

Edge Computing

Lecture 01: Introduction

Logistics

- Lectures:
 - [LECTURE TIMES]
- Labs:
 - [LAB TIMES]
- Final Project:
 - Check out devices at the Makerspace
- Join Slack from Canvas
 - Share Q&A in slack
 - Answering questions is highly encouraged
 - Do not send emails about technical questions, as it limits discussions. Share your knowledge.



Today:



WHAT IS EDGE
COMPUTING?



SYLLABUS



LOGISTICS



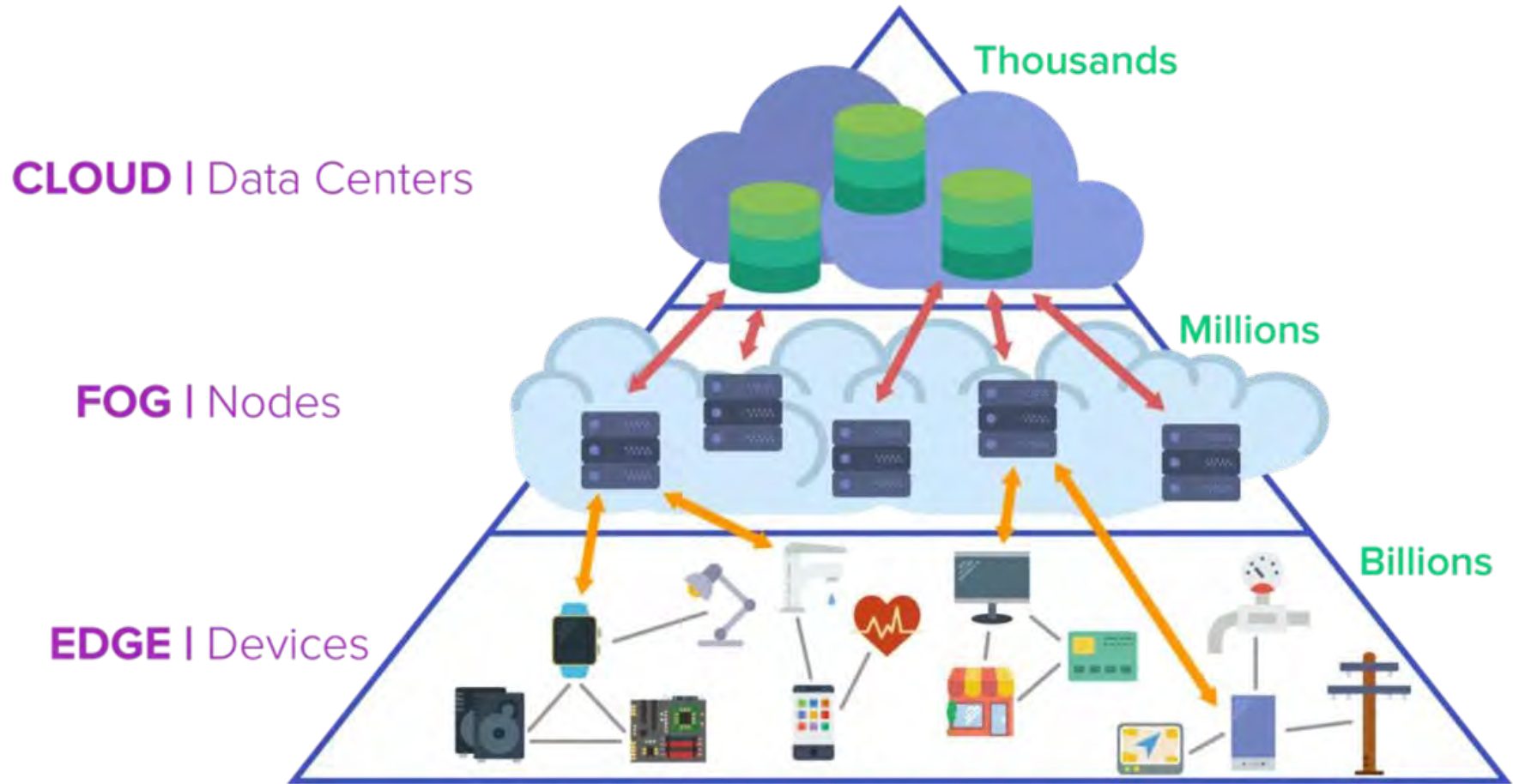
HOMEWORK

What is Edge Computing?

- Breakout activity
 - Search online to create an answer to the question “What is Edge Computing?”
 - Put your name and answer in [Quiz 0: What is Edge Computing](#)
 - Bad example: John Smith - Edge computing is computing on the edge
 - An opportunity to find your teammates for projects
 - An updated version of roster

What is Edge Computing?

- Is a buzzword
- Money making scheme
- Verizon's newest product
- Cool stuff you can do with 5G
- IoT's coolest cousin
- ML in real world
- Self-driving cars
- Smartphones
- A computing paradigm
- Low latency computation
- In-situ processing





Fog Computing

O

Networking architecture that serves as the middle layer between Edge and Cloud computing

O

Named Fog for being a "lower Cloud"

Topics

- Edge computing and its applications
- Edge systems: architecture, design, and optimization
- Edge ML: machine learning on the edge
- Edge devices: hardware acceleration
- Edge & Cloud: Middleware
- Edge ML Research: systems and applications

Course Objectives

After taking this course, you should be able to:

- Describe the structure and components of an Edge Network
- Make decisions on workload distribution and system tradeoffs between Edge devices and Cloud resources
- Understand and identify the priorities of Edge Computing in different scenarios and use cases
- Analyze and profile different architectures that will aid on processing the data
- Draw cost-benefit analysis where resources are limited
- Design an Edge ML application from scratch
 - e.g. AR/VR, health care, self-driving cars

Course Objectives

In addition, you get trained with

- Methodologies to do independent research
- Programming skills
- System design skills

Course Structure

- Quiz (10%)
- Labs (20%)
- Programming Exams (10%)
- Paper Presentation (20%)
- Final Project (40%)



Lecture & Theory

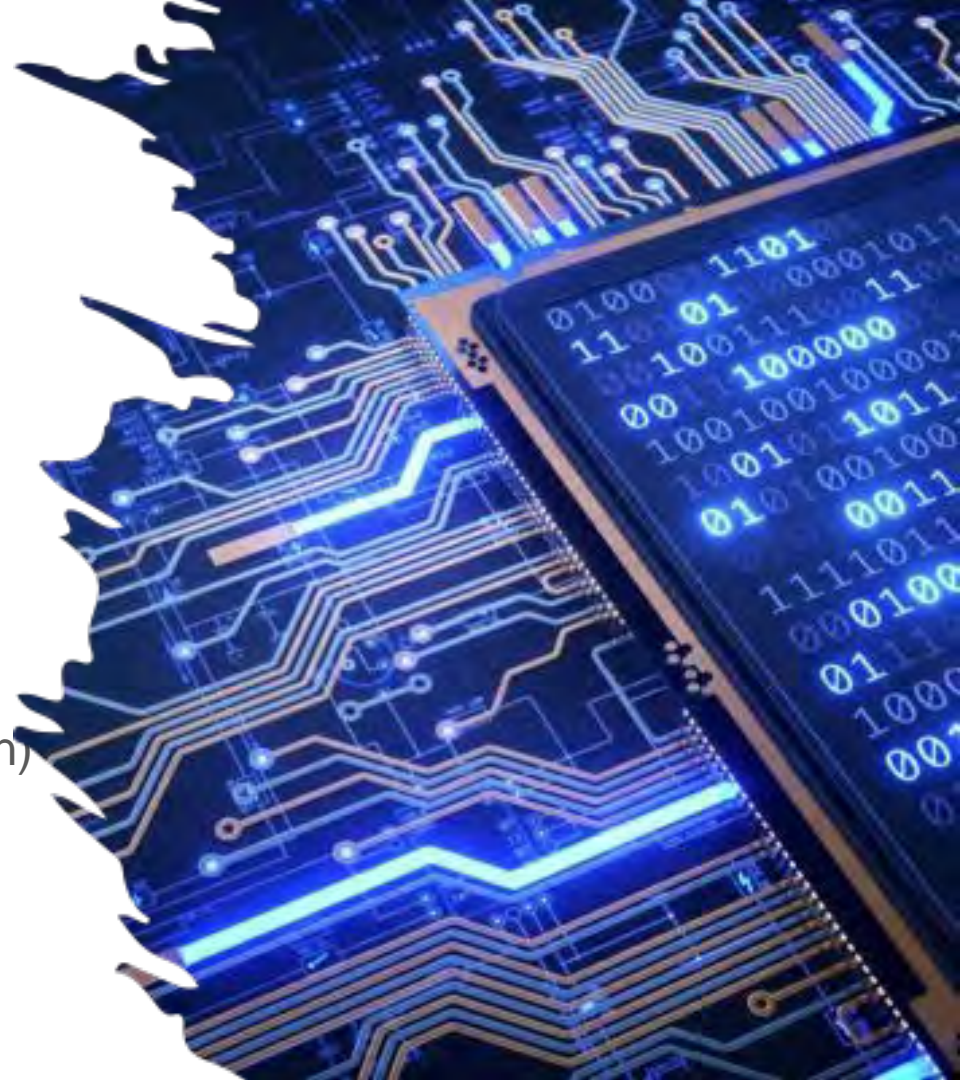
- Edge computing paradigm
- Performance challenges
- System optimization
- ML on the edge
- Hardware architectures
- Ethics & Security
- Edge ML research frontier
(researcher position at CISL)

Paper Presentation (20%)

- Find a top-tier conference paper/project on Edge Computing / Edge ML
 - Examples: <https://github.com/gigwegbe/tinymml-papers-and-projects> (some are dated)
 - Preferably relevant to your final project
 - Treat as related work search (avoiding reinventing the wheel)
 - E.g. object detection, car, pedestrian, cyclist detection has been done
 - E.g. health monitoring, heart rate, sleep quality monitoring has been done
- Topic is unlimited
 - Systems and infrastructure, AR/VR, health care, transportation, agriculture, smart grid, etc.
- Make presentation slides
 - Summarize the **problem**, **challenges**, and **contributions** of the paper
 - Dive into design details and evaluations
- Make a Quiz for the audience
 - 5x multiple choice questions focusing on presentation details
- Present the slides in class (Week 6-7)

Lab & Practice

- Setting up your edge devices (Nvidia Jetson Nano)
- Measuring performance
- Using docker with Nano
- Hardware & software acceleration
- Setting up a communication network
- Accessing cloud computing
- Running Edge ML (e.g. face detection)
- Innovate novel applications



Final Project (40%)

- Design your favorite Edge ML application
 - Example app domains:
 - Health care, transportation, AR/VR, security, systems and infrastructure, agriculture, smart farms, energy, manufacturing...
 - *E.g.* self-driving cars, sleep monitoring, mask detection, rain/cloud/solar power forecast, gait estimation, *etc.*

Deadline	Milestone	Description	%
Week 4	Proposal	Idea, motivation, methodology, plan	10
Week 7	Deployment	Progress, resource, obstacles, remaining tasks	15
Week 9-10	Presentation	Demo, technical presentation	10
Week 10	Report	Final summary of the entire project	5

Grace Day

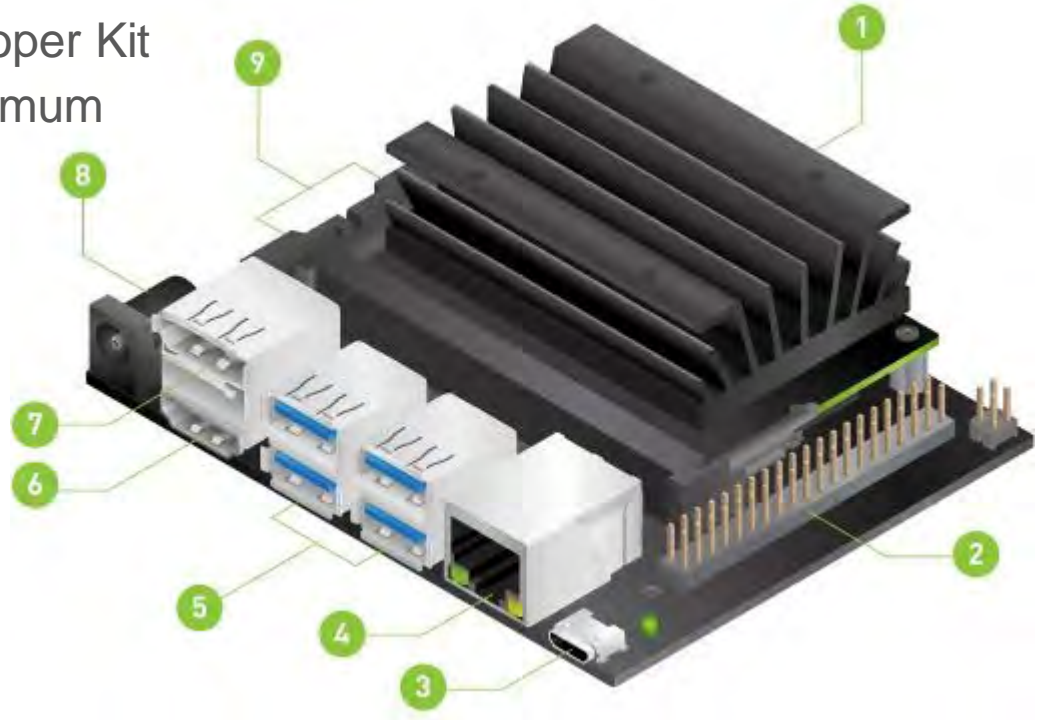
- Each team has three (3) grace days
- Applied to labs only
- Not Applicable to Final Project or Presentation
 - Start early!

Sample Quarter Schedule

Week	Day	Date	Lecture	Lab Issue Date	Lab Due (End of Day)	Project Due (End of week)
1	Mon	01/06	Introduction			
	Wed	01/08	Edge Computing and Its Applications	Lab 0: Setup		
2	Mon	01/13	Edge Systems: Architecture			
	Wed	01/15	Edge Systems: Design and Optimization	Lab 1: Profiling Tools for Jetson	Lab 0	
3	Mon	01/20	Holiday	Final Project Description		Exam 1
	Wed	01/22	Edge ML: Basics of ML	Lab 2: Object Recognition	Lab 1	
4	Mon	01/27	Edge ML: Quantization and Pruning			Proposal
	Wed	01/29	Edge Computing Hardware: Architectures	Final Project Consultation		
5	Mon	02/03	Edge Computing Hardware: Special Accelerators	Lab 3: Client-Server Communication	Lab 2	Paper Pres. Slides & Quiz
	Wed	02/05	Edge & Cloud: Middleware			
6	Mon	02/10	Paper Presentation			
	Wed	02/12	Paper Presentation	Lab 4: Connecting to the Cloud	Lab 3	
7	Mon	02/17	Holiday			Deployment
	Wed	02/19	Paper Presentation			
8	Mon	02/24	Ethics, Privacy & Security		Lab 4	
	Wed	02/26	Edge Computing Research			
9	Mon	03/03	Project Presentation			
	Wed	03/05	Project Presentation			
10	Mon	03/10	Project Presentation			Report
	Wed	03/12	Project Presentation			

Materials

- NVIDIA Jetson Nano Developer Kit
- MicroSD card w/ 32GB minimum
- Ethernet cable
- USB keyboard and mouse
- Any monitor with HDMI port
- Micro-USB power supply
 - or alternatively...
 - 5v 4A AC power supply
 - Jump-pin switch
- Micro-USB to USB
- Your own laptop



Books (not required)

The following are textbooks used as reference for this class. While useful, they are not required. All of them are free on UCR library

- Situnayake, D., & Plunkett, J. (2023). AI at the Edge. O'Reilly
- Buyya, R., & Srirama, S. N. (Eds.). (2019). Fog and edge computing: principles and paradigms. John Wiley & Sons.
- Al-Turjman, F. (2019). Edge computing: From Hype to Reality. Springer

Academic Integrity

- Cite your sources
 - Never copy and paste or paraphrase from any source without properly citing
- Discussion is encouraged but make sure to implement on your own
- Code plagiarism will be checked, and will be given a 0 for the project/lab/exam
- Partial points will be given for honest efforts

Team up

- By default, labs and final projects are done in a team of two (2) members
- Exception can be granted for 3 members if the final project scope is large
 - Apply for exception before Lab 0
- Sign up sheet: [EE/CS131: Team sign-up](#)
- Deadline: Tuesday before Lab
 - TA will issue Jetson Nanos for registered team members