2024 Nobel Prize in Physics made a category error

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Abstract

The 2024 Nobel Prize in Physics made a category error in awarding a pattern recognition circuit or program the prize. The neuron and implication that it was responsible for thought was discovered by biologists and the physical understanding of information worked synergistically with the concept. The Artificial Neural Network (ANN) is a construct of Computer Science and made possible by Applied Science and Engineering; it simply recognises patterns. It doesn't follow that the paradigm of ANNs explains intelligence nor how it emerges in the Universe and more worthy recipients in this area would have been the original people who came up with Information Theory or those looking at the limits of computation in Quantum Computing or even those who have seen Godellian limitations in physics, such as the incomputability of the spectral gap in certain materials.

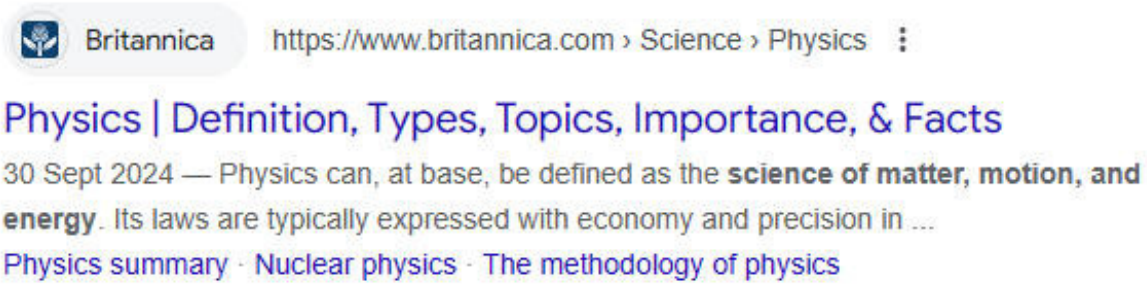
Introduction

This is an essay opinion piece on the Physics Nobel 2024, which left many people either a) asking for a separate prize for Computer Science, b) thinking it was engineering and all the pure science or mathematical thought were done already and awarded to different disciplines, c) wondering just what it had to do with Physics? I think all these observations are correct. A citation list wasn't made but the hyperlinks are in blue and should take you to the references.

The announcment (essentially for a pattern recognition circuit, read on)

Sabine Hossenfelder's opinion on the matter[1]

What is Physics?



[1] Hossenfelder claims that Physics is dead, people aren't accepting new ideas... She and others like her are part of the problem. They probably look down on engineers or anyone who hasn't done the Theoretical Minimum and spent two decades of their adult life regurgitating the products of great minds. Some people come to this knowledge as and when they need it. Others stuff their minds and are too afraid to have new ideas/or there is a Law of Diminishing Returns in effect. Let us remember too that Marconi, Dirac and Feynman were all engineers or started out doing engineering (Leonard Susskind was a plumber!) It's a no-nonsense way of thinking. Two of my cosmology related papers resulted from a run-in with Hossenfelder.

The definition above would, by that token, put Harry Nyquist, Ralph Hartley, Claude Shannon, Leon Brillouin under consideration for Information Theory, which actually *is Physics* and *is fundamental;* it relates to the physical "cost" of information and how fundamental laws influence its manipulation. As is too the physics and dynamics of *physical* self-ordering and self-optimising systems, some of which lead to intelligence.

Others types of self-ordering and self-optimising systems *lain over physical systems* (a bit like the laws for any universe may be laid over a real physical computer in some computer game) may lead to patterns, like solitons or Boom and Bust economic cycles, computer characters having complex characters but then that is getting into Applied (or even Pure, sometimes) Mathematics, Economics, Chemistry, Biology, Psychology - all over the place. It isn't really dependent on the *physics of this universe* but the mathematics...

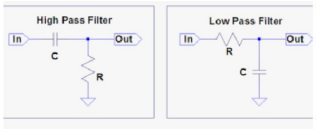
Still, if your viewpoint is "everything is Physics", many would assure you that **"everything *is* mathematics"** (patterns, structure, relations) instead - nothing can exist in a logical and structural vacuum without contradicting its own existence. (I'm sure some will shout Godel and physicists will say, yeah, we've seen that too (**incomputability of the spectral gap**) - that study was more worthy of a Physics Nobel in my opinion, as it gets at the core of what one can or can't do with information and computation and how it manifests *physically*.

What is Mathematics?

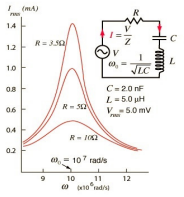
Presumably if different universes exist with different laws or constants, they could have life, intelligence, economics, psychology, etc. **but all universes would have mathematics** or just be a formless gloop or void

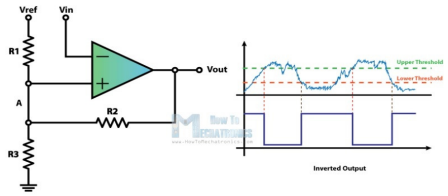
What we have in the 2024 physics prize is an award for a **pattern recognition circuit** - just as an LCR (inductor, capacitor, resistor) circuit can recognise a sine-wave buried in noise, a Schmitt trigger can regenerate digital levels buried in noise, an Auto-correlation/Matched filter can recognise some arbitrary signal vector buried in noise.

A Neural network is similar to a non-linear auto-correlation filter that deals with multi-dimensional data - it's like the off-spring of a Schmitt trigger and an Auto-correlation filter: a neural network recognises some arbitrary vector signal (1D, 2D, 3D whatever) buried in noise. You train it by monitoring when the output peaks for your chosen dataset by correcting all the coefficients of the network and nodes (essentially Schmitt triggers - artificial neurons) to affect this (back-propagation - "training").



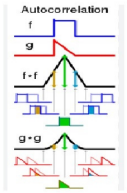
"Recognises" low or high frequencies, like your bass/treble control

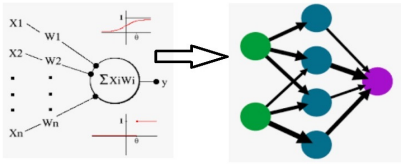




Recognises sine-waves **Recognises digital signals**

Artificial neuron and Neural Network





Auto-correlation recognises whatever waveform you program

ChatGPT

Recognises more complex data like a 2D image

The discovery of the neuron was pure science, the discovery of Information Theory was Philsophy/Mathematics/Physics but the perceptron and Artificial Neural Network is Engineering or Computer Science and not worthy of a Physics Nobel.

<u>All pattern recognition devices and electrical or computer engineering now</u>

That is what is happening when you do those CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) tests. It was prior trained and then presents you with a noisy image to see *if your neural network* (your brain as we understand it in an engineering/computer science manner, currently) is human or some *simple robot* trying to trick a webpage. This is all venerable but one for Computer/Data Science, IEEE or IET type awards. Applied mathematics at best. All concepts were previously known or relevant to other disciplines.

Comparing it to intelligence is fallacious; you wouldn't say that life is *just* a chemical reaction (showing that chemistry and physics underpins the data-storage of life, DNA, <u>*was*</u> Nobel-worthy). That would be reductionism gone mad and if it is a *component* of intelligence, <u>the biologists got there first</u>[2] observing actual neurons and then the engineers (including physicists and anyone else who can *apply* science *to build stuff* to some design brief) and computer scientists <u>rendered the artificial version of the neuron</u> (the perceptron, as it was called), then the artificial neural network (ANN). It is telling that one can run an

[2] Santiago Ramón y Cajal (1852–1934), Charles Sherrington (1857–1952), Warren McCulloch and Walter Pitts (1943), Alan Lloyd Hodgkin and Andrew Huxley (1950s).

ANN/pattern recognition circuit on a Turing Machine. That may show the limitation of the paradigm.

Anyway, *real* neurons maybe altogether more sophisticated and have quantum processes directly pertinent to processing and higher functions such as **consciousness**, as Roger Penrose believes. In my view too, Quantum Computers solving problems faster (and even intractable problems) than a Turing Machine, WOULD BE WORTH a Nobel Prize in Physics. You couldn't get more fundamental physics than what the Laws of Nature are telling you is permissible. Furthermore, when Quantum AI can do this…

and demonstrate self-awareness, introspection, intuition and prove deep connections between Information Theory (Physics) and Consciousness and what Brian Josephson (and others like the Fundamental Fyziks Group) have been saying about a need for a new physics (for ages now), *that* would be well-worth a Computer Science/Physics cross-over Nobel.

Carry on making such category errors and The Physics Prize will lose relevance or maybe just confuse everyone.