[EPS EDITORIAL]

The 2024 Nobel Prize in Physics

The Nobel prize in Physics 2024 has been awarded to John Joseph Hopfield and Geoffrey Hinton *"for foundational discoveries and inventions that enable machine learning with artificial neural networks"* (ANNs). John Joseph Hopfield created an associative memory that can store and reconstruct patterns in data. Geoffrey Hinton invented a method that can autonomously find properties in data.

Artificial neural networks are at the core of Artificial Intelligence (AI) which has recently invaded many aspects of our lives, from pure science to TV adverts for all kinds of products. This rapid expansion of AI raises several questions.

The simplest one concerns the attribution of the Nobel prize to Physics. The enormous implications of the use of machine learning reach many other fields beyond Physics. The decision of the Nobel committee is based on the fact that "physics has been a driving force underlying inventions and development of ANNs (see https://www.nobelprize.org/uploads/2024/11/advanced-physicsprize2024-3.pdf for a detailed description). John Joseph Hopfield invented the Hopfield network, that describes a material's characteristics due to its atomic spin. Geoffrey Hinton used tools from statistical physics to create the Boltzmann machine, which can learn to recognise characteristic elements in a set of data.

A much more difficult question is the evaluation of the impact of AI on our lives, and the level of acceptance we should have. By delegating decisions to a machine, we may risk a loss of control. This dilemma is not new: going back for example to "2001: A Space Odyssey" (Arthur C. Clarke and the Stanley Kubrick movie) you might decide not to adopt decisions made by a machine. On the contrary, if you play chess, you will appreciate that a machine can beat a world champion (Deeper Blue 1997, not yet based on ANN's, and the recent and extremely efficient AlphaZero). Nowadays AI has already colonised a wide range of domains from protein design to healthcare (diagnosis as well as robotic surgery), automatised text or image analysis and production, car driving or finance. AI can even reach silver-medal standard in solving International Mathematical Olympiad problems.

A major public event was the recent advent of Large Language Models (like ChatGPT, Gemini, Claude Copilot, Perplexity, Jasper, ...) giving free access to artificial intelligence to everyone with a web browser. This allowed anyone to measure the extraordinary prowess of the machines. Teachers now must check that homework submitted by their students was indeed their own work, and not machine produced. Teachers might as well ask the machine to prepare the exam questions. Incidentally, this editorial could have been written by a machine (it was not).

The generalised use of AI will affect an enormous number of jobs. This change is as important as the industrial revolution, and some control is necessary, but not easy to implement. Recently, Geoffrey Hinton quit his role at Google so he could speak more freely about the dangers of the technology he helped create.

Another question, probably more philosophical but of fundamental importance for scientists, is "can a machine create?" It is interesting to notice two wordings that are used: machine learning and artificial intelligence. Most of the successful results already obtained come from data analysis, that is to say from existing knowledge. This is machine learning. Artificial intelligence sounds more ambitious. What is true is that a machine can detect (or help to detect) patterns much faster than our brains, but the question is then where is imagination/invention?

Last but not least one aspect should be mentioned: artificial intelligence is an energy glutton, much less energy efficient than our brains. In this aspect, scientific research and progress is necessary.

Whatever our feelings are towards the impact of ANN's on our society, congratulations to the Nobel Prize laureates John Joseph Hopfield and Geoffrey Hinton. ■

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