Προκλήσεις «γνωρίζω-κατανοώ» στην εποχή της τεχνητής νοημοσύνης και ο ρόλος των «παραδοσιακών» υπολογισμών

Challenges "knowing-understanding" in the era of AI and the role of "traditional" computing

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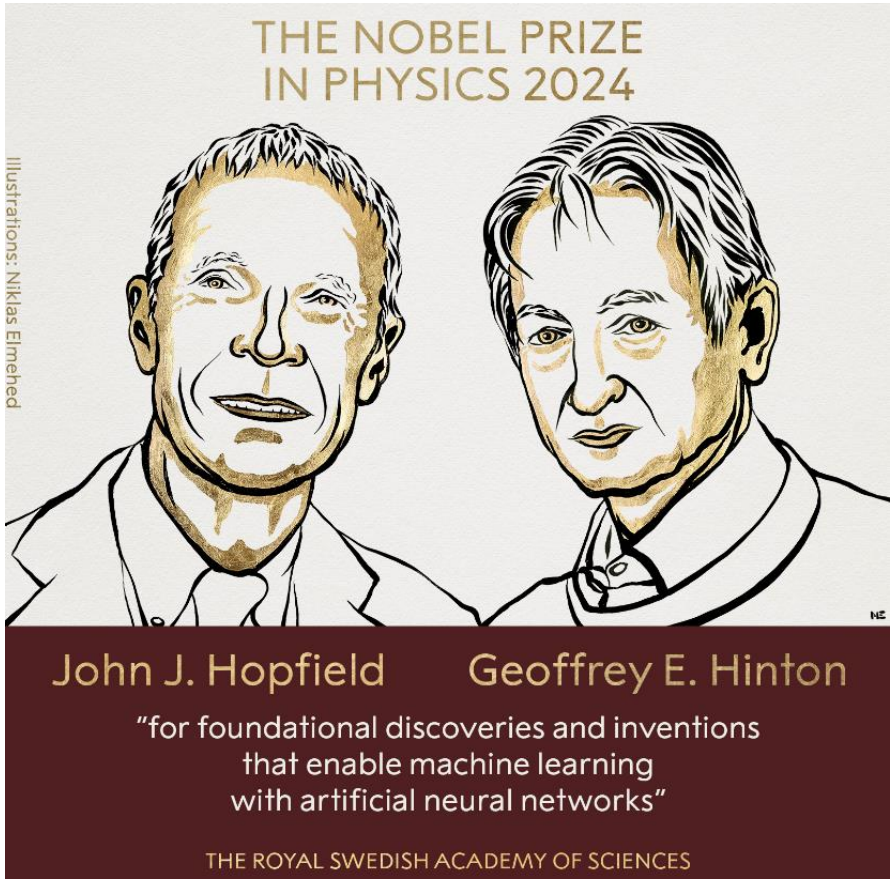
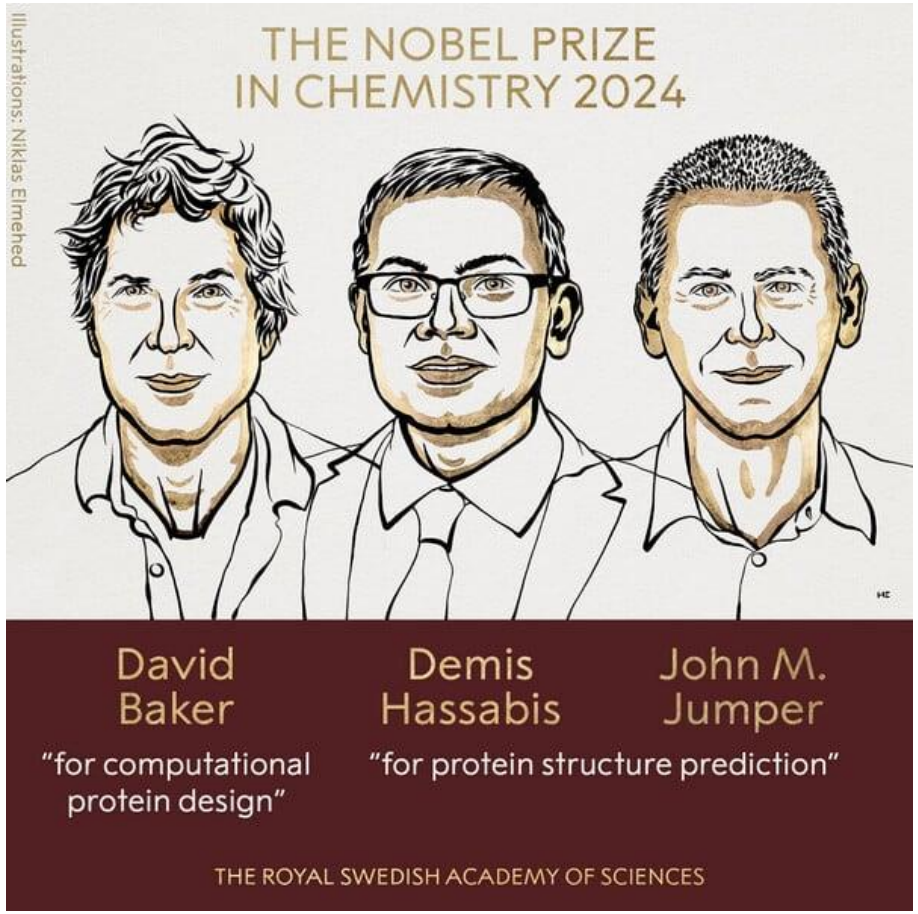
2024 NOBEL PRIZES IN PHYSICS AND CHEMISTRY



Το βραβείο Νόμπελ 2024 στην Φυσική απονεμήθηκε στους **John J. Hopfield** (Princeton) και **Geoffrey E. Hinton** (University of Toronto «για θεμελιώδεις ανακαλύψεις και εφευρέσεις που επιτρέπουν την μηχανική μάθηση με τεχνητά νευρωνικά δίκτυα»



Με το Νόμπελ Χημείας 2024 τιμώνται κατά το ήμισυ ο βιοχημικός **David Baker** (U. Washington) "για τον υπολογιστικό σχεδιασμό πρωτεϊνών" και κατά το άλλο ήμισυ ο **Demis Hassabis** και **John Jumper** (Deepmind/Google) για τις εργασίες τους στην "πρόβλεψη πρωτεϊνικής δομής μέσω της τεχνητής νοημοσύνης”

THE MATHEMATICAL BACKGROUND OF THE NEURAL NETWORKS INTERDISCIPLINARITY

Portfolio optimization

Markowitz model

risk minus returns; no. of assets of type-i; risk tolerance

$$F = \sum_{ij} C_{ij} n_i n_j - \zeta \sum_i R_i n_i$$

correlations between assets; return on i'th asset

Spin glasses

Sherrington-Kirkpatrick model

Hamiltonian; spin at site i

$$H = \sum_{ij} J_{ij} s_i s_j + \sum_i h_i s_i$$

couplings between sites; external magnetic field at i'th site

Neural networks

Hopfield model

energy function; state of neuron i

$$E = \sum_{ij} w_{ij} v_i v_j + \sum_i \theta_i v_i$$

weights of the learning rule; activation threshold for i'th neuron

Knowing-versus-understanding /

critical thinking – creative thinking

Richard Feynman, "Seeking New Laws" speech (1964–65),

"…Imagine a discussion between a Mayan astronomer and his student. The Mayans were able to calculate with great precision… eclipses and for the position of the moon in the sky… It was all done by arithmetic. There was no discussion of what the moon was. There was no discussion even of the idea that it went around. They just calculated the time… Suppose… a young man… said, 'Maybe those things are going around, and there are balls of something like rocks out there…' 'Yes,' says the astronomer, '…how accurately can you predict eclipses?'… 'Well, we can calculate eclipses more accurately than you can with your model, so you must not pay any attention to your idea because obviously the mathematical scheme is better.'"

In this tale, Feynman shows how the Mayans could *know* (i.e., calculate future events data-wise) without *understanding* the deeper physical nature of celestial bodies. It's a perfect reflection of the difference between rote prediction and conceptual insight.

The huge educational challenge, not only at the level of university education:
The right mixture of AI and basic principles in curricula

Knowing/predicting without sacrificing understanding

Curricula should be disruptively redesigned / who will implement all these?
Physical teachers ? virtual teachers/”agents” ?

A horizontal cross-engineering disciplinary course was introduced at NTUA since last year for junior undergrads

The Hellenic Institute of Advanced Studies (HIAS) Summer Course on AI , 2024

The physics is in the data – how to “extract” the physics from the data so as to understand? Is hybridization, e.g. PINNs (physics informed neural networks), an answer ?

The physics is in the data/predictions derived via “traditional” codes approximating solutions of problems originating from first principles (e.g. differential equations/conservation laws)

The data from legacy codes/digital twins are indispensable for training and validating neural nets esp. if scarcity from other sources (e.g. industry) . High performance computing is crucial.

Happening in Greece:

AI factories – Pharos project with European funding . A petaflop machine DAEDALUS to be installed at the NTUA campus in Lavrion soon.

The 1st Greeks in AI conference in Athens, 19-20 July 2025.