PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 1 - Computer Science and Engineering

PARTENARIATO PNRR Research Field: SOFTWARE ENGINEERING FOR QUANTUM COMPUTING

<table>
<thead>
<tr>
<th>Monthly net income of PhD scholarship (max 36 months)</th>
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<tr>
<td>€ 1400.0</td>
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In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Quantum computing is reaching significant and promising advancements and represents one of the ground-breaking initiatives that are expected to change the way we conceive programming today. However, the research on quantum computing today is still focusing mostly on addressing technical problems at the physical and hardware level. For instance, an important issue that is being considered is how to deal with interferences in the hardware that cause significant noise in the results obtained by a quantum computer. Programming a quantum computer still means combining low level quantum logic gates in a quantum circuit or formulating a problem in terms of a specific mathematical structure.

A crucial issue from the software engineering standpoint is the identification of effective design and programming abstractions that allow people skilled in computer science to take advantage of the enormous power of quantum computing still keeping the complexity of design and programming activities under control and enabling analysis and testing of the developed code.

The objective of this PhD work is to provide a contribution in this context. The work will start with a systematic...
The work will be highly experimental and will include:

- the development of programming examples to derive lessons learnt;
- the definition of proper abstractions and their validation in multiple cases to demonstrate their generality;
- the implementation of development and verification frameworks to support quantum computing programmers;

Methods and techniques that will be developed and used to carry out the research

- The extensive validation and refinement of the defined abstractions will be the focus of the core part of the work. To start addressing the problem of how to validate quantum software, the usage of model-checking techniques will be experimented.


The research will be mainly carried out at Politecnico di Milano, but visits to other internationally recognized research centers will be pursued.

### Educational objectives
- Learn about the research methods (both sperimental and theoretical) adopted in software engineering
  - Learn about quantum computing
  - Advance the state of the art on approaches to simplify the development of quantum computing programs and to increase their quality
  - Learn how to conduct a case study-based evaluation
  - Learn how to write scientific papers in the area of software engineering

### Job opportunities
Considering the significant interest quantum computing is raising and the need to have people able to develop software according to this paradigm, we expect PhD graduates in this area to be very successful in finding multiple job opportunities both in industry and academia.

### Composition of the research group
- 8 Full Professors
- 3 Associated Professors
- 2 Assistant Professors
- 10 PhD Students

### Name of the research directors
Elisabetta Di Nitto

### Contacts
elisabetta.dinitto@polimi.it

### Additional support - Financial aid per PhD student per year (gross amount)

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<thead>
<tr>
<th>Housing - Foreign Students</th>
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<tbody>
<tr>
<td>Housing - Out-of-town residents (more than 80Km out of Milano)</td>
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### Scholarship Increase for a period abroad

<table>
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<tr>
<th>Amount monthly</th>
<th>700.0 €</th>
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<tr>
<td>By number of months</td>
<td>6</td>
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Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information.
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EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

This project research is in the framework
CN-HPC
CENTRO NAZIONALE PER HPC, BIG DATA E QUANTUM COMPUTING
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D.D. 1031 del 17/06/2022