Atos Quantum Learning Machine: Heading towards a quantum-accelerated life science

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1. Introduction

The first quantum revolution, led in the early twentieth century by young Europeans of the likes of Einstein, Heisenberg and Planck, gave birth over the years to major inventions including the transistor, the laser, MRI and GPS. Today, taking advantage of Atos' expertise in supercomputers and cyber security, Atos is fully committed to the second quantum revolution that will disrupt all our clients' business activities in the coming decades, from medicine to agriculture through finance.

However, the computer research community has come to realize that no General-Purpose Quantum Computing (GPQC) will be available on the market for 10 to 15 years. In the meantime, a lot of research and engineering steps are needed, both in terms of the hardware and software environment.

Until we have stable physical quantum processors or accelerators capable of supporting several thousand coherent and entangled qubits, Atos has decided to focus on software environments and tools to enable end-users to work on these fundamental problems with a view to preparing themselves as early as possible for the arrival of the first generation of GPQC.

Thus, Atos is launching its appliance known as QLM (Quantum Learning Machine) capable of simulating quantum processors up to 40 qubits, offering the scientific community the opportunity to prepare for the scientific challenges of tomorrow.

Atos Quantum targets notably the following developments and industrial integration:

- Developing a quantum simulation platform to enable researchers to test, as of now, algorithms and software for future quantum computers
- Creating an algorithm development and programming cluster to develop a portfolio of quantum applications, in particular for Big Data, Artificial Intelligence, supercomputing and cyber security
- Developing new quantum safe cryptography algorithms to make applications inviolable by quantum methods and preserve existing safety levels that enable, amongst other things, the secure operation of the Internet, electronic business, and the protection of personal data.

Quantum Computing could a have large impact in the coming decades. It is generally admitted that it will allow hugely enormous, complex problems to be solved in a reasonable amount of time, and to accelerate machine learning and prescriptive analytics.

2. Presentation contents

This presentation will be in echo with the conference done in Science Museum around "FUTURE OF QUANTUM COMPUTING. From Quantum Intelligence to Virtual Humans. Depending on the contents of this presentation, we will adapt our presentation to propose to the audience complementary inputs.

The Atos presentation will consist in:

- Quantum computing introduction: this part focuses on presenting quantum computing basic concepts necessary for the overall understanding.
- Quantum computing for healthcare: presentation of the use cases in healthcare that might benefit from quantum computing.
- Presentation of Atos solution:
    - Atos Quantum Learning Machine: This quantum computer simulator is an appliance with a modular power package that meets all the needs of the market with configurations from 30 to 40 qubits. It answers the needs of different organizations, enabling researchers, students and engineers to develop and test today, the quantum applications and algorithms of tomorrow's computer. The appliance designed by the Atos Quantum laboratory - the first major industrial quantum program in Europe launched in November 2016 - has been the subject of major innovations. Atos QLM is an appliance that integrates a software layer that will provide the user with a complete environment for the development, execution and optimization of quantum circuits. The Atos QLM appliance is the fastest and most efficient way to validate algorithmic results thanks to its implementation, which allows the simulation of physical qubits on a deterministic machine.

Figure 1: *Atos Quantum Learning Machine visual*

    - High-End Quantum Service offer presentation:
        - presentation of the trainings offers in quantum computing and quantum algorithms
        - Proof of concept service for supporting our customer in the transition to quantum computing
        - Presentation of the methodology setup for Proof of Concept in quantum computing done by Atos with Bayer and University of Aachen. Computing and life science experts from Atos, Bayer and RWTH Aachen University have evaluated the use of quantum computing in research and analysis of human disease patterns. They are using the Atos Quantum Learning Machine, to research the evolution of multi-morbidity human diseases from large data repositories. The strategy was to target quantum algorithms that could deliver benefit from next-generation 'Noisy Intermediate-Scale Quantum' (NISQ) processors. The results of the study were integrated in the overall medical data analysis to compare a classical method for the evolution of human comorbidities with the quantum-enhanced ones.


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