The University of Texas at Austin
Chandra Department of Electrical and Computer Engineering
Cockrell School of Engineering

Spring 2024

Machine Learning and Data Analytics for EdgeAI

ECE 361E, Unique 17130

Lectures: Tue/Thu 3:30-5:00pm CST (ECJ 1.312)

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Office Hours: Wednesday 1:30-3:00pm (via Zoom)
Thursday 12:00-1:30pm (in-person, EER 0.814)

Background

Large amounts of data are generated nowadays on edge devices, such as phones, tablets, and wearables. For example, video cameras collect footage, our smart watch counts our steps, and our phone locates us. Essentially, edge devices collaboratively develop a data rich environment that can be capitalized on to improve the 'intelligence' of the Internet of Things (IoT). By improving 'intelligence' we mean training Machine Learning (ML) models and making useful inferences using the data collected by edge devices.

Recently, deep learning models have pushed this intelligence from the cloud to the edge for many applications, such as computer vision, healthcare, autonomous driving, speech and natural language processing. However, due to their enormous computational complexity, deploying such models on constrained edge devices remains a critical bottleneck for large-scale adoption of intelligence at the edge. To this end, we envision a new paradigm called EdgeAI, which targets the widespread deployment of deep learning on networked edge devices.

Machine Learning and Data Analytics for EdgeAI is an in-depth (undergraduate) introduction to ML and system optimization for edge computing and IoT applications from a cyber-physical systems perspective. By scope and contents, this class explores fundamental principles and data analytics behind the model-architecture co-design where real-time, hardware, energy, and privacy constraints of edge devices play a major part.

The course requirements consist of several homework assignments, a project, class activities, and a midterm exam. Students will acquire new skills while working with state-of-the-art software tools (e.g., PyTorch, ONNX, etc.) that are widely used in academia and industry; these tools will be used both in homework and project assignments.

This class targets ECE/CS students with basic background in data science and/or neural networks.

Catalog Description

Edge computing; Internet-of-Things (IoT); cyber-physical systems; energy-aware machine learning (ML); deep learning; model compression; knowledge distillation; federated learning; ML security; system optimization; model-architecture co-design; object detection; social sensing;

Pre-requisites

A grade of at least C- in Computer Science 342 or Electrical Engineering 460J.

Required Textbook

None. Lecture handouts, tutorials and research papers will be assigned throughout the semester.

Grading Policy

The following grading scheme is used to compute student scores in this course:

40%	Homework
30%	Project
20%	Midterm exam
10%	Class participation

Class participation is expected throughout the semester; this will be evaluated based on in-class interactions and class activity. Also, each component of this grading scheme should be completed as required to get a passing grade, irrespective of the overall points accumulated. Final letter grades will be based on a straight scale (90/80/70/60) using +/- increments and a small amount of (upward) curving.

Homework and project assignments late submission penalty: 15% penalty per day, up to two days late. Discussion of homework problems and project topics is encouraged, but make sure to submit your own (independent) solution. Homework and project assignments will be done in teams of two students. More details will be provided in a timely manner.

Each student is expected to abide by the UT Honor Code: *"As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity."* Copying any part of a solution without explicit reference to its source is plagiarism and considered cheating. The University disciplinary procedures will be invoked if any form of cheating is detected. Please see the Student Conduct and Academic Integrity. Also, publishing and/or distributing any material related to this class without the explicit approval from the course instructor is strictly prohibited; any such violation will result in failing this class.

Planned Topics[1]

The topics discussed in this class belong to the following broad categories:

- **[Algorithms]**: Deep learning; model compression (e.g., pruning; quantization); distributed learning (e.g., federated learning); model-architecture co-optimization; edge AI.
- **[Architectures]** Cyber-physical systems; edge devices; on-device ML (e.g., accuracy, memory, speed, power, real-time, etc.); mobile processors.
- **[Applications]** Edge computing; Internet-of-Things (IoT); image classification; object detection; healthcare.

[1] A detailed schedule will be available on Canvas; this schedule may be revised during the term.

Class format

This class will meet twice a week, in-person; this is the best way to learn the material and engage in discussions. This class is using the Lectures Online recording system. This system records the audio and video material presented in class for you to review after class. Links for the recordings will appear in the Lectures Online tab on the Canvas page for this class. You will find this tab along the left side navigation in Canvas.

To review a recording, simply click on the Lectures Online navigation tab and follow the instructions presented to you on the page. You can learn more about how to use the Lectures Online system at http://sites.la.utexas.edu/lecturesonline/students/how-to-access-recordings/. You can find additional information about Lectures Online at: https://sites.la.utexas.edu/lecturesonline/.

Video materials and recordings related to class activities are reserved only for students and TA's for educational purposes and are protected by FERPA laws if any students are identifiable in the video. Video recordings should *not* be shared outside the class in any form. Students violating this university policy could face misconduct proceedings.

Use of Canvas

We use Canvas to distribute course materials, communicate and collaborate online, submit homework and project assignments, and post solutions and grades. *Students are responsible for checking Canvas course site regularly for class work and announcements. Make sure you turn your Canvas notifications ON for this class.*

Electronic Mail Notification Policy

Email will be used as the primary communication tool. You will be responsible for checking your email regularly for class work and other announcements. The complete text of the University electronic mail notification policy and instructions for updating your e-mail address are available at http://cio.utexas.edu/policies/university-electronic-mail-student-notification-policy.

Students with Disabilities

The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Services for Students with Disabilities (SSD) at 471-6259, http://diversity.utexas.edu/disability.

Religious Holy Days

Religious holy days sometimes conflict with class and examination schedules. If you miss an examination, work assignment, or other project due to the observance of a religious holy day you will be given an opportunity to complete the work missed within a reasonable time after the absence. It is the policy of The University of Texas at Austin that you must notify your instructor at least fourteen days prior to the classes scheduled on dates you will be absent to observe a religious holy day.

Counseling and Mental Health

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help.

Asking for support sooner rather than later is very important. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. The Counseling and Mental Health Center (CMHC) provides counseling, psychiatric, consultation, and prevention services that facilitate students' academic and life goals and enhance their personal growth and well-being: http://cmhc.utexas.edu/.