III Workshop de Computação Quântica - UFSC

Prof. Dr. Eduardo Duzzioni

Departamento de Física
Universidade Federal de Santa Catarina
Florianópolis - SC

28 de Outubro de 2020

Histórico do evento

- I Workshop de Computação Quântica - UFSC
  1. Minicurso de introdução à computação quântica
  2. Temas das palestras: computação quântica, otimização, controle quântico, IA, criptografia pós-quântica e informação quântica com fótons.
  3. http://www.workshop-cq.ufsc.br/2018/
- II Workshop de Computação Quântica - UFSC
  1. Minicurso de introdução à computação quântica
  2. Hackathon de Computação Quântica
  3. Temas das palestras: computação quântica, IA, criptografia pós-quântica, criptografia quântica, algoritmos quânticos, simuladores quânticos.
  4. http://www.workshop-cq.ufsc.br/2019/

Todos os vídeos das edições anteriores podem ser encontrados no nosso canal no YouTube: **GCQ-UFSC**
https://www.youtube.com/channel/UC5dp-MbpdnKQxHgH9sotC3g/featured

Realização

Este evento é uma realização do grupo de Computação Quântica da UFSC
http://www.gcq.ufsc.br/

Professores:

- EID - Física
- Jerusa Marchi - Ciência da Computação
- Paulo Manoel Mafra - Ciência da Computação
- Clovis Aparecido Caface Filho
- Gisele Bosso de Freitas

Estudantes:

- Caio Boccato Dias de Góes - Física
- Otto Menegasso Pires - Ciência da Computação
- Evandro de Chagas Ribeiro da Rosa - Ciência da Computação
- Daniel Boso - Ciência da Computação
- Teo Haeser Gallarza - Ciência da Computação
- Tomaz de Souza Cruz - Física

Comunicação antes, durante e depois do evento

Slack do evento:
https://join.slack.com/t/brazilquantum/shared_invite/zt-htli8j7r-5GiwmkpvzSA8xv33h2QGiQ

Obrigado Brazil Quantum!

Perguntas aos palestrantes

https://app.sli.do/event/d68c0j97

O evento

O que esperar deste evento?

Motivação

g1 | ge | gshow | vídeos ASSINE JÁ MINHA CC

G1 FLORIANÓPOLIS, UMA CIDADE PARA TODOS

ESPECIAL PUBLICITÁRIO

"Ilha do Silício": Rede de Inovação Florianópolis faz da capital um polo de tecnologia

Ações conjuntas entre a Prefeitura Municipal e a Associação Catarinense de Tecnologia que fomentam a inovação e estimulam negócios locais colocam Florianópolis no mapa mundial do empreendedorismo tecnológico

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Page last updated at 12:48 GMT, Friday, 2 October 2009 13:48 UK

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Brazil's bid for tech-powered economy

By Tayfun King
BBC Click

At first glance Florianopolis, in southern Brazil, resembles the quintessential picture postcard resort. It has become one of South America's most popular destinations, a magnet for sun seekers.

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Segunda revolução quântica

Através da manipulação individual dos agentes do mundo quântico é possível utilizar as suas propriedades como emaranhamento, squeezing e superposição de estados quânticos para crias tecnologias quânticas:

- **Sensores quânticos e metrologia quântica:** sensores de campos magnéticos, campos elétricos, temperatura, etc, e medidas ultraprecisas de tempo, espaço e fase. São utilizados em satélites para GPS, definição de tempo, resolução ótica, detecção de terremotos, ondas gravitacionais, matéria escura, ...

- **Comunicação quântica:** distribuição de chaves quânticas e gerador quântico de números aleatórios. São utilizados em comunicação por cabo ou espacial e em segurança.

Segunda revolução quântica

- **Computação quântica:** Permite a construção de algoritmos quânticos mais velozes para o processamento de informação. Podem ser utilizados para acelerar buscas em banco de dados, quebrar chaves criptográficas, resolver problemas de álgebra linear, big data, Machine Learning, problemas de otimização na indústria farmacêutica e química, na agricultura, na produção de energia, como petróleo e gás, etc.

- **Memória quântica:** Permite armazenar uma quantidade exponencialmente maior de informação. São úteis como memórias de computadores quânticos (QRAM).

Segunda revolução quântica

- **Simulação quântica:**Permite usar computadores quânticos para simular outros sistemas Físicos. São úteis na própria Física, permitindo simular de maneira eficiente moléculas e materiais, possibilitando a descoberta de novas moléculas e materiais.

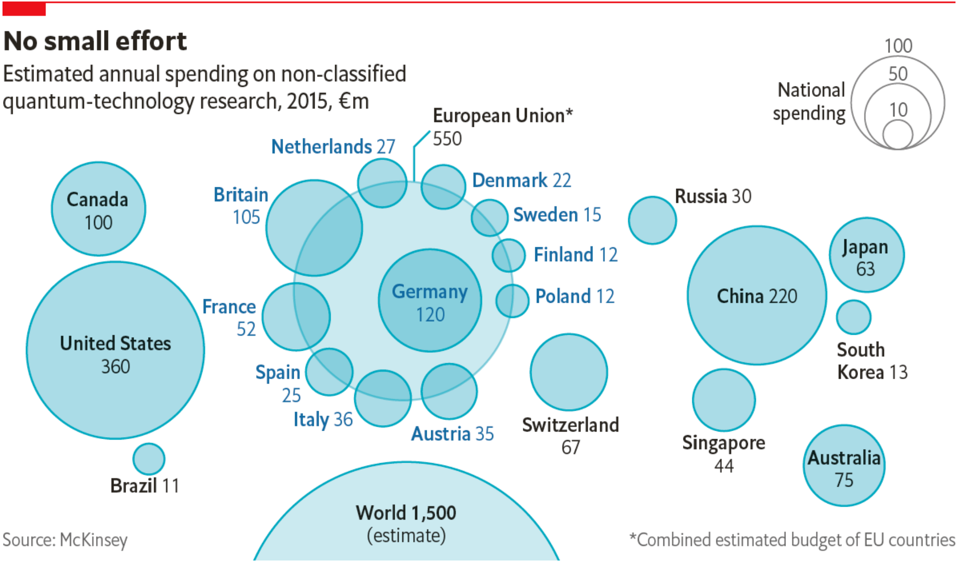
- **Redes quânticas:** Permitem a realização de computação quântica distribuída e a criação da internet quântica.

Players

Companhia/Organização	Exemplos	Total
Governos/ Organizações sem fins lucrativos	Beijing Academy of Quantum Information Sciences (BAQIS), na China; Berkeley Quantum, nos EUA; CEA-Leti, na França; Centre for Quantum Computation & Communication Technology (CQC2T), na Austrália; NASA Ames – Quantum Artificial Intelligence Laboratory (QuAIL), nos EUA; Perimeter Institute , no Canadá; Russian Quantum Center, na Rússia; Quantum World Association.	45
Startups	Cambridge Quantum Computing Limited (CQC), no Reino Unido; D-Wave Systems Inc., no Canadá; Huawei, na China; IonQ, nos EUA; Quantum Mads, na Espanha; Rigetti Computing, nos EUA; Tokyo Quantum Computing, no Japão; Xanadu, no Canadá.;	195
Grandes empresas	Amazon Braket, nos EUA; Google Quantum AI Lab, nos EUA; IBM, nos EUA; Intel, nos EUA; Mitsubishi Electric, no Japão; Nokia Bell Labs, na Finlândia; Toshiba – Cambridge Research Laboratory, no Reino Unido.	26
Universidades	MIT Center for Quantum Engineering (MIT-CQE), nos EUA; University of California Berkeley – Berkeley Quantum Information & Computation Center, nos EUA; University of British Columbia – Quantum Matter institute, no Canadá; University College London – Quantum Science and Technology Institute (UCLQ), no Reino Unido; University of Tokyo, no Japão; Sorbonne Université – Quantum Information Center, na França; University of Lisbon/Instituto de Telecomunicações, em Portugal; National University of La Plata – Quantum Information Research Group (QILP), na Argentina.	137

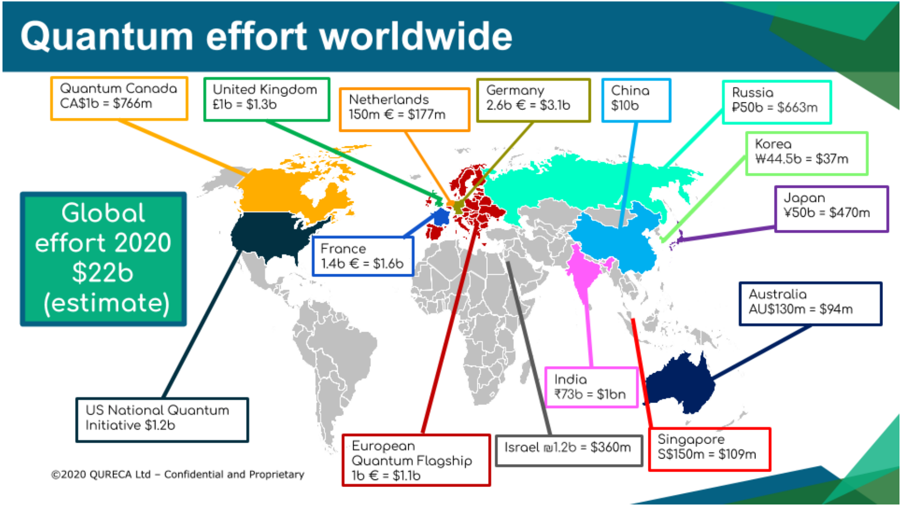
Fonte: https://quantumcomputingreport.com (Em 22-10-2020)

Cifras investidas em 2015



Fonte: https://www.economist.com

Cifras investidas em 2020



Fonte: https://www.qureca.com

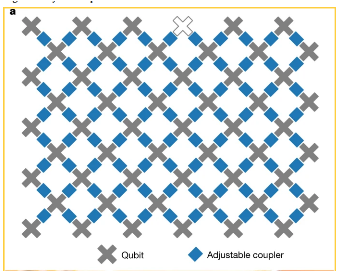
Supremacia Quântica

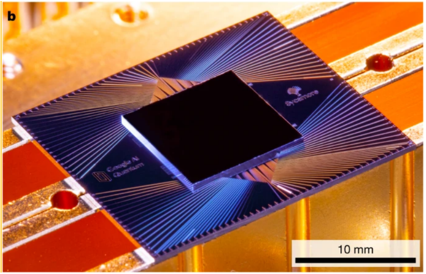
Article | Published: 23 October 2019

Quantum supremacy using a programmable superconducting processor

Frank Arute, Kunal Arya, [...] John M. Martinis

Nature **574**, 505–510(2019) | Cite this article





Fonte: https://www.nature.com

Simulação de moléculas, para design de fármacos e descoberta de materiais

Quantum Chemistry in the Age of Quantum Computing

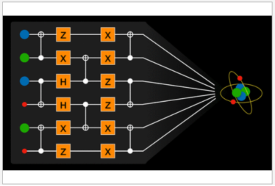
Yudong Cao, Jonathan Romero, Jonathan P. Olson, Matthias Degroote, Peter D. Johnson, Mária Kieferová, Ian D. Kivlichan, Tim Menke, Borja Peropadre, Nicolas P. D. Sawaya, Sukin Sim, Libor Veis, and Alán Aspuru-Guzik*

Cite this: *Chem. Rev.* 2019, 119, 19, 10856–10915
Publication Date: August 30, 2019
https://doi.org/10.1021/acs.chemrev.8b00803

SUBJECTS: Algorithms, Wave function, Quantum mechanics, Mathematical methods, Hamiltonians

Abstract

Practical challenges in simulating quantum systems on classical computers have been widely recognized in the quantum physics and quantum chemistry communities over the past century. Although many approximation methods have been introduced, the complexity of quantum mechanics remains hard to appease. The advent of quantum computation brings new pathways to navigate this challenging and complex landscape. By manipulating quantum states of matter and taking advantage of their unique features such as superposition and entanglement, quantum computers promise to efficiently deliver accurate results for many important problems in quantum chemistry, such as the electronic structure of molecules. In the past two decades, significant advances have been made in developing algorithms and physical hardware for quantum computing, heralding a revolution in simulation of quantum systems. This Review provides an overview of the algorithms and results that are relevant for quantum chemistry. The intended audience is both quantum chemists who seek to learn more about quantum computing and quantum computing researchers who would like to explore applications in quantum chemistry.



Fonte: https://pubs.acs.org/

Algoritmo que pode simular processos quânticos que duram mais do que o tempo de coerência dos próprios qubits

npj | Quantum Information

www.nature.com/npjqi

ARTICLE OPEN

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Variational fast forwarding for quantum simulation beyond the coherence time

Cristina Cîrstoiu[1,2,6], Zoë Holmes[1,3,4,6], Joseph Iosue[1,5], Lukasz Cincio[1], Patrick J. Coles[1]✉ and Andrew Sornborger[3]✉

Trotterization-based, iterative approaches to quantum simulation (QS) are restricted to simulation times less than the coherence time of the quantum computer (QC), which limits their utility in the near term. Here, we present a hybrid quantum-classical algorithm, called variational fast forwarding (VFF), for decreasing the quantum circuit depth of QSs. VFF seeks an approximate diagonalization of a short-time simulation to enable longer-time simulations using a constant number of gates. Our error analysis provides two results: (1) the simulation error of VFF scales at worst linearly in the fast-forwarded simulation time, and (2) our cost function's operational meaning as an upper bound on average-case simulation error provides a natural termination condition for VFF. We implement VFF for the Hubbard, Ising, and Heisenberg models on a simulator. In addition, we implement VFF on Rigetti's QC to demonstrate simulation beyond the coherence time. Finally, we show how to estimate energy eigenvalues using VFF.

npj Quantum Information (2020)6:82 ; https://doi.org/10.1038/s41534-020-00302-0

Fonte: https://www.nature.com

“Ampliando Simulações Fundamentais de Química Quântica”

Google AI Blog

The latest news from Google AI

Scaling Up Fundamental Quantum Chemistry Simulations on Quantum Hardware

Thursday, August 27, 2020

Posted by Nicholas Rubin and Charles Neill, Research Scientists, Google AI Quantum

Accurate computational prediction of chemical processes from the quantum mechanical laws that govern them is a tool that can unlock new frontiers in chemistry, improving a wide variety of industries. Unfortunately, the exact solution of quantum chemical equations for all but the smallest systems remains out of reach for modern classical computers, due to the exponential scaling in the number and statistics of quantum variables. However, by using a quantum computer, which by its very nature takes advantage of unique quantum mechanical properties to handle calculations intractable to its classical counterpart, simulations of complex chemical processes can be achieved. While today's quantum computers are powerful enough for a clear computational advantage at some tasks, it is an open question whether such devices can be used to accelerate our current quantum chemistry simulation techniques.

In “Hartree-Fock on a Superconducting Qubit Quantum Computer”, appearing today in *Science*, the Google AI Quantum team explores this complex question by performing the largest chemical simulation performed on a quantum computer to date. In our experiment, we used a noise-robust variational quantum eigensolver (VQE) to directly simulate a chemical mechanism via a quantum algorithm. Though the calculation focused on the *Hartree-Fock* approximation of a real chemical system, it was twice as large as previous chemistry calculations on a quantum computer, and contained ten times as many quantum gate operations. Importantly, we validate that algorithms being developed for currently available quantum computers can achieve the precision required for experimental predictions, revealing pathways towards realistic simulations of quantum chemical systems. Furthermore, we have released the code for the experiment, which uses OpenFermion, our

Fonte: https://ai.googleblog.com

“Roteiro da IBM na escalada da tecnologia quântica”

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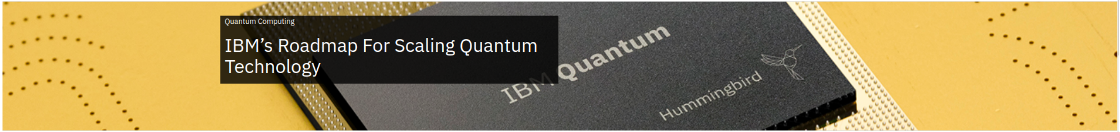


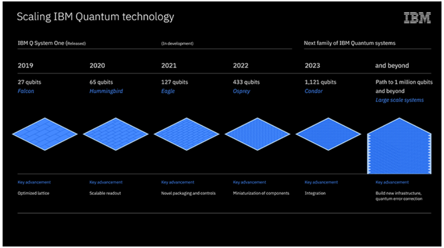
September 15, 2020 | Written by: Jay Gambetta

Categorized: Quantum Computing

Share this post:

Back in 1969, humans overcame unprecedented technological hurdles to make history: we put two of our own on the Moon and returned them safely. Today’s computers are capable, but assuredly earthbound when it comes to accurately capturing the finest details of our universe. Building a device that truly captures the behavior of atoms—and can harness these behaviors to solve some of the most challenging problems of our time—might seem impossible if you limit your thinking to the computational world you know. But like the Moon landing, we have an ultimate objective to access a realm beyond what’s possible on classical computers: we want to build a large-scale quantum computer. The future’s quantum computer will pick up the slack where classical computers falter, controlling the behavior of atoms in order to run revolutionary applications across industries, generating world-changing materials or transforming the way we do business.

Today, we are releasing the roadmap that we think will take us from the noisy, small-scale devices of today to the million-plus qubit devices of the future. Our team is developing a suite of scalable, increasingly larger and better processors, with a 1,000-plus qubit device, called IBM Quantum Condor, targeted for the end of 2023. In order to house even more massive devices beyond Condor, we’re developing a dilution refrigerator larger than any currently available commercially. This roadmap puts us on a course toward the future’s million-plus qubit processors thanks to industry-leading knowledge, multidisciplinary teams, and agile methodology improving every element of these systems. All the while, our hardware roadmap sits at the heart of a larger mission: to design a full-stack quantum computer deployed via the cloud that anyone around the world can program.



Fonte: https://www.ibm.com/blogs

“IonQ revela o computador quântico mais poderoso do mundo”

IONQ   Company   Technology   Resources   Get Started

COLLEGE PARK, MD — OCTOBER 1, 2020

IonQ Unveils World’s Most Powerful Quantum Computer.

IonQ, the leader in quantum computing, today unveiled its next generation quantum computer system. The new hardware features 32 perfect qubits with low gate errors, giving it an expected quantum volume greater than 4,000,000.

The new system consists of perfect atomic clock qubits and random access all-to-all gate operations for efficient software compilation of applications. It will be first available via private beta, and then commercially available on Amazon Braket, where IonQ’s 11 qubit system is generally available for customers today, and Microsoft's Azure Quantum. Pre-existing IonQ customers and partners, including 1QBit, Cambridge Quantum Computing, QC Ware, Zapata Computing and more are excited to experience the benefits of the new system, enabling them to drive towards the first wave of quantum applications.

The company's trapped-ion quantum computers have a proven track record of outperforming all other available quantum hardware. With this new iteration, IonQ continues to lead the quantum computing field into the future. IonQ is already

Fonte: https://ionq.com/news

Serviços disponíveis

- D:Wave The Quantum Computing Company™
- IBM Quantum Experience.
- rigetti
- XANADU
- aws Amazon Braket: Rigetti, IonQ, D-Wave.
- Microsoft Azure Quantum: Honeywell, IonQ e QCI.

Computação quântica no Brasil

Como está o avanço da computação quântica no Brasil?