CRÉDIT AGRICOLE
CORPORATE & INVESTMENT BANK

Quantum Computing Initiative

AN OVERVIEW

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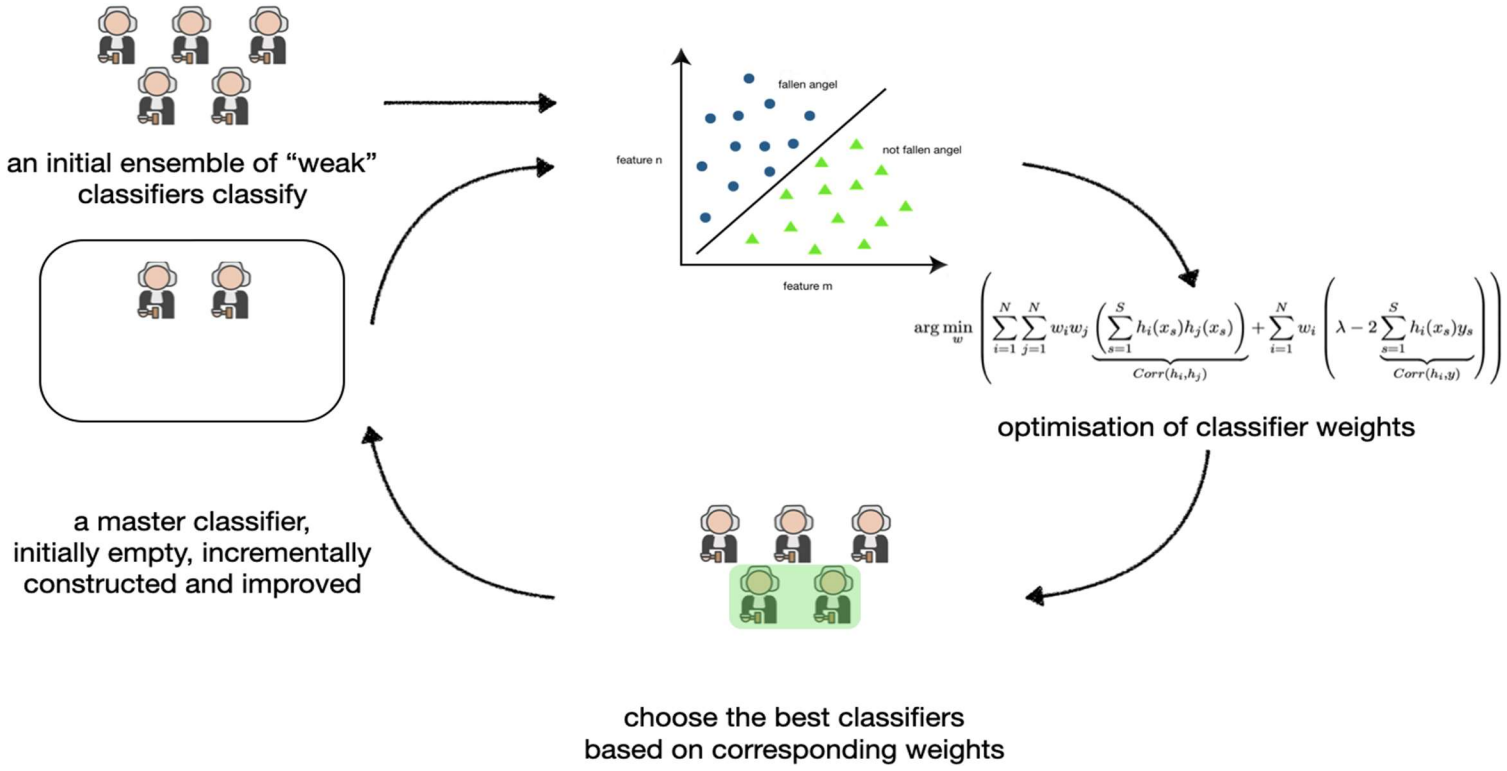
Quantum computing in finance

- Banks run a lot of computations on a daily basis to solve different types of problems
  - Pricing financial instruments : calculating the price of tailor-made payoffs accurately
  - Portfolio optimization under constraints : asset allocation, optimal hedging,
  - Model calibration : Rating models, asset dependent LGDs, correlation and volatility models
  - Risk measures estimation and forecast : Tail risk, sensitivities to risk factors, scenario-based stress tests

- Accuracy and speed are key for a bank to survive in the financial industry. Failing to deliver fast and accurate calculations generates commercial and financial losses
- Banks use of complex quantitative algorithms, sophisticated hardware and high computational capacity to achieve computations that are acceptable both in terms of precision and speed
- As quantum computers bring the promise of disruptive computation capacity, Credit Agricole CIB has launched projects aiming at implementing real world financial problems in a quantum computer
- The problem presented in the following is about the optimization of a risk measure. Its “classical version” is used within the bank in a daily basis

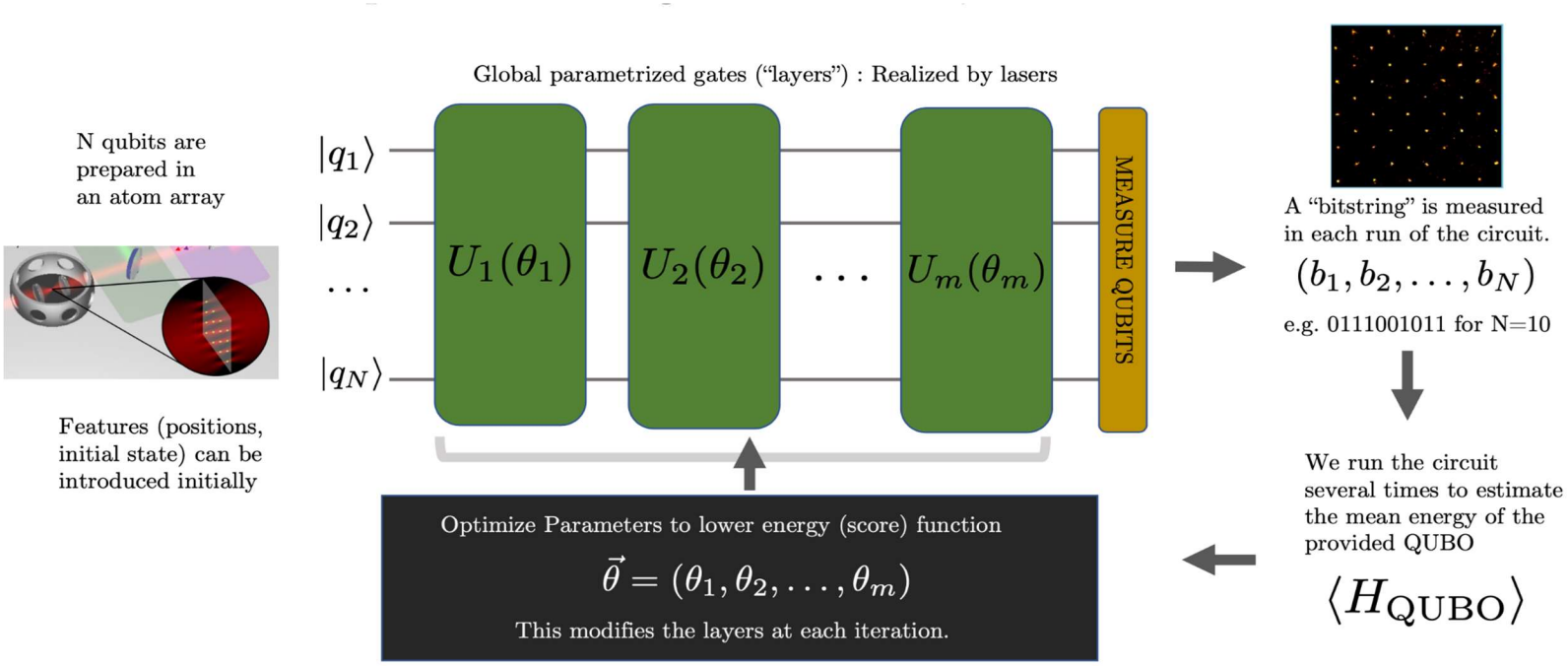
Problem Implementation

QBOOST Algorithm



Problem Implementation

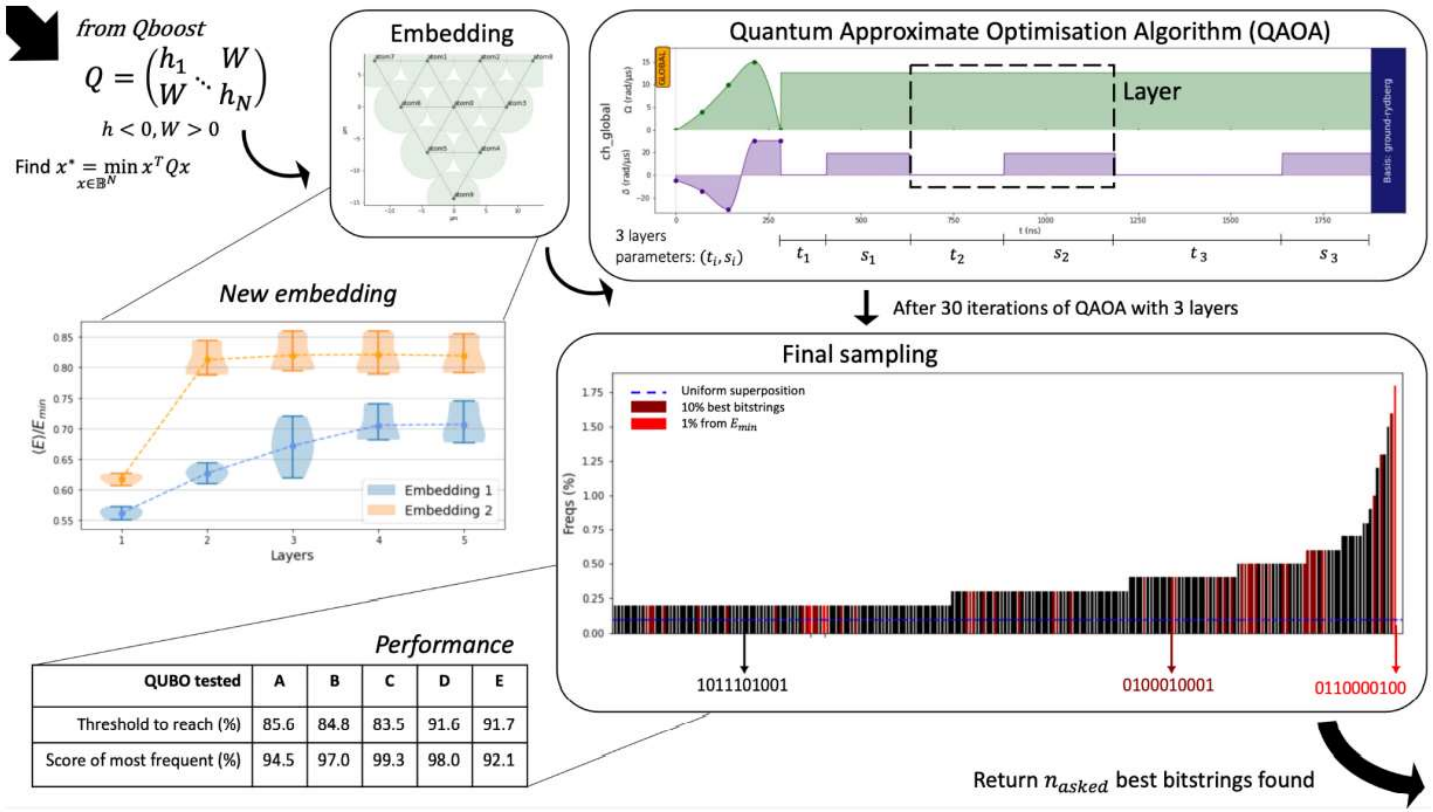
QAOA Algorithm



When the desired accuracy is obtained, we sample the final circuit and analize the statistics.

Problem Implementation

QAOA Implementation

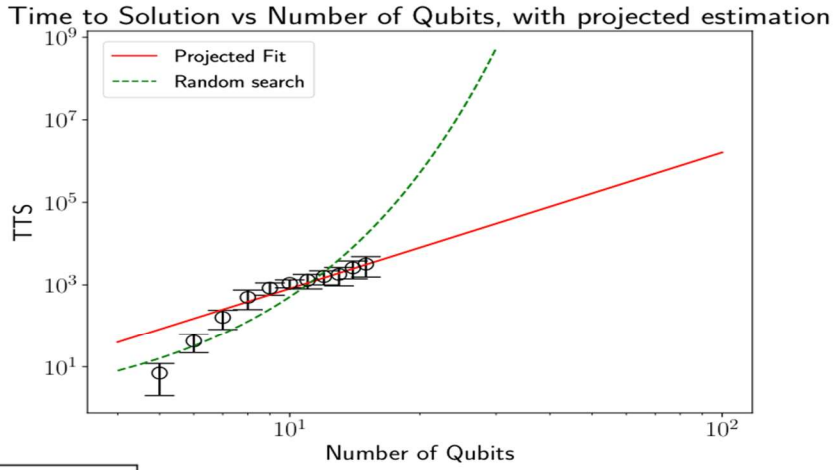


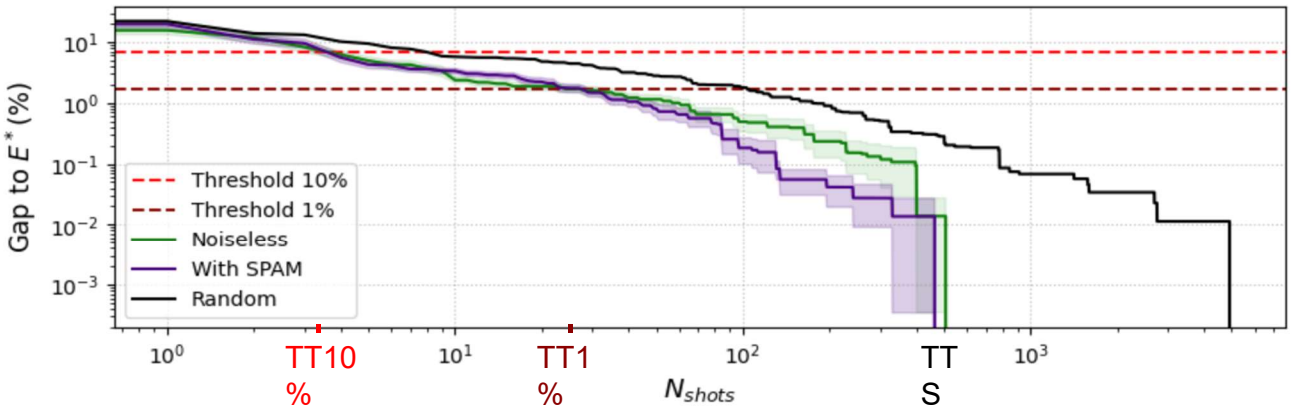
QUBO tested	A	B	C	D	E
Threshold to reach (%)	85.6	84.8	83.5	91.6	91.7
Score of most frequent (%)	94.5	97.0	99.3	98.0	92.1

Problem Implementation

Time to Solution

- Shot budget increases with QUBO size
- TTS (plot) is an upper bound (a ceiling) to the number of shots necessary to observe the solution.
- TTS is related to the machine time (in hours) by a factor of ~ 10^5 (depends on the clock rate of the QPU)
- **We estimate the running time to be on the order of ½ day for 100 qubits**





Qubo 0	pTT10%	pTT1%	pTTS
Random	9.89	101.6	1049
Optimised	4.4	15.3	180