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Master programmes in Artificial Intelligence 4 Careers in Europe

University of Ruse “Angel Kanchev”

MULTIAGENT SYSTEM WITH ARTIFICIAL INTELLIGENCE

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ARTIFICIAL INTELLIGENCE – Agent Oriented Approach

1. Definition
2. Characteristics
3. Rational Agent
4. Agents' Types
5. Environment

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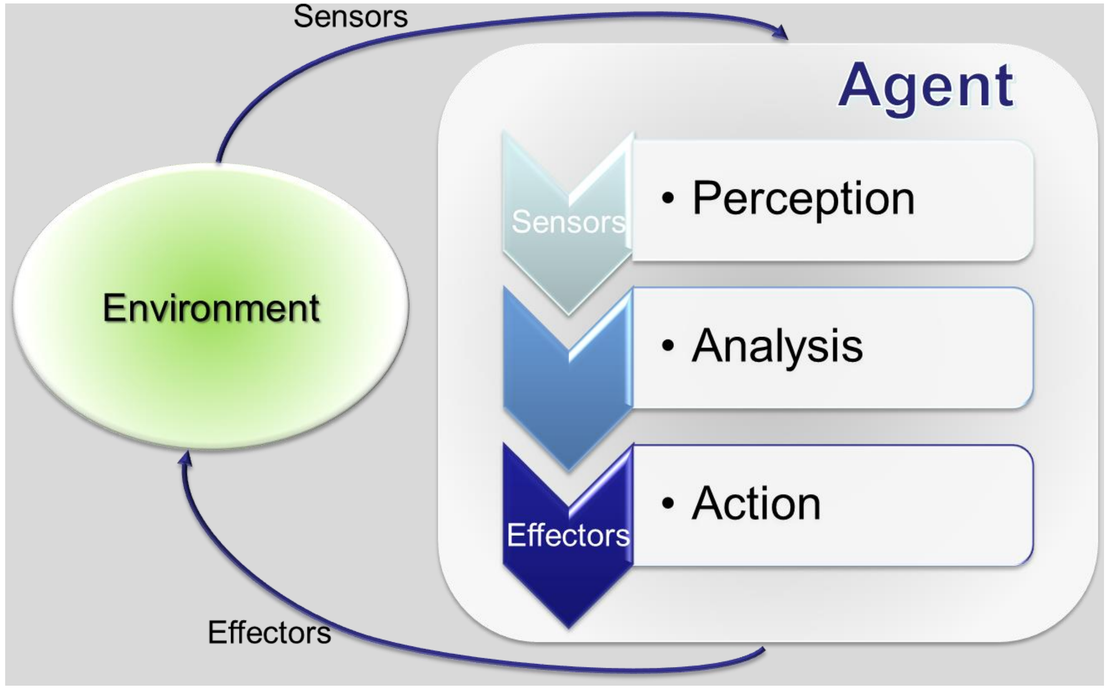
Definition

Intelligent Agent

Intelligent agent - any system that has the ability to perceive the environment through sensors, analyze what is perceived and perform actions in it through effectors

The prototype of on Agent is a Person:

- Person sensors – eyes, ears, skin, tongue, nose, neuromuscular system, etc.;
- Effectors – limbs, eyes, tongue, etc.;
- Perception: at the lowest level – electrical signals; after processing - visual objects, sounds ...
- Analyses – through the brain
- Actions - movement, running, carrying an object...



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Characteristics

Intelligent Agent

Autonomy: the property of the agent to determine its behavior based on accumulated experience (at the expense of built-in knowledge) and to act on its own initiative

Adaptability: ability of the agent to teach oneself in action to respond to changes in the environment and to adapt to those that are permanent to communicate with other agents through some sign system

Mobility: self-directed movement of an agent from one medium to another in a networked environment

Collaboration: working in multi-agent systems involving division of tasks, pooling of results and exchange of knowledge and experience

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Characteristics

Intelligent Agent

Rationality

A rational agent – actions to increase his chance of success

- Consistency of perceptions
- Embedded and acquired knowledge

Involves gathering information

A performance measure is needed to be able to assess such as:

- Default rate;
- Pass Level;
- Speed;
- Required resources...

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Rational Agent

Intelligent Agent

An ideal rational agent - For any conceivable perceptual grouping, a rational agent must be able to select an activity that's anticipated to attain the most extreme result, given the prove given by the perceptual arrangement and anything is implanted within the agent's information

Rational action depends on:

- Performance Measure (Objectives)
- The sequence of perceptions
- Knowledge of the environment
- Possible actions

The ideal rational agent acts according to the function

Percept Sequence x World Knowledge → Action

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Rational Agent

Intelligent Agent

The agent's program - a function realizing the transition from perceptions to actions. The body of the program is a cycle, with each step involving perception, selection, and action

Techniques: knowledge-based reasoning; statistical analysis; fuzzy logic; Neural Networks; evolutionary (genetic) programming, etc.

Architecture: the hardware on which the program works - a regular computer or a specialized device.

⇒ Agent = Architecture + Program

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Agents' Types

Intelligent Agent

Table-driven agent:

- uses a perception / action table to determine its next action;
- are implemented through a lookup table.

The table looks for an optimal variant of a perception/action pair

Problems:

- the table can get very large (chess – 10^{120} states)
- no knowledge of the current state;
- are not adaptable when the environment changes;
- usually requires a lot of time for the designer to define (or train the agent)
- conditional returns to a previous state cannot be performed;
- … practically impossible

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Agents' Types

Intelligent Agent

Common reflex agent

- Uses derived rules of type condition - action
- It obeys rules
- Perceptions must be interpreted
- An example from the field of fire fighting:

  If (tank_is_empty) then return_to_refuge

Problems:

- still too large to generate and store;
- no current status knowledge;
- not adaptable to a changing environment (needs to change or adapt rules)
- cannot make conditional transfers to past states.

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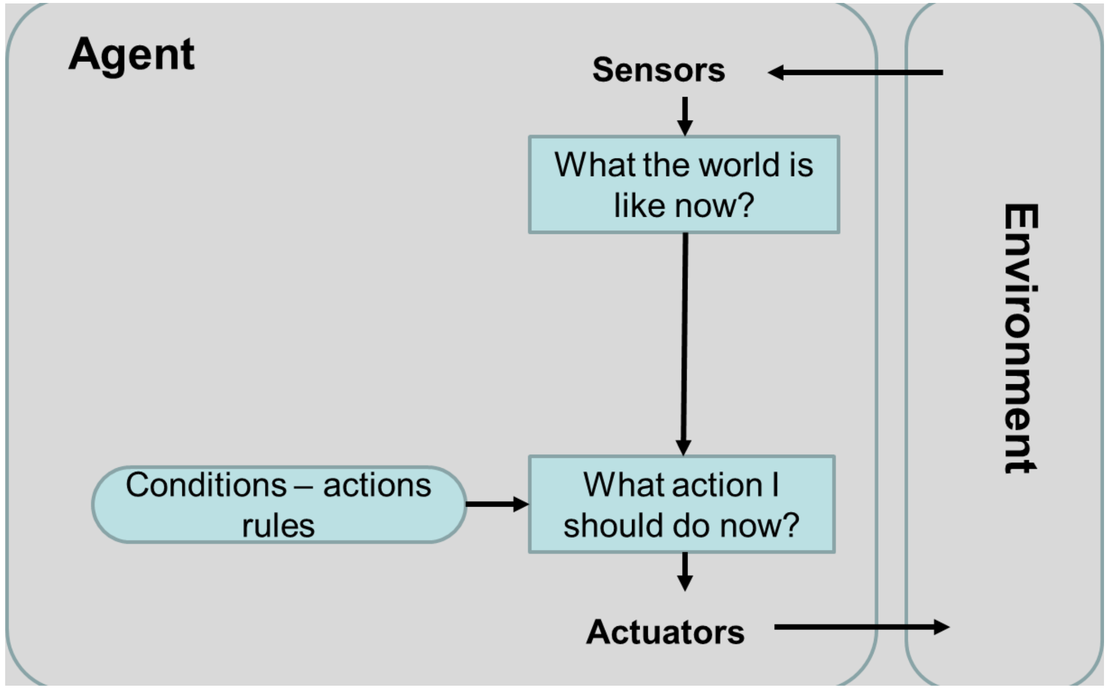
Agents' Types

Intelligent Agent

Schematic diagram of a simple reflex agent. We use rectangles to denote the current internal state of the agent's decision process, and ovals to represent the background information used in the process. (Artificial Intelligence, A Modern Approach. Stuart Russell and Peter Norvig. Fourth Edition. Pearson Education, 2020)



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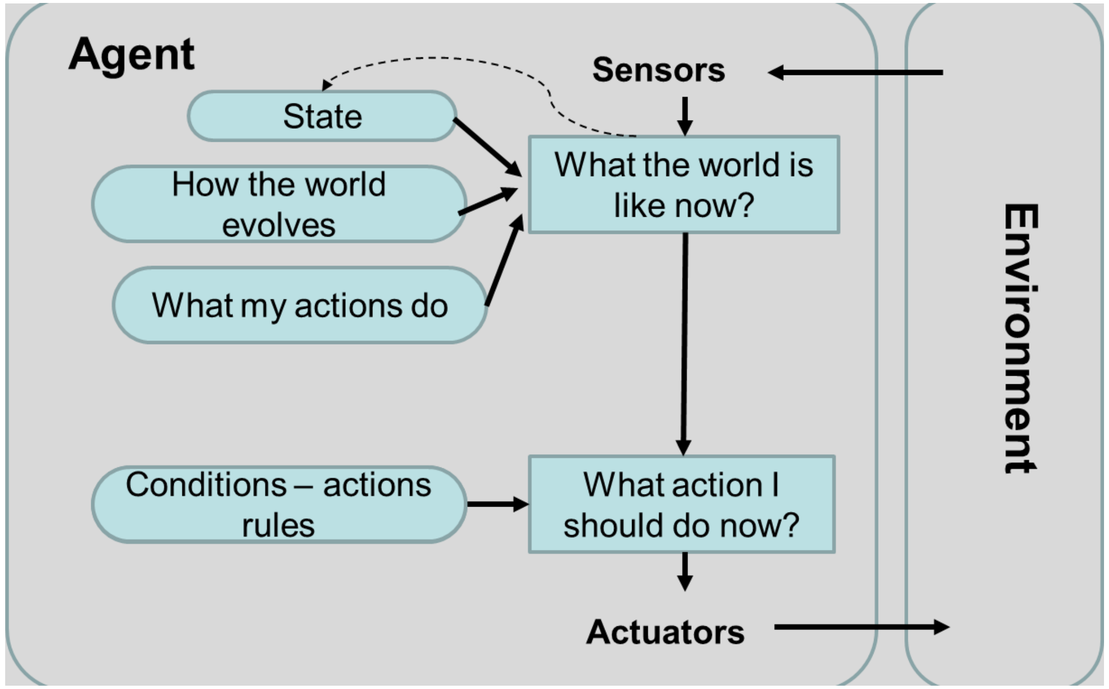
Agents' Types

Intelligent Agent

Model-based reflex agent:

- Updating the internal state representing the perceptual history
- Predicting consequences of actions given the state
- It needs the ability to represent a change in the environment

(Artificial Intelligence, A Modern Approach. Stuart Russell and Peter Norvig. Fourth Edition. Pearson Education, 2020)



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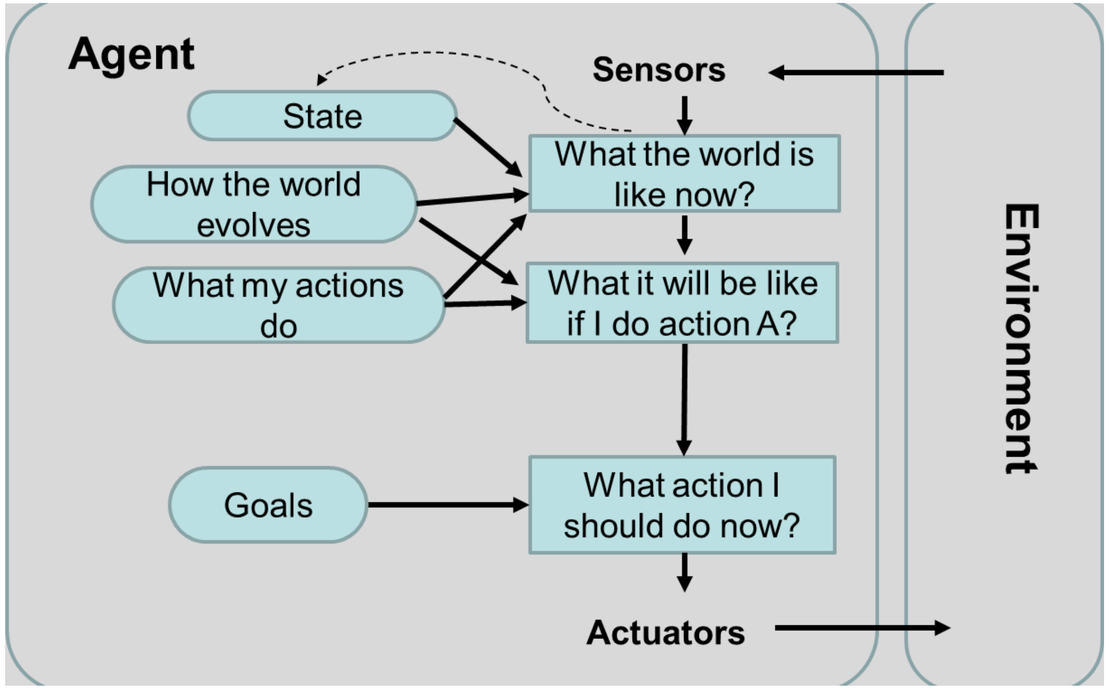
Agents' Types

Intelligent Agent

Model-based, goal-based agent:

- A detailed presentation of the goal - as a desired situation
- Selecting the target with the highest expected applicability (highest chance of being useful)
- Actions are generated by planning to the selected target state
- Analysis of long sequences of possible actions before deciding whether the goal has been achieved (looking into the future, "what will happen if I do ...?")

(Artificial Intelligence, A Modern Approach. Stuart Russell and Peter Norvig. Fourth Edition. Pearson Education, 2020)



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Agents' Types

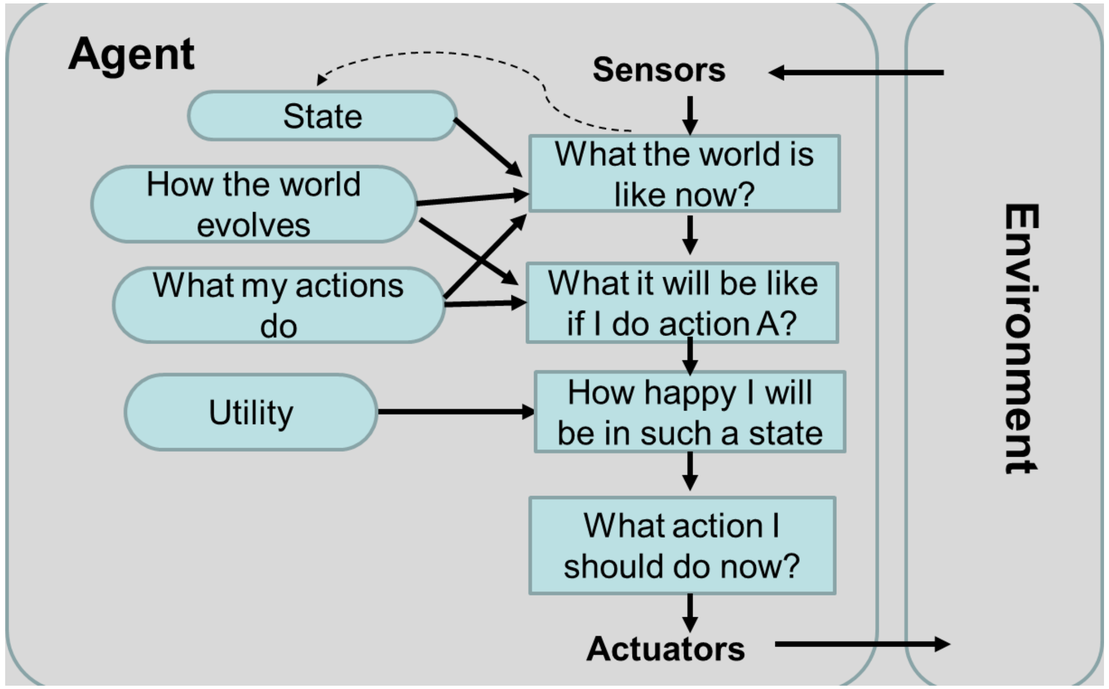
Intelligent Agent

Model-based, utility-based agent:

- How to determine the appropriate course of action given many alternatives
- Applicability function

  U: State → Real number

  - measure of success from a given condition
- Allows decisions comparing choices between conflicting goals and choices between probability of success and goal importance (if achievement is uncertain).



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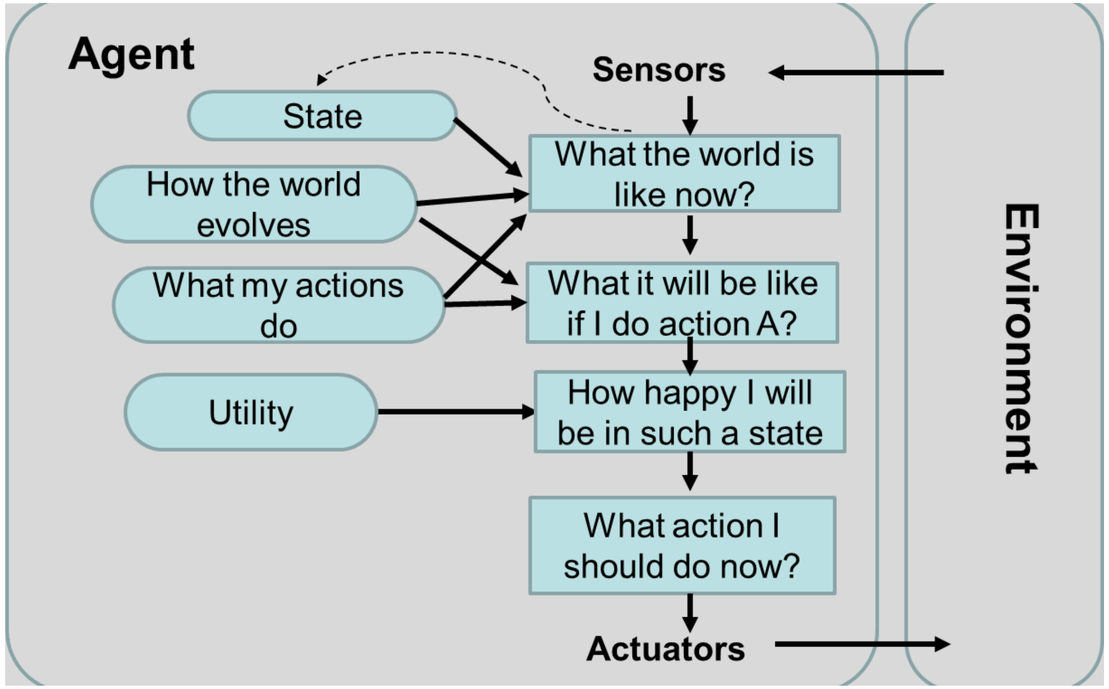
Agents' Types

Intelligent Agent

It uses a model of the world, along with a utility function that measures its preferences among states of the world. Then it chooses the action that leads to the best expected utility, where expected utility is computed by averaging over all possible outcome states, weighted by the probability of the outcome.

(Artificial Intelligence, A Modern Approach. Stuart Russell and Peter Norvig. Fourth Edition. Pearson Education, 2020)



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Environment

Intelligent Agent

The type of the environment could be different, depending on the goal, situation etc.

The Environment's types are:

- ***Accessible / Inaccessible*** (fully observable or partially observable) - Are relevant aspects of the environment available to the sensors?
- ***Deterministic / stochastic*** - Is the next state of the environment completely determined by the current state and the chosen action? If only the actions of the other agents are non-deterministic (indeterminate), the environment is called strategic.
- ***Episodic / Resultant (subsequent)*** - Can the quality of an action be assessed in an episode (perception + action) or does future development matter for quality assessment?

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Environment

Intelligent Agent

- ***Static / dynamic*** - Can the environment change while the agent is deliberating? If the environment does not change, but the agent changes its performance over time, the environment is referred to as semi-dynamic.

- ***Discrete / continuous*** - Is the environment discrete (chess) or continuous (a robot moving around a room)?

- ***With / without intelligent opponents*** - they must have information about the strategic, game-theoretic aspects of the environment. In the engineering environments – without; in social and economic systems – with.

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Environment

Intelligent Agent

Task	Accessible	Deterministic	Episodic	Static	Discrete	Agents
Image analysis	Fully	Deterministic	Episodic	Semi	Continuous	One
Parts lifting robot	Partially	Stochastic	Episodic	Dynamic	Continuous	One
Control in a refinery	Partially	Stochastic	Resultant	Dynamic	Continuous	One
Interactive English learning	Partially	Stochastic	Resultant	Dynamic	Discrete	Multi
Taxi driving (self driving car)	No	Stochastic	Resultant	Dynamic	Continuous	Multi

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References

1. Russel, S. and Norvig, P. Artificial Intelligence: A Modern Approach, fourth edition, Pearson, 2022
2. Michael Wooldridge, An Introduction to Multiagent Systems, 2009
3. David Poole, Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, second edition, Cambridge University Press 2017 (Available at https://artint.info/index.html)

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