The Nobel Prize in Physics 2024

8 October 2023.

The Nobel Prize Committee

Announced that the 2024 Nobel Prize in Physics

Is awarded jointly to

John J. Hopfield and Geoffrey E. Hinton

for "pioneering work in the development of Artificial Intelligence".

Description

John Hopfield of Princeton University and Geoffrey Hinton of the University of Toronto both did their crucial work in the early 1980s, at a time when computer hardware was unable to take full advantage of it. Dr Hopfield was responsible for what has become known as the Hopfield network—a type of artificial neural network that behaves like a physical structure called a spin glass, which gave the academy a tenuous reason to call the field "physics". Dr Hinton's contribution was to use an algorithm known as backpropagation to train neural networks.

Artificial neural networks are computer programs based loosely on the way in which real, biological networks of nerve cells are believed to work. In particular, the strengths of the connections (known as weights) between "nodes" (the equivalent of neurons) in such networks are plastic. This plasticity grants a network the ability to process information differently in response to past performance; or, in other words, to learn. **Hopfield networks**, in which each node is connected to every other except itself, are particularly good at learning to extract patterns from sparse or noisy data.

Dr Hinton's algorithm turbocharged neural networks' learning ability by letting them work, in effect, in three dimensions. Hopfield networks and their ilk are, in essence, two-dimensional. Though they actually exist only as simulations in software, they can be thought of as physical layers of nodes. Stack such layers on top of one another, though, and train them by tweaking the weights as signals move both backward and forward between the layers (i.e, back-propagated as well as forward-propagated) and you have a much more sophisticated learning system.

Dr Hinton also, for good measure, tweaked Dr Hopfield's networks using a branch of maths called statistical mechanics to create what are known as Boltzmann machines. (Statistical mechanics, which underlies modern understanding of the second law of thermodynamics, was invented by Ludwig Boltzmann, a near contemporary of Alfred Nobel.) Boltzmann machines can be used to create systems that learn in an unsupervised manner, spotting patterns in data without having to be explicitly taught.

It is, then, the activities of these two researchers which have made machine learning really sing. AI models can now not only learn, but create (or, for sceptics, reorganise and regurgitate in a most sophisticated manner). Such tools have thus gone from being able to perform highly specific tasks, such as recognising cancerous cells in pictures of tissue samples or streamlining particle-physics data, to anything from writing essays for lazy undergraduates to running robots.

Possible Applications

Thanks to their work from the 1980s and onward, John Hopfield and Geoffrey Hinton have helped lay the foundation for the machine learning revolution that started around 2010.

In recent years, this technology has also begun to be used when calculating and predicting the properties of molecules and materials – such as calculating protein molecules' structure, which determines their function, or working out which new versions of a material may have the best properties for use in more efficient solar cells.

Prize amount:

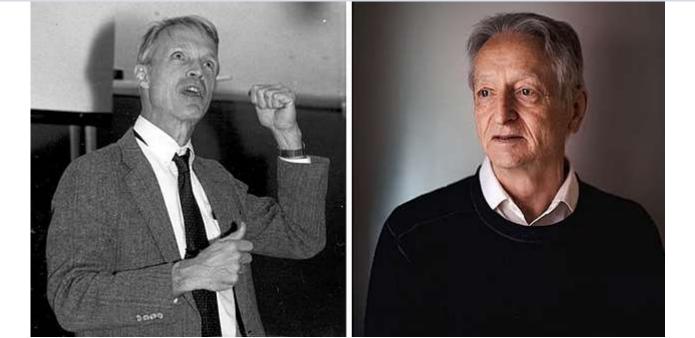11 million Swedish kronor, to be shared equally between the Laureates.

About the Winners

John J. Hopfield, born 1933 in Chicago, IL, USA. PhD 1958 from Cornell University, Ithaca, NY, USA. Professor at Princeton University, NJ, USA.

Geoffrey Hinton, born 1947 in London, UK. PhD 1978 from The University of Edinburgh, UK. Professor at University of Toronto, Canada.

left: John Hopfield right: Dr. Geoffrey Hinton

Previous Winners of the Nobel Prize in Physics

- **2023** - Anne L'Huillier, Pierre Agostini and Ferenc Krausz for producing pulses of light so short (measured in attoseconds) that can be used to capture and study rapid processes inside atoms.

- **2022** - Alain Aspect, American John Clauser and Austrian Anton Zeilinger for **research into quantum mechanics** - the science that describes nature at the smallest scales;

- **2021** - Syukuro Manabe, Klaus Hasselmann and Giorgio Parisi were given the prize for **advancing our understanding of complex systems**, such as Earth's climate;

- **2020** - Sir Roger Penrose, Reinhard Genzel and Andrea Ghez received the prize for their **work on the nature of black holes**;

- **2019** - James Peebles, Michel Mayor and Didier Queloz shared the prize for **ground-breaking discoveries about the Universe;**

- **2018** - Donna Strickland, Arthur Ashkin and Gerard Mourou were awarded the prize for their **discoveries in the field of laser physics.**

SAINTS PERSPECTIVES
Things Exceptional (Nobel Prizes)

References

AI researchers receive the Nobel prize for Physics
The Economist, Oct 8th 2024
https://www.economist.com/science-and-technology/2024/10/08/ai-researchers-receive-the-nobel-prize-for-physics

'Godfather of AI' shares Nobel Physics Prize
BBC News, Oct 8, 2024
https://www.bbc.com/news/articles/c62r02z75jyo