TERATEC / TQCI – IBM Seminar

Industrialization and deployment of quantum computing technologies : **Typical Hurdles identified to scale**

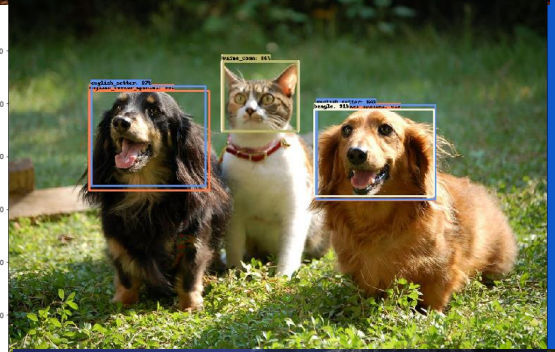
IBM

EDF

Planning

- Delivering Machine Learning & Delivering Quantum Algorithms

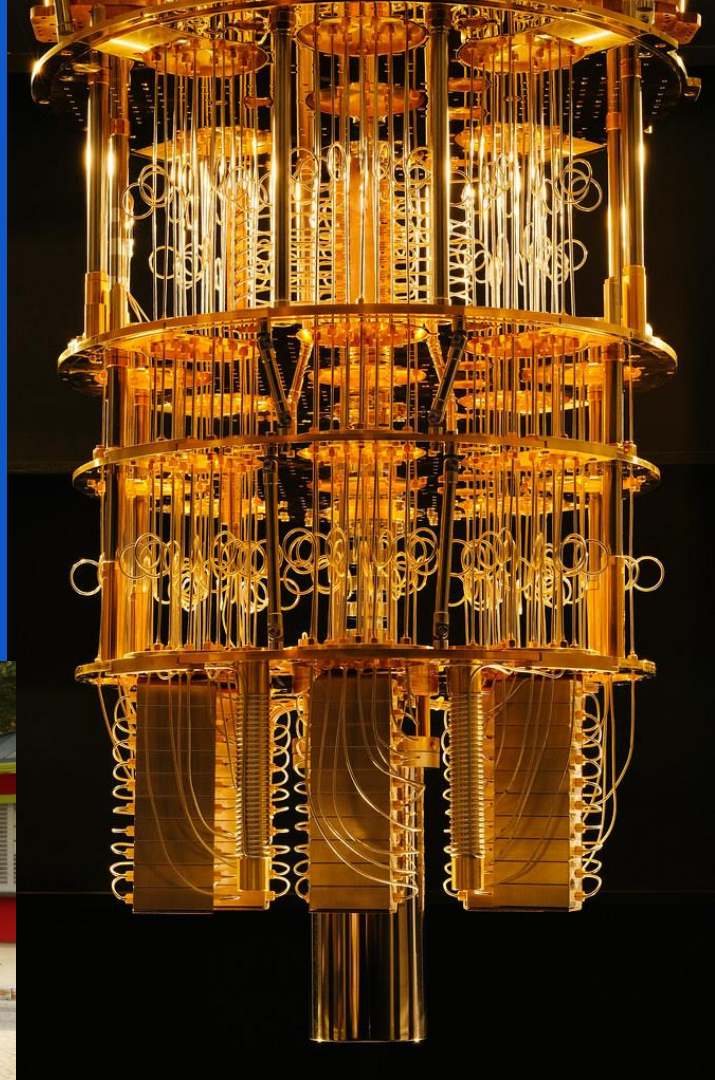
- Some thoughts on the scaling, apart from hardware



Delivering Machine Learning

&

Delivering Quantum Algorithms



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< 2018 : Delivering Machine Learning despite some bottlenecks

An example of bad google trad translation which was common at that time

Machine Learning before 2018

Was not in use anywhere except in tech companies	✗
Was struggling to theoretically demonstrate its convergence	✗
Was coming with a lot of promise and buzz	✓
Was not considered as a science	✗
Was accused of being black boxes	✗
Needed a lot of recipes to work	✗

< 2018 : Delivering Machine Learning VS Error corrected algorithm today

Machine Learning before 2018		Error corrected Quantum Algorithms
Was not in use anywhere except in tech companies	✗	✗ Is not in use anywhere
Was struggling to theoretically demonstrate its convergence	✗	✓ Theoretically demonstrated as superior
Was coming with a lot of promise and buzz	✓	✓ Come with a lot of promises and buzz
Was not considered as a science	✗	✓ Is considered as science
Was accused of being black boxes	✗	✓ Who cares about black boxes?
Needed a lot of recipes to work	✗	✓ Should always work

<2018 : Delivering Machine Learning VS Noisy Variational today …

Machine Learning before 2018		Noisy Variational algorithms	
Was not in use anywhere except in tech companies	✗	✗	Is not (seriously) in use anywhere
Was struggling to theoretically demonstrate its convergence	✗	✗	Has no demonstration of convergence
Was coming with a lot of promise and buzz	✓	✗	Applications begins to concern end users
Was not considered as a science	✗	✓	Is considered as science
Was accused of being black boxes	✗	✓	Who cares about black boxes?

<2018 : … Delivering Machine Learning VS Noisy Variational today

Machine Learning before 2018

Needed a lot of recipes to work ×

BUT

Benefited from abundant and free IT resources to demonstrate empirically its superiority ✓

And Non Black boxes free libraries that allowed end users to play with the tool (including cuda & Tensorflow) ✓

Last month 18M download of Tensor Flow !

Noisy Variational algorithms

× Needs a lot of recipes to work

AND

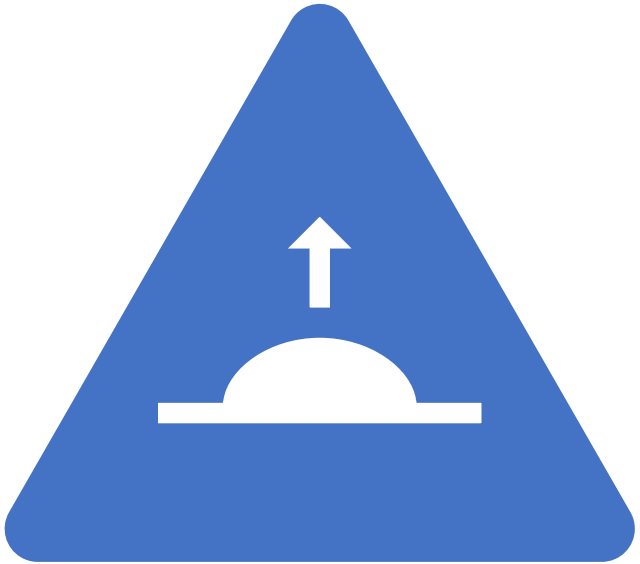
× Suffers from expensive resources (both for industries and academics)

× Benefits from qiskit but some competitors propose a packaging quantum into an easy « quantum free » access is growing

Question

Will we demonstrate anything on Noisy machines without a free and abundant access to machines?

Some thoughts on the road to scaling



The Wait (for machines) and See temptation

Wait until machines to arrive might be a problem :

A lot of algorithms hurdles to overcome

On NISQ : convergence, interest when compared to their classical counterparts

On FTQC : Oracle encoding, search space for some algorithms, …

Beside algorithms, the question of encoding the case of interest is a major issue

➔ The Roadmap on hardware might be completed with a roadmap on software and integration (at least internally)

Poc-king limitations
The journey from 2019 to now.

Until now, we were PoC-king a lot on toy model

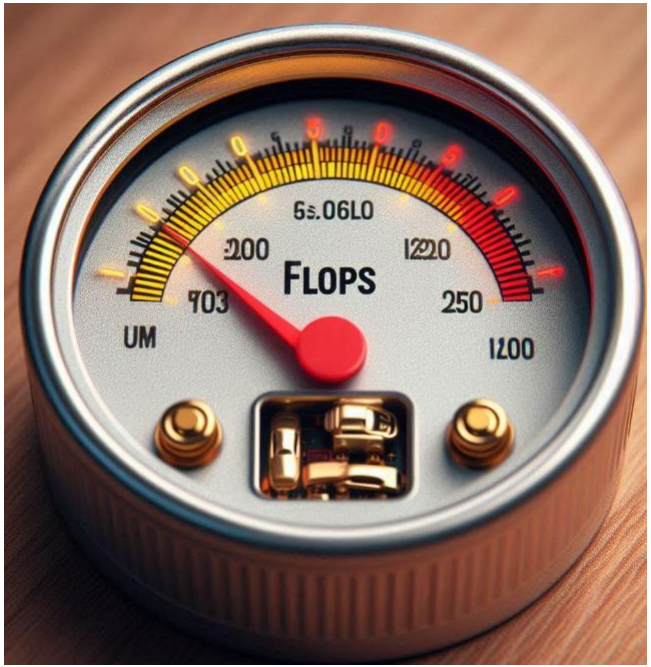
Great to train a team

But Doesn’t allow to have a set of decisive conclusions

For NISQ the scientific method may cost M€ of hardware to have a beginning of conclusion

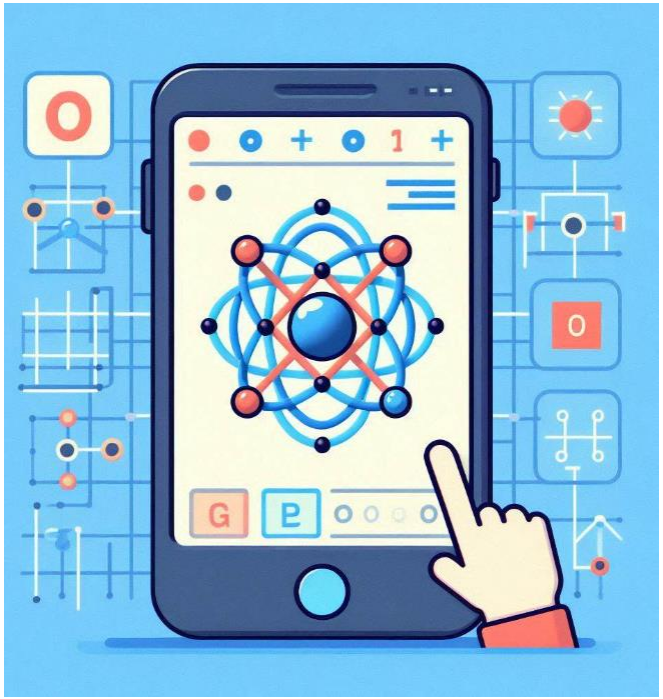
The next generation of use case have to be at an industrial level

The Quantum Advantage only trap



- The brute force comparison between classical and quantum might be a bad bet
- New usages of Quantum have to arise, even on historical topics.
- It requires a deep expertise both at the client level and at the Quantum level

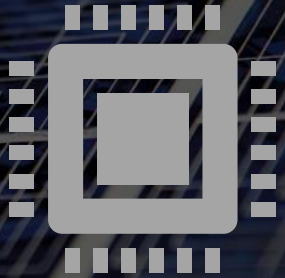
Our needs of an *iQuantum*



- As we also need to imagine new usages,
- Industries still need to understand the tool to create new internal usages

➔ The Quantum part of Quantum Computing needs to be explained not hidden behing a too simplictic interface

Integration needs



The answer to the integration topic is not *cloud only.*

A lot of businesses interested in Quantum need to know how these machine will be **physically integrated** to their whole stack which sometime can’t rely on the cloud

Take away

- Non corrected and non theoretically demonstrated algorithms needs a cheap and massive access to hardware to demonstrate their benefits
- Industries need to invent new usages and to that end, we need to be fluent in quantum and in our business
- The integration question is a big one