Machine Learning and Data Analytics for EdgeAI

EE379K, Unique 17545, Spring 2021

Lectures: TTh 12:30-2:00pm CST, on-line

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Class webpage:	Canvas: https://utexas.instructure.com/

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, pop quizzes, and a midterm exam. Students will acquire new skills while working with state-of-the-art software tools (e.g., PyTorch, TensorFlow, TVM, etc.) that are widely used in academia and industry; these tools will be used both in homework and project assignments.

This class targets ECE and CS students, with basic background in data science 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, tutorial and research papers will be assigned throughout the semester.

Grading Policy

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

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

Class participation is expected throughout the semester; this will be evaluated based on a few pop quizzes (specific details will be provided in a timely manner). Also, each and every component of this grading scheme should be completed as required in order to get a passing grade, irrespective of the overall points accumulated. Final grades will be assigned using plus and minus increments.

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 of any part of a solution without explicit reference to its source is plagiarism and considered cheating. University disciplinary procedures will be invoked if any form of cheating is detected. Please see Student Conduct and Academic Integrity.

Class format

This class is fully on-line. Students are strongly encouraged to attend lectures remotely for synchronous delivery; this is the best way to learn the material and engage in class discussions. Access to lectures recording will be uploaded to Canvas.

Homework and project assignments, as well as exam materials will be submitted via Canvas following specific guidelines that will be provided in a timely manner.

Video streaming and recording of 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 streams and recordings should *not* be shared outside the class in any form. Students violating this university policy could face misconduct proceedings.

Planned Topics[1]

• **[Applications]** Edge computing; Internet-of-Things (IoT); image classification; object detection; social sensing; cloud vs. on-device ML;

• **[Architectures]** Cyber-physical systems; computation vs communication; hardware (e.g., memory, speed, power, etc.) and application constraints (e.g., real-time, accuracy, etc.); mobile processors, FPGA, accelerators;

• **[Algorithms]**: Deep learning; model compression; quantization; pruning; knowledge distillation; federated learning; model-architecture co-design;

Use of Canvas

We use Canvas to distribute course materials, communicate and collaborate online, submit assignments, and post solutions and grades. *Students are responsible for checking Canvas course site regularly for class work and announcements.*

As with all computer systems, there are occasional scheduled downtimes, as well as unanticipated disruptions. Notification of disruptions will be posted on the Canvas login page. Scheduled downtimes are not an excuse for late work. However, if there is an unscheduled downtime for a significant period of time, an adjustment will be made if it occurs close to the due date.

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 each of your instructors 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 often helpful. 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/.

COVID-19 Pandemic

Due to the COVID-19 pandemic, lectures, assignments, and office hours will be adapted to follow the university guidelines regarding this matter. Please let the instructor know if you face difficulties in accessing course resources or completing work. The University provides student emergency assistance through Texas One Stop (US citizens), Texas Global (International), Student Emergency Fund (All Students). Follow all the necessary measures to ensure your safety during the pandemic.

[1] The detailed schedule is available on Canvas (check under Syllabus).