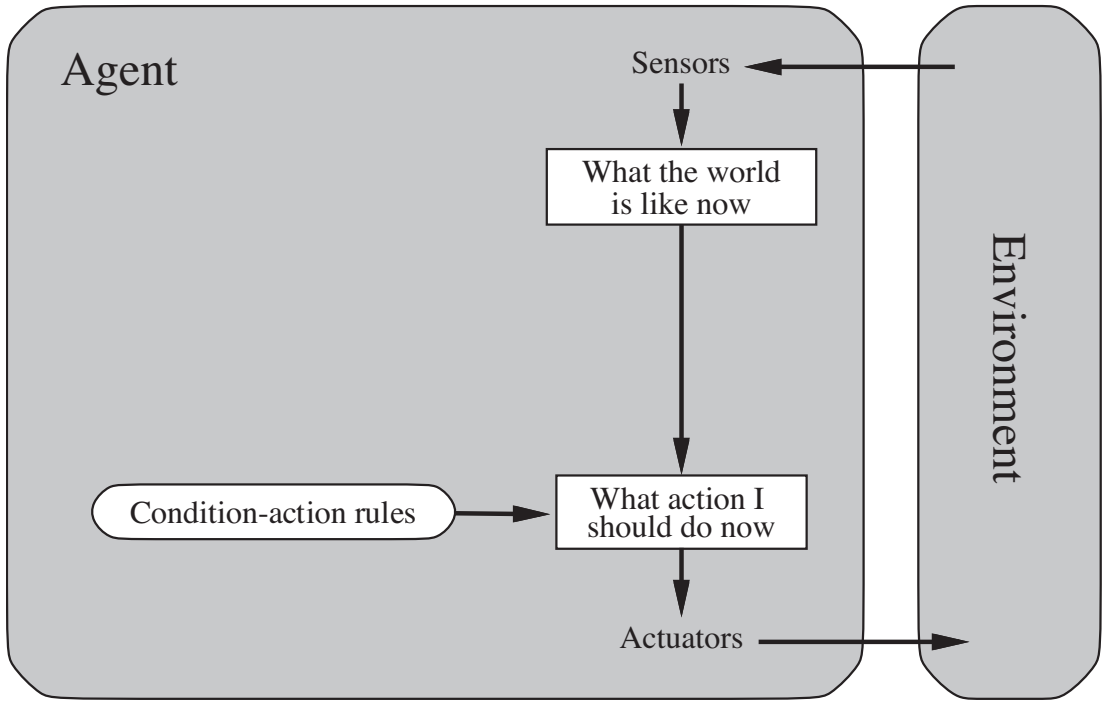
Agent types

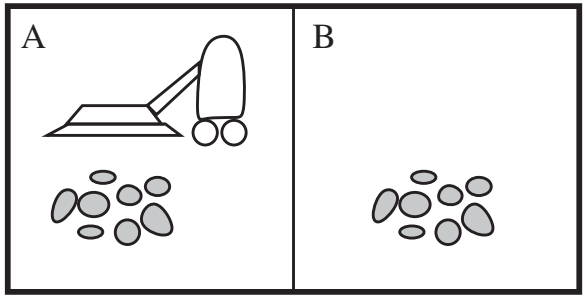
- Four basic types in order of increasing generality:
  - Simple reflex agents
  - Model-based reflex agents
  - Goal-based agents
  - Utility-based agents
- All of which can be generalized into learning agents that can improve their performance and generate better actions.

Simple reflex agents

- Simple reflex agents select an action based on the current state only ignoring the percept history.
- Simple but limited.
- Can only work if the environment is fully observable, that is the correct action is based on the current percept only.



Vacuum (reflex) agent



- Let's write the algorithm for the Vacuum cleaner...
- Percepts: location and content (location sensor, dirt sensor).
- Actions: Left, Right, Suck, NoOp

Percept	**Action**
[A, clean]	Right
[A, dirty]	Suck
[B, clean]	Left
[B, dirty]	Suck

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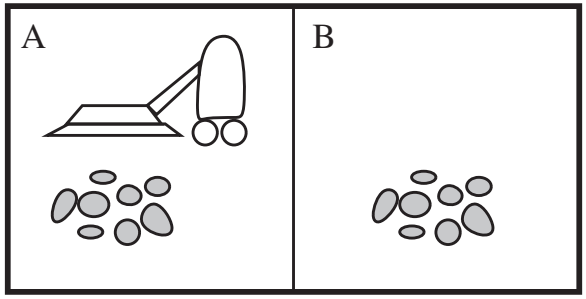

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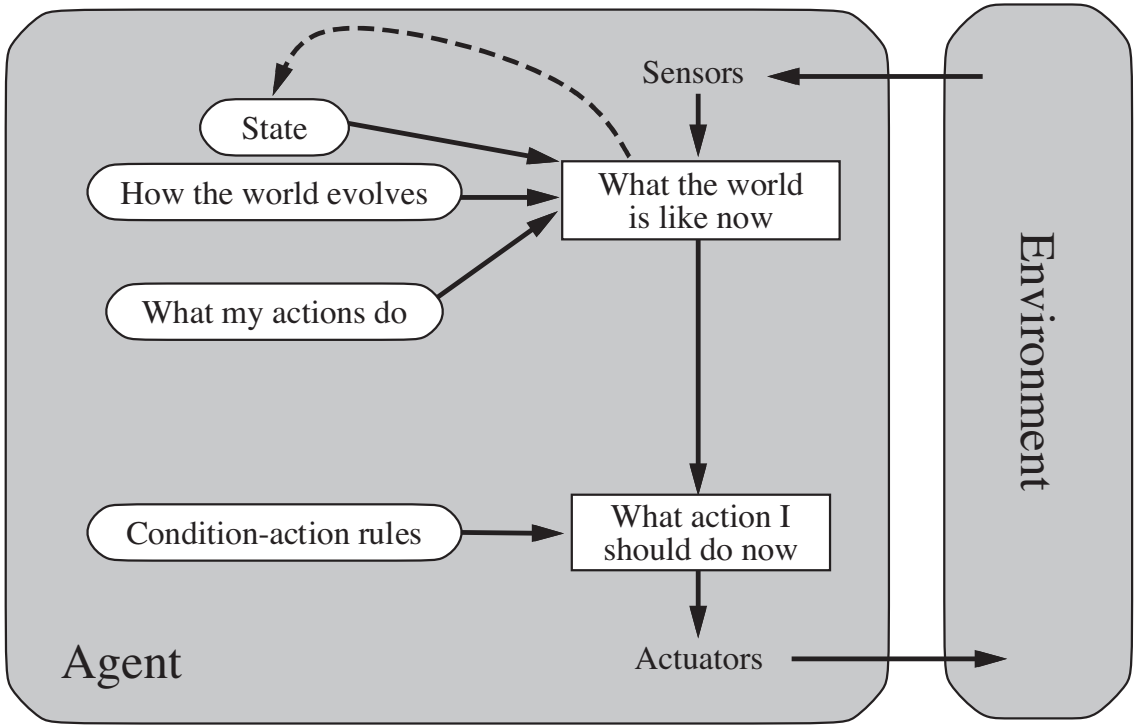
[B, clean]	Left
[B, dirty]	Suck

What if the vacuum agent is deprived from its location sensor?

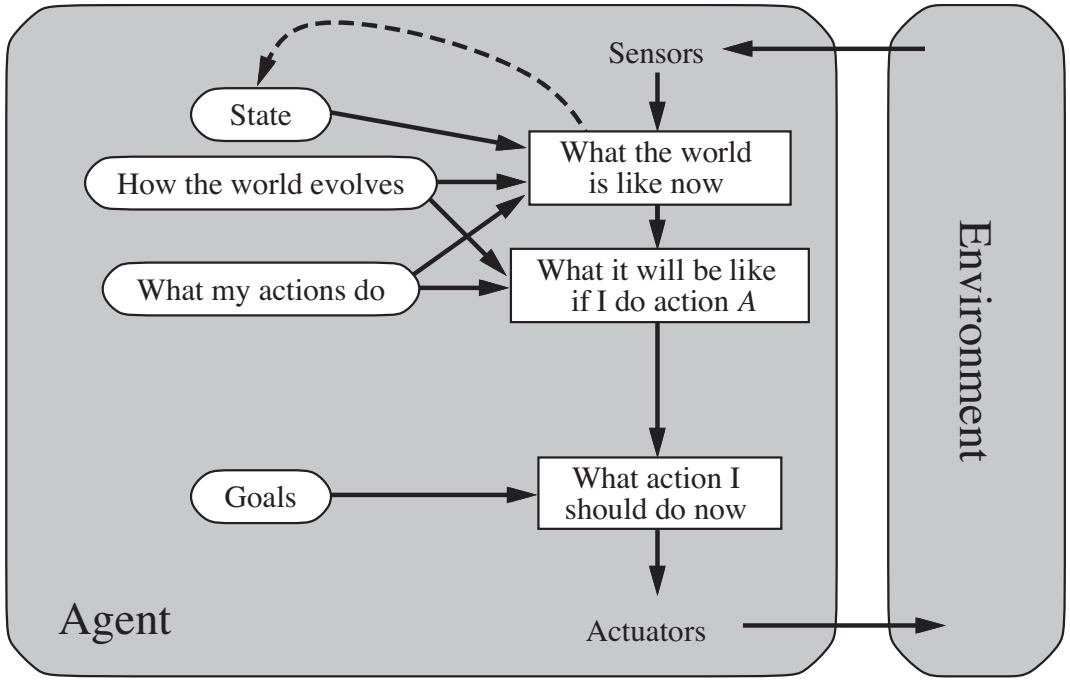
Model-based reflex agents

- Handle partial observability by keeping track of the part of the world it can't see now.
- Internal state depending on the percept history (best guess).
- Model of the world based on (1) how the world evolves independently from the agent, and (2) how the agent actions affects the world.



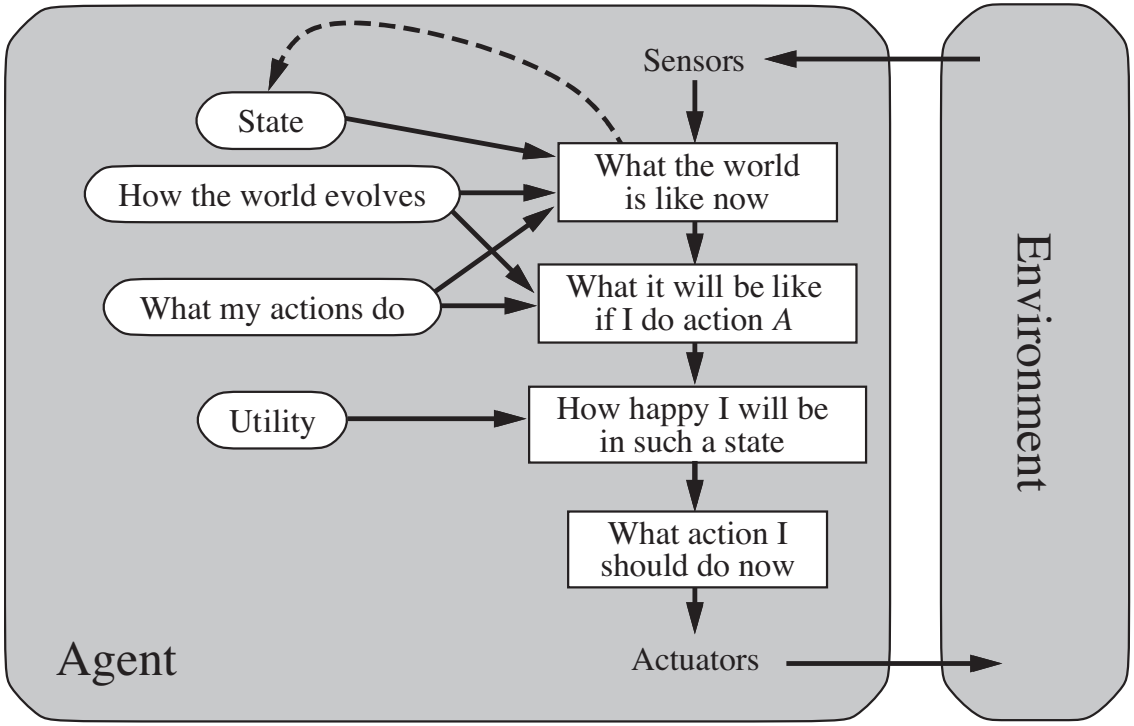
Goal-based agents

- Knowing the current state of the environment is not enough. The agent needs some goal information.
- Agent program combines the goal information with the environment model to choose the actions that achieve that goal.
- Consider the future with "What will happen if I do A?"
- Flexible as knowledge supporting the decisions is explicitly represented and can be modified.



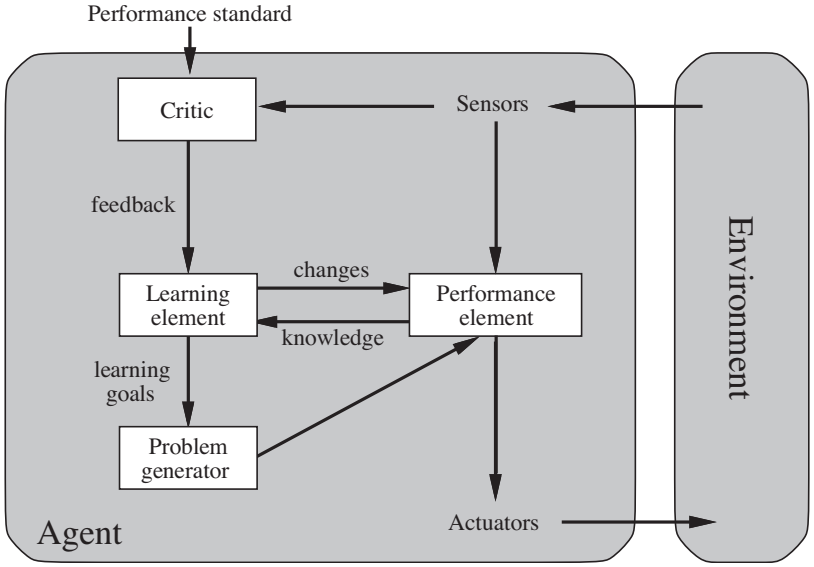
Utility-based agents

- Sometimes achieving the desired goal is not enough. We may look for quicker, safer, cheaper trip to reach a destination.
- Agent happiness should be taken into consideration. We call it utility.
- A utility function is the agent's performance measure
- Because of the uncertainty in the world, a utility agent choses the action that maximizes the expected utility.



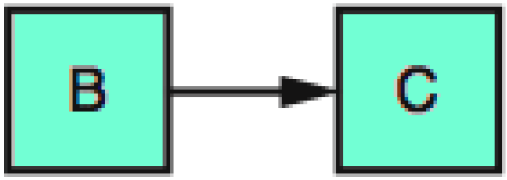
Learning agents

- Programming agents by hand can be very tedious. "Some more expeditious method seem desirable" Alan Turing, 1950.
- Four conceptual components:
  - Learning element: responsible for making improvements
  - Performance element: responsible for selecting external actions. It is what we considered as agent so far.
  - Critic: How well is the agent is doing w.r.t. a fixed performance standard.
  - Problem generator: allows the agent to explore.



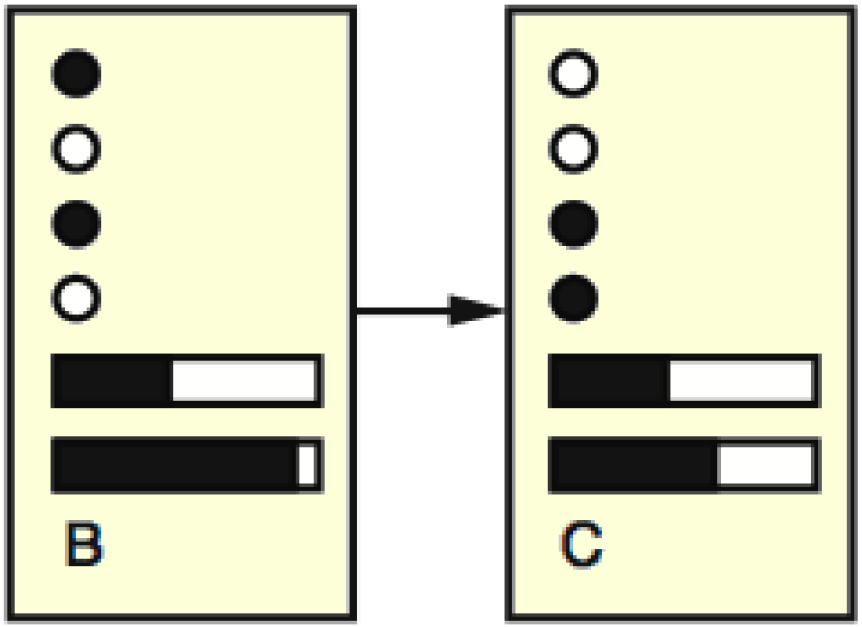
Agent's organization

a) Atomic Representation: Each state of the world is a **black-box** that has no internal structure. E.g., finding a driving route, each state is a city. AI algorithms: search, games, Markov decision processes, hidden Markov models, etc.



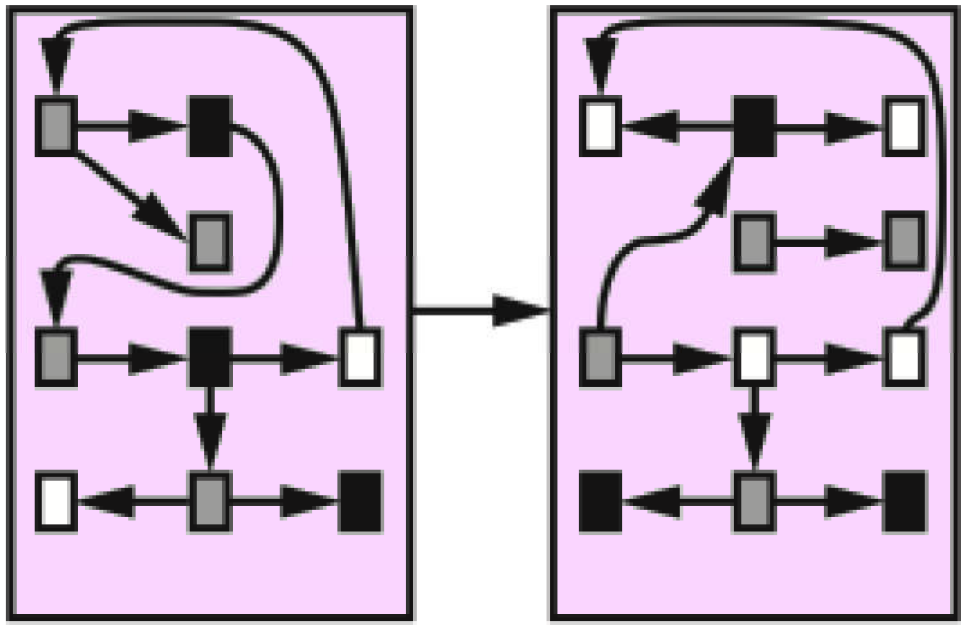
Agent's organization

b) Factored Representation: Each state has some **attribute-value properties**. E.g., GPS location, amount of gas in the tank. AI algorithms: constraint satisfaction, and Bayesian networks.



Agent's organization

c) Structured Representation: Relationships between the objects of a state can be explicitly expressed. AI algorithms: first order logic, knowledge-based learning, natural language understanding.



Intelligent agents

- The concept of intelligent agent is central in AI.
- AI aims to design intelligent agents that are useful, reactive, autonomous and even social and pro-active.
- An agent perceives its environment through percept and acts through actuators.
- A performance measure evaluates the behavior of the agent.
- An agent that acts to maximize its expected performance measure is called a rational agent.
- PEAS: A task environment specification that includes Performance measure, Environment, Actuators and Sensors.

Agent = Architecture + Program

Intelligent agents

- Four types of agents: Reflex agents, model-based agents, goal-based agents, and utility-based agents.
- Agents can improve their performance through **learning**.
- This is a high-level present of agent programs.
- States representations: atomic, factored, structured. Increasing expressiveness power.

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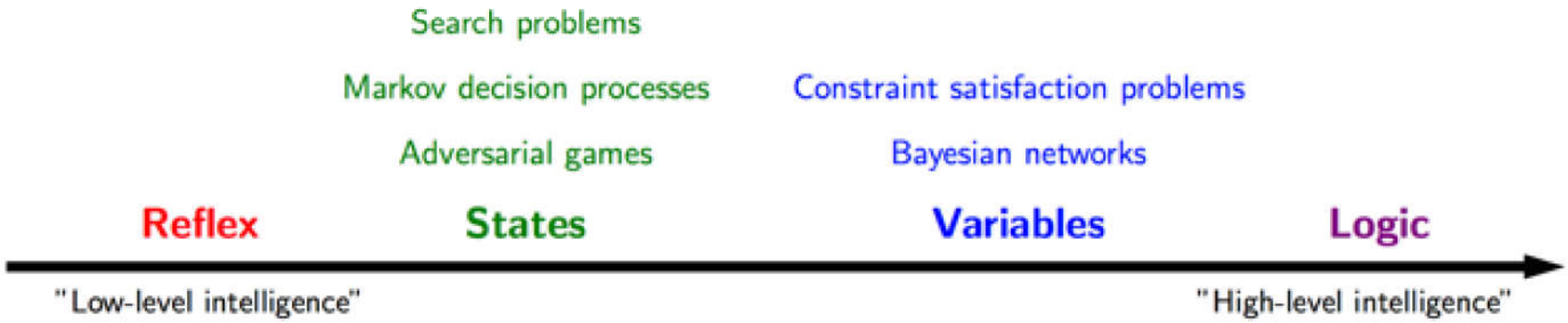

Credit: Courtesy Percy Liang

Credit

- Artificial Intelligence, A Modern Approach. Stuart Russell and Peter Norvig. Third Edition. Pearson Education.

http://aima.cs.berkeley.edu/