Quantum for Logistics: solving real-world bin packing and package delivery routing problems using quantum annealers

Eneko Osaba

Esther Villar-Rodriguez

TECNALIA, Basque Research and Technology Alliance (BRTA), 48160 Derio, Spain.

eneko.osaba@tecnalia.com

Research focused on the conjunction between quantum computing and logistic problems has been very prolific in recent years. This talk is focused on two problems of this kind: the three-dimensional Bin Packing Problem and a real-world-oriented package delivery routing problem. More concretely, how such realistic problems can be addressed from the perspective of a quantum annealer will be detailed. For doing that, two quantum-classical hybrid systems will be described, coined ***Quantum for Real Bin Packing Problem*** (*Q4RealBPP [1,2]*) and ***Quantum for Real Package Delivery*** (*Q4RPD*), respectively. The main strength of these systems is their ability to cope with real-world restrictions. Indeed, the two optimization problems addressed in this talk have been defined involving a Spanish company specializing in transport and logistics. On the one hand, *Q4RealBPP* deals with constraints such as overweight restrictions, preferences for package ordering, and affinities among item categories, among many others. On the other hand, *Q4RPD* deals with a heterogeneous fleet of vehicles, priority demands, and the representation of the capacities using two values (weight and dimension), among others. Both *Q4RealBPP* and *Q4RDP* resort to the Leap Constrained Quadratic Model (*CQM*) Hybrid Solver of D-Wave. Finally, different kinds of visual demonstrations will be shown to illustrate the practical potential of the developed systems (examples in Figure 1 for the *Q4RealBPP* and Figure 2 for the *Q4RPD*.

References

[1]   Romero, S. V., Osaba, E., Villar-Rodriguez, E., Oregi, I., & Ban, Y. (2023). Hybrid approach for solving real-world bin packing problem instances using quantum annealers. Scientific Reports, 13(1), 11777.

[2]   Romero, S. V., Osaba, E., Villar-Rodriguez, E., & Asla, A. (2023). Solving Logistic-Oriented Bin Packing Problems Through a Hybrid Quantum-Classical Approach. arXiv preprint arXiv:2308.02787.
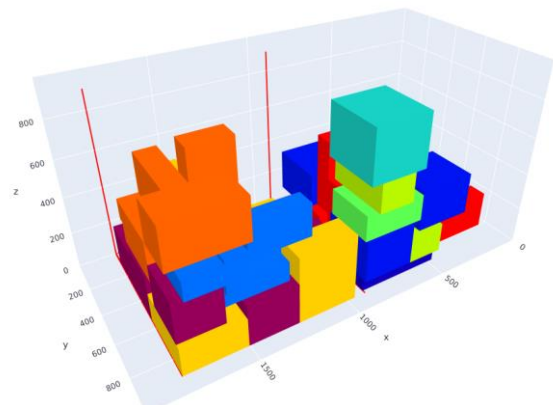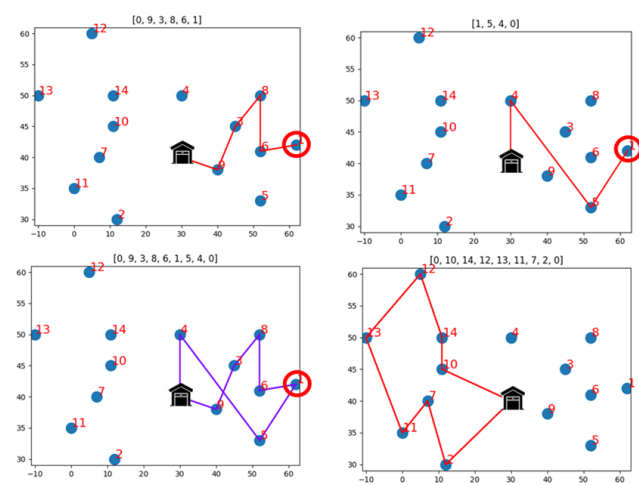
Figures

Figure 1: Example of a *Q4RealBPP* output

Figure 2: Examples of *Q4RPD* outputs