Review of a Doctoral Thesis at FIT BUT

Doctoral thesis (hereinafter referred to as "thesis"), title of the thesis:

APPLICATIONS OF FORMAL METHODS IN APPROXIMATE COMPUTING

Name of the doctoral student (hereinafter referred to as "student"), name and surname:

JIŘÍ MATYÁŠ

Name and institution of the reviewer (full name of the reviewer, full name and country of the institution):

Prof. Laura Pozzi, Università della Svizzera italiana (USI), Lugano, Switzerland

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Please state your opinion on the following aspects of (I) the student's thesis and (II) the student's overall achievements, and (III) state your conclusion (a minimum of approx. 300 characters foreach item below is recommended):

I. Thesis

Appropriateness and relevance

Is the area addressed by the thesis appropriate to the particular scientific discipline of the thesis and does the thesis address relevant problems within the chosen area?

Jiri's thesis addresses the automatic generation of approximate circuits given an exact counterpart. This represents an important aspect of electronic design automation (EDA). Up to recently, EDA only dealt with exact-circuit synthesis; in the last few years, however, much attention has been devoted to approximate-circuit synthesis in order to produce low-energy counterparts. Jiri's thesis addresses an extremely timely problem.

A summary of the contributions of the thesis

From your point of view, please summarize what the goal of the thesis is, what the main contributions of the thesis are, and whether the thesis has achieved the chosen goal. Please indicate also specific contributions of the student.

As mentioned in the above point, the area of research of Approximate Computing, and in particular the synthesis of approximate circuits given exact counterparts, is extremely timing and important, in the journey towards low-power, low-resources computing. In particular, the thesis deals with the *automatic* generation of approximate circuits, and hence it proposes algorithms and methodologies to derive push-button approaches, without the need to involve hardware designers in the loop.

Novelty and significance:

Please assess the level of novelty of the results and their significance for the given scientific area, for its further development, and if applicable for possible applications in practice.

Regarding the methods used: this thesis leverages SAT-based approaches and genetic approaches as core methodologies for approximate circuit design. The former (SAT-based) method is not used *only* in this thesis: other works exist that proposed to use it before. It is however in my opinion still cutting-edge, and one of the most promising techniques at hand. The latter (genetic) is more specific to this research group: as far as I know it was first proposed by them. (I am not sure if specifically by Jiri or it was proposed by PhD students before his time. In any case, definitely innovative).

Regarding results: the various methodologies proposed allow scalability beyond what the state of the art has achieved. Hence the work definitely improves on the state of the art.

Evaluation of the formal aspects of the thesis:

Please evaluate formal qualities of thesis and its language level.

The formalization of concepts is very well done. The various contributions are explained clearly, the organization is well structured, the language is excellent.

One minor thing I propose to improve in the writing, is the flow between Chapter 4 and 5. When reading the second paragraph of Chapter 5, one has a feeling of dejà vu, and in fact that paragraph was already the subject of Section 4.2. And, in a sense, much of Chapter 5 is related to 4 and they could potentially be merged, and repetitions removed.

Apart from this minor comment, as mentioned above I find the thesis very well written.

Quality of publications

Has the core of the thesis been published at an appropriate level? Please judge the quantity and quality of the publications. When judging the quality, please take into account internationally recognized standards (WoS/Scopus quartiles, CORE ranks, specific knowledge of flagship publication channels of a given community, etc.) in a way appropriate for the given area of the thesis.

Both the quantity and the quality of publications derived from this work are very good. ICCAD is one of the top conferences in the Design Automation area. SAT and CAV, in the formal verification area, are also top conferences. So, to summarize, my opinion of the overall publication level is definitely very good.

II. Student's overall achievements

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Overall R&D activities evaluation:

Does the student's thesis, the results included into it, and possible other scientific achievements listed in the list of scientific activities indicate that he/she is a person with scientific erudition and creative abilities?

Absolutely. The candidate shows a very good understanding of this area of research, and he shows excellent ability in creating pertinent, interesting, and innovative methods in order to advance the state of the art. The experiments that he has designed in order to compare to state-of-the-art are also well targeted, and the comparison is fair. The candidate that he has reached a very good level of maturity in the process of learning how to do research.

One comment on Chapter 6: I cannot find the details of *how* you extract sub-circuits. What algorithm, what methodology do you use in order to decide what to extract? I believe this is missing, and if so it should be added.

Assessment of other characteristics (optional):

More characteristics of the student may be added here (e.g., awards, grant participation, international collaboration, etc.).

III. Conclusion

*The conclusion should contain an explicit statement saying whether, in your opinion, the thesis and the student´s achievements until now meet the generally accepted requirements for the award of an academic degree (in accordance with Section 47 of Act No. 111/1998 Coll., on higher education institution).**

* *Short overview of both the Act and corresponding internal BUT regulations is enclosed.*

To conclude, I'd like to recommend acceptance of this thesis. Jiri has produced excellent, innovative, creative, interesting PhD work.

Lugano, Switzerland, 4.12.2023

Prof Laura Pozzi