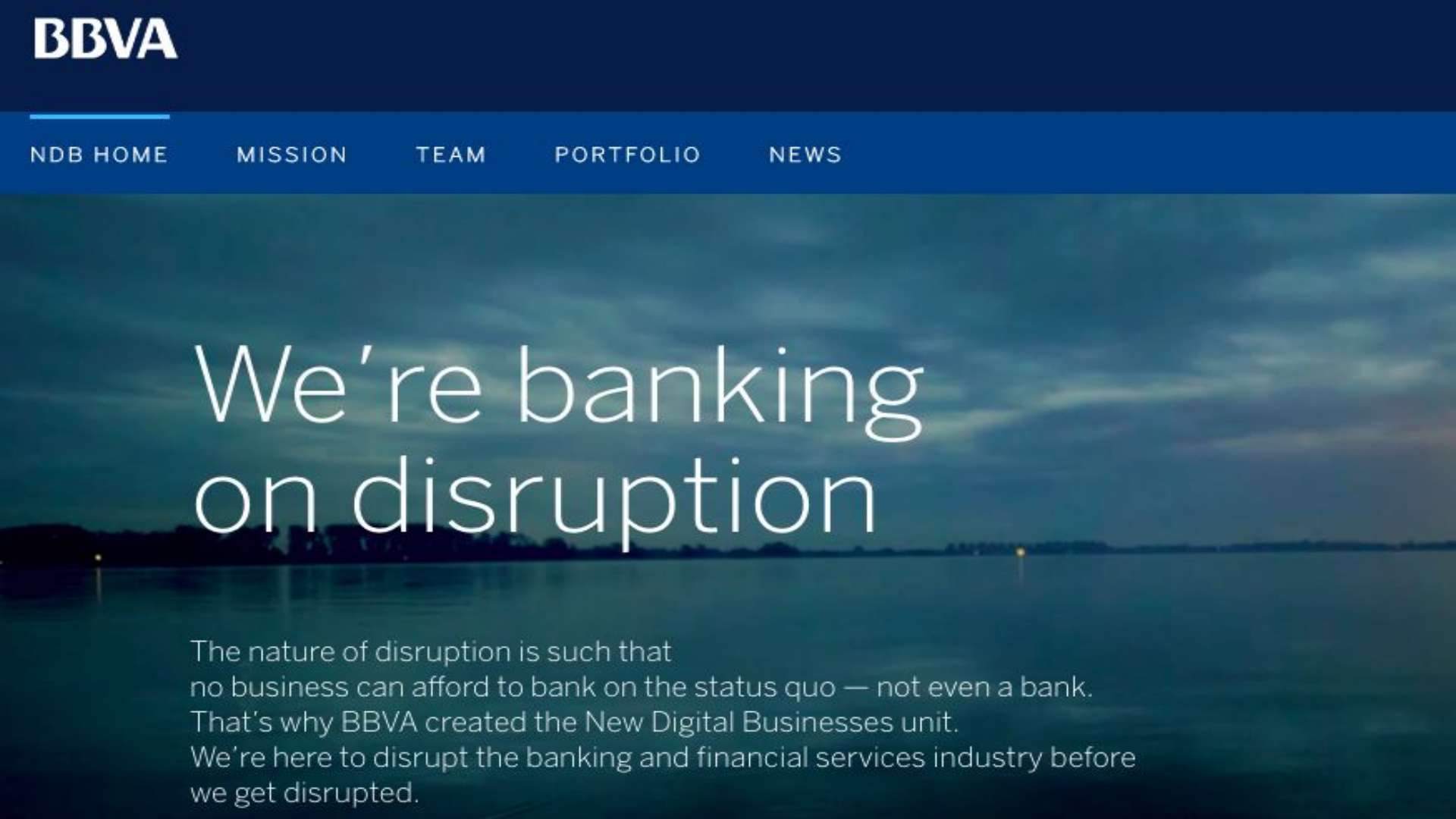
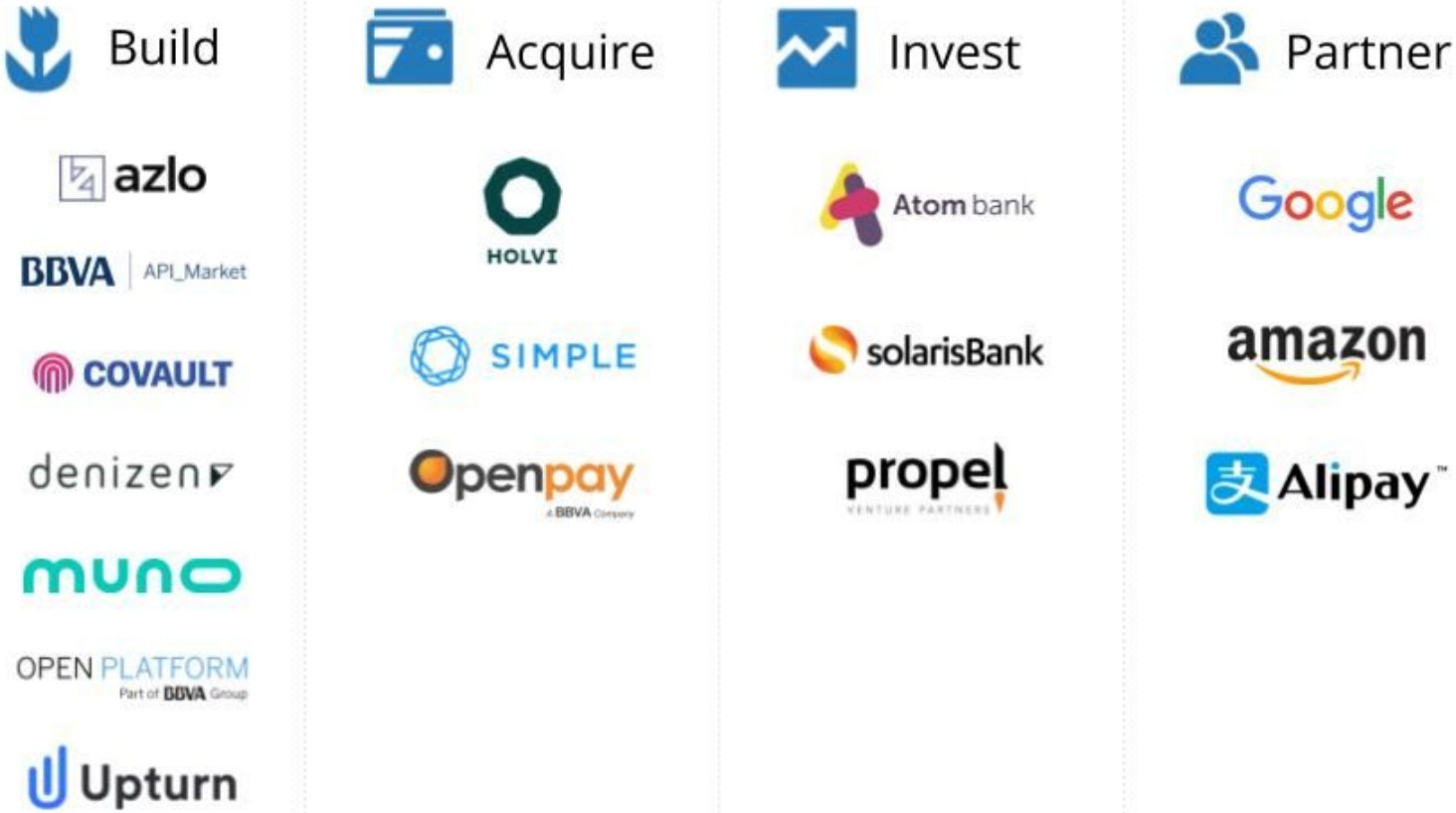
BBVA

Creando Oportunidades

Quantum Information and visions for financial uses cases

May 2019


BBVA
NDB HOME
MISSION
TEAM
PORTFOLIO
NEWS
We're banking on disruption
The nature of disruption is such that
no business can afford to bank on the status quo — not even a bank.
That's why BBVA created the New Digital Businesses unit.
We're here to disrupt the banking and financial services industry before we get disrupted.


Build
azlo
BBVA API_Market
COVAULT
denizen
muno
OPEN PLATFORM
Part of BBVA Group
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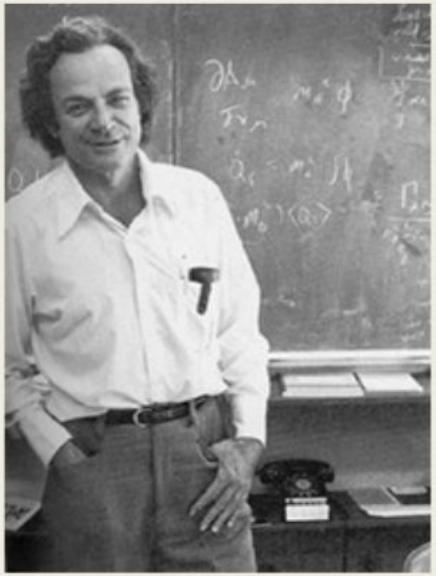
R&D

- "Simulating Physics with Computers"

  Richard Feynman – Keynote Talk, 1st Conference on Physics and Computation, MIT, 1981



Is it possible to build computers that use the laws of quantum mechanics to compute?

Juan Ignacio Cirac

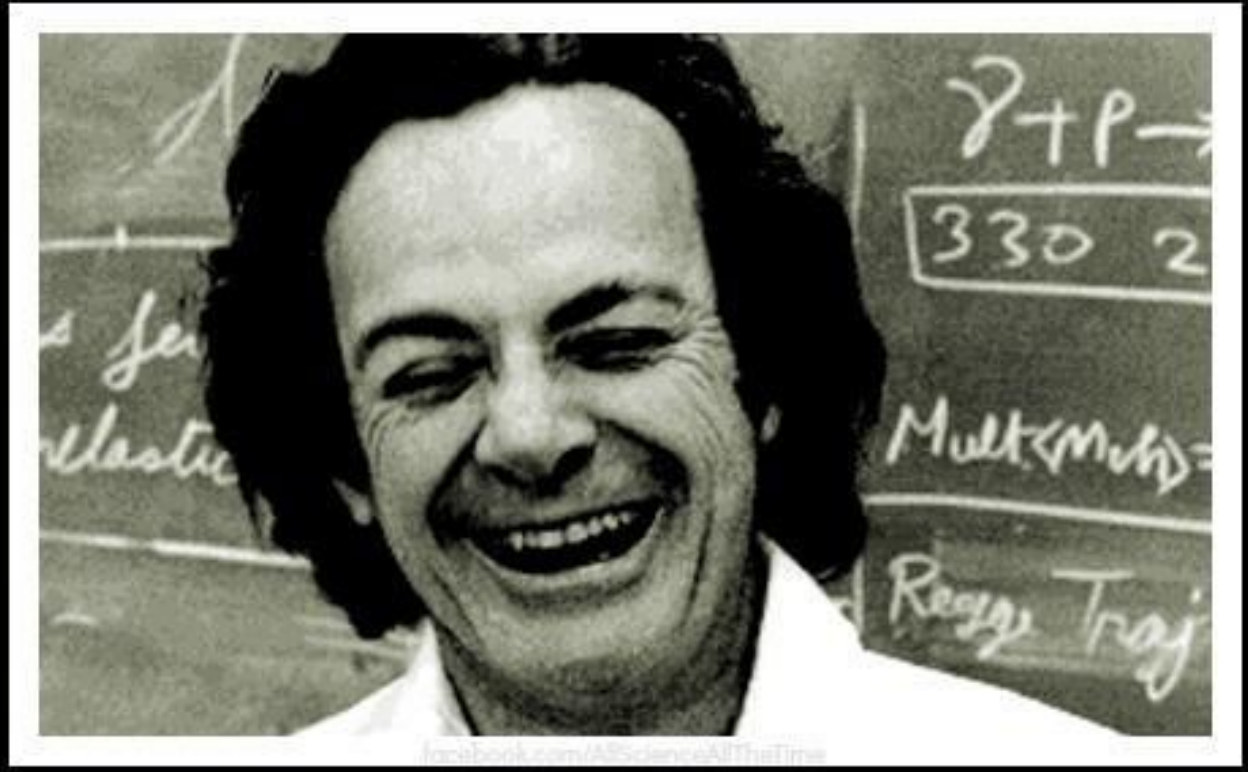
VOLUME 74, NUMBER 20 PHYSICAL REVIEW LETTERS 15 MAY 1995

Quantum Computations with Cold Trapped Ions

J. I. Cirac and P. Zoller*
Institut für Theoretische Physik, Universiät Innsbruck, Technikerstrasse 25, A-6020 Innsbruck, Austria
(Received 30 November 1994)

A quantum computer can be implemented with cold ions confined in a linear trap and interacting with laser beams. Quantum gates involving any pair, triplet, or subset of ions can be realized by coupling the ions through the collective quantized motion. In this system decoherence is negligible, and the measurement (readout of the quantum register) can be carried out with a high efficiency.

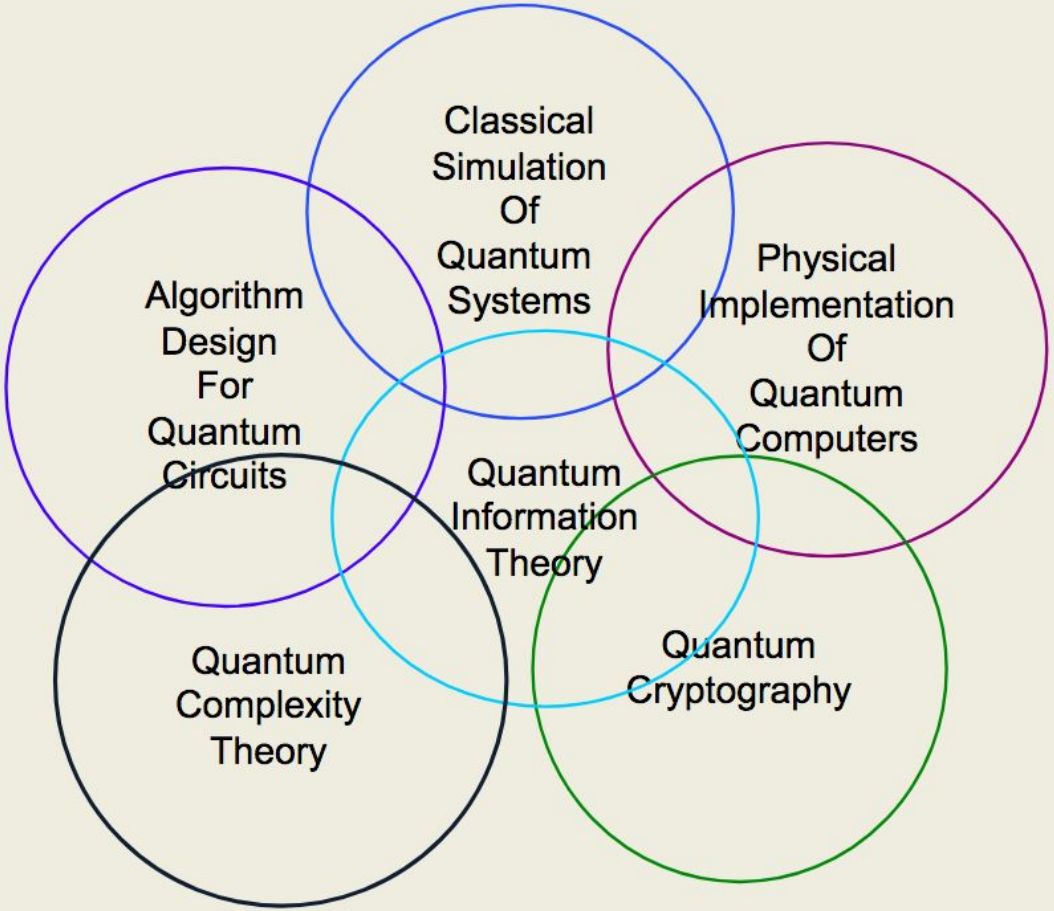
1995. When the scientific community began to take seriously the possibility of building a physical quantum computer



"Anyone who claims to understand quantum theory is either lying or crazy."

-Richard Feynman

Computer Science <-> Quantum Mechanics

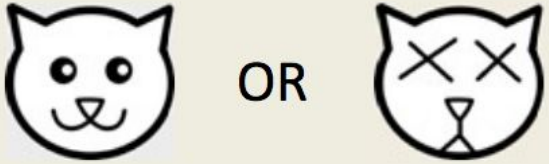


A natural classification of different quantum technologies according the role of quantum/classical information

- **Acquisition**
  - Quantum clocks, quantum random number generators, quantum sensing...
- **Storage**
  - Quantum memories
- **Processing**
  - Quantum computation, quantum simulation, quantum AI...
- **Communication**
  - Quantum teleportation, quantum cryptography....

Information: 1 Bit Example (Schrodinger's Cat)

- Classical Information:
  - A bit is in state 0 or state 1
- Classical Information with Uncertainty
  - State (p_0, p_1)
- Quantum Information
  - State is partly 0 and partly 1
  - State is (α_0, α_1) where α_0, α_1 are **complex**.



X=1 X=0

X=1 with prob p_1 X=0 with prob p_0

$$\alpha_1 \left| \text{cat} \right\rangle + \alpha_0 \left| \text{cat} \right\rangle$$

Mathematical representation: example

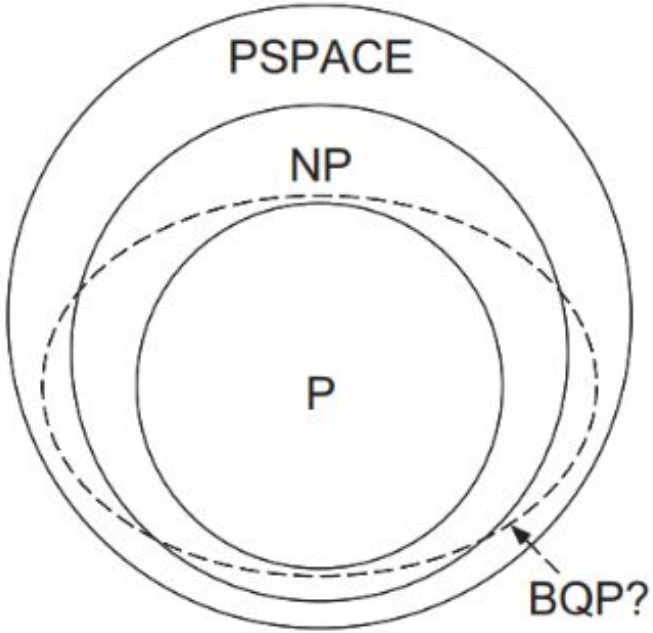
$$|\Psi\rangle = \frac{1}{\sqrt{2}}\left(|\text{  }\rangle + |\text{  }\rangle\right)$$

Jon Snow is neither alive nor dead: the outcome of the experiment is not defined until measured.

$|\ \ \rangle$ Dirac notation for a vector (ket)

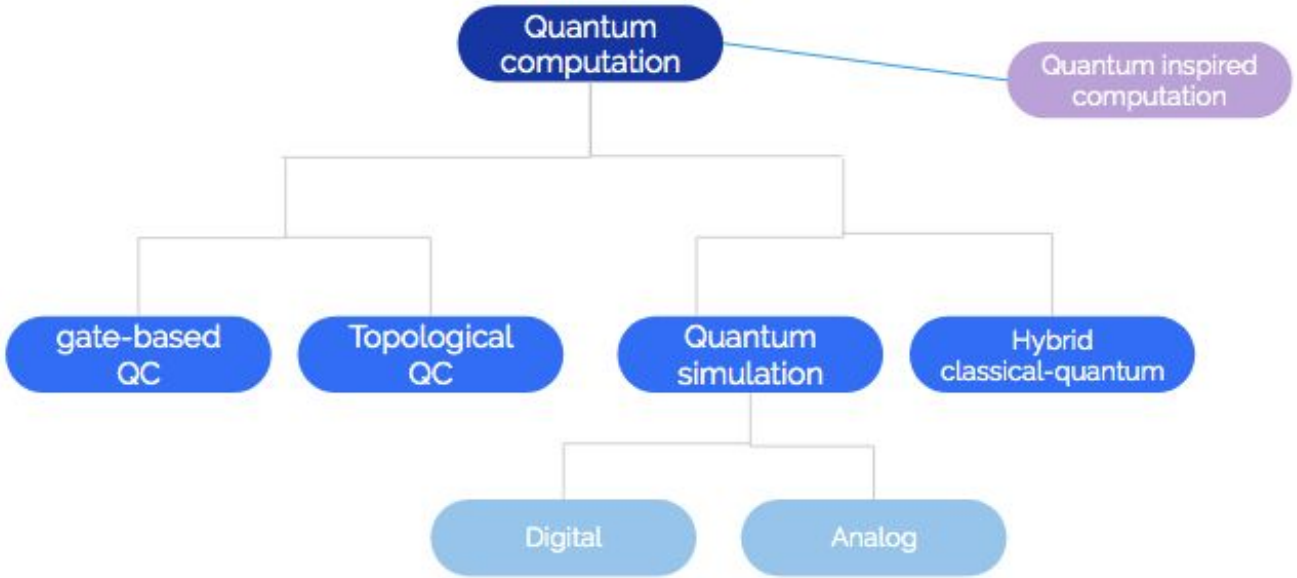
$|\Psi\rangle$ Jon Snow's wave function

Computational Complexity



Quantum computers can solve all **P** and certain **NP** problems (not all), like factoring.

Types of quantum computation



Quantum algorithms

Quantum algorithms based on the quantum Fourier transform: *Classically, the fast Fourier transform takes about $n2^n$ steps, n being the number of bits. On a quantum computer it takes about n^2 ⇒ exponential speed-up*

Quantum search algorithms: Given a search space of size N, classically it takes about N operations to find an element. Quantum search algorithms allow to find it in √N⇒quadratic speed-up

Credit scoring:

optimal feature selection for credit scoring[12], or using neural network training in network in credit scoring[13], are optimization problem that may be improved using quantum resources previously mentioned.

Risk analysis and asset pricing:

Monte Carlo simulations[14] are frequently employed for risk estimation, like VaR quantification, and for asset pricing or derivatives pricing[15].

Portfolio and Trading Optimization:

in this category we include different versions of optimization problems such as portfolio optimization[7], index tracking optimization[8], dynamic portfolio selection, optimizing trading trajectories[9] or optimal arbitrage opportunities[10].

Ethics ^{2}

Gerd

Exponential technologies needs exponential ethics