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Approximate Computing: Evolutionary Methods for Functional Approximation of Digital Circuits

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ABSTRACT

Approximate computing deviates from long-held paradigm and attracted towards intrinsic application resilience to enhance the efficiency by relaxing the parameter of full accuracy. The specifications of digital circuits are violated while explicitly designing. The benefits are in terms of area, performance, power consumption, and speed. For approximating circuit, synthesis tools depend on available technique to check whether the synthesized circuit meets the set parameters and provides the quality. Mostly used approach is circuit simulator for analyzing responses received from all input variables but it is an exhaustive approach and can be used only for a small number of inputs. So this paper focuses on techniques, methods used to approximate circuits and to use formal methods for solving challenges faced by traditional methods. The use of evolutionary methods for circuits has led to the promising results. Major challenges in these methods are the ability to automatically synthesize approximation circuits without relying on the skill of designers. Strategies for generating approximate circuits, methodologies for evaluating the error with benchmarks used are tabulated in paper. The exact circuit, error and their approximate threshold are required for simplification which leads to selecting synthesis techniques for circuit transformations. The criteria of selection of approximate logic synthesis method are based on error analysis, number input and desired output, use of types of application and digital circuits like adder, multiplier, FIR, FFT etc. Introduction, principle, methods of approximate computing with major sub-areas of research work conducted in field of functional approximation which are apropos for designing and testing of circuits are main concern of paper.

Selection and peer-review under responsibility of the scientific committee of the 3rd International Conference on “Advancement in Nanoelectronics and Communication Technologies”.

1. Introduction

As CMOS' physical dimensions reduce to a few tens of nanometers, improving circuit performance and/or boosting efficiency has become increasingly difficult. Challenging issues like higher process variability typically seen in the smallest technology nodes during manufacturing, testing, verification and design. To address this issue the most prominent approach developed is approximate computing. It exploits the fact that computing nowadays not only limited to calculating and obtaining precise result. Rather these computing platforms are used for intrinsic resilience applications such as mining, signal processing, data processing and synthesis. The idea of approximation is well observed to simplify implementations, reduce output quality for benefit of saving resources and make system better and efficient. Computing efficiently with good-enough results produces large improvement in energy consumption. Here functional correctness is redefined from obtaining precise results to produce good-enough results. It means that precise and typically area-intensive circuits aren't always required. Rather a lot less difficult, inexact circuits might be utilized in guaranteed application without presenting any critical debasement in outcomes delivered by this application [2]. Due to development of low power consuming electronics devices and inherent error resilience based applications there is huge demand of approximate computing.

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