Lyon, September 7, 2018

Report on the thesis of Vojtěch MRÁZEK

The thesis of Vojtěch MRÁZEK discusses a very important and interesting topic that is the need to improve the power consumption/performance ratio in computing systems.

In this context, the thesis investigates the Approximate Computing (AxC) as principal technique for reducing the power consumption. More in particular, it targets efficient design methods for approximate circuits. These automated design methods are based on Evolutionary Algorithms (EAs). The main contribution of the thesis can be classified depending on the target layer of the computing system:

- **Transistor-level:** Cartesian genetic programming has been used as EA in order to reduce the power consumption of small circuits that are typically used in a technology library. Circuits were described at transistor-level;
- **Gate-Level:** at this level, the contribution was to evolve combinational circuits described at gate-level. In particular, the target circuits were adders and multipliers. It is important to mention that an approach based on formal verification techniques was exploited to formally prove that approximated circuits do not exceed the fixed limit of quality degradation (i.e., the introduced error was really the intended one);
- **RTL-Level:** here the idea was to analyze the behavior of multipliers used in NN classification. The analysis shown that most of time (80%) the result of the multiplication produces zero. In this sense, the evolutionally algorithm could be specifically configured in order to fit this particular constraints;
- **Application-Level:** the thesis proposes a new data-independent error metric called the *distance error*. This metric allows to approximate circuit described on a higher level of abstraction (i.e., application level).

Manuscript Format:

The manuscript is structured in four chapters:
- Chapter 1 provides the introduction to the research area and research objectives;
- Chapter 2 presents the state-of-the-art available in the literature;
- Chapter 3 summarizes the contributions. This chapter is indeed a collection of selected author's papers (seven papers). For each one, a short description is provided plus the contribution. Full version of the papers are given in annex;
- Chapter 4 summarizes the obtained results and proposes directions for the future research.

The manuscript appears to be well organized and using a correct language: it adequately overviews the state of the art in the area (mentioning the most important related papers), properly describes the faced problems and the considered solutions, and reports experimental results. The manuscript clearly proves that the candidate owns a good theoretical knowledge and practical expertise in the field of approximate computing, digital circuit design, evolutionary algorithms and in general about computer engineering.

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Results:

From a technical point of view, the work done by Vojtěch appears definitely sound and describes some interesting solutions, whose effectiveness and limitations are clearly demonstrated not only from a theoretical point of view, but also resorting to a wide range of experimental results carried out on different case studies.

The work of Vojtěch leads to the seven publications detailed in the manuscript plus 16 other publications for a total of 23 publications. It is important to specify that among the 23 publications there are three journals and 20 conference papers. Moreover, I would like to stress the quality of the publications. In fact, we can count up to 5 papers published in the top rank (A1 quality) conferences.

The results are not only publications. I would like to mention the opensource library *EvoApprox8B* containing the approximate versions of adders and multipliers. I personally use this library for my research work and I really thank Vojtěch and his supervisor for that.

Vojtěch also significantly participate to many research projects and grant. It would be better to specify for each one the level (international/national) and describe a bit more in detail the contribution.

Finally, Vojtěch had a significant numbers of awards, and especially for the DATE'17 best IP award.

Based on the above considerations, I believe that Vojtěch MRÁZEK has performed a very good research work reflected in his publications, and that his manuscript owns the characteristics required to allow its discussion and to positively consider it in view of the degree of PhD from the Brno University of Technology.

Sincerely,

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