CS-724

Advanced logic synthesis and quantum computing

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Cursus	Sem.	Type
Computer and Communication Sciences		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Project report
Workload	60h
Hours	**28**
Lecture	20
Exercises	8
Number of positions	

Remark

Next time: Spring 2022

Summary

Logic synthesis describes techniques to map complex functionality into a sequence of a few, simple, and small logic primitives. It finds application dominantly in digital design, but is most recently also frequently used in cryptography and quantum computing.

Content

The course is structured into two major parts. In the first part, the course will present an overview of modern logic synthesis data structures and algorithms, including an in-depth investigation of an AIG package, Boolean function manipulation techniques using truth tables, BDDs and SAT, formulation of the exact synthesis problem using SAT solving, various logic restructuring methods, and discussion on beyond-CMOS Boolean paradigms.
The second part discusses quantum compilation, which is the automatic translation of quantum algorithms into quantum circuits that can run on physical quantum computers. After an introduction into quantum algorithms, quantum circuits, and quantum gates, the course will present automatic compilation techniques based on the logic synthesis techniques described in the first part. The whole compilation flow is illustrated, and the course will present how the resulting circuits can be run on currently available physical quantum computers.

Keywords

Logic synthesis, optimization, algorithms, SAT solving, efficient data structures, quantum computing, quantum compilation

Learning Prerequisites

Required courses

No specific course requirement.

Recommended courses

CS 472 (helps, but not mandatory, the course is self-contained)

Important concepts to start the course

Knowledge of digital circuits, data structures and algorithms, and programming.

Learning Outcomes

By the end of the course, the student must be able to:

- Implement data structures and algorithms to manipulate logic networks
- Integrate incremental SAT solving into efficient algorithms
- Implement a program on a quantum computer and optimise it

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.

Assessment methods

Project 100%

Resources

Bibliography

Isaac Chuang and Michael Nielsen: Quantum Computation and Quantum Information

Ressources en bibliothèque

- saac Chuang and Michael Nielsen: