

# Nobel Prize in Physics 2024 awarded to John J. Hopfield, Geoffrey E. Hinton for discoveries that enable machine learning

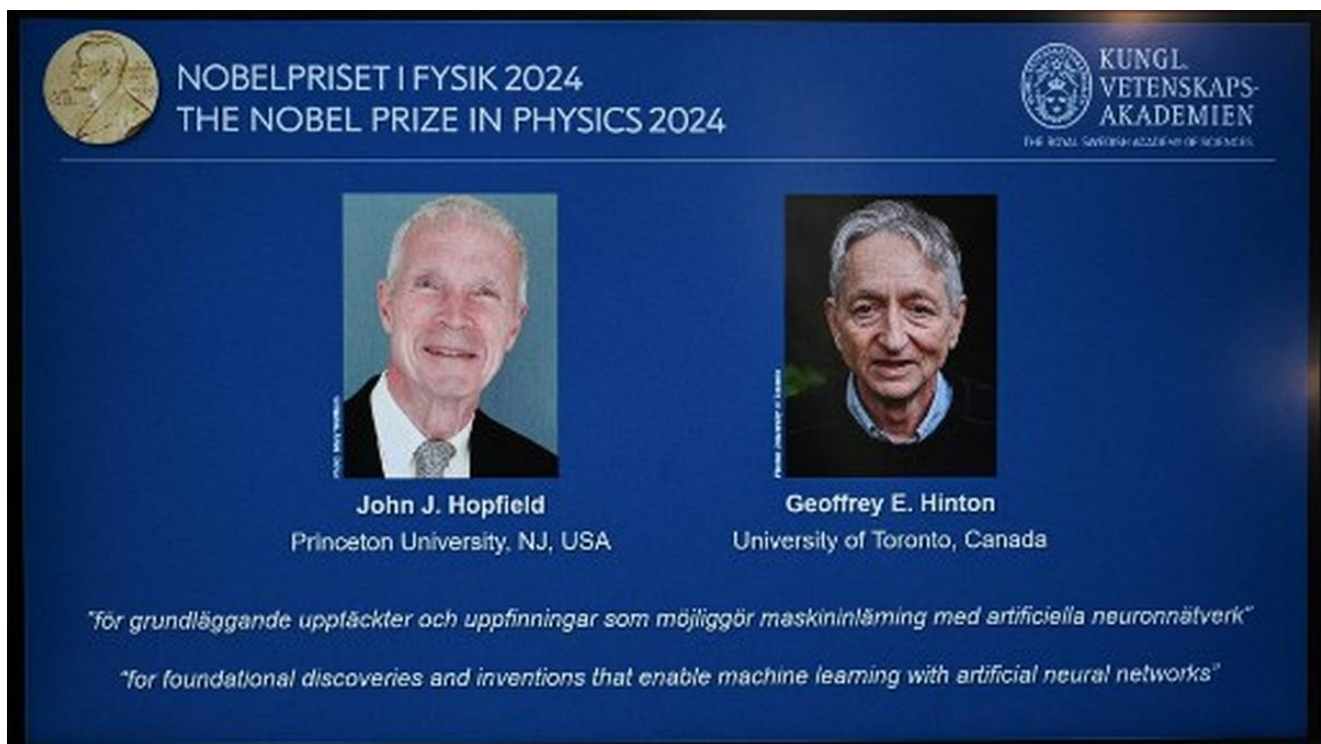
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**The laureates' work has been used to solve problems in physics, chemistry, biology, medicine, finance, and health**

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Vasudevan Mukunth



A screen shows the laureates of the 2024 Nobel Prize in Physics, U.S. physicist John J Hopfield and Canadian-British computer scientist and cognitive psychologist Geoffrey E Hinton, during the announcement by the Royal Swedish Academy of Sciences in Stockholm, Sweden on October 8, 2024. | Photo Credit: AFP

The 2024 Nobel Prize in physics has been awarded to John Hopfield and Geoffrey Hinton "for foundational discoveries and inventions that enable machine learning with artificial neural networks," the Royal Swedish Academy of Sciences announced on Tuesday (October 8, 2024).

While many areas of research have used machine learning (ML) models and artificial neural networks (ANNs) to process data, these terms have entered the household thanks to the explosion of chat AI apps, including OpenAI's ChatGPT.

ANNs are collections of neurons, or more broadly nodes capable of processing data, connected to each other in specific ways. A connection between two neurons allows information to flow between them. In a recurrent neural network, information can flow both ways.

Hopfield, a professor at Princeton University in the U.S., is credited with developing the Hopfield network, a type of recurrent neural network. Its neurons learn and process information based on Hebbian learning — an idea in neuropsychology that if one neuron repeatedly triggers a second, the connection between the two becomes stronger.

Did you know that an artificial neural network is designed to mimic the brain?

Inspired by biological neurons in the brain, artificial neural networks are large collections of "neurons", or nodes, connected by "synapses", or weighted couplings, which are trained to perform... [pic.twitter.com/r0SgLdW8Ca](https://pic.twitter.com/r0SgLdW8Ca)

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The rules of a Hopfield network are based on the physics of a group of atoms, each producing its own small magnetic field. The processes the network performs to complete an incomplete pattern or to denoise an image are the same ones that, by analogy, would reduce the total energy of the magnetic atoms.

“In his 1982 paper, Hopfield asked a basic question about the ability of a large collection of simple neurons to form computational tasks as a spontaneous collective or emergent phenomenon,” Spenta Wadia, founding director of the International Centre for Theoretical Sciences, Bengaluru, said.

“He analysed this in a model system which included biological ingredients. The paper laid the foundation of the use of statistical physics methods and ideas in neural circuit modelling.”

Hinton, a professor at the University of Toronto, and his peers adapted another network called the Boltzmann machine to perform cognitive tasks, building on the principles of the Hopfield network among others.

He made a breakthrough in the 2000s by developing a learning algorithm for a modified ANN called a restricted Boltzmann machine (RBM). A layer of neurons could be trained as an RBM and multiple layers could be stacked, creating the first ANNs capable of deep learning.

This work has had “amazing success for a large number of applications to physics, chemistry, biology, medicine, finance, health and many other areas,” Prof. Wadia said.

Last year, the physics Nobel Prize was awarded to Pierre Agostini, Ferenc Krausz, and Anne L’Huillier for their help developing attophysics.

The 2024 physics prize follows the announcement of the physiology/medicine prize on October 7, to Victor Ambros and Gary Ruvkun for the discovery microRNA and opening the door to the world of post-transcriptional gene regulation.

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