

QHealth:

“Quantum pharmacogenomics applied to ageing”

Authors

Mario Piattini, aQuantum/UCLM, mario.piattini@uclm.es

Jose Luis Hevia, aQuantum, julis.hevia@alhambra.it.com

Guido Peterssen, aQuantum, guido.peterssen@alhambra.it.com

Topic(s)

Quantum pharmacogenomics, quantum health, personalized medicine, quantum software development

Background

Different industrial “revolutions” can be identified; the first revolution took place at the end of the 18th century thanks to the steam engine and the appearance of the telegraph, while the second can be placed in the first decade of the 20th century, with the combustion engine powered by oil, electricity, the telephone, and the radio. This was followed by a third revolution brought about by computers and the emergence of the Internet. In the last two decades we are witnessing another confluence of technologies (social networks, mobile, big data and data analytics, cloud computing, artificial intelligence, blockchain, Internet of Things (IoT), etc.); which is causing a real “digital transformation” of companies and organizations. The next revolution, which comes from nanotechnology, biotechnology, genomics, and quantum computing, which is based on exploiting the properties of quantum mechanics, has already begun.

In fact, as the IBM Institute for Business Value highlights: “We are living in the Quantum Decade, when quantum computers are getting ready to overperform their classical cousins in a meaningful task, achieving what we call Quantum Advantage” [1]. The same report remarks that: “The integration of quantum computing, AI, and classical computing into hybrid multicloud workflows will drive the most significant computing revolution in 60 years”.

One of the sectors where the potential of quantum technologies can be most exploited is the medical and health sector. Informatel [2] highlights how quantum computing can be used to predict disease and patient outcomes. Other examples are [3], [4] and [5]. In our case, we are interested in improving elderly drugs treatment, including adverse effects of other drugs that can be optimally treated by non-pharmacological methods, or by reducing the dose of the drug causing adverse effects. The use of these drugs is often inappropriate, since their benefit is low, their cost is high, and the new drug may cause additional toxicity. To solve the problem of inappropriate drug use in the elderly, it is

essential to have ICT tools to support prescribing that allow both individualization at a specific time of prescription and modelling over time.

Presentation

The general aim of project “QHealth: Quantum pharmacogenomics applied to ageing” is mainly human-oriented: the increase in longevity and quality of life of older adults. The project is the results of scientific and technological cooperation of a multidisciplinary team of researchers and technologists from the companies aQuantum, Gloin and Madrija and the University Institute of Biosanitary Research of Extremadura (INUBE) in collaboration with the Pharmacogenetics and Personalized Medicine Unit, the University of Extremadura (UEx) and the University of Castilla La Mancha (UCLM).

The project is funded by the Center for the Development of Industrial Technology (CDTI) of the Ministry of Science and Innovation of Spain, in the 2020 CDTI Missions Program which has a total budget of € 5,160,477.00.

QHealth is researching about the correlation among the genetic variables and other variables related to the health history of the patients. The study includes the adverse reactions to prescribing drugs in order to predict unwanted side effects of a specific one. This will be analyzed in function of the drugs consumption history of the patients, the reactions the older adult has experimented, and his/her physiological and genetic limitations.

In order to achieve this aim, we are designing scientific, methodological and technological models to establish the scientific and technical fundamentals of a classical/quantum hybrid system able to carry out optimizations and simulations whose realization in classical hardware is not possible in acceptable timescales. The hybrid system, in combination with classical health applications, will give its outputs to medical professionals involved in prescribing drugs to older adults.

Moreover, the methodological and technological environment created by the project, will allow to map the evolution of the patient related with the prescribing drug consumption and its genetic and environmental limitations onto quantum simulations. This will, for the first time, allow doctors the possibility of using the results offered by quantum computing technology for carrying out proactive ageing treatments.

This will not only have a human impact it will also have a financial impact because it will optimize the investments that health systems make in financing drugs and address the adverse effects that drugs often generate in older people.

As the technological basis of the project, QPath® [6] will be used to support a hybrid computing architecture, so that multidisciplinary teams from any field of knowledge do not have to worry about the tools and manufacturer-specific execution platforms, but only about the knowledge. Also, the best practices of Quantum Software Engineering [7], [8] are being deployed in order to assure the quality of the final hybrid system.

The aim of the members of the Consortium is to exploit the results of the research of the QHealth project for the development of the artifacts required for a hybrid classical/quantum platform specialized in services to pharmacogenomics applied to ageing. The execution of those future developments will be carried out both individually and with the collaboration of [aQuantum Partner Network](#) [9], the collaboration network of aQuantum in which

participate all the companies of the Consortium. This assures the continuity of the research up to the practical application of results.

References

1. IBV. The Quantum Decade. A playbook for achieving awareness, readiness, and advantage. IBM Institute for Business Value, 2021.
Available: <https://www.ibm.com/downloads/cas/J25G35OK>
2. Informatech (2020). Better and faster together... Quantum computing + artificial intelligence. The Virtual Quantum Computing Summit. Informatech.
3. Sarkar, A., Al-Ars Z. y Bertels, K. (2020). QuASeR: Quantum Accelerated De Novo DNA Sequence Reconstruction. arXiv:2004.05078v1.
4. Boev, A.S., Rakitko, A.S., Usmanov, S.R., Kobzeva, A.N., Popov, I.V., Ilinsky, V.V., Kiktenko, E.O. y Fedorov A.K. (2020). Genome assembly using quantum and quantum-inspired annealing. arXiv:2004.06719v2.
5. Marx, V. Biology begins to tangle with quantum computing. Nat Methods 18, 715–719 (2021). <https://doi.org/10.1038/s41592-021-01199-z>
1. QuantumPath. <https://www.quantumpath.es/> Accessed July 14th 2021.
2. Piattini, M., Peterssen, G., Pérez-Castillo, R., Hevia, J.L., Ezequiel Murina, et al. The Talavera Manifesto for Quantum Software Engineering and Programming. QANSWER 2020 QuANtum SoftWare Engineering & pRogramming. Proceedings of the 1st International Workshop on the QuANtum SoftWare Engineering & pRogramming, Talavera de la Reina, Spain, February 11-12, 2020. <http://ceur-ws.org/Vol-2561/paper0.pdf>
3. Piattini, M., Serrano, M., Pérez-Castillo, R., Peterssen, G. and Hevia, J.L. Towards a Quantum Software Engineering. IT Professional, vol. 23, no. 1, pp. 62-66, 1 Jan.-Feb. 2021, doi: 10.1109/MITP.2020.3019522.
4. <https://www.aquantum.es/partner-network/>. Accessed July 14th 2021.

Poster

QHealthProject

“QHealth: Quantum pharmacogenomics applied to ageing”

Guido Peterssen, Jose Luis Hevia, Mario Piattini

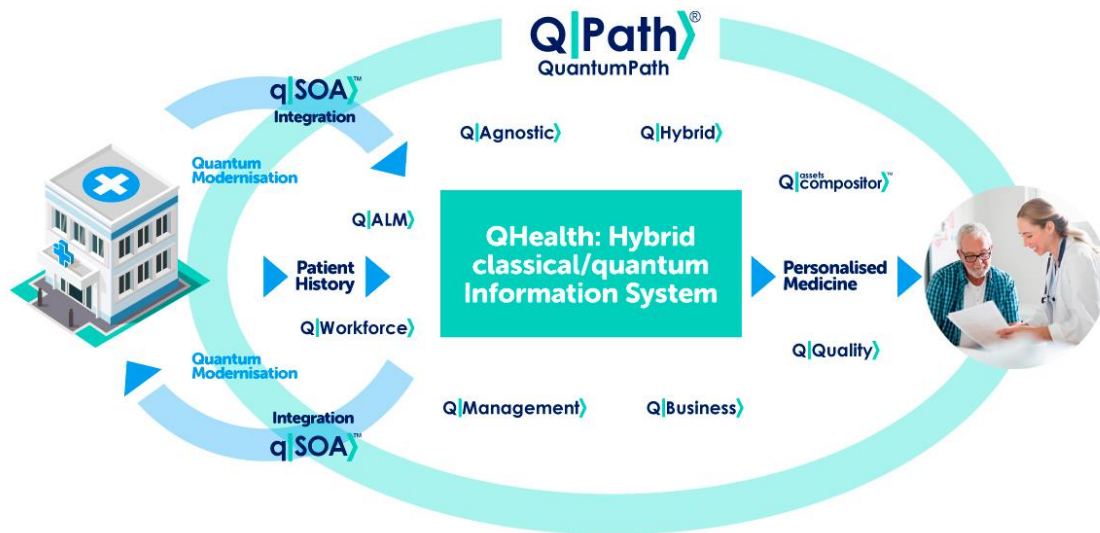
Aim of the project

The increase in longevity and quality of life of older adults, by conducting research about the correlation among the genetic and other variables related to the health history of the patients. The study will include the adverse reactions to prescribing drugs to predict unwanted side effects of a specific one.

Solution

The creation of a methodological and technological environment, based on QuantumPath®, that allows the development of future health software solution which use quantum computing for the optimization of prescribing drugs administration.

Development of high-quality quantum algorithms and software applications for pharmacogenomics and personalized medicine for the real world



Consortium



Supported by

