COMP3710: Special Topics in Computer Science - Computer Microarchitecture
Semester 2, 2021

This is a draft version of the course description. The content is subject to change.

According to the 2017 Turing Award winners John Hennessy and David Patterson, we are in the new golden age for computer architecture. The limitations of semiconductor scaling, the rising software complexity, and growing calls for infrastructure efficiency require fundamental breakthroughs in the way we design general-purpose processors. This course discusses the various tradeoffs a computer architect must make and understand for designing processors. We begin with understanding the fundamental principles behind the design of an instruction set architecture (ISA). We then take a subset of a widely used ISA and build an in-order pipelined processor for our simplified ISA. We identify bottlenecks in the in-order pipeline and then build a high-performance out-of-order pipeline. We explain how out-of-order pipelines hide high memory latency and exploit instruction-level parallelism with register renaming, branch prediction, speculative execution and recovery, superscalar execution, and load/store queues. The second half of the course covers the cache hierarchy, including critical optimizations for a well-performing cache hierarchy. We also cover the interaction of a modern cache hierarchy with virtual memory. The laboratory sessions introduce processor simulation and critical metrics for quantifying performance, cost, and efficiency.

Background Knowledge: Our primary focus in on the design and implementation of processors. We expect students to know at least one modern ISA and have some experience with assembly language programming (e.g., COMP2300 or ENGN2219). Some experience with systems programming languages (e.g., C/C++) and working in a Linux environment is helpful.

Assessments: Three practical assignments (30%), three homework assignments (30%), two reading assignments with written commentary (20%), and a final presentation (20%). The written commentary and the final presentation are mandatory. We expect and will provide guidelines for good writing and presentation.

Textbooks: Computer Organization and Design: The Hardware/Software Interface
Computer Architecture: A Quantitative Approach