Internship in ESA's Advanced Concepts Team
On
Treewidth-aware Quantum Annealing

European Space Research and Technology Centre
ESA ESTEC

Candidates interested are encouraged to visit the ESA website:
https://www.esa.int/gsp/ACT/about/jointheteam/

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https://jobs.esa.int/job/Noordwijk-Intern-in-ESAs-Advanced-Concepts-Team/1001306401/

Topic Description

While full-fledged quantum computers with multiple logical qubits seem still out of reach, quantum annealers are near-term quantum hardware present today. Systems such as the D-Wave 2X [1] have up to 1152 (non-logical) qubits. However, these systems can only solve quadratic unconstrained binary optimization problems (QUBOs) [2].

The objective of this internship is a hybrid approach [4] for solving QUBOs using tools from structural graph theory [3]. A graph decomposition partitions the QUBO into manageable parts, which can be solved with a conventional solver, and into computationally challenging parts, which get sent to the quantum annealer. The project explores the performance of conventional tools like maximum satisfiability or integer linear programming solvers on the structurally simple parts. Furthermore, it evaluates the obtained speedup if the complex parts of the problem are solved using a quantum annealer.

Objectives

The objectives of this internship are threefold:

1) The development of a script that decomposes a given QUBO using available tree decomposition libraries.

2) Collect benchmarks from previous academic studies and use the decomposition to identify structural easy parts. Evaluate the performance of maximum satisfiability or integer linear programming solvers on these easy parts.

3) Develop the logic to solve the remaining parts using available quantum annealers using the vendor's API and combine the obtained results with the partial solutions from the previous step.

Joining the ACT

Creativity and out-of-the-box thinking are essential in the ACT. Therefore, the team is constantly striving to be a diverse, inclusive and equitable workplace bringing together people from various backgrounds. We strongly encourage people from under-represented groups to apply to be part of our team as diversity is central to our mission and core values.

In order to make our hiring as fair as possible, we also ask applicants to not include photos in their CVs.

References

[1] http://www.dwavesys.com/d-wave-two-system

[2] https://en.wikipedia.org/wiki/Quadratic_unconstrained_binary_optimization

[3] https://en.wikipedia.org/wiki/Treewidth

[4] Pelofske, Hahn, Djidjev: Solving larger maximum clique problems using parallel quantum annealing