ESE-587
Hardware Architectures for Deep Learning
Spring 2020

Stony Brook University

Syllabus

1. Course Staff and Office Hours

Instructor: Peter Milder
Office Hours: Monday and Wednesday (10:00am to 12:00pm)

Office hours may change. Please check Blackboard for up-to-date information.

2. Course Description

This course focuses on the design and implementation of specialized digital hardware systems for executing deep learning algorithms. The course is divided into three sections. First, students will study field-programmable gate arrays (FPGAs) and related tools. Second, the course will present an overview of modern deep learning algorithms and applications (e.g., visual object recognition, or speech recognition). Third, students will apply this knowledge to complete a significant design project implementing and optimizing a deep learning algorithm on an FPGA.
Prerequisite: ESE 507 or equivalent hardware/FPGA experience.
Spring, 3 credits, grading ABCF.

3. Assignments and Grading

The course will include smaller assignments and larger projects, culminating in a final project at the end of the semester. Examples of smaller assignments include written assignments (e.g., read a section of the textbook and answer questions or summarize) or small experiments (e.g., test out an idea in software). Larger projects will include implementing hardware systems on a field-programmable gate array using modern commercial tools and methods, and working with software frameworks (e.g., PyTorch) to design and test deep learning algorithms. The final project will consist of implementation and evaluation of (all or a portion of) a deep learning-based application on an FPGA. (Students will have access to an FPGA development board with all required software tools and a tutorial.)

Students must prepare a detailed report of their project work including project description, description of the solutions and experimental results. Students must submit the project report, and code (hardware description language and software) of their implementation.

Course grading: The course grade is computed as follows: assignments (30%) + warmup projects (30%) + final project and presentation (40%).

4. Textbook and Materials

"Deep Learning." Ian Goodfellow, Yoshua Bengio and Aaron Courville. MIT Press. 2016. ISBN: 978-0262035613. Available online for free at: http://www.deeplearningbook.org

Additional material will be provided in the form of tutorials, lecture slides, videos, research papers, and ebooks.

5. Schedule

Classes will be held in room 226 of Frey Hall on Mondays and Wednesdays from 4:00 to 5:20pm. A full schedule of assignments, topics, and readings can be found on Blackboard.

6. List of Topics

The following list of topics is meant to provide a general idea of the class material, but it is not intended as a week by week schedule. A full schedule of topics will be available on Blackboard.

Design for Field-Programmable Gate Arrays (FPGAs)

1. Hardware description languages (short review)
2. HDL simulation and synthesis
3. FPGA and FPGA-SOC architectures
4. Modern FPGA design tools

Deep Learning Algorithms

1. Mathematical background
2. Convolutional and recurrent networks
3. Applications
4. Software libraries (PyTorch)

FPGAs for Deep Learning

1. Overview of hardware architectures for deep learning
2. Effective management of FPGA memory resources
3. Optimizing algorithms and data representation for FPGA arithmetic resources
4. Integrating hardware and software

7. Student Learning Objectives

Students will acquire:

1. an ability to apply knowledge of mathematics, science, and engineering;
2. an ability to identify, formulate, and solve engineering problems;
3. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

8. Electronic Communication Statement

Email and especially email sent via Blackboard (http://blackboard.stonybrook.edu) is one of the ways the faculty officially communicates with you for this course. It is your responsibility to make sure that you read your email in your official University email account. For most students that is Google Apps for Education (http://www.stonybrook.edu/mycloud), but you may verify your official Electronic Post Office (EPO) address at http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo.

If you choose to forward your official University email to another off-campus account, faculty are not responsible for any undeliverable messages to your alternative personal accounts. You can set up Google Mail forwarding using these DoIT-provided instructions found at http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail.

If you need technical assistance, please contact Client Support at (631) 632-9800 or supportteam@stonybrook.edu.

9. Student Accessibility Support Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or at sasc@Stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

10. Academic Integrity Statement

Each student must pursue their academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

11. Critical Incident Management Statement

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine

are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.