

# AI Entities

- When creating artificial intelligence, the purpose is to produce entities that are able to operate independent of human direction
  - An entity may act on a human's behalf though
- These entities need to have the following properties:
  - **autonomy** = needs no direct involvement to perform duties
  - **reactivity** = must be able to perceive and react to its environment
  - **proactivity** = must exhibit goal-directed behaviour
  - (**sociability** = interacts with other agents)

# Intelligent Agents

- **Agents** = a software entity that exists in an **environment** and acts on that environment based on its **perceptions** and **goals**.



- Another possible agent example:
- NAVLAB (video)

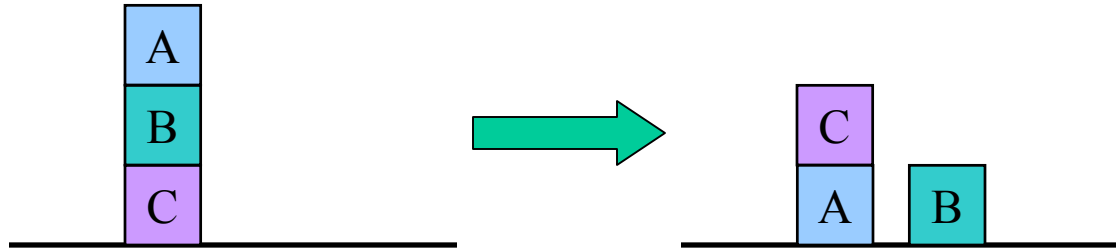


# Degrees of Intelligence

- Focusing on rational agents (agents that try to do the best thing under the circumstances), one tends to measure the intelligence of the agent according to:
  1. the ability to perceive and understand a variety of circumstances
  2. the ability to adopt complex goals and manage them to arrive at an optimal objective
  3. the ability to act effectively to achieve its interests
  4. the ability to adapt to new circumstances

# Agent Environments

- Usually described in terms of “worlds”
  - e.g. “**Blocks world**” = planning domain, moving blocks from one configuration to another, given movement rules

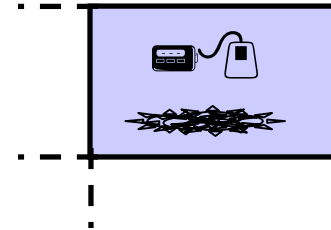


- Steve’s favorite: **Vacuum-cleaner world**
  - environment: rooms with connections between the rooms and dirt in zero or more rooms
  - perceptions: current room, adjacent rooms, existence of dirt
  - actions: suck, move, **no-op**
  - goal: remove dirt from all rooms

# Types of Agents

- Simple reflex agents

- operate on current state of environment, ignores all past perceptions (knee-jerk reactions)
- very simple, not very intelligent
- VC example:
  - if dirt exists, suck
  - move to random room

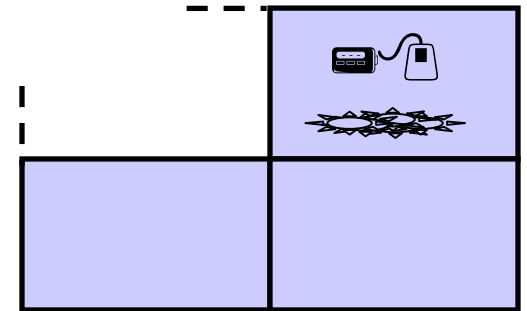


- hard to verify success for complex tasks
  - good for simple agents (bar code scanners, e.g.)

# Types of Agents (cont'd)

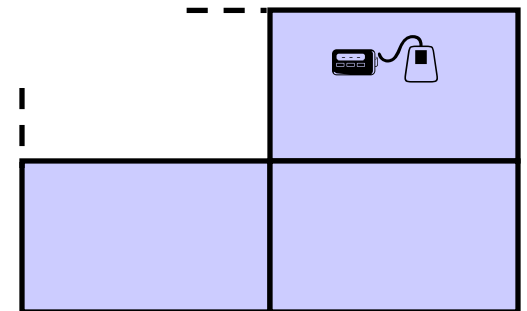
- **Model-based agents**

- Also act on current state, but keeps track of the other parts of the world that it can't currently see
- Needs to store a representation of the current world, somehow



- **Goal-based agents**

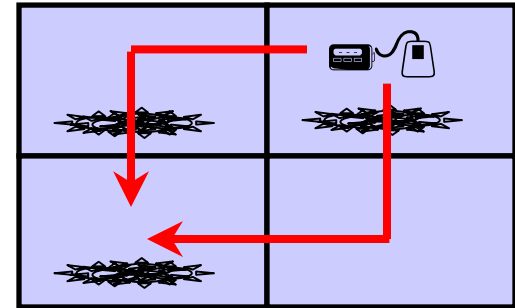
- incorporates goals into its decision-making process when selecting an action to perform
- tries to achieve a desirable state
- often needs to have more intuition about its environment



# Types of Agents (cont'd)

- **Utility-based agents**

- when multiple paths exist to an agent's goals, the possible actions are given a weight called a utility, that allows the agent to select the best action
- usually involves a utility function that maps the next state to a number value that indicates the agent's "happiness"



- **Learning-based agents**

- "experiments" with various actions to try to find the set that produce the optimal results, and then follows those actions
- requires database of actions, performance evaluation, learning mechanism
  - e.g. car-driving robot

# Multi-Agent Systems

- When multiple agents work towards a collective goal, the rules for each agent change. It is no longer sufficient for agents to act solely in their own interests
  - Example: The Prisoner's Dilemma

Agent A

		Agent A	
		Confess	$\neg$ Confess
Agent B	Confess	A: 5 years B: 5 years	A: 10 years B: 1 year
	$\neg$ Confess	A: 1 year B: 10 years	A: 2 years B: 2 years

What is the optimal strategy here?

# Multi-Agent Systems

- States and perceptions are changed to accommodate the collective:
  - a larger model of the environment is developed by the collective explorations of the agents
  - the number of possible actions rises exponentially with the number of agents
    - if each agent has  $n$  moves and there are  $m$  agents, there are  $O(n^m - nm)$  more actions to consider in the collective process than in the isolated process.
  - utilities and goals are evaluated collectively to determine the overall benefit of the action combinations

# Multi-Agent Applications

- RoboCup
  - robot soccer league
  - international competition
  - also offers search & rescue, RoboCup junior, and a dance competition
- Radiation cleanup, bomb disposal robots
- Still a lot of current multi-agent research being conducted today

