Artificial Intelligence

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The website at footnote says[1] There are four types of AI

- Narrow AI
- General AI
- Super AI
- Reactive machines
- Limited memory
- Theory of mind
- Self awareness

1 Tools

2 Evolutionary computation

Wikipedia [2]

3 Proposed prespectives

From facebook To verify facebook's view on what are particularities of machine intelligence check Mikolov et al. (2016).

4 Intelligent Agents (IA)

An intelligent agent is an autonomous entity capable of

- performing actions on its environment
- perceiving its environment
- aiming to accomplish a goal

[1] https://theengineeringofconsciousexperience.com/types-of-artificial-intelligence/
[2] https://en.wikipedia.org/wiki/Evolutionary_computation

Rizk et al. (2018) [41]).

It can be a **physical entity such as robots with sensors and actuators** or a **virtual entity such as software agents**. A very good philosophical discussion on IA can be found at Ngobye et al. (2010).

Different types of agents

- simple reflex agents
- model-based reflex agents
- goal-based agents
- utility-based agents
- learning agents

Goal based agents Russell, S.J., Norvig, P.: Artificial Intelligence: A Modern Approach, 2nd edn. Prentice Hall Press, Upper Saddle River, NJ, USA (2003)

Goal-based agents further expand on the capabilities of the model-based agents, by using "goal" information. Goal information describes situations that are desirable. This allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state. Search and planning are the subfields of artificial intelligence devoted to finding action sequences that achieve the agent's goals Wikipedia (2020).

Ego-thing go-Things are defined as intelligent systems that perceive their internal parameters and adapt them- selves when facing non-stationary situations. Kanapram et al. (2019)[5]

Qualities of a self-aware IA (see document on self-awareness) Must implement well the following characteristics from self awareness point of view which are core capabilities of agents operating in highly dynamic, interactive, and uncertain environments in order to achieve reasonable autonomy.

- initialization
- inference
- anomaly detection
- model creation
- interface with control

However, genuine autonomous systems are required to fulfill a variety of system properties, including efficiency (minimizing the resource consumption), security (protecting against threads), and safety (operating in conformance with requirements).

Brain in an IA Agents **communicate** with each other, and **make decisions** on their own in order to achieve their individual as well as collective goals. To this end they are equipped with a 'brain' (Ciprich et al., 2008).

Self-awareness self-awareness (SA) is a capability of an autonomous system to describe the acquired experience about itself and its surrounding environment with appropriate models and correlate them incrementally with the currently perceived situation to expand its knowledge continuously. At a rather abstract level, SA can be defined as the capacity to become the object of one's own attention, which arises when an agent focuses not only on the external environment but also on the internal milieu. Regazzoni et al. (2020). Private self-aspects relate to externally unobservable events and characteristics such as emotions, physiological sensations, perceptions, values, goals, and motives, whereas public self-aspects are visible attributes such as behavior and physical appearance.

Belief-Desire-Intentions (BDI)-like definition A well-known agent theory is the Belief-Desire-Intentions (BDI) framework that was first proposed by Bratman (Bratman, 1999).

BDI describes **beliefs** as the representation of the agent's **knowledge** about the **current world/environment** and **messages from other agents** as well as the internal information. **Desires** represent a state that the agent is trying to achieve and 'intentions' are the chosen means to achieve the agent's desires, generally implemented as plans. Thus, an agent is characterised by its beliefs, goals (desires), and intentions – it will intend to do what it believes will achieve its goals given its beliefs about the world. Additional to these three components, a BDI agent is usually assumed to have a plan library – a set of "plans as recipes" that it can use to achieve particular goals given particular preconditions. Figure Bratman (1999) - 1.

Roles of an IA An intelligent agent exhibits the fundamental properties of Rizk et al. (2018) [42]

- perception
- reasoning
- learning
- decision making
- problem solving
- interaction
- communication

Evaluation It is evaluated based on its (Rizk et al. (2018) [42])

- solution optimality
- generality
- robustness
- efficiency
- autonomy
- ability to learn and improve

categorization based on underlying architecture Rizk et al. (2018) [41]

- simple reflex agents: react to current sensory input only
- model-based reflex agents: keep an internal state of the environment
- goal-based agents: perform actions that lead to accomplishing their goals
- utility-based agents: maximize their utility

Policy A function that maps status to an action in an IA(Intelligent agent) action. A policy is **optimal** if it has the highest utility (Rizk et al., 2018).

5 Swarm intelligence(SI)

(-¿multi-agent systems)

6 Decision making/planning

Multi-agent systems To see its application in multi-agent systems see muti-agent systems decision making section

Robotics See robotics section decision making

6.1 General

Decision making is planning and control. It enables an agent to accomplish its goals by determining what action to perform. Rizk et al. (2018). It determines the sequence of actions, or policy, that agents should perform to complete their assigned task once the complex tasks have been decomposed to sub-tasks and allocated to cooperating groups of agents.

Episodic :

- Episodic decision making: Output is a single action
- Sequential decision making: Output is a sequence of actions or policy
  - Finite horizon: implies that decisions need to be made for a finite number of time steps
  - Infinite horizon: problems last forever.

Categorization depends on the decision making algorithm's instigator

- reactive: react to environmental changes
- deliberative: initiate actions without external triggers
- hybrid: can react to the environment or initiate actions based on their planning algorithm.

Evaluation Rizk et al. (2018)

- policy optimality: A policy is optimal if it has the highest utility
- search completeness: A search algorithm is complete if it guarantees to return an optimal policy in finite time, when it exists.
- time complexity: Time complexity quantifies the amount of time needed to search for a solution
- space complexity: quantifies the amount of computational memory needed.

6.1.1 Reinforcement Learning

RL allows agents to learn a policy by rewarding "good" behavior and punishing "bad" behavior through a reward signal.

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