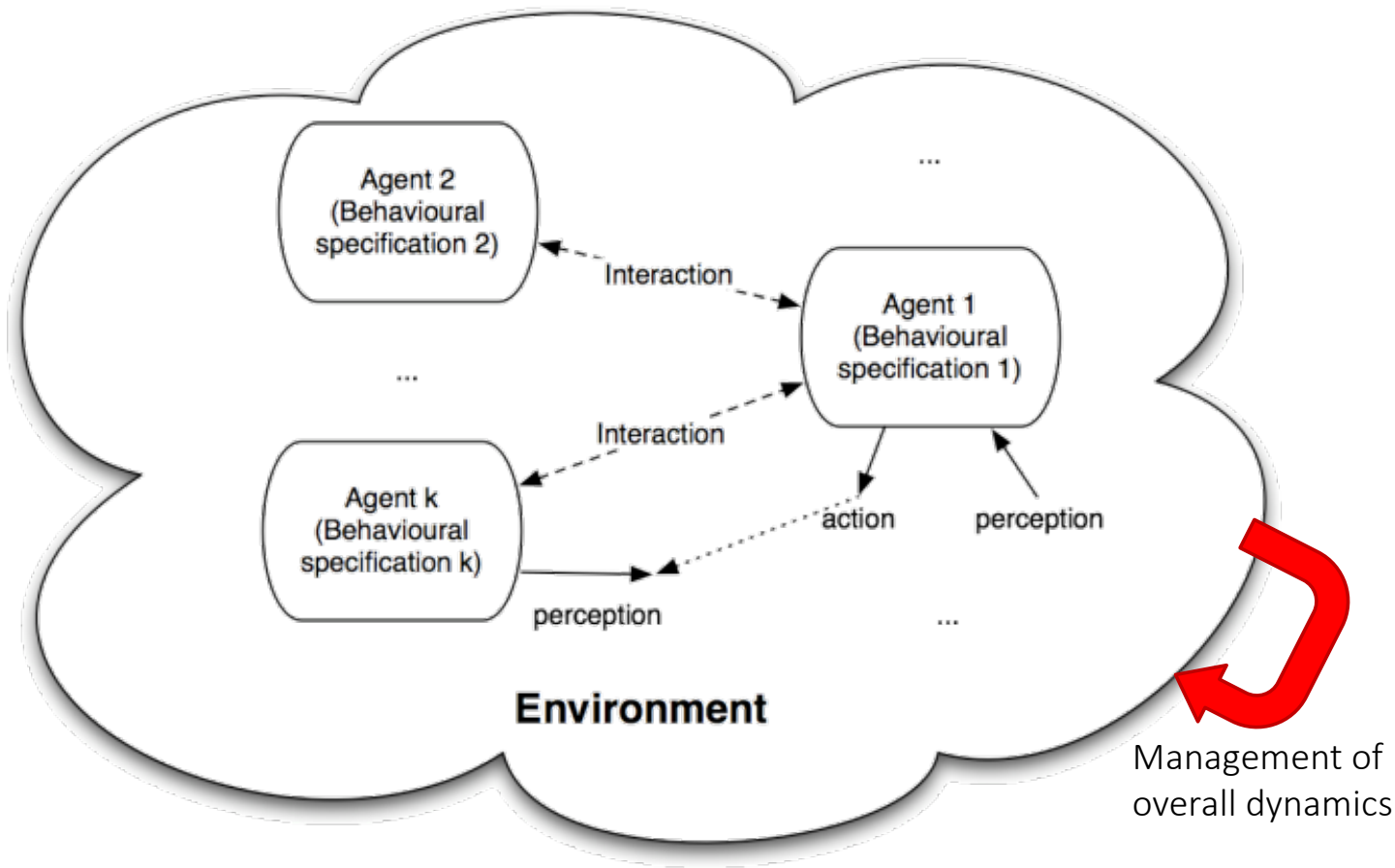
Generally considers the environment as an information provider or as a constraint
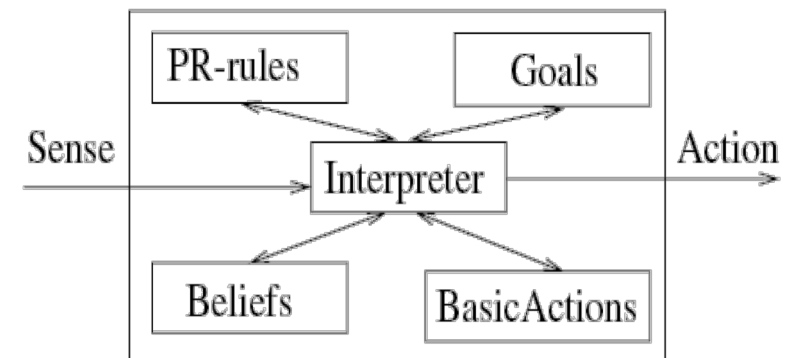
goxy($R1,R2$) ←
pos($R1$),door($R1,R3$),not $R1$ = $R2$ | Go($R1,\ R3$);goxy($R3,R2$),

Agents and environment - a reference model

Agent 2 (Behavioural specification 2)

Agent 1 (Behavioural specification 1)

Agent k (Behavioural specification k)

Interaction

Interaction

action   perception

perception

Environment
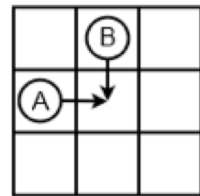
Management of overall dynamics

Environment responsibilities
- Supplying agents' perceptions
- Receiving agents' actions
- Regulation of actions' effects (and conflicts!)
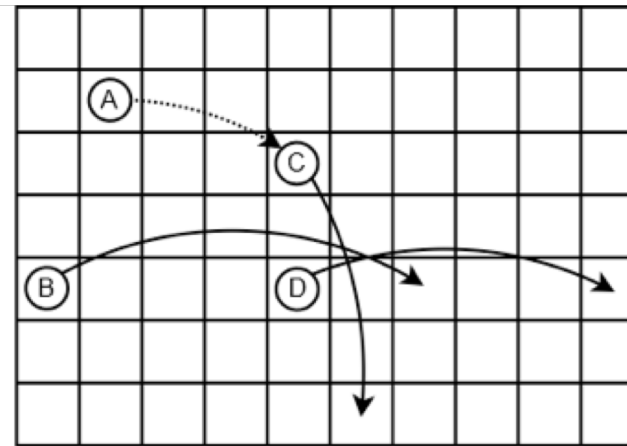- Updating of overall environmental state (whole notion makes sense in simulation context, virtual environments…)

Environment, rules and their enforcement: example of movement

From Klüpfel, 2003 and Kirchner et al., 2004

Usual ($v_{max}=1$) conflict — (a)
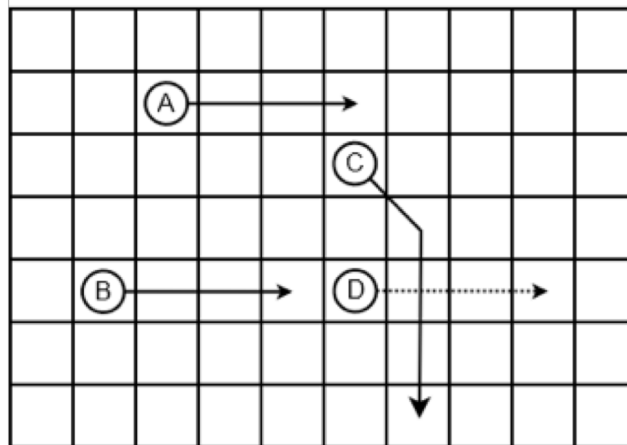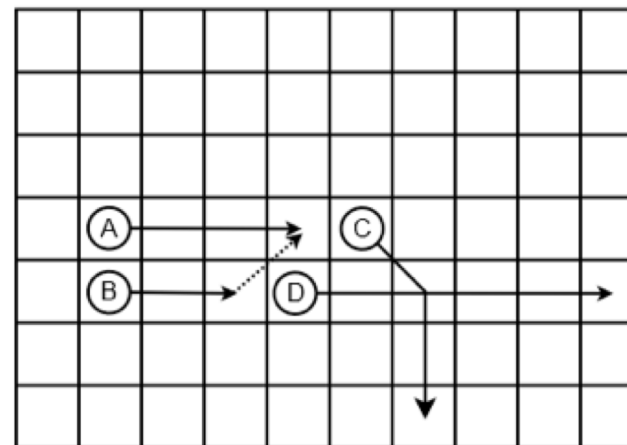
Hop or stop conflict — (b)

No crossing path conflict — (c)

Sub-steps conflict — (d)

Klüpfel, H., A Cellular Automaton Model for Crowd Movement and Egress Simulation. Ph.D. thesis, University Duisburg-Essen, 2003.

Kirchner, A., H. Klüpfel, K. Nishinari, A. Schadschneider, and M. Schreckenberg, Discretization effects and the influence of walking speed in cellular automata models for pedestrian dynamics. Journal of Statistical Mechanics: Theory and Experiment, Vol. 2004, No. 10, 2004, p. P10011.

Interaction models: comparative view

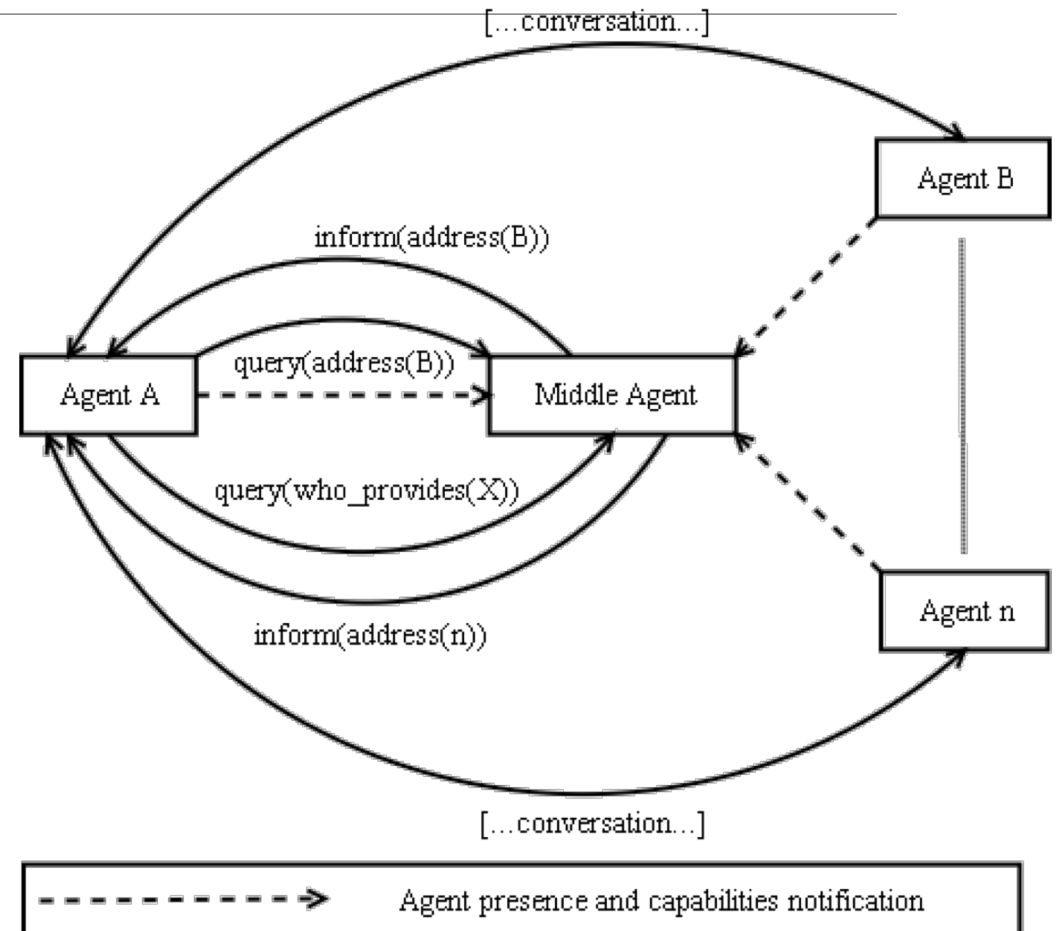|	Direct interaction	Indirect Artifact based	Indirect Spatially founded
Time/space uncoupling	No	Yes	Yes
Name uncoupling	No	Yes	Yes
Agent environment	Communication infrastructure	Shared artifact (e.g. blackboard, tuple space)	*Spatial representation of agents' environment* (e.g. lattice, graph) and *its properties*
Agent context	Well known *middle-agents*, other *known agents* and its *knowledge base*	*Information present in the artifact* (and viewable according to access rules), and *its state*	*Viewable portion of space* (a set of cells/nodes and viewable information) and *its state*

Environment: direct interaction models

In this framework an agent must have some a-priori acquaintance (at least with a facilitator)

Considering communication as an action, its acquaintance effectively represents its environment

In practice facilitators are delegated the functionalities that are tipically ascribed to the environment

Environment: indirect interaction

Indirect interaction requires a medium, effectively representing agents' environment

◦ An artifact or set of artifacts

◦ A more 'explicit' representation of an environment (a grid, a graph, etc.)

In this case perception and mediated interaction are effectively 'delegated' to the environment

Different approches provide distinct notions of perception and distinct mechanisms of interaction

$emit(f)$

$Compare_T(f'\,c,t) = true$