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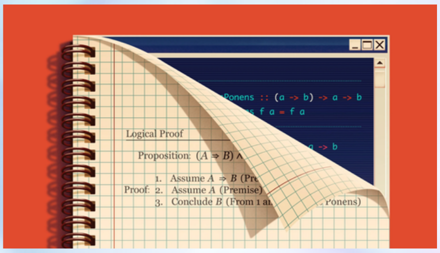
Byte Quest

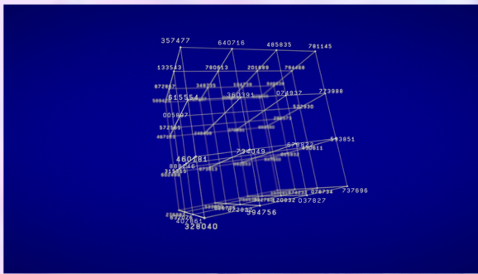
Department of
CSE

THE PHYSICAL PROCESS THAT POWERS A NEW TYPE OF GENERATIVE AI

TINY LANGUAGE MODELS COME OF AGE



THE DEEP LINK EQUATING MATH PROOFS AND COMPUTER PROGRAMS



THIRTY YEARS LATER, A SPEED BOOST FOR QUANTUM FACTORING

Department Vision

To be a center for academic excellence in the field of Computer Science and Engineering education to enable graduates to be ethical and competent professionals.

Department Mission

To enable students to develop logic and problem solving approach that will help build their careers in the innovative field of computing and provide creative solutions for the benefit of society.

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THE PHYSICAL PROCESS THAT POWERS A NEW TYPE OF GENERATIVE AI

Physicists like Max Tegmark at MIT are exploring ways to apply their understanding of physical processes to enhance artificial intelligence (AI) algorithms, particularly neural networks used in image generation. The focus is on replacing opaque "black box" algorithms with physics-inspired generative models. Tegmark's team introduced the Poisson flow generative model (PFGM), where data is represented by charged particles creating an electric field, governed by the Poisson equation. This approach, utilizing electrostatic forces, can generate high-quality images at speeds 10 to 20 times faster than traditional methods like diffusion-based models.

The PFGM has evolved into an extended version, PFGM++, introducing a parameter allowing adjustment of the system's dimensionality. This innovation offers increased model variability: lower dimensions enhance robustness, tolerating estimation errors, while higher dimensions ease training, requiring less data. This flexibility aims to strike a balance between model resilience and ease of training, a crucial aspect the researchers are exploring to optimize the model's performance. Moreover, the team is delving into other physical processes, like the Yukawa potential related to weak nuclear forces, to potentially develop new generative models with broader applications beyond image generation.

TINY LANGUAGE MODELS COME OF AGE

In the realm of language model research, two Microsoft researchers introduced an innovative approach to training smaller language models by immersing them in a focused diet of children's stories. By utilizing a dedicated data set of synthetic stories generated by larger language models, Ronen Eldan and Yuanzhi Li aimed to train and assess these miniature models' storytelling capabilities. Despite their modest sizes—ranging from one to thirty million parameters, significantly smaller than the state-of-the-art models—these tiny models exhibited surprising proficiency in storytelling, outperforming larger models like GPT-2, a 1.5-billion-parameter model, in this specific task. The synthetic stories, carefully constructed to train these smaller models, offered a streamlined approach, showcasing potential avenues for assembling high-quality training data sets without the need for vast amounts of data scraped from the internet.

The research highlights the potential of smaller, specialized models trained on curated synthetic data, shedding light on the factors affecting model performance and hinting at intriguing possibilities for more efficient model training. It introduces a novel direction for training language models, offering insights into the capabilities of smaller models and questioning the necessity of colossal data sets for achieving high-quality language understanding and generation.

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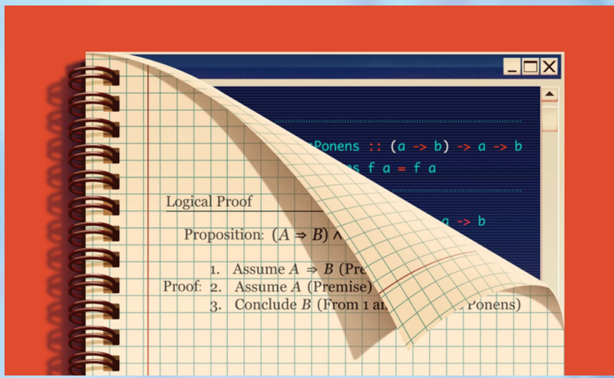
THE DEEP LINK EQUATING MATH PROOFS AND COMPUTER PROGRAMS

The Curry-Howard correspondence is a profound concept that links computer science with mathematical logic, equating computer program elements to logical propositions and proofs. Initially observed by Haskell Curry in 1934 and later deepened by William Alvin Howard in 1969, this correspondence establishes a fundamental link between types and programs in computer science and propositions and proofs in mathematical logic.



Types in computer science, akin to categories of values, address the issue of paradoxes, such as Russell's set paradox, through a hierarchy system. Curry and Howard demonstrated that functions inhabiting types are equivalent to proving logical propositions, where a function of type A → B corresponds to the logical implication "If A, then B."

This correspondence has significant implications, providing the foundation for software verification and advancing functional programming languages in computer science. In mathematics, it birthed proof assistants like Coq and Lean, enabling the formalization of mathematical concepts and proofs in a computer-verifiable format. Researchers continue exploring this linkage, uncovering connections between various logical systems and computational models beyond Curry's and Howard's initial insights.

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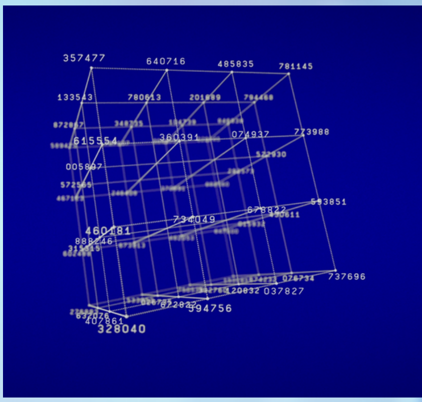
THIRTY YEARS LATER, A SPEED BOOST FOR QUANTUM FACTORING



Peter Shor's groundbreaking algorithm from the 1990s presented a quantum solution for factoring large numbers, posing a significant threat to public-key cryptography systems, which relied on the complexity of factoring. However, a new variant of this algorithm, developed by Oded Regev from New York University, represents a fundamental improvement by reducing the relationship between the size of the number being factored and the required quantum operations.

Shor's algorithm leveraged quantum superposition and period finding to factor large numbers exponentially faster than classical methods. Regev's advancement involves techniques from lattice-based cryptography, enhancing Shor's algorithm by working in high-dimensional spaces. This multidimensional approach optimizes the quantum computation, reducing the number of steps required, although it initially demanded more qubits.

Regev's algorithm initially necessitated additional qubits compared to Shor's algorithm. However, recent modifications by researchers like Vinod Vaikuntanathan and Seyoon Ragavan have reduced the memory requirements, bringing the new variant closer to practical implementation. This development highlights the need for continued exploration in quantum computing, revealing unforeseen advancements in well-established problems and suggesting the existence of more undiscovered quantum algorithms.

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