Intelligent Agent

- One definition: An (intelligent) **agent** perceives it environment via sensors and acts rationally upon that environment with its effectors. Hence, an agent gets precepts one at a time, and maps this percept sequence to actions.
- Another definition: An agent is a computer software system whose main characteristics are situatedness, autonomy, adaptivity, and sociability.

Agent Characteristics

- Situatedness

  The agent receives some form of sensory input from its environment, and it performs some action that changes its environment in some way. Examples of environments: the physical world and the Internet.
- Autonomy

  The agent can act without direct intervention by humans or other agents and that it has control over its own actions and internal state.
- Adaptivity

  The agent is capable of (1) reacting flexibly to changes in its environment; (2) taking goal-directed initiative (i.e., is pro-active), when appropriate; and (3) learning from its own experience, its environment, and interactions with others.
- Sociability

  The agent is capable of interacting in a peer-to-peer manner with other agents or humans.

Examples of Agents

Agent Type	**Percepts**	**Actions**	**Goals**	**Environment**
Bin-Picking Robot	Images	Grasp objects; Sort into bins	Parts in correct bins	Conveyor belt
Medical Diagnosis	Patient symptoms, tests	Tests and treatments	Healthy patient	Patient & hospital
Excite's Jango product finder	Web pages	navigate web, gather relevant products	Find best price for a product	Internet

Webcrawler Softbot	Web pages	Follow links, pattern matching	Collect info on a subject	Internet
Financial forecasting software	Financial data	Gather data on companies	Pick stocks to buy & sell	Stock market, company reports

How to Evaluate an Agent's Behavior/Performance?

- Rationality => Need a performance measure to say how well a task has been achieved. An ideal rational agent should, for each possible percept sequence, do whatever actions will maximize its performance measure based on (1) the percept sequence, and (2) its built-in and acquired knowledge. Hence includes information gathering, not "rational ignorance."
- Types of objective performance measures: false alarm rate, false dismissal rate, time taken, resources required, effect on environment, etc.
- Examples: Benchmarks and test sets, Turing test (there is no homunculus!)

Approaches to Agent Design

1. **Simple Reflex Agent**
    - Table lookup of percept-action pairs defining all possible condition-action rules necessary to interact in an environment
    - Problems
        - Too big to generate and to store (Chess has about 10^{120} states, for example)
        - No knowledge of non-perceptual parts of the current state
        - Not adaptive to changes in the environment; requires entire table to be updated if changes occur
        - Looping: Can't make actions conditional
2. **Reflex Agent with Internal State**
    - Encode "internal state" of the world to remember the past as contained in earlier percepts
    - Needed because sensors do not usually give the entire state of the world at each input, so perception of the environment is captured over time. "State" used to encode different "world states" that generate the same immediate percept.

- Requires ability to represent change in the world; one possibility is to represent just the latest state, but then can't reason about hypothetical courses of action
- Example: Rodney Brooks's Subsumption Architecture
  Main idea: build complex, intelligent robots by decomposing behaviors into a hierarchy of skills, each completely defining a complete percept-action cycle for one very specific task. For example, avoiding contact, wandering, exploring, recognizing doorways, etc. Each behavior is modeled by a finite-state machine with a few states (though each state may correspond to a complex function or module). Behaviors are loosely-coupled, asynchronous interactions.

3. **Goal-Based Agent**
   - Choose actions so as to achieve a (given or computed) goal= a description of a desirable situation
   - Keeping track of the current state is often not enough--- need to add goals to decide which situations are good
   - Deliberative instead of reactive
   - May have to consider long sequences of possible actions before deciding if goal is achieved--- involves consideration of the future, "what will happen if I do...?"
4. **Utility-Based Agent**
   - When there are multiple possible alternatives, how to decide which one is best?
   - A goal specifies a crude distinction between a happy and unhappy state, but often need a more general performance measure that describes "degree of happiness"
   - Utility function U: State --> Reals indicating a measure of success or happiness when at a given state
   - Allows decisions comparing choice between conflicting goals, and choice between likelihood of success and importance of goal (if achievement is uncertain)