EXPLORING THE APPLICATION OF QUANTUM TECHNOLOGIES TO TRANSPORTATION, LOGISTICS AND VEHICLE ROUTING (Quantum-ITS)

Modality: Half-day (e.g., 3 hours plus breaks)

SCOPE

Quantum Computing is considered as the next frontier in computing, and it is attracting a lot of attention from the current scientific community. These technologies introduce new mechanisms, based on quantum mechanics, to solve a wide variety of problems more efficiently: from those traditionally solved by means of machine learning and optimization, to simulation. By leveraging quantum phenomena, such as superposition and entanglement, the quantum information processing and the pure quantum or hybrid algorithms (both classical and quantum procedures interplaying) are expected to achieve a speed and/or precision advantage in modelling systems and in solving complex optimization problems. As a result of the growing interest in this field, quantum computing has already been successfully applied to a plenty of use cases, being transportation one of the most intensively studied ones. Probably, being routing problems the main representative.

Last but not least, quantum technologies are shaking up the design, control and monitoring by new quantum sensors vastly improving the accuracy of the measurement. By collecting atom level data, the advanced versions of day-to-day technologies will incorporate more reliable geolocation and less vulnerable guidance systems which will be cornerstone for autonomous navigation.

The Quantum-ITS special session, to be held during IEEE ITSC 2023, aims at fostering discussions around the latest findings and research achievements, as well as the exchange of novel ideas in the application of quantum technologies to transportation, logistics and vehicle routing problems. With all this, interested colleagues are invited to submit contributions via the IEEE ITSC 2023 submission system, with an emphasis on (but not limited to) the following topics:

TOPICS

- Hybrid classical-quantum methods for addressing optimization problems.
- Application of Quantum Annealers for solving real-world oriented problems.

Applied to the following fields (not limited):
- Traveling Salesman and Vehicle Routing Problems.
- Efficient management of vehicle fleets.
- Environmentally friendly mobility planning.
- Last-mile logistics.
- Development of quantum-gates based methods (QAOA, VQE...).
- Quantum Algorithms and Complexity.
- Quantum Machine Learning Approaches.
- Latest advances of quantum-inspired computation, especially for optimization, machine learning and deep learning.
- Quantum sensing for Transport systems.
- Quantum sensing for next generation of navigation systems.
- Quantum simulation for complex logistic problems.
- Design of transportation facilities.
- Traffic flow optimization problems.
- Industrial problems in the logistic chain (Bin Packing Problem, Job Shop Scheduling...).
- Improvements in the public transportation network.
- Autonomous Vehicles.
- Flight Optimization Problem.

GUEST ORGANIZERS

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BRIEF BIOGRAPHIES OF EDITORS

Eneko Osaba (PhD) works at TECNALIA as researcher in the ICT/OPTIMA area. He obtained his PhD degree on Artificial Intelligence (Cum Laude) in 2015 in the University of Deusto. He has participated in the proposal, development and justification of more than 40 research projects. He has contributed in the development of more than 150 papers, including more than 30 Q1. He has performed several stays in universities of United Kingdom, Italy and Malta. He served as a member of the program and/or organizing committee in more than 60 international conferences. At HAIS 2015 and IDC 2018, Eneko was also member of the organizing committee, and he organized several special sessions in conferences such CEC, IEEE ITSC or GECCO. Besides this, he is member of the editorial board of International Journal of Artificial Intelligence, Data in Brief and Journal of Advanced Transportation. Furthermore, he has acted as guest editor in journals such as Journal of Computational Science, Neurocomputing, Swarm and Evolutionary Computation and IEEE ITS Magazine. In 2022, Eneko was recognized by the Basque Research and Technology Alliance as one of the most promising young researchers of the Basque Country, Spain.

Esther Villar Rodríguez (PhD) holds a PhD (Cum Laude) in Information and Communication Technologies (2015) from the University of Alcalá (Spain), a BSc in Computer Science (2010) by the University of Deusto, and a M.Sc. (2012) in Computer Languages and Systems by UNED (National University of Distance Education, Spain). She was a senior researcher in Artificial Intelligence at TECNALIA (Spain), specialized in Shallow Learning and Deep Machine Learning models, distributed privacy-aware learning strategies (including Federated Learning), Reinforcement Learning and outlier detection, among others. She authored several contributions at conferences and articles in journals related to these research areas, with a focus on their applicability to practical problems (prediction and optimization of management and industrial processes, resource planning, scheduling, energy efficiency, and other assorted applications alike). She was the head of the Artificial Intelligence group in
Optima (Optimization, Modelling and Analytics) from the ICT department in TECNALIA Research & Innovation, mainly in charge of the definition of the technological strategy and funding plan. From 2022 on, she is the leader of the Quantum Technologies group in TECNALIA Research & Innovation, department created as a result of the new company technological strategy spanning from 2022 up to 2025. She is also directing a doctoral thesis focused on collaboration mechanisms and optimal exploration in Reinforcement Learning applied to problems with sparse rewards and collaborates technically and actively in new lines such as Quantum Computing or Coevolutive/Multitasking Optimization.

Izaskun Oregi (PhD) (f) received her degree in Physics from the University of the Basque Country, in 2011. In 2012 she got her M.Sc. degree in Physics of Complex Networks from the Polytechnical University of Madrid and in 2017 the M.Sc. degree in Mathematical Engineering from the Universidad Complutense of Madrid. She received her PhD in Artificial Intelligence from the University of the Basque Country, in 2020. To carry out her PhD, Izaskun received a doctoral grant from TECNALIA Research & Innovation, where she works as a researcher. She is also a part-time lecturer at EUNEIZ University. Izaskun's research interests are time series analysis, supervised and unsupervised machine learning models for time series, and quantum machine learning.

Yue Ban (PhD) (f) is dedicated to the forefront fields of quantum computing, quantum control, quantum sensing. She obtained her PhD in Physics (Cum Laude) at the University of the Basque Country in 2013 with the financial support from Basque Government Fellowship. From Oct. 2013 to Apr. 2017, she was a Lecturer and an Associate Professor at Shanghai University. From May 2017 to May 2019, with Juan de la Cierva Fellowship, she was working in the Institute of Material Science of Madrid, ICMM-CSIC, developing solid-state-based quantum information processing. From Aug. 2019 to July 2022, she worked as a postdoctoral researcher at the university of the Basque Country, funded by EU FET Open Project “Quromorphic”, focusing on quantum machine learning and quantum sensing. Since July 2022, she is a researcher at TECNALIA Research & Innovation, doing research in the field of quantum computing, quantum simulation and quantum sensing. She is the guest editor of Theme Issue of Shortcuts to Adiabaticity: Theoretical, Experimental and Interdisciplinary Perspectives, Philosophical Transactions of the Royal Society A. Her expertise strengthens the interface between quantum control and solid-state physics, which allows her to boost the multidisciplinary research of modern quantum technologies on versatile solid-state platforms.

Sebastián V. Romero (m) holds a MSc in Physics "specialty in Nuclear and Particle Physics" (University of Santiago de Compostela, 2021) and a BSc in Physics (University of Santiago de Compostela, 2020). Being experienced in several projects related with Particle Astrophysics and Quantum Computing, at the present time he is working at TECNALIA Research & Innovation (Derio, ES) as a quantum technologies researcher studying and developing valuable quantum algorithms for quantum simulations and quantum optimization. Regarding quantum simulations, his research interests surround drug discovery, protein folding, lithium-ion battery simulations and molecular dynamics. Regarding quantum optimizations, he is devoted on solving combinatorial problems of interest for logistic companies such as the bin packing problem (BPP) and the vehicle routing problem (VRP), among others.