Hello!
• What & Why

• Mechanics (How)

• Expectations

What Are Distributed Systems

Program

Runs on

Node A

Node B

Node C

...

What Is A Node?

• Something that can execute logic & maintain state
Asynchronous Model

→ Asynchronous Model

\[ n \text{ CONNECTED BY A COMMUNICATION MEDIUM THAT} \]

\[ \text{Is Slow} \]

Connected by a communication medium that

\[ (n = 3, 5, \ldots) \]

\[ \text{Asynchronous Model} \]

→ Other Nodes Cannot Decide Whether A Node Has Failed Or

→ Byzantine: Stop Making Progress

→ Crash-Resilient: Miss Some Steps, But Then Make Progress

Ins't This Just Concurrent Parallel/Multi-threaded Programming?

Can Communicate With Other Nodes Functionally Evenly Read Or Write To Shared Memory

By Process/Thread On A Server?
Can arbitrarily delay messages [Reads & writes from shared memory take arbitrary time]

Can drop messages

Must be fair

Resending a message enough time is sufficient.

Problem:

How to design algorithms & systems that

- Work even when some processes fail
- In the asynchronous model

Many basic tasks are impossible.

Two Generals

\[ x_0, y = \max (x_0, x_1) \]
\[ y = 2 \quad \text{if} \quad y - 2 = 0 \]

WHY? (Beyond Intellectually Interesting)

- Fault Tolerance

- Scaling Resources & Users

Course Mechanics

Papers
- Expectation about details, proofs, etc.

- Time commitment

Expected structure:

Exams (40%)

Readings → Discussion & Clarification → Lectures → Labs (40%) → Extend → Final Project (15%)
Focus in lectures

- Define requirements & correctness
- Assumptions & invariants
- How protocols maintain invariants
- Things not covered in the paper

Labs

Elixir?
Collaboration & Communication

Message Passing & The Asynchronous Model

On Boot:
- \text{send}(\times_0^0) (i \in V/2)
- On \text{recv} \ x_i \in V/2
- \text{from} (i \in V/2)
- \text{send}(\text{ack})
- On \text{tween} ( )
FAIRNESS

If process $P$ sends $P'$ message $M$ infinitely often
then $P'$ (if alive) receives $M$ infinitely often.

$x \in \mathbb{N}$

$\leq$

$P \xrightarrow{x} P'$

WHY ASSUME & WHY REALISTIC?