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New directions for artificial intelligence: human, machine, biological, and quantum intelligence

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Motivation

1. Despite the great progress made in theoretical research of artificial intelligence (AI) in recent decades, there is a need to outline a theoretical system and scientific classification to guide research and development (R&D) in AI. There is an opportunity to develop a framework to complement the theoretical system to guide the direction of R&D, while avoiding uneven development.

2. The comparison of “once learning” to “one-shot learning” and “you only look once” (YOLO) is made to establish “once learning mechanism” to simulate human’s behavior “once seen, never forgotten” (in Chinese: 过目不忘).

Four types of AI

1. Artificial human intelligence (AHI) focuses on the development of human-like learning, human-like robots, and other human-oriented AI.

2. Artificial machine intelligence (AMI) focuses on the development of machine learning (ML), machine-like robots, and other machine-oriented AI.

3. Artificial biological intelligence (ABI) focuses on the realization of bio-inspired learning, bio-robots, and other biological oriented AI.

4. Artificial quantum intelligence (AQI) focuses on the quantum generalizations of AI and the development of new methods of quantum AI.

Classification standards

The classification standards and methods to distinguished AI branches are as follows:

(1) human-, machine-, biological-, and quantum-oriented AI R&D;

(2) information input processed by dimension increase or reduction;

(3) the use of one/a few or a large number of samples for knowledge learning.

Summary of the classifiers

AI can be divided into the following basic theory categories: ABI, AHI, AMI, and AQI.

Table 3 Summary of the classifiers of AI

Topic	ABI	AHI	AMI	AQI
AI object	Biological-oriented	Human-oriented	Machine-oriented	Quantum-oriented
Learning	Heuristic	Human-like	ML/DL	Quantum learning
Robotics	Bio-robots	Human-like	Machine-like	Quantum-like
Input	Dimensionality increase		Dimensionality reduction	
Sample	Few data		Big data	
Knowledge	+Symbolic		+Numeric	

Insights

1. Although the motivations and purposes differ from those of “once learning,” “one-shot learning,” and YOLO, the first step of the information input process of these three approaches follows the “once learning” mechanism (OLM).

2. “Once learning” is limited to the planar graph and text learning of two-dimensional information, but it can be extended to multi-dimensional information.

3. The parallel learning mechanism of “once learning” has been proposed for quantum computing. Some scholars have made promising progress on this topic.

Summary and future directions

Some standards and classification methods are discussed here, including the object of research, scale of input samples, and dimension increase or reduction.

In future research, it is imperative to discuss the following topics:

(1) classification standards;

(2) classification methods;

(3) development plans for each branch of AI;

(4) AI concepts and sub-branch extensions.

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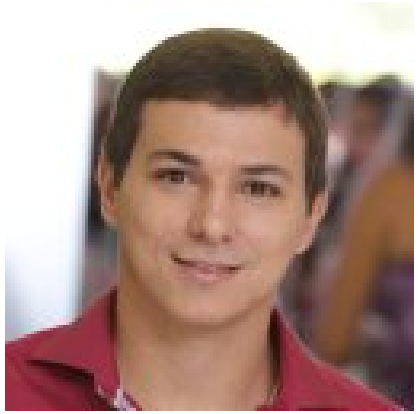

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