

Nobel 2024

The Nobel Prize in Physics 2024



Ill. Niklas Elmehed © Nobel Prize
Outreach

John J. Hopfield

Prize share: 1/2



Ill. Niklas Elmehed © Nobel Prize
Outreach

Geoffrey E. Hinton

Prize share: 1/2

The Nobel Prize in Physics 2024 was awarded jointly to John J. Hopfield and Geoffrey E. Hinton "for foundational discoveries and inventions that enable machine learning with artificial neural networks"

This year's laureates used tools from physics to construct methods that helped lay the foundation for today's powerful machine learning. John Hopfield created a structure that **can store and reconstruct information**. Geoffrey Hinton invented a method that **can independently discover properties in data and which has become important for the large artificial neural networks** now in use.

John Hopfield invented a network that uses a method for saving and recreating patterns. We can imagine the nodes as pixels. The **Hopfield network** utilises physics that describes a material's characteristics due to its atomic spin – a property that makes each atom a tiny magnet. The network as a whole is described in a manner equivalent to the energy in the spin system found in physics, and is trained by finding values for the connections between the nodes so that the saved images have low energy. When the Hopfield network is fed a distorted or incomplete image, it methodically works through the nodes and updates their values so the network's energy falls. The network thus works stepwise to find the saved image that is most like the imperfect one it was fed with.

Geoffrey Hinton used the Hopfield network as the foundation for a new network that uses a different method: the **Boltzmann machine**. This can learn to recognise characteristic elements in a given type of data. Hinton used tools from statistical physics, the science of systems built from many similar components. The machine is trained by feeding it examples that are very likely to arise when the machine is run. The Boltzmann machine can be used to classify images or create new examples of the type of pattern on which it was trained. Hinton has built upon this work, helping initiate the current explosive development of machine learning.

Short history