Opinions Libres

le blog d'Olivier Ezratty

Books and papers

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In English

- **How to compare logical qubits?**, a technical paper of 45 pages (March 2026).

How to compare logical qubits?

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(Dated: March 10, 2026)

As the transition from NISQ (noisy intermediate scale quantum computing) to FTQC (fault-tolerant quantum computing) is going on, quantum scientists and industry vendors face a complexity challenge not only to deliver what's in their plans, blueprints and roadmaps but also on how to communicating about it. Many underlying concepts and figures of merit deserve to be explained given all logical qubit are not born equal and experiments are quite different from one to the other. This paper is structured as a tutorial and review paper which describes how quantum error correction, logical qubits, and fault-tolerance operate from a systems engineering standpoint. It also helps understand what quantum computing industry vendors are planning and delivering. It shows the links between concepts, techniques, figures of merit, software and hardware components. It is of particular interest for quantum software developers and engineers who want to connect the dots between circuit size requirements and FTQC systems present or future capabilities. While vendors are driving the development and experimentation of error correction and fault-tolerance engines, we outline that their critical path is in the improvement of the scaling of their hardware, physical qubit operation fidelities, and connectivity.

I. Introduction

While several "quantum advantages" have been claimed with NISQ quantum computers (noisy intermediate scale quantum computing) in several quantum physics simulation experiments [1–6], the consensus with quantum computer science academics and industry vendors is that industry utility quantum advantage will necessitate the use of FTQC (fault-tolerant quantum computers) [7, 8].

In most cases, NISQ algorithms face various limitations, particularly when being based on variational circuits, which are plagued by scaling problems like barren plateaus as the number of qubits increases [9]. These circuits can exploit techniques like quantum error mitigation [10] and improvements in physical qubit fidelities. It can currently extend their reach to about 7,500 physical gates and 100 to 200 physical qubits. But industry-grade algorithms require between a million gates (10^6) [7] and a million gates (10^{12}), if not beyond ($> 10^{15}$ for some resource estimations in computational fluid dynamics and complex chemical simulations) [8, 11]. Only this capability will enable the execution of large gate-based quantum circuits supporting a wealth of quantum algorithms for quantum chemistry simulations, solving various linear equations, up to, potentially, reaching the realms of quantum machine learning and combinatorial optimizations [12].

The quest for the creation of utility-grade FTQC systems drives a mobilization of academics and industry vendors. Quantum computing industry vendor published roadmaps span from 5 to 10 years. All face a complexity challenge, particularly due to the difficulty to scale the number of physical qubits while maintaining and even improving their operation fidelities. The field of quantum error correction (QEC) and fault-tolerant quantum computing (FTQC) is both burgeoning and cryptic. Most related scientific papers are hard to grasp by quantum software developers. The quantum computing community faces a double complexity challenge for the development of FTQC systems and on how to create bridges with the quantum software community.

Qubit platforms and industry vendors are at different stages in maturity. Some have even not yet reached a minimum level to support basic NISQ applications with at least a couple dozen physical qubits. They may publish blueprints based on various hardware assumptions. Other vendors may conduct impressive experiments but their results are made of various components which are not always assembled in an end-to-end fashion. A last small category of vendors directly target FTQC systems with skipping the NISQ route for various technical reasons.

On the end-user site, software developers care about relatively simple figures of merit like the supported circuits size in existing or future FTQC systems, estimated computing times and FTQC system costs. These figures of merit are rarely accessible when industry vendors describe their logical qubits. There are multiple technical reasons for this as we will see. One is that the field of QEC and FTQC is incredibly complex. We propose here to create a bridge between the quantum software and QEC-FTQC communities.

This tutorial paper is here to clarify the situation and help quantum software developers, quantum computing engineers and others to connect the dots between the QEC/FTQC academic and industry landscape and their algorithmic needs. It is organized as follows:

Section I clarifies the difference between quantum error correction and fault-tolerant quantum computing and summarizes in a large table the key components of QEC and FTQC. It highlights what computer information science specialists may look for in industry vendor achievements as well as roadmaps, and how to find it.

Section II describes how quantum error correction works on a logical qubit memory, what types of errors are corrected and how. It is focused on surface, color, and qLDPC codes.

Section III elaborates on the very notion of logical qubits and some related sizing aspects.

Section IV looks at the key features of fault-tolerance and how they are implemented, particularly for the realization of logical quantum gates. It helps quantify the space, time and energetic overheads of QEC/FTQC.

Section V provides an overview of the current industry vendors achievements across multiple qubit modalities with a mix of experiments, theoretical work, and blueprints. It comes from the vendors themselves, and from the academic labs which are working with them.

Then, a **glossary** defines the key technical terms mentioned in this paper.

A. What is the difference between QEC and FTQC?

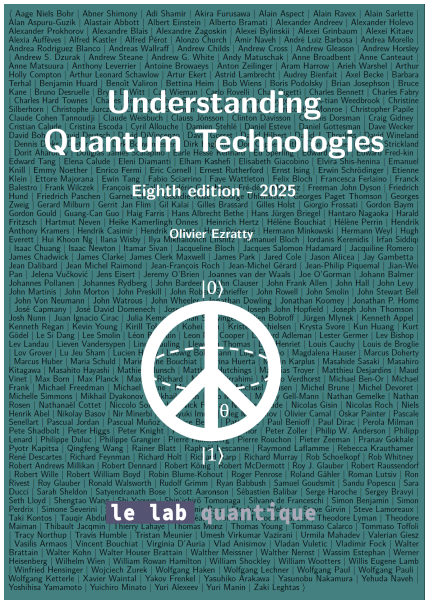
Let's first define what are quantum error correction (QEC) and fault-tolerant quantum computing (FTQC). There's a fuzzy line between both depending on the definition.

Quantum error correction is associated with the act to correct the data sitting in a quantum memory made of logical qubits, *aka* "data at rest", corresponding to the qubits that are idle for some time during a circuit execution (see it represented in Figure IV.E). It fights against decoherence and extends the qubit information lifetime. That's what Google did with its Willow chip experiment in 2024. In many cases, multiples logical qubits are corrected simultaneously [13, 14].

Fault-tolerance is about extending QEC using multiple features with the end-goal being to enable the successful execution of a quantum circuit with logical operations error rates compatible with its size.

The first definition of FTQC was crafted by Peter Shor in a seminal 1997 paper [15]. It was the ability to construct a polynomial-sized quantum circuit that can successfully run on a quantum computer despite the presence of decoherence and gate inaccuracies. It comprised multiple elements: the definition of new error tolerance threshold of $O(1/\log^c t)$ inaccuracies and decoherence per gate for a computation with t gates, c being a constant, the use of error correction codes without decoding the data itself, using noisy gates to compute directly on encoded qubits and correcting errors as they occur, correcting decoherence errors and qubit control inaccuracies errors.

- **Understanding Quantum Technologies** 2025, 8th edition, published in September 2025, 1,524 pages. A short 38-pages version is also available.



- **Quantum computing and artificial intelligence: status and perspectives** by Giovanni Acampora, Andris Ambainis, Natalia Ares, Leonardo Banchi, Pallavi Bhardwaj, Daniele Binosi, G. Andrew D. Briggs, Tommaso Calarco, Vedran Dunjko, Jens Eisert, Olivier Ezratty, Paul Erker, Federico Fedele, Elies Gil-Fuster, Martin Gärttner, Mats Granath, Markus Heyl, Iordanis Kerenidis, Matthias Klusch, Anton Frisk Kockum, Richard Kueng, Mario Krenn, Jörg Lässig, Antonio Macaluso, Sabrina Maniscalco, Florian Marquardt, Kristel Michielsen, Gorka Muñoz-Gil, Daniel Müssig, Hendrik Poulsen Nautrup, Evert van Nieuwenburg, Roman Orus, Jörg Schmiedmayer, Markus Schmitt, Philipp Slusallek, Filippo Vicentini, Christof Weitenberg, and Frank K. Wilhelm, arXiv, May 2025 (32 pages). I coordinated the redaction of this paper from June 2024 to June 2025 on behalf of the European Quantum Flagship.

Quantum computing and artificial intelligence: status and perspectives

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(Dated: June 2, 2025)

Contents

I Executive summary

Two computing revolutions are currently in the making with *artificial intelligence* (AI) and *quantum computing*, with different levels of maturity and market footprints. While the European Union's scientific position in both domains is significant, it is still squeezed between the US dominance and China's increasing role, particularly with AI. However, as demonstrated by the emergence of DeepSeek, within the AI domain of large language models, innovation, scientific astuteness, and open source models can significantly alter the market balance.

Leadership in these domains comes from scientific excellence and the capability to create strong integrated software platforms, to build significant, scalable, and efficient computing infrastructure, and to spur the creation of as generic as possible use cases for end users, from enterprise and public services to consumer markets. A tight integration between academic research and industry R&D is a fundamental enabler of scientific progress and market success.

Quantum computing is still a promise in the making, but its synergies with AI are already there and growing [1–3]. Many AI-driven techniques are already enabling significant progress in quantum computing research and industry developments, from optimizing qubit control and *quantum error mitigation* (QEM) [4] strategies in the early stage *noisy intermediate-scale quantum* (NISQ) regime [5] to designing novel quantum algorithms [6], highlighting the importance of mastering this dual discipline as an enabling technology.

Likewise and the other way around, early evidence of quantum advantage in faster computing times, better results, or the need for less training data for solving specific *machine learning* (ML) problems illustrates how uniting AI and quantum resources could bring value, even though the required large-scale, *fault-tolerant quantum computers* (FTQCs) likely needed to obtain clearer such advantage remain a longer-term objective.

Public investment in the convergence of AI and quantum computing could strengthen the EU competitiveness by building on the existing research excellence in both fields and accelerate the transition from laboratories to market applications. One strategic goal of employing quantum computing is to advance AI-based solutions for healthcare, finance, materials discovery, and security. It is a mid- to long-term target, but one that will determine industrial and scientific leadership in both domains. Likewise, the EU AI and quantum research landscape should encourage the development of both open source and commercial integrated software engineering platforms.

As international competition escalates, ensuring support for academic research and private-sector innovation at this intersection will not only secure the economic benefits associated with disruptive breakthroughs but also reinforce the EU's position as a prominent global player in emerging deep-tech ecosystems. A carefully orchestrated funding strategy that spans fundamental research, talent cultivation, and technology-transfer incentives will ensure a robust pathway from visionary lab-scale projects to tangible, high-impact in-

- **The Two-Spin Enigma: From the Helium Atom to Quantum Ontology**, Entropy, November 2023, a quantum foundations paper coauthored with Philippe Grangier, Alexia Auffèves, Nayla Farouki and Mathias Van den Bossche (**paper backstory**).

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Article

The Two-Spin Enigma: From the Helium Atom to Quantum Ontology

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Abstract: The purpose of this article is to provide a novel approach and justification of the idea that classical physics and quantum physics can neither function nor even be conceived without the other—in line with ideas attributed to, e.g., Niels Bohr or Lev Landau. Though this point of view may contradict current common wisdom, we will show that it perfectly fits with empirical evidence, and can be maintained without giving up physical realism. In order to place our arguments in a convenient historical perspective, we will proceed as if we were following the path of a scientific investigation about the demise, or vanishing, of some valuable properties of the two electrons in the helium atom. We will start from experimentally based evidence in order to analyze and explain the physical facts, moving cautiously from a classical to a quantum description, without mixing them up. The overall picture will be that the physical properties of microscopic systems are quantized, as initially shown by Planck and Einstein, and that they are also contextual, i.e., they can be given a physical sense only by embedding a microscopic system within a macroscopic measurement context.

Keywords: quantum physics; helium; electron spin; contextuality; operator algebra

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Citation: Grangier, P.; Auffèves, A.; Farouki, N.; Van Den Bossche, M.; Ezratty, O. The Two-Spin Enigma: From the Helium Atom to Quantum Ontology. *Entropy* **2024**, *26*, 1004. https://doi.org/10.3390/e26121004

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1. Prologue

"Quantum mechanics occupies a very unusual place among physical theories: it contains classical mechanics as a limiting case, yet at the same time it requires this limiting case for its own formulation." L.D. Landau and E.M. Lifshitz, *Quantum Mechanics* [1].

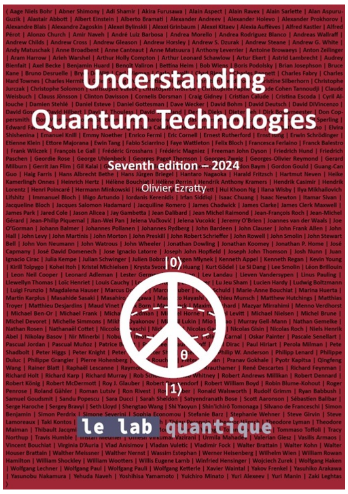
"When you have eliminated all the impossible, then whatever remains, however improbable, must be the truth." A. Conan Doyle, *The Case-Book of Sherlock Holmes* [2].

In 1923, Max Born gave a series of lectures at the University of Göttingen, from which he drew a monograph entitled *The Mechanics of the Atom* [3]. The second edition of this book was published in 1927 in English, just after the founding articles on quantum mechanics, and he wrote the following in the Preface:

"Since the original appearance of this book in German, the mechanics of the atom has developed with a vehemence that could scarcely be foreseen. (… However,) it seems to me that the time is not yet arrived when the new mechanics can be built up on its own foundations, without any connection with classical theory. It would be giving a wrong view of the historical development, and doing injustice to the genius of Niels Bohr, to represent matters as if the latest ideas were inherent in the nature of the problem, and to ignore the struggle for clear conceptions which has been going on for twenty-five years."

Entropy **2024**, *26*, 1004. https://doi.org/10.3390/e26121004 https://www.mdpi.com/journal/entropy

- **Understanding Quantum Technologies** 2024, 7th edition, published in September 2024, 1,554 pages. A short 26-pages version is also available.



- **AI, LLMs and quantum science can empower each other?** (24 pages with a 70 pages appendix, January 2024) which describes how LLM-based chatbot could help teachers, students, researchers and other quantum professionals.

How AI, LLMs and quantum science can empower each other?

Olivier Ezratty [1]

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Large Language Models (LLMs) based chatbots such as OpenAI's ChatGPT 4.0 and Google's Bard are emblematic of the broader generative artificial intelligence advances. They have garnered substantial attention in academic, economical and policy making discourses. This paper aims to examine the intersection of LLMs chatbots with quantum science and technology, focusing on their potential to empower research methodologies and pedagogical approaches within these disciplines. It explores with many examples the capabilities of LLM-based tools by assessing their existing and potential future utility in various academic functions and in the industry. These range from facilitating basic question-and-answer interactions to more complex activities such as software development, writing scientific paper, scientific papers reviewing, experiments preparation, research ideation and fostering collaborative research practices in quantum science. The rapid evolution of LLMs and other related tools implementing various forms of so-far primitive reasoning suggests they have the potential to significantly alter the research and educational landscapes, similarly to the transformative impact of the Internet and its associated tools. Accordingly, this paper suggests the creation of a quantum science domain specific LLM based chatbot using open source models and scientific corpus. It also contextualizes LLM-based chatbots within the broader spectrum of machine learning technologies which are already used in the advancement of quantum science and technology. It then quickly explores how quantum computing might or might not further advance machine learning applications and language-based models. The conclusion is that AI may have a profound impact in shaping the trajectory of quantum science research, education, and technology developments while the other way around is quite uncertain, at least in the short to mid-term.

2

I. INTRODUCTION

This paper looks at the intersection of machine learning and quantum science, with a focus on large language models chatbots. It investigates the various ways quantum scientists can benefit from these new tools and urges them to learn how to make the best use of them. It describes the existing as well as future use cases for LLMs with the observation that they have a significant potential to alter research methodologies and pedagogical approaches in quantum science with academics, researchers and within the industry. It also explores the various other ways machine learning techniques and quantum technologies can help each other.

Part II describes how LLMs fit into the generative AI landscape, the key features of LLM-based chatbots, their size and their training data sources, their figures of merit, and how to make best use of them with prompt engineering. It assesses their reasoning capabilities and shows how it will grow with the addition of various symbolic AI tools, on the road to so called "artificial general intelligence". This part also describes how to create domain specific LLM chatbots using LLM fine tuning and retrieval-augmented generation (RAG) with documents databases. It suggests the launch of a quantum science domain LLM based chatbot using open source language models.

Part III showcases how LLM chatbots can be used in the context of quantum science by researchers, teachers, students, and industry professionals. It covers the process of learning and studying quantum science and technologies, reviewing, and writing scientific and other papers, doing classical and quantum software development, conducting research ideation and collaborative research.

Part IV inventories the use cases of other types of machine learning-based tools in quantum science with research and technology developments in quantum physics and hardware, quantum software and tools and other domains like quantum sensing and quantum communications and cryptography.

Part V covers the potential use cases of quantum computing in machine learning applications including large language models. It also shows how quantum inspired algorithms can help reduce the computing and energetic footprint of classical machine learning solutions.

Part VII supplemental materials contain a wealth of prompts and results covering various fields of quantum science, including learning, summarizing the state of the art, listing figures of merits for technologies like single photon sources and detectors, circulators, traveling wave parametric amplifiers, analyzing a paper, producing a position paper, and creating a quiz.

Part IX contains an extensive bibliography for readers willing to dig into the way LLMs and their tools operate.

The intended audience of this paper is students, researchers and professionals in the broad quantum science and technology ecosystem who have a limited knowledge and understanding of machine learning and particularly, large language models chatbots. A preliminary understanding of machine learning and neural network basics is however a plus here[1].

II. LLM-BASED CHATBOTS PRIMER

Generative AI refers to a subset of artificial intelligence algorithms and technologies that create new content of various formats (texts, images, 3D models or even humans, videos, music, software code, molecules, etc.), based on the patterns and information learned from large datasets, and with existing content of the same type (e.g., for responding to a text question by a text answer) or of different types (e.g., creating some image or video based on a text specification). This differs from other machine learning models that are focused on labelling, clustering, or interpreting data and making various predictions not in relation with media content creation (e.g., forecasting sales and inventory, or planning a robot movement)[2].

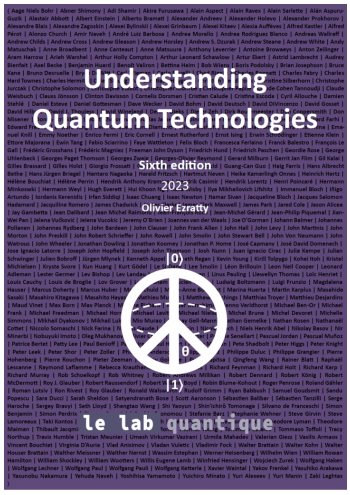
Generative AI tools make use of deep learning neural networks models that are trained on vast amounts of data, allowing them to implicitly understand patterns and structures within the training data. Once trained, these models generate new content extrapolated from existing content. Three well-known generative AI tools are large language models based on transformers like OpenAI GPT (Generative Pre-trained Transformer), which generates human-like text in chatbots, GANs (Generative Adversarial Networks) and VAE (Variational Autoencoders), which create realistic images, videos, and music under various constraints (using a given style, changing its format, filling voids, adding bokeh to a picture background, etc.), with applications in verticals like healthcare[3] and artistic creation. These models can produce content not explicitly programmed in the model but by understanding the data they were trained on[4].

Generative AI applications include the transformation of existing content (improving image resolution, converting them from monochrome to color, making people younger or older, creating new music) or the generation of content using content of different types (creating a text description of an image, creating an image based on its description, creating videos and sound of a person based on a text script, turning a sketch into a picture or even a 3D model, etc.). We will differentiate here the generative AI algorithms and models from the products which are using it.

LLM features

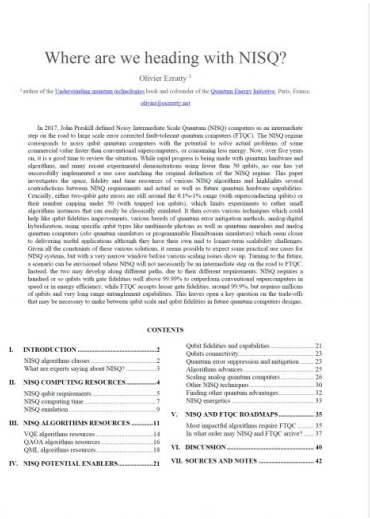
As of January 2024, the most popular generalist large language models-based chatbots were ChatGPT 4.0 ($20/month subscription[5 6 7]), Google Bard (free[8]) and Llama2 from Meta (free). Other such tools include Claude 2 from Anthropic but its regular access is limited to US and UK users. These tools use language models based on the transformer neural network model, which was invented in 2017 by a Google AI team[9]. To clarify the LLM terminology, ChatGPT 4.0 is a chatbot product that is using a language model, GPT-4, and other software tools and generative AI models like DALL-E which generates images based on their text description. Google Bard is based on the PaLM2 language model, and soon its Gemini successor.

- **Understanding Quantum Technologies** 2023, 6th edition, published in September 2023, 1,366 pages.



- **Perspective on superconducting qubit quantum computing**, EPJ-A, May 2023, a review paper on superconducting qubits.

- **Where are we heading with NISQ?** (50 pages, May 2023, arXiv) is a review of the state of the art and prospects of noisy quantum computers.


Where are we heading with NISQ?

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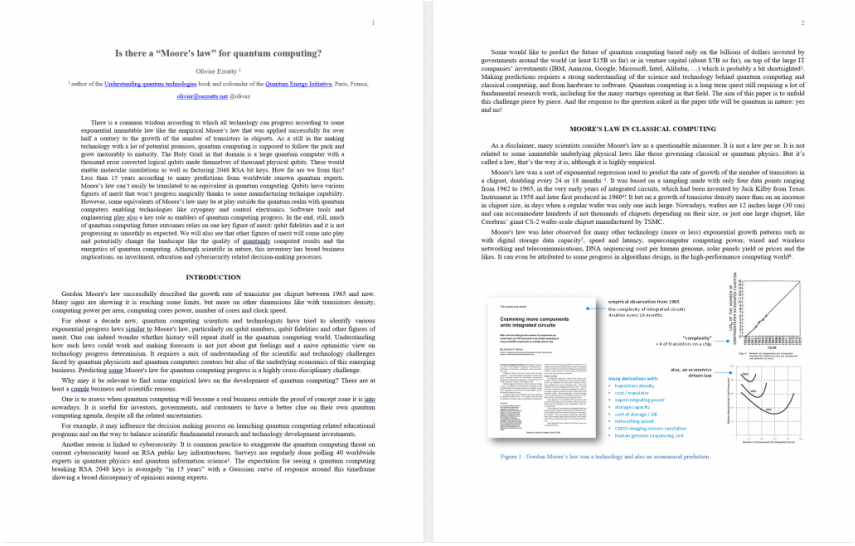
In 2017, John Preskill defined Noisy Intermediate Scale Quantum (NISQ) computers as an intermediate step on the road to large scale error corrected fault-tolerant quantum computers (FTQC). The NISQ regime corresponds to noisy qubit quantum computers with the potential to solve actual problems of some commercial value faster than conventional supercomputers, or consuming less energy. Now, over five years on, it is a good time to review the situation. While rapid progress is being made with quantum hardware and algorithms, and many recent experimental demonstrations using fewer than 50 qubits, no one has yet successfully implemented a use case matching the original definition of the NISQ regime. This paper investigates the space, fidelity and time resources of various NISQ algorithms and highlights several contradictions between NISQ requirements and actual as well as future quantum hardware capabilities. Crucially, either two-qubit gate errors are still around the 0.1%-1% range (with superconducting qubits) or their number capping under 50 (with trapped ion qubits), which limits experiments to rather small algorithms instances that can easily be classically emulated. It then covers various techniques which could help like qubit fidelities improvements, various breeds of quantum error mitigation methods, analog-digital hybridization, using specific qubit types like multimode photons as well as quantum annealers and analog quantum computers (also quantum simulators or programmable Hamiltonian simulators) which seem closer to delivering useful applications although they have their own road to longer-term scalability challenges. Given all the constraints of these various solutions, it seems possible to expect some practical use cases for NISQ systems, but with a very narrow window before various scaling issues show up. Turning to the future, a scenario can be envisioned where NISQ will not necessarily be an intermediate step on the road to FTQC. Instead, the two may develop along different paths, due to their different requirements. NISQ requires a hundred or so qubits with gate fidelities well above 99.99% to outperform conventional supercomputers in speed or in energy efficiency, while FTQC accepts lesser gate fidelities, around 99.9%, but requires millions of qubits and very long range entanglement capabilities. This leaves open a key question on the trade-offs that may be necessary to make between qubit scale and qubit fidelities in future quantum computers designs.

CONTENTS

- **Is there a Moore's law for quantum computing?** (32 pages, Mars 2023, arXiv) qui pose la question de l'éventuelle existence d'une loi de Moore pour l'augmentation de la puissance des ordinateurs quantiques. La réponse est normande : cela dépend des indicateurs !



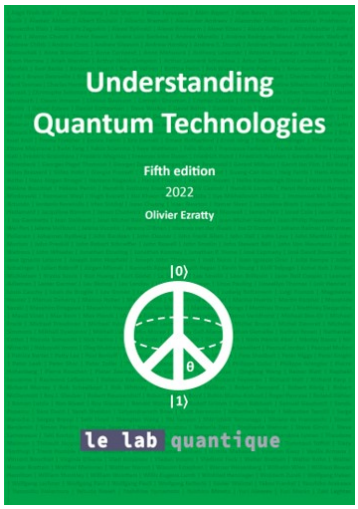
Is there a "Moore's law" for quantum computing?

Olivier Ezratty

MOORE'S LAW IN CLASSICAL COMPUTING

Figure 1 : Gordon Moore's law was a technology and also an economical prediction.

- **Understanding Quantum Technologies** 2022, 5th edition, published in September 2022, 1,128 pages.



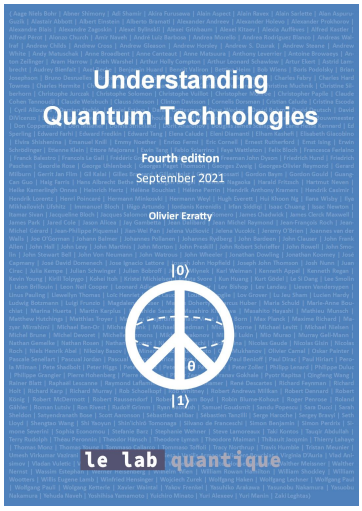
- **Mitigating the quantum hype** (24 pages, February 2022, arXiv) which describes the quantum hype phenomenon and proposes various ways to mitigate its potential negative effects.

Mitigating the quantum hype

Olivier Ezratty

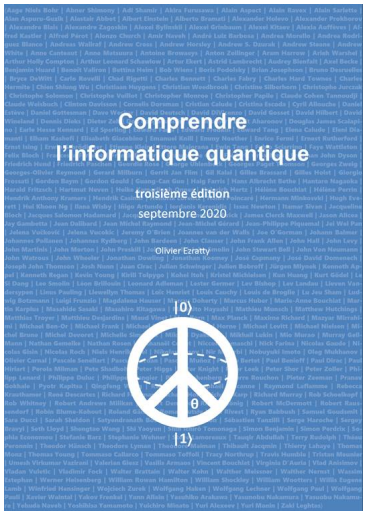
HYPE ONTOLOGY

- **Understanding Quantum Technologies 2021**, 4th edition, published in September 2021, 836 pages. It is the first version in English of this book, the three first named "Comprendre l'informatique quantique" having been published in French.

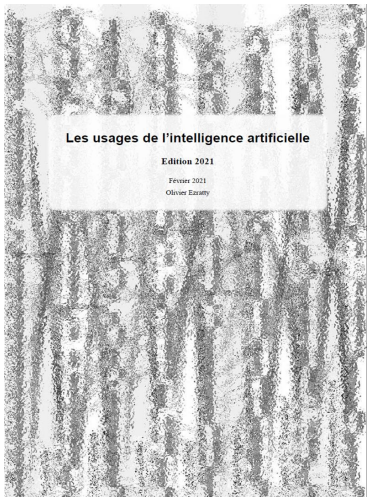


In French

- L'ebook **Comprendre l'informatique quantique**, troisième édition, publiée en septembre 2020, 682 pages, les deux premières datant de septembre 2018 et septembre 2019. C'est un condensé unique et complet qui fait un tour d'horizon très large des enjeux scientifiques, technologiques, industriels, géopolitiques et sociétaux de l'informatique quantique.

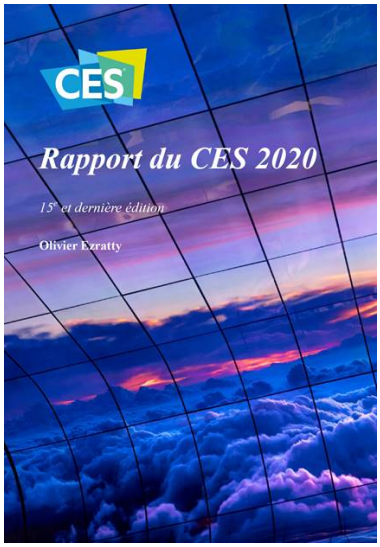


- L'ebook **Les usages de l'intelligence artificielle 2021**, en février 2021, 742 pages, une grosse mise à jour des éditions de 2017, 2018 et 2019.

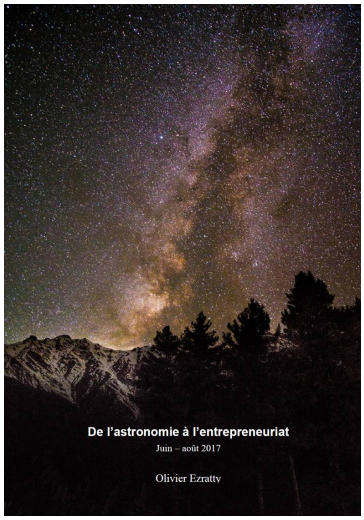


- Le **Guide des Startups 2019**, 23e édition, en avril 2019, 548 pages. C'est la dernière édition en date de 2022.

- Le **Rapport du CES 2020**, publié en janvier 2020, de 366 pages, le dernier d'une série lancée en 2006.

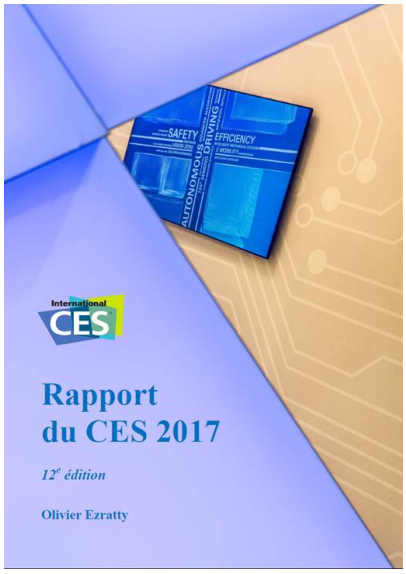


- Une compilation de 12 articles sur **l'astronomie et l'entrepreneuriat** publiée en août 2017 sous forme d'un ebook. Elle est focalisée sur la découverte des instruments d'observation de l'Univers, les télescopes spatiaux et terrestres ainsi que les radiotélescopes, puis sur les entrepreneurs qui s'intéressent à la conquête spatiale.



- J'ai rédigé la préface de "**Objets Connecté – La nouvelle révolution numérique**", un livre paru en février 2016 aux éditions ENI et écrit par Renaud Acas, Eric Barquisseau, Yves-Marie Boulvert, Frédéric Dosquet, Eric Dosquet et Jérémy Pirotte.

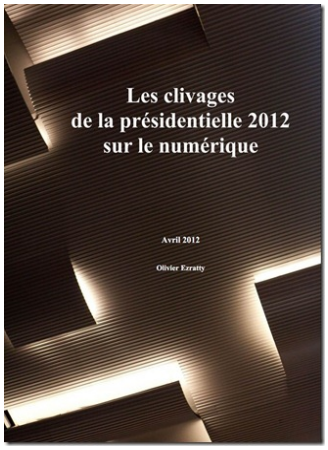
- Le **Rapport du CES 2017**, publié en janvier 2017. 396 pages, dans la lignée des rapports précédents.



- "**Tout tout tout sur la high-tech**", publié aux éditions Kawa. Il s'agit de la version "livre" du Rapport du

CES 2013.

- Une contribution sur le thème des blogs et celui des réseaux sociaux dans le **Dictionnaire Politique de l'Internet et du Numérique**, un ouvrage collectif paru en 2009 et diffusé par La Tribune.
- Le **Rapport du CES 2013**, publié en janvier 2013. 272 pages.
- Le **Rapport du CES 2012**, publié en janvier 2012. 244 pages.
- Le **Rapport du CES 2011**, publié en janvier 2011. 246 pages.
- Le **Rapport du CES 2010**, publié en janvier 2010. 204 pages.
- Le **Rapport du CES 2009**, publié en janvier 2009. 192 pages.
- Le **Rapport du CES 2008**, publié en janvier 2008. Ce document de 178 pages dresse un panorama très complet des technologies présentées au CES et lancées pendant l'année 2007.
- Le **Rapport du CES 2007**, publié en janvier 2007. Ce document de 164 pages avec 435 illustrations fait le tour des nouveautés présentées au CES et de l'année 2006.
- Le **Rapport du CES 2006**, publié en février/mars 2006 qui décrit les grandes tendances de ce salon. J'y décris également la présence française sur ce salon et les leçons que l'on peut en tirer.
- Le livre blanc sur **Les opportunités de la télévision numérique** qui fait un point sur ce secteur d'activité et particulier sur le développement de l'IPTV. Il met en évidence les bouleversements en cours de la chaine de valeur de ce secteur et propose quelques pistes d'actions pour l'industrie française.
- Les **clivages de la présidentielle 2012 sur le numérique**, un recueil d'une série de six articles au format PDF sur la manière dont les candidats à la présidentielle 2012 ont traité le thème du numérique. Le document traité également des propositions des professionnels du secteur et fournit quelques pistes de solutions à différents problèmes notamment au sujet de l'entrepreneuriat et de l'enseignement supérieur.



- Un **panorama des logiciels photo** qui reprend et complète une série de sept articles publiés en septembre 2008 sur les logiciels et services en ligne dédiés au traitement de la photo numérique.

- Un ensemble de propositions pour les Assises du Numérique "**Développer l'entrepreneuriat et faire réussir les startups dans les TICs**" publié en juillet 2008. C'est un document conçu de manière collective avec un grand nombre de contributeurs, cités dans la couverture.
- Un essai comparant **Google et Microsoft**, dans leurs stratégies de croissance, les effets de leur taille, leur relation au marché et à leur écosystème.
- Un **Trop d'Etat – Oui mais où ça?**, un essai publié en mars 2007 analysant les dépenses du secteur public dans son ensemble et tentant d'identifier où des économies ou redéploiements pourraient être réalisés.
- La coordination d'un numéro spécial "Opportunités de l'industries informatique en France" de la revue Centraliens (des anciens élèves de l'Ecole Centrale Paris) paru en juin 2006 et dont l'un des articles est disponible sur ce blog: l'**interview de Bernard Liautaud** de Business Objects.
- Une série d'articles sur le thème "Décrypter Microsoft" publiés dans la revue **DecisionMakers IT**, le premier étant dédié aux **programmes partenaires** de l'éditeur.
- Un **comparatif de lecteurs RSS** sous forme de tableau commenté associé à **ce post**.
- Un **Compte-rendu d'installation de Windows Vista**, datant de novembre 2006.
- Une étude de cas sur "**Le défi de l'innovation dans Windows**", publiée à l'occasion d'une présentation

réalisée aux Entretiens de la Technologie de Louis le Grand organisés par l'Institut de l'Entreprise en août 2005. Je l'ai faite pour le compte de Microsoft France.