EC700: Advanced Topics in Computer Architecture -- Spring, 2020

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Course Description (catalog): With the coming end of Moore’s Law, computer architects are finding that radical new designs are likely to be necessary to maintain current rates of performance advances. This has led to an explosion of research into beyond-CPU architectures. Topics include a spectrum of innovation, from hardware that is already entering the mainstream, such as increasingly sophisticated accelerators, to technologies pushing technological bounds, such as quantum computing. With so many great new ideas, leading to groundbreaking research in so many directions, it is challenging to keep up with, much less to master, all of this new material! The aim of this course is to provide a foundation in research directions that appear to be either most promising or most the most potentially transformative.

Lectures will cover a broad array of subjects concentrating on their potential impact in High Performance Computing: Quantum Computing, Machine Learning Architectures, Neuromorphic Computing, Accelerators, and High Speed Interconnects. The concepts will be reinforced with research paper readings and also with homework and project assignments that involve system design and analysis.

Prerequisites: Background in computer architecture, including one or more of EC513, EC526, EC527, or EC535; programming in C or C++; experience with using Linux; basic linear algebra

Texts: There are no mandatory textbooks for this class, but every class will have corresponding readings from research papers or book chapters. A reading list will be listed on Blackboard together with links to all texts.

Course Mechanics
• Style: For each major topic the instructor will give two to three introductory lectures. These will be followed by paper presentations and discussion by class members. In addition there will be some small programming assignments and a project. Students will be required to read and evaluate papers before the class when they are presented.
• Grading: Paper participation and evaluation: 25%
  Paper presentations:  20%
  Other assignments: 25%
  Project:  30%
• Lecture Scribes: In each lecture, a student will be selected to be scribe for the lecture content. A brief but clear list of discussion items, covered topics, key insights, and important questions is sufficient. Another student will review the lecture notes for accuracy. Lecture notes can be written in any editing tool, but should be submitted as pdfs. Final pdf should be emailed to the instructor before the next lecture. Notes will be shared with the class.
- **Paper evaluations:** We will be reading research papers from top-tier conferences and journals. These papers will be essential supplements to the lectures and to the projects. Most weeks, each student will be submitting 1-2 paper evaluations. The evaluations should be brief (1-2 sentence per question) but specific and technical, and should answer the following questions:
  - What is the problem described in the paper?
  - Why is it an important problem?
  - What is the hypothesis or solution in the paper and what is the acclaimed novelty?
  - Strengths?
  - Weaknesses?
The evaluations are due at the beginning of the lecture that is associated with the given paper. Students should be both submitting online and bringing a printed hard copy to the course with them. Late submissions will not be considered.

- **Paper presentations:** Each student will select a paper from the course paper reading list (the list will be provided, selections are first-come first-serve) and present that paper during a lecture. The presentation will be followed by a technical discussion.

- **Programming and other assignments:** There will be (tentatively) three mini projects during the class. These projects will involve writing code for non-standard modalities (e.g., quantum and neuromorphic). You will have around 2 weeks to complete each mini project.

- **Project:** Instead of a final exam, this class has a final project, which will involve analysis, implementation, and a well-polished presentation of the project details and outcomes (both as a report and an in-class presentation). You will have around a month to complete your project. Projects will be completed individually or in teams of 2 students.

**Academic Honesty:** All students are responsible for reading Boston University's academic conduct policy. If you are unclear about any item related to academic honesty, you should immediately ask the professor. Dishonesty in representing one's academic work is a serious ethical violation, and will be reported according to university policy.

**Course Website and Communication:** You are required to periodically check the course website on BU Blackboard Learn and your e-mail. Blackboard will have the course schedule, slides, links to reading materials, projects, announcements, and a discussion board.