

PhD position in ICT available in Trento (Italy) on “Quantum Annealing for SAT Solving”

under the supervision of prof. **Roberto Sebastiani** (DISI, University of Trento)
in collaboration with **D-Wave Systems Inc.** (<http://www.dwavesys.com>)
sponsored by **Q@TN Project** (<https://www.quantumtrento.eu>)



!! Deadline: June 15th, 2020 !!

<http://disi.unitn.it/rseba/QTN-DWAVE-Recruit-phd.pdf>

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One PhD position in ICT on the research project “**Quantum Annealing for SAT Solving (QUASI)**” is available at the International Doctorate School in Information and Communication Technologies at The Department of Computer Science and Engineering (DISI) of the University of Trento, Italy (<http://www.ict.unitn.it/>), under the supervision of Prof. **Roberto Sebastiani** (<http://disi.unitn.it/rseba/>). The research activity is sponsored by the **Q@TN Project** (<https://www.quantumtrento.eu>) and is in direct collaboration with **D-Wave Systems Inc.** (<http://www.dwavesys.com>).

Ph.D. courses will start on December 1st, 2020, and the thesis must be completed in three-four years. The selected student should be available for an internship (e.g. 3-month) at D-Wave, in Vancouver (CA). People enrolled in Ph.D. courses are expected to move to Trento, and will receive monetary support during the phases of their activity.

Aim and Scope

The goal of the project is to investigate the usage of D-Wave’s *quantum annealers* (QAs) to solve hard propositional satisfiability (SAT) problems (and related NP-Hard problems) by exploiting quantum effects to cope with the inherent complexity of the problem. The proposed research is to develop effective and efficient encoding procedures from SAT to problems which fit into, and can be solved by, D-Wave’s QAs. These procedures will be presumably based on Satisfiability Modulo theories, automated-reasoning and graph-manipulation techniques. The ultimate goal is to solve problems (e.g., from cryptanalysis) which are currently out of the reach of state-of-the-art SAT solvers.

Duration and support

Ph.D. program will start in late Autumn 2020, and the thesis must be completed in three-four years. The selected student should be available for an internship (e.g. 3-month) at D-Wave, in Vancouver (CA). People enrolled in Ph.D. courses are expected to move to Trento, and will receive monetary support during the phases of their activity.

Candidate Profile

The ideal candidate should have an MS or equivalent degree in computer science/engineering, mathematics or equivalent, combine a good theoretical background (algorithms, logic) with good software development skills, and have some background knowledge in or some experience with at least one the following areas (in order of preference):

- Satisfiability Modulo Theories (SMT),
- Propositional Satisfiability (SAT),
- Automated reasoning and Computational Logic,
- Constraint Solving and Optimization,
- Graph Manipulation Algorithms, Operational Research.

No background knowledge in quantum physics is required.

The candidate should be able to work in a collaborative environment, with a strong commitment to reaching research excellence and achieving assigned objectives. The position is subject to the evaluation of the PhD admission committee of the ICT school of DISI (<http://ict.unitn.it>).

Applications and Inquiries

Potentially-interested candidates should do both:

- inquire for further information and/or apply by sending an email to roberto.sebastiani@unitn.it. with subject: 'PHD ON Q@TN PROJECT'. (Emails may be processed automatically, so that those not complying with the above format have high chances to be ignored.) Applications should contain a statement of interest, with a Curriculum Vitae, and possibly names & addresses of up to three reference persons, all in PDF.
- apply to the international call of the ICT school of DISI (<http://ict.unitn.it>) indicating explicitly your choice for grant C2. Application Deadline: **June 15th 2020**.
<https://ict.unitn.it/education/admission/reserved-topic-scholarships#C2>

Detailed Research Description

We plan to investigate the usage of quantum annealers (QAs) "for real", that is, to actually solve very-hard though relatively-small SAT/MaxSAT problems (and eventually SAT/MaxSAT-encoded Constraint-Satisfiability/Optimization problems). The idea is to develop encodings from SAT/MaxSAT to Ising-minimization problems which fit into, and can be solved by, D-Wave's Pegasus QAs (or other QAs, when/if available). These encodings must be performed both effectively (i.e., in a way that uses only the limited number of qubits and connections available within the QA topology, while optimizing the performance of the QA algorithm), and efficiently (i.e., using a limited computational budget for computing the encoding).

This work is intended as a follow up of ongoing activity in collaboration with D-Wave Systems Inc. The PhD candidate initially will extend the approach we have begun with D-Wave's Chimera topology. The main encoding scheme consists of a combination of offline and on-the-fly processes, the former performed by means of automated reasoning procedures (SMT, OMT), the latter by means of place-and-route or graph-embedding procedures.

The encoded problems will be tested on D-Wave's new Pegasus quantum annealers. The ultimate goal is to solve by QAs problems which are very challenging or even out of the reach of current SAT/MaxSAT tools. We envisage an internship at D-Wave.

Proponent and Contact Person

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About DISI and University of Trento

University of Trento (<http://www.unitn.it/en>) has been recognized as the best university in Italy and #36 in Europe by Europe Teaching Rankings 2018 of Times Higher Education https://www.timeshighereducation.com/rankings/europe-teaching/2018#!/page/0/length/50/sort_by/rank/sort_order/asc/cols/undefined. DISI (<http://disi.unitn.it>) has been recognized among the top three ICT University Department in Italy. DISI currently consists approximately of 40 faculties, 70 research staff and support people, 20 postdocs and 140 Doctoral students, plus administrative and technical staff. DISI covers all the different areas of information technology (computer science, telecommunications, and electronics) and their applications.

About D-Wave Inc.

D-Wave (www.dwavesys.com) is the world's only commercial supplier of quantum computers. D-Wave's systems are being used by some of the world's most advanced organizations and D-Wave is the leader in the development and delivery of quantum and hybrid quantum-classical computing systems and software. D-Wave's technology is focused on annealing-based quantum computing.

Location

Trento is a lively town of about 100.000 inhabitants, located 130 km south of the border between Italy and Austria. It is well known for the beauty of its mountains and lakes, and it offers the possibility to practice a wide range of sports. Trento enjoys a rich cultural and historical heritage, and it is the ideal starting point for day trips to famous towns such as Venice or Verona, as well as to enjoy great naturalistic journeys. Detailed information about Trento and its region can be found at http://www.trentino.to/home/index.html?_lang=en.