ECE 618: Hardware Accelerators for Machine Learning

Syllabus

Spring 2023

Instructor: Weiwen Jiang <wjiang8@gmu.edu> (703)993-5083

Class Meeting: Lectures – Monday 07:20 PM - 10:00 PM

Location: Fairfax Campus | Innovation Hall | Room 131

Website: https://jqub.ece.gmu.edu/2023/01/01/HA4ML23S/

Zoom: https://go.gmu.edu/HA4ML23

Course Materials: Course materials will be posted before or after the class. No formal textbook is required.

Recommended Prerequisites: (ECE 511 or CS 465) and (ECE 527 or ECE 554 or CS 580 or CS 688) or permission of instructor.

Course Description: This course covers the hardware design principles to deploy different machine learning algorithms. The emphasis is on understanding the fundamentals of machine learning and hardware architectures and determining plausible methods to bridge them. Topics include precision scaling, in-memory computing, hyperdimensional computing, architectural modifications, GPUs and vector architectures, quantum computing as well as recent hardware programming tools such as Xilinx AI Vitis, Xilinx HLS, and IBM Qiskit.

Schedule: The course schedule will follow the outline below. However, depending on the course progress and requirements and/or weather and health closures or other unforeseen circumstances, it will be rearranged. Assignments are assigned throughout the semester and are due **before** the date of the lecture indicated. Additional assignments maybe assigned.

SECTION I: Classical Computing Accelerators for Machine Learning

Date	Topic
Week 1 (1.23)	Course Information & Machine Learning for Embedded Systems Recap
Week 2 (1.30)	Domain Specific Computing
Week 3 (2.06)	Vector Architectures and GPU Architectures

SECTION II: Novel Post-Moore Computing Accelerators for Machine Learning

Date	Topic

Week 4 (2.13)	FPGA Accelerator Designs
Week 5 (2.20)	In-Memory Computing Accelerator Design
Week 6 (2.27)	Hyperdimensional Computing Accelerators (1)
Week 7 (3.06)	Hyperdimensional Computing Accelerators (2)
Week 8 (3.20)	Midterm Exam

SECTION III: Other Accelerator Related Topics

Date	Topic
Week 9 (3.27)	Project Proposal
Week 10 (4.03)	Quantum Neural Network Accelerators
Week 11 (4.10)	Hands-on Accelerator Design (1)
Week 12 (4.17)	Project Overview
Week 13 (4.24)	Hands-on Accelerator Design (2)
Week 14 (5.01)	Project Presentations

* The schedule might change during the semester depending on the progress of the class.

Project: The project can be done in a team of 1-3 students. Students can choose a project topic from a list of topics suggested by the instructor, posted on the Blackboard. They can also suggest a project topic by themselves but MUST be relevant to the course. Projects can be of different types: software-hardware co-design, analytical, and mixed. All types of projects are expected to involve some experiments and literature searches. Students will be asked to write a project specification, deliver project reports, give a project presentation (a video recording is recommended), and develop a comprehensive project report.

Exams: This course includes a **Midterm exam**. Exam date is specified in the course schedule.

If (for extraordinary circumstances) you cannot make one of the scheduled exams, you must speak with the instructor in advance to arrange for an alternate time to take the exam.

If you fail one of the exams or do not submit assignments or discussions, I reserve the right to give you a failing grade for the course.

Attendance: **Attendance in the class is mandatory.** If you miss class with prior permission, you must consult with one of your classmates to obtain the notes and/or problem solutions that were presented.

Grading: The final grade for the course is based on my best assessment of your understanding of the material and your participation in the class during the semester. The exams, assignments, and class problems will be used to determine your final grade according to the following weighting:

- Quiz 10%
- Midterm Exam 20%

- Research paper presentation 20%
- Assignments and Labs 20%
- Project (including proposal and discussion) 30%

Exams are given on the dates specified on the course schedule. Absence from taking exam will result in a score of zero unless cleared in advance with the instructor and arranged for a makeup session. Excusable absences are normally related to unavoidable and documented emergency situations. The final letter grade will be assigned accordingly. If you have any concerns with the exam procedure or turning-on during the exam, let me know within two weeks of the semester beginning.

Classroom Etiquette:

- Email Communications: Students must use their MasonLive email account to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information. Homework assignments and other course material will be emailed to your MasonLive email account. Also, when you send me an email, please write ECE618 on the subject line.
- Cellphones are to be turned off during class; minimally they must be silenced. Emergency calls may be taken but must be taken outside of the classroom. Texting, using your laptop for something other than lecture-related work, etc. is considered a distraction to me and to the other students trying to learn in the class, and will not be tolerated.
- You are expected to abide by the Mason Honor Code. Violations of the Honor Code are taken very seriously and will be prosecuted to the fullest extent. This includes, but is not limited to, cheating on homework assignments, quizzes, projects, labs, and exams. For more information about the Mason Honor Code and about the Honor Committee, please visit the website for the Office of Academic Integrity (http://oai.gmu.edu/).
- Avoid Reposting Course Material: It is not allowed to reposting course material. The course materials (lecture notes, homework, projects, exams, solutions, and anything else posted on the course website) are copyrighted. You may not upload them to any other website or share them with any on-line or off-line test bank.
- Office of disability services: Mason provides accommodations through the Office of Disability Services (ODS) http://ods.gmu.edu. If you are a student with a disability and you need academic accommodations, please see me and contact ODS at 993-2474.
- University Policies: The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies.