Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

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# New programming paradigms for optimization

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## 1. Introduction

Although today CPUs are designed with parallelism in mind, many algorithms are confined in single-threaded environments. With CPUs, GPUs are becoming more general-purpose, enabling the SIMD paradigm to exploit their capabilities.

## 2. Goals

I applied different optimization techniques for improving theoretical algorithms and analyzing complex systems. The common ground of the problems I studied is their use of complex data structures (e.g., graphs) and the possibility of solving them using parallel algorithms. In a few cases, I improved the current state-of-the-art or unraveled problems previously unsolved in reasonable times or industrial environments.

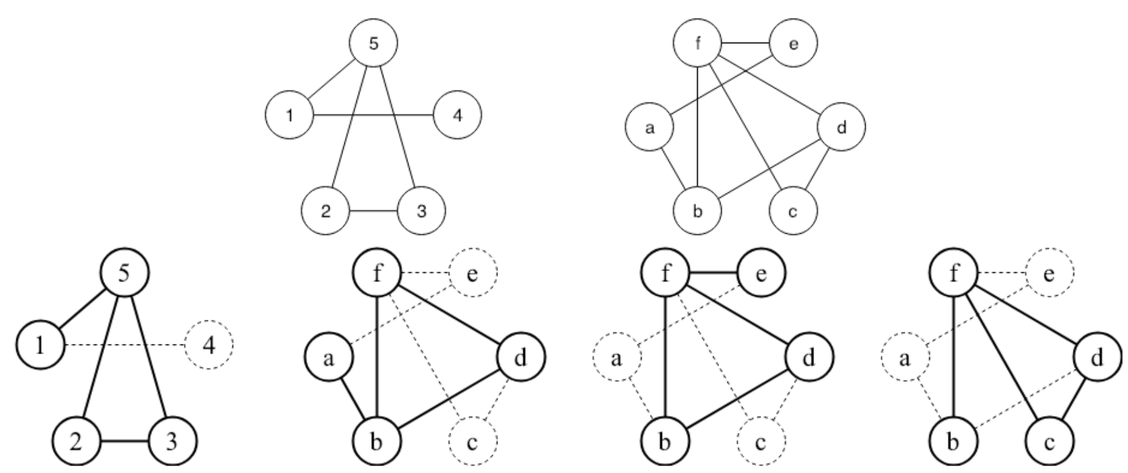
## 3. Research focus

The focus of my research was mainly divided into two separate fields:

- Parallelization of algorithms dealing with graphs on both CPU and GPU architectures.
- Parallelization of the analysis of System-on-Chip automotive devices in the testing area.

## 4. Graphs

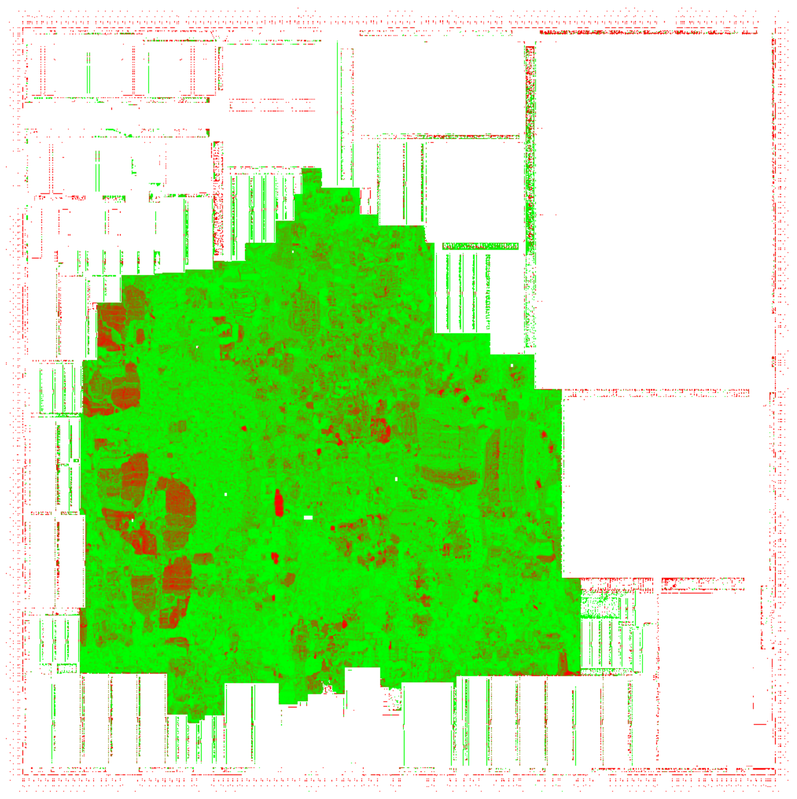
I focused on improving an existing algorithm (named McSplit) for solving the Maximum Common Subgraph problem. Although this puzzle has been proven NP-complete, it is of paramount importance in many modern fields, such as chemistry, biology, social network studies, and other.




I used neural networks to assess the similarity between the nodes of the graphs, partially transforming a blind breadth-first search into a best-first algorithm [1].

## 5. Testing

In the testing domain, I evaluated the ability of test patterns to stress the device under test [2]. Moreover, I rated the coverage of test programs through the construction of a dependency graph and its analysis in terms of data connectivity [3].



## 6. References

1. A. Calabrese et al., “Exploiting Deep Learning to Compute the Maximum Common Subgraph”, Applied Soft Computing (under revision)
2. D. Appello et al., "Parallel Multithread Analysis of Extremely Large Simulation Traces," in IEEE Access, vol. 10, pp. 56440-56457, 2022, doi: 10.1109/ACCESS.2022.3177613.
3. F. Angione et al., “An innovative Strategy to Quickly Grade Functional Test Programs”, ITC 2022.