LEAP Life - Computer Literacy – January 6, 2026

Day 2

What does Object Oriented Programming Mean to You?

What are the benefits of OOP?

- **Encapsulation**
  - Briefly talked about this best practice…
    - Prior to OOP, data could be encapsulated
    - OOP enables encapsulation of the data as well as its supported behaviors
  - This is particularly beneficial for larger code bases as it makes them more
    - modular
    - readable
    - maintainable
    - scalable

- **classes** are templates that define state (variables) and methods (functions) that are tightly coupled together.
- **instances** are specific objects created from the **class** template that have their own state based on the **class** definition.
  - Your program may involve very many instances of a particular class, just as it may involve many **integer** or **string** variables.
- A lot more core concepts to come but let's start on an example that demonstrates these two most core ones

```
class ExamScore:
    student_id: str
    exam_name: str
    score: float
```

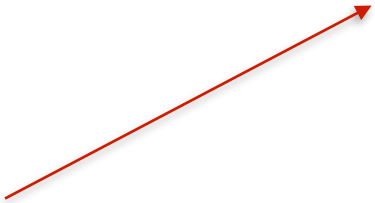
three pieces of information
encapsulated together

```
class ExamScore:
    student_id: str
    exam_name: str
    score: float
```

creation of an **instance** of the **ExamScore** class

```
expected = ExamScore(
    student_id="U123",
    exam_name="midterm",
    score=75.4
)
```

```
@dataclass
class ExamStats:
    average_final: float
    unique_students: int

    def to_dictionary(self):
        return {
            "average_final": self.average_final,
            "unique_students": self.unique_students
        }
```



behavior (converting to a dictionary) encapsulated together with state

```python
@dataclass
class ExamStats:
    average_final: float
    unique_students: int

    def to_dictionary(self):
        return {
            "average_final": self.average_final,
            "unique_students": self.unique_students
        }
```

invocation of a method (behavior) on an instance of the **ExamStats** class

```python
result = read_and_compute(
    LocalCSVDataFetcher(INPUT_FILENAME),
    ExamDataProcessor()
)

with open(OUTPUT_FILENAME, "w") as out:
    json.dump(result.to_dictionary(), out, indent=2)
```

What does the term Interface mean to you?

```python
from dataclasses import dataclass

@dataclass
class ExamScore:
    student_id: str
    exam_name: str
    score: float

@dataclass
class ExamStats:
    average_final: float
    unique_students: int

    def to_dictionary(self):
        return {
            "average_final": self.average_final,
            "unique_students": self.unique_students
        }

class DataFetcher:
    def fetch(self) -> [ExamScore]:
        raise NotImplementedError

class DataProcessor:
    def compute_average_final(self, scores: [ExamScore]) -> float:
        raise NotImplementedError

    def compute_number_of_unique_students(self, scores: [ExamScore]) -> int:
        raise NotImplementedError
```

contracts.py in Base repo

Day 2 Hands-on Exercise 1

- Re-factor your code to use classes
- Re-factor your code to implement interfaces
- Update your tests to cover your updated structure
- Make sure your code still works
  - From base repo, copy the following files:
    - main.py
    - contracts.py
    - exam_data_processor.py
    - local_csv_data_fetcher.py
    - test_exam_data_processor.py
    - test_local_csv_data_fetcher.py
- **Too make everything work, you should only have to change:**
  - **exam_data_processor.py**
  - **local_csv_data_fetcher.py**
- You can disable your old tests if needed

Day 2 Hands-on Exercise 1 - What did you learn?

What does the term Cloud Computing mean to you?

What is Cloud Computing?

Cloud computing is the delivery of on-demand computing resources, including **storage**, **processing power**, and **applications**, over the internet, allowing users to access and manage data and services **remotely without owning the physical infrastructure**.

Definition & History

1950 -1960

- mainframe computers were very expensive and resource intensive so engineers started thinking about time sharing techniques for them

Definition & History

1970 -1990

- IBM introduced VM (virtual machine) operating system as a way to allow multiple, separate environments to be executed on the same physical machine

Definition & History

1990 -2010

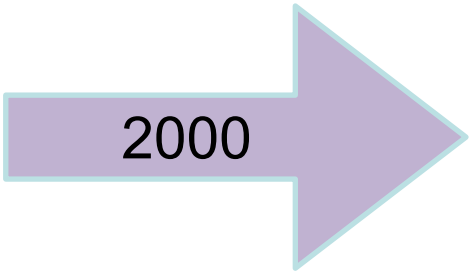
- Majority of companies rent/own data centers, or space in data centers, and manage their physical infrastructure there
- Deploying new services or scaling existing ones requires months of planning overhead
  - procure machines
  - install machines in data center
  - bring them on-line etc…

Definition & History

1990 -2000

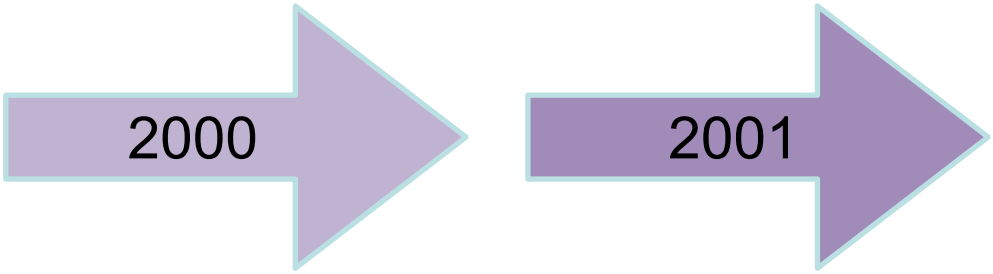
- Software as a Service starts to gain popularity. Companies like **Salesforce** pioneer large scale, enterprise software delivery with zero installed software.

Definition & History



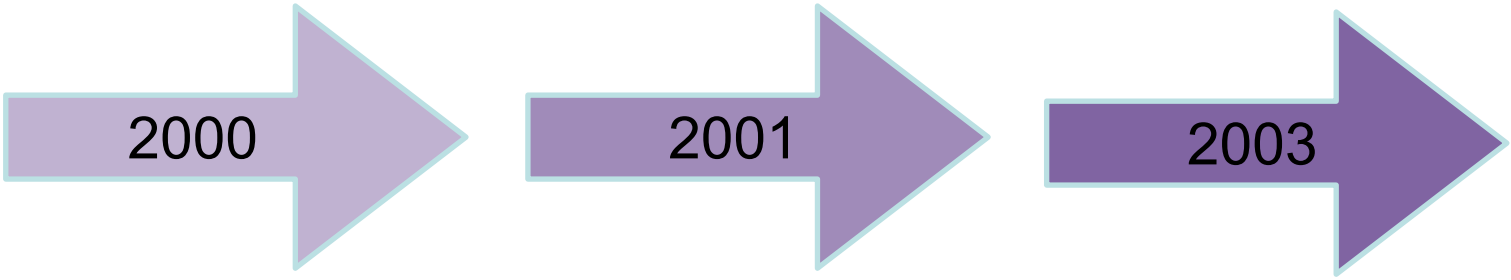
- Amazon dominates on-line sales of physical books

Definition & History



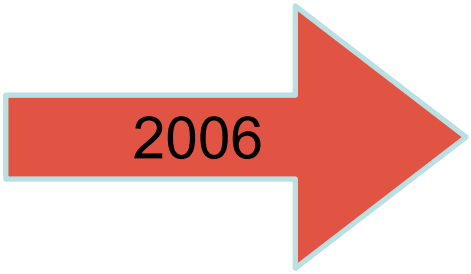
- Amazon dominates on-line sales of physical books
- Amazon opens up their virtual store platform to other retailers

Definition & History



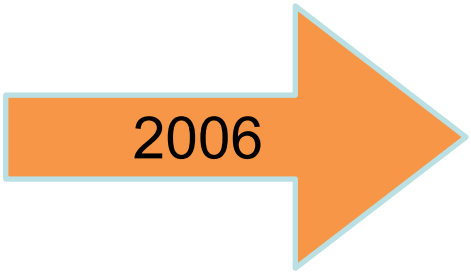
- Amazon dominates on-line sales of physical books
- Amazon opens up their virtual store platform to other retailers
- Group of Amazon engineers realize that Amazon purchases infrastructure to meet their spike loads, but during regular load only ~ 10% of their infrastructure is utilized.
- What day of the year would a much higher fraction of their infrastructure get utilized on?

Definition & History



- Amazon releases Simple Storage Service (S3). Consumers can access scalable, cheap file-like storage via API's.

Definition & History



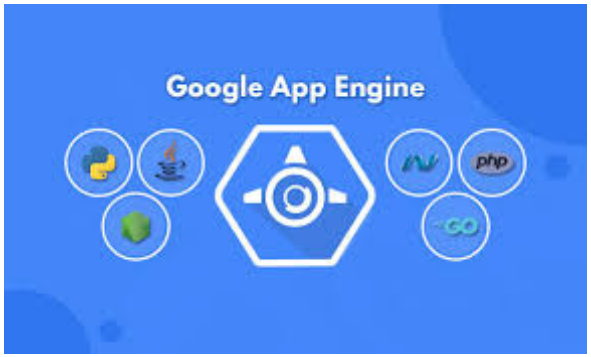
amazon EC2

- Amazon releases Elastic Compute Cloud (EC2) - one of the first “cloud computing” offerings. Consumers could rent virtual machines in Amazon for $0.10 / hour.

Definition & History

2008-2010

- Amazon innovation catches on and first competitors to Amazon emerge

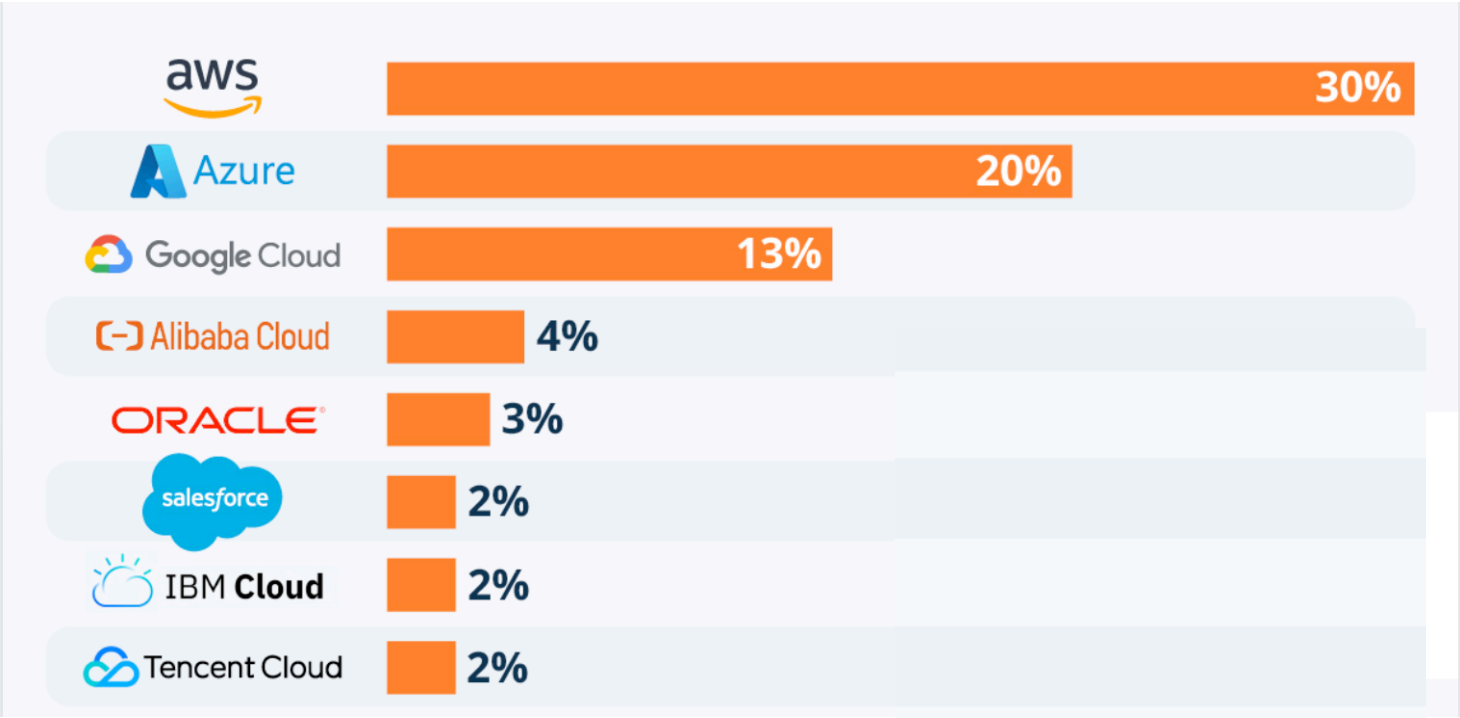


Definition & History

- In 2008, Amazon's competitors were in their infancy and Amazon had virtually 100% of the market share.
- **What do you think the market share is today?**

Definition & History

today



Definition & History

- In 2008, global cloud computing revenue was ~ **$6 billion**.
- **What do you think global cloud computing revenue is today?**

Definition & History

- Depends on how you measure it exactly but its somewhere in the $700 - $900 billion range. **100x from 2008**

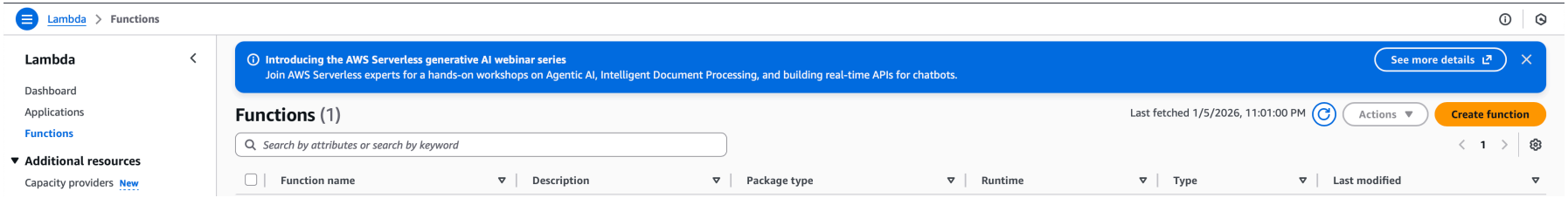
Lambda

- Serverless computing service
- You write code and define events that should trigger that code
- Code can be in one of ten or so supported languages
- Examples of triggers:
  - file uploaded
  - HTTP request made
  - Event appears in the queue
  - database row inserted

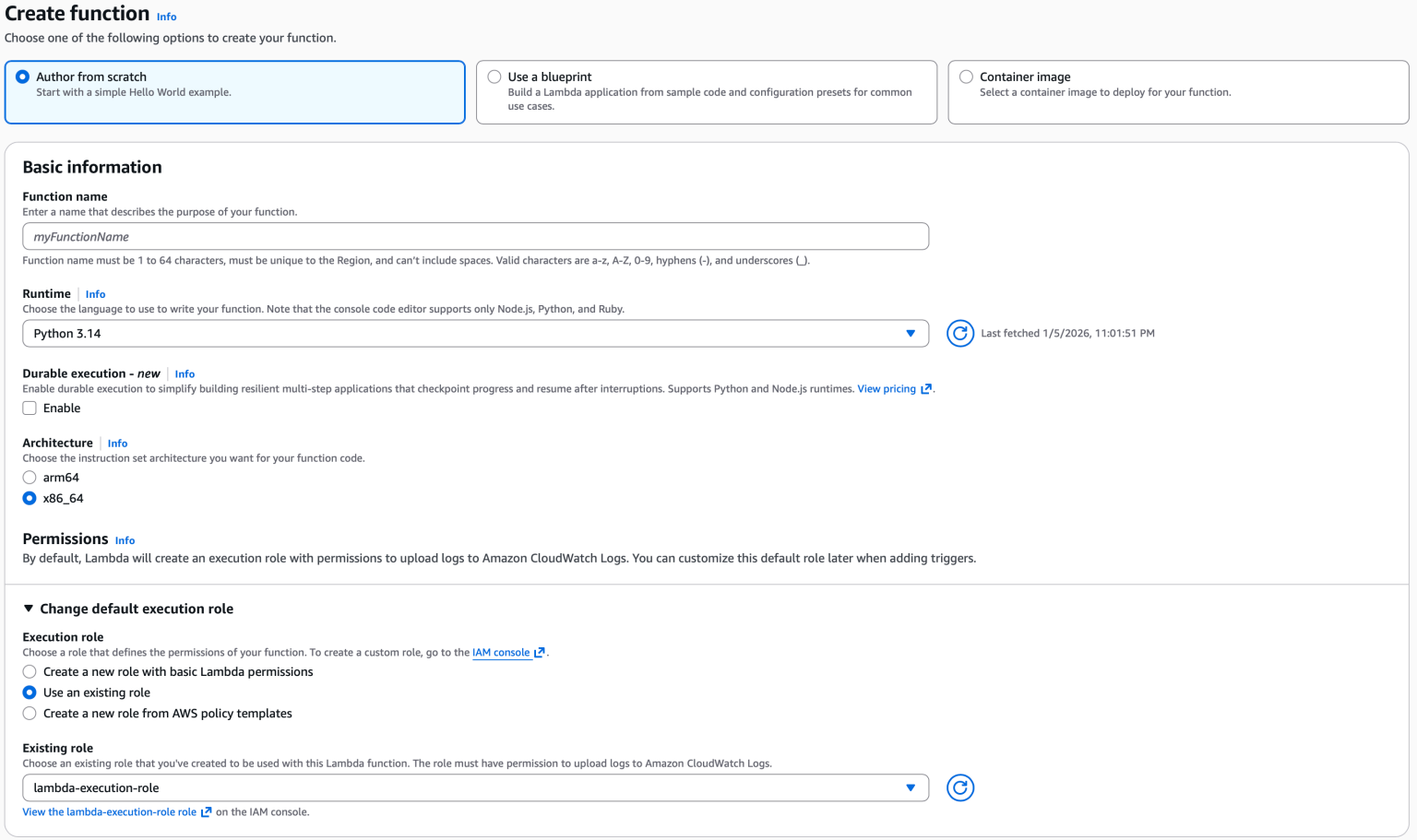
Day 2 Hands-on Exercise 2

- Re-factor to prep for cloud
  - create three folders where all of your code should go:
    - common
    - local
    - aws
- for AWS Lambda, wrap exam score results in HTML
  - by getting **lambda_app.py** from **base**
  - We will configure AWS Lambda to call **lambda_handler** in **lambda_app.py**
- can get S3 data reading by getting **s3_data_fetcher.py** from **base**

Setting Up Your Lambda Functions



Setting Up Your Lambda Functions

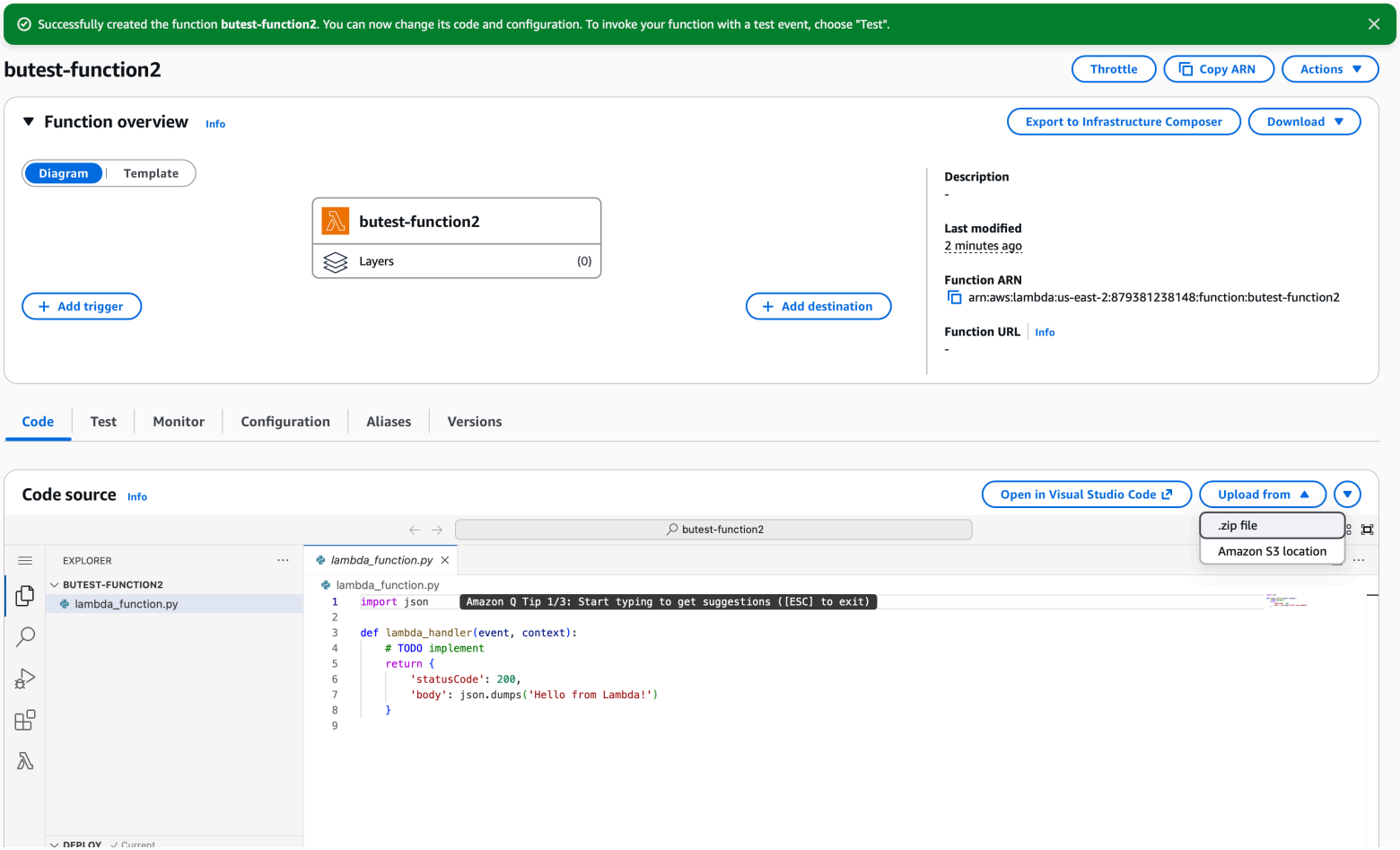


To create zip file that you can upload to AWS Lambda

```
zip -r lambda.zip aws common -x "*/__pycache__/*" "*.pyc" ".DS_Store"
```

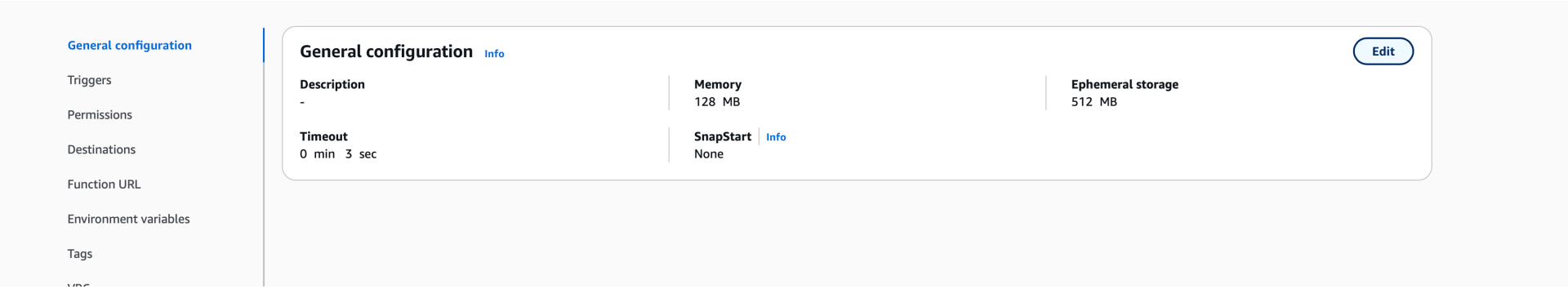
can copy this from README of our **base** repo

Upload your zip file to AWS Lambda …

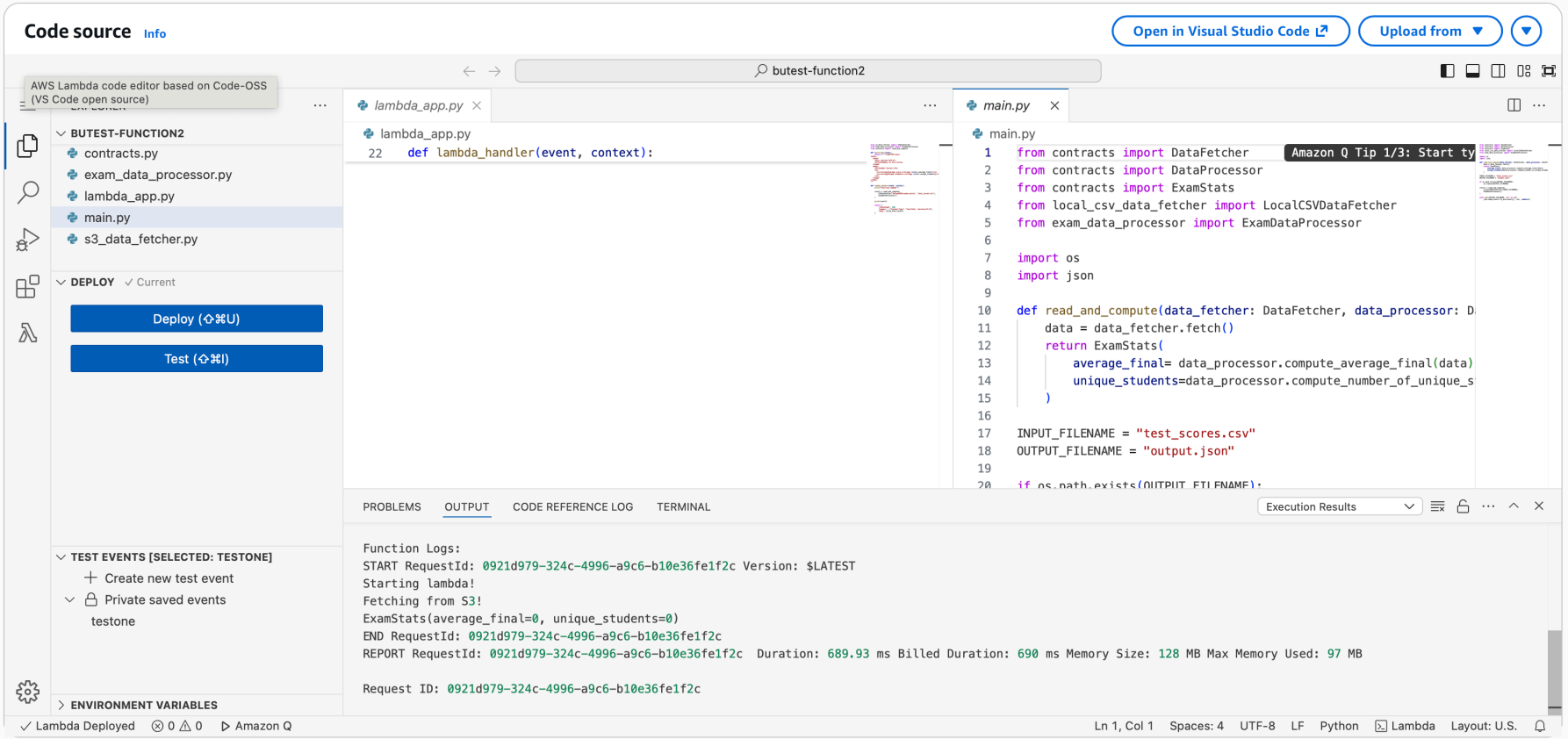


Edit Runtime Setting and set Handler to lambda_app.lambda_handler

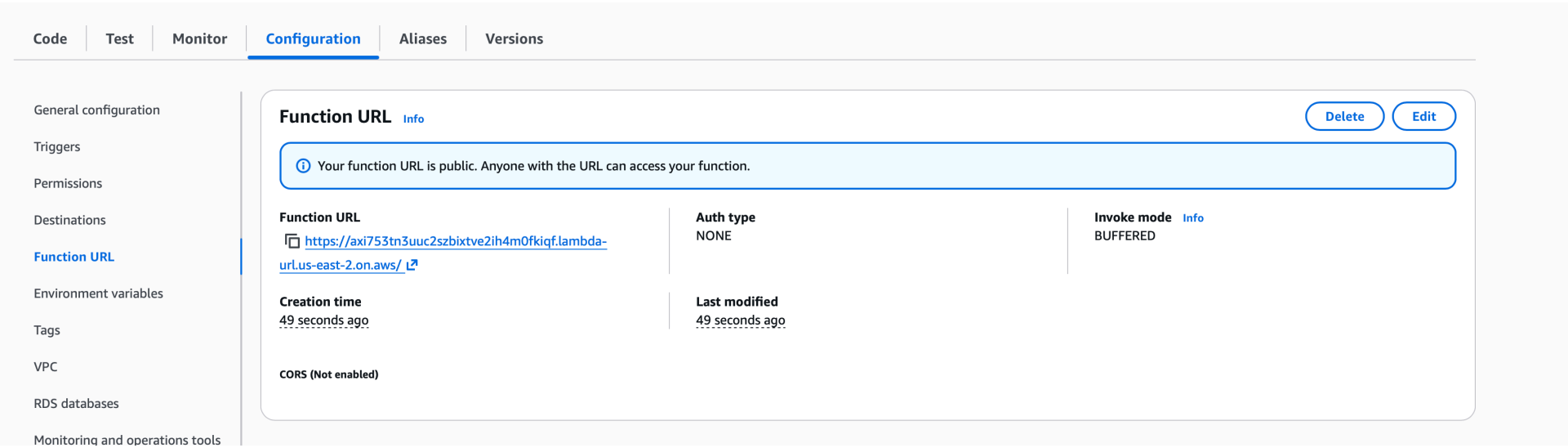
Edit Configuration to Extend Timeout to 10 seconds



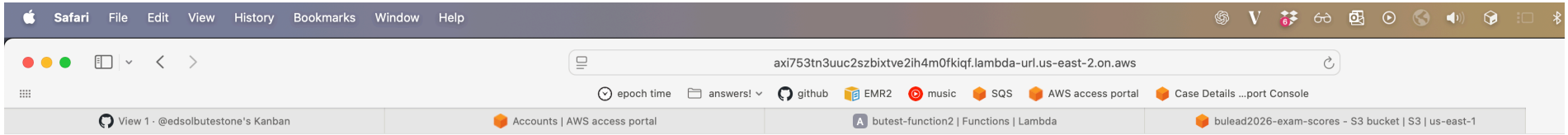
Test Your Function



Create a Function URL for your Function with Auth = None



Go to your Function URL to see it in Action!



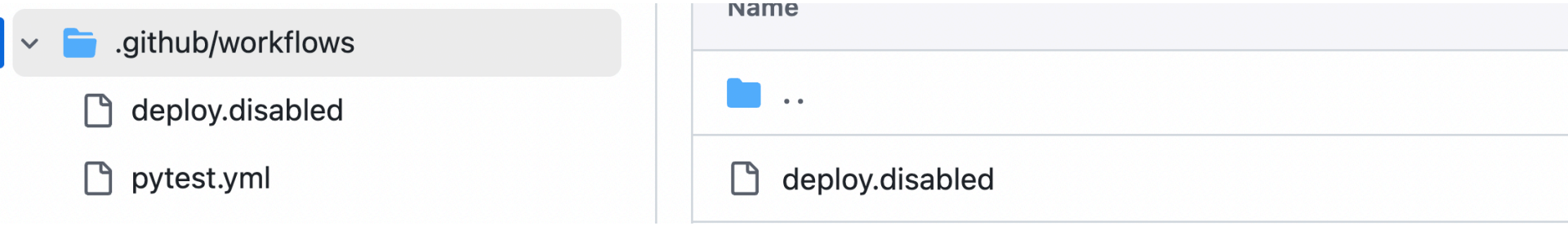
Student Scores!

- **Average score:** 0
- **Unique students:** 0

Day 2 Hands-on Exercise 3

- Setting up your AWS accounts
- Set up your Lambda Function and manually alter its code
- Invoke your function via a web browser, confirm behavior, tweak the code and refresh to confirm changes reflected

In your repos - rename deploy.disabled to deploy.yml



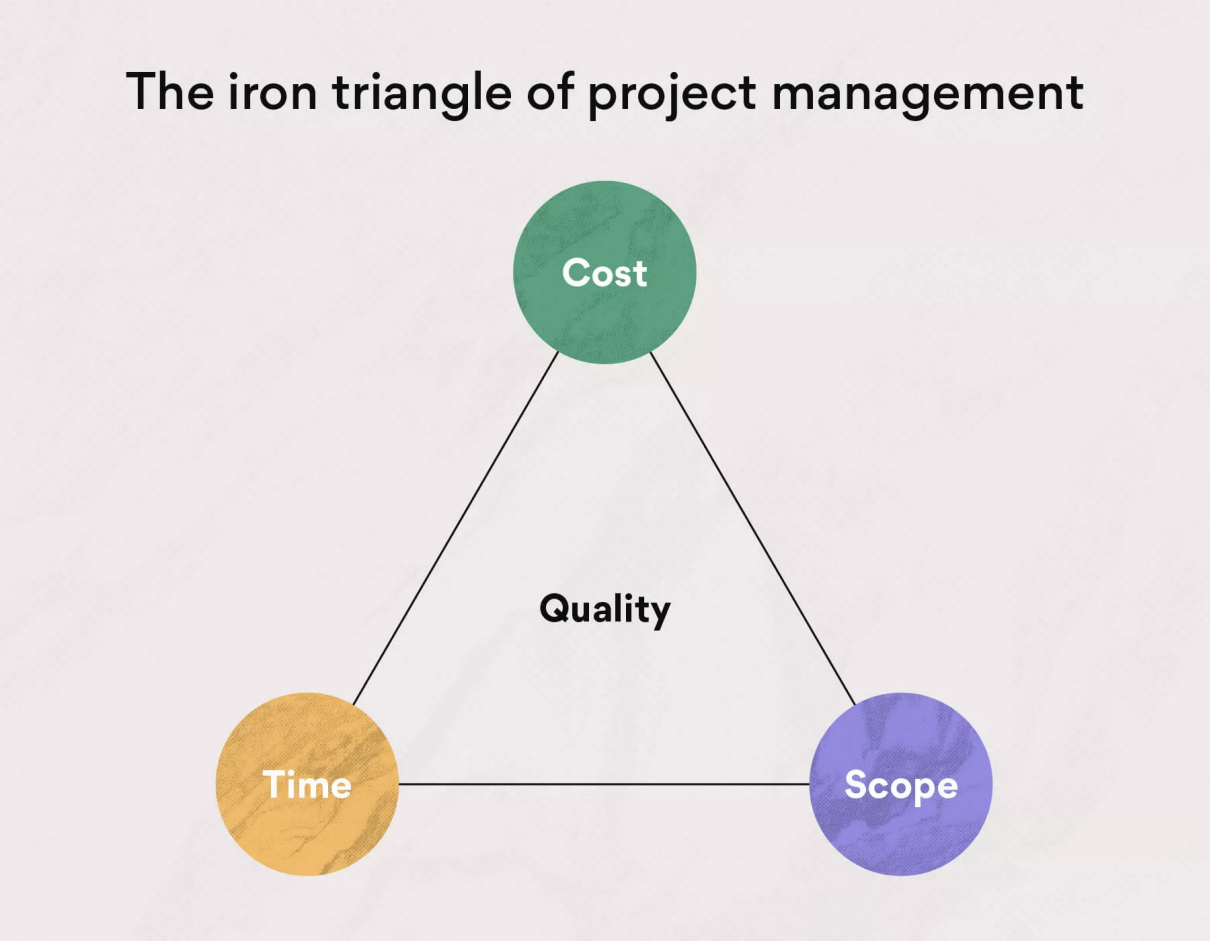
deploy.yml

```yaml
name: CD (Deploy to Lambda)

on:
  workflow_run:
    workflows: ["Python tests (pytest)"]
    types: [completed]
    branches: [main]

jobs:
  deploy:
    if: ${{ github.event.workflow_run.conclusion == 'success' }}
    runs-on: ubuntu-latest

    permissions:
      contents: read
      id-token: write

    steps:
      - name: Check out code at the commit that passed CI
        uses: actions/checkout@v4
        with:
          ref: ${{ github.event.workflow_run.head_sha }}

      - name: Configure AWS credentials (OIDC)
        uses: aws-actions/configure-aws-credentials@v4
        with:
          role-to-assume: arn:aws:iam::879381238148:role/github-actions-lambda-deployer
          aws-region: us-east-2 # MAKE SURE REGION IS CORRECT HERE

      - name: Build Lambda zip
        run: |
          rm -f lambda.zip
          zip lambda.zip contracts.py lambda_app.py s3_data_fetcher.py exam_data_processor.py

      - name: Deploy to Lambda
        run: |
          aws lambda update-function-code \
            --function-name butest-function2 \ # UPDATE YOURN FUNCTION NAME HERE
            --zip-file fileb://lambda.zip

      - name: Wait for update to complete
        run: |
          aws lambda wait function-updated --function-name butest-function2 # UPDATE YOURN FUNCTION NAME HERE
```

Day 2 Hands-on Exercise 4

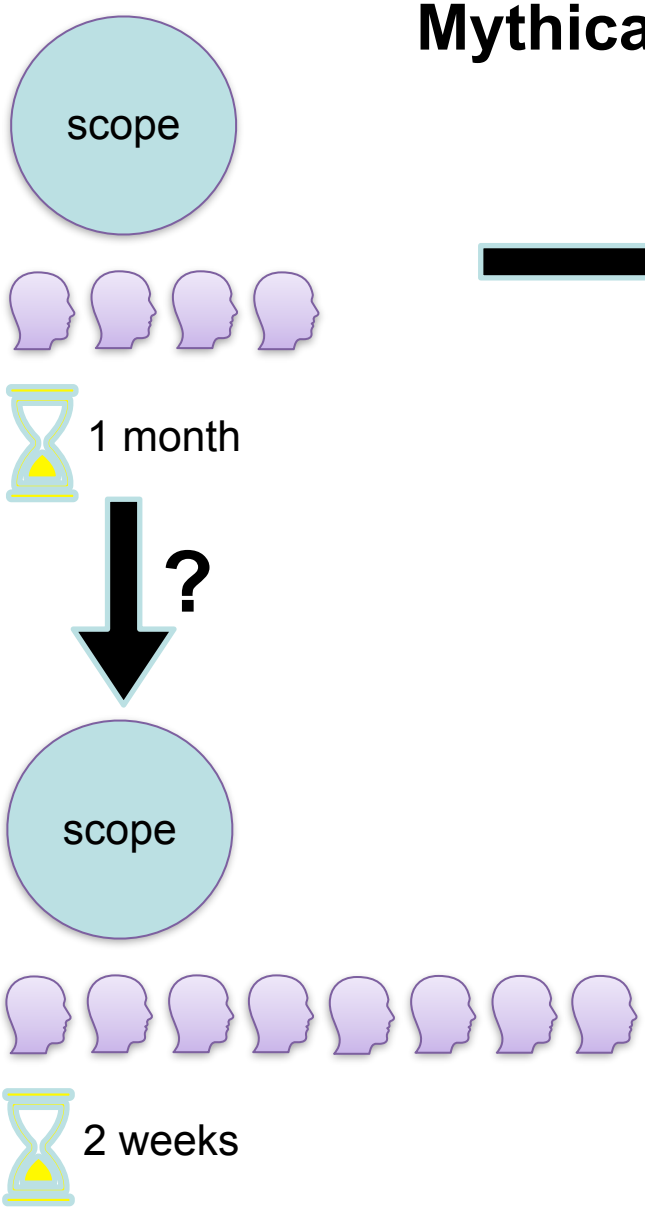
- Set up Continuous Deployment of your Lambda function code via GitHub Actions
- Validate that you can make changes, have the code deployed automatically, and confirm behavior by invoking your function via a web browser

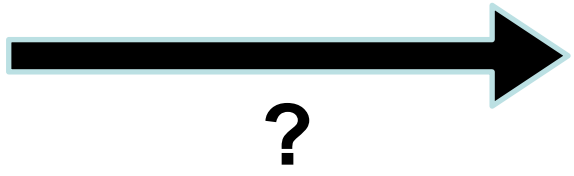
Iron Triangle

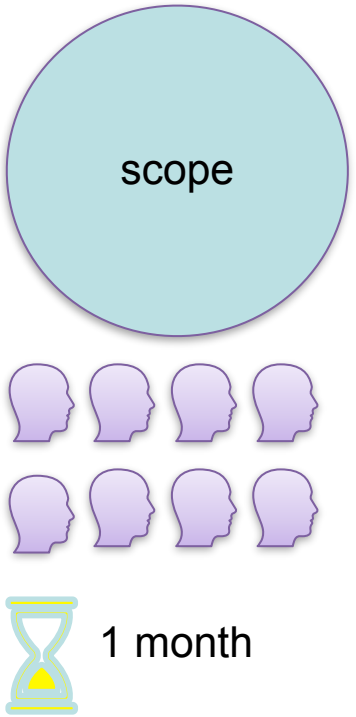


- No one wants to ship low quality software.
- We assume that the quality bar is very high and we are not willing to sacrifice on it.
- The other three dimensions play a game of tug of war:
  - Increasing Scope requires an increment of Time or Cost
  - Reducing Cost requires a reduction in Scope or increment of Time.
  - Reducing Time requires reducing Scope or an increment of Cost

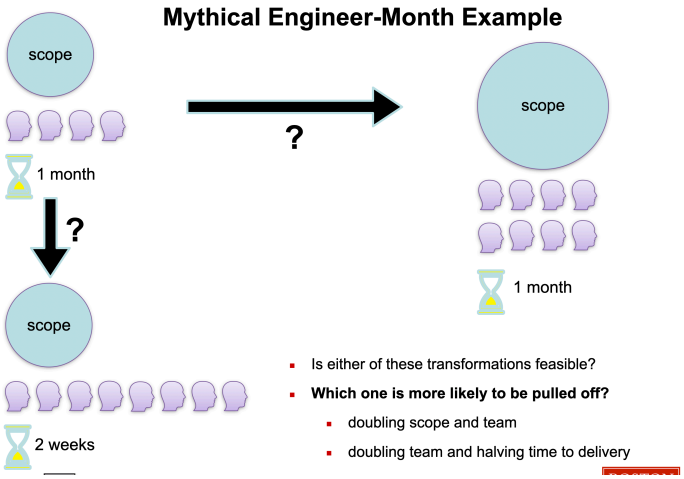
Mythical Engineer-Month Example







- Is either of these transformations feasible?
- **Which one is more likely to be pulled off?**
  - doubling scope and team
  - doubling team and halving time to delivery



- Fred Brook's classic 1975 book The Mythical Man-Month: Essays on Software Engineering.
- The central idea is that adding more people to a late software project often makes it later, rather than speeding it up.
- Software engineering should not be thought of as linear work.
- **Communication overhead is exponential with the the number of people involved on a project**.

Roles in a Waterfall World

project planning

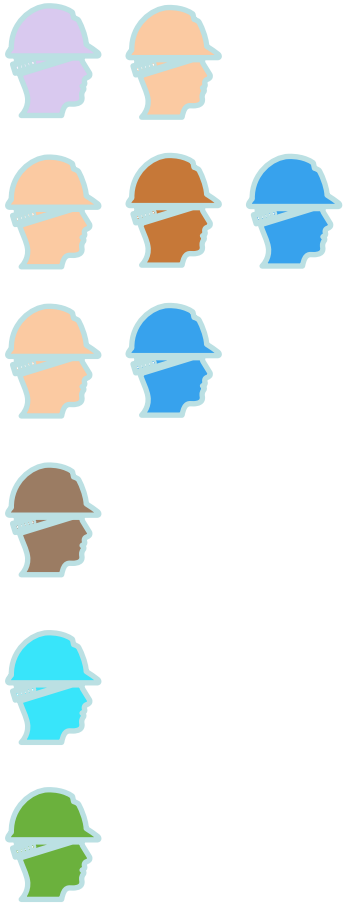
requirements & analysis

design

coding

testing

deployment



CEO

product manager

UX researcher

designer

developer

quality assurance

release engineer

Agile

Agile Development

is ***adaptive*** rather than predictive

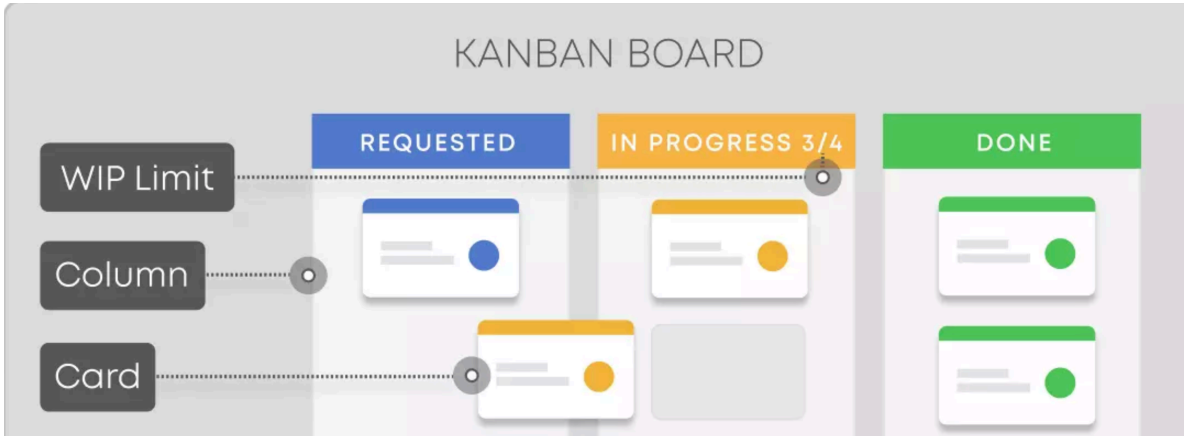
is ***people-oriented*** rather than process-oriented

Martin Fowler

Agile

- There are multiple methodologies and processes that are considered **Agile**, we will dig into a few of them, but the main distinction from its predecessor methodologies:
  - In **Plan-driven** processes, e.g. Waterfall, success is measured according to how well development follows the detailed, predictive plan.
  - In **Agile** processes, careful plans are still made, but are thought to be in constant revision to reflect learnings and a quickly evolving ecosystem.
  - In **Agile** processes, success is measured based on value delivered by the software.

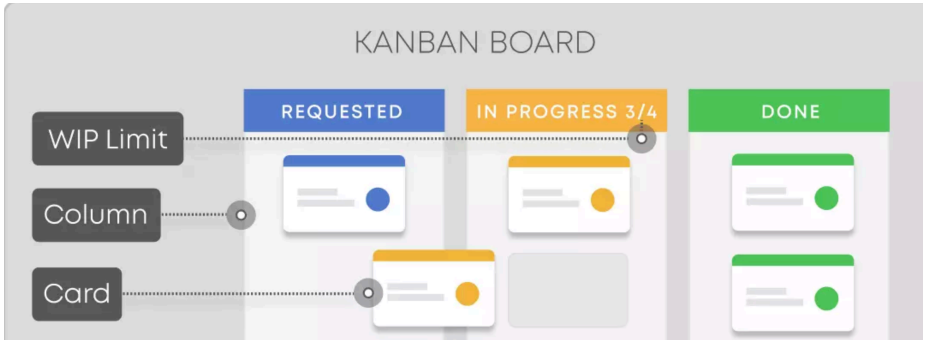
Kanban

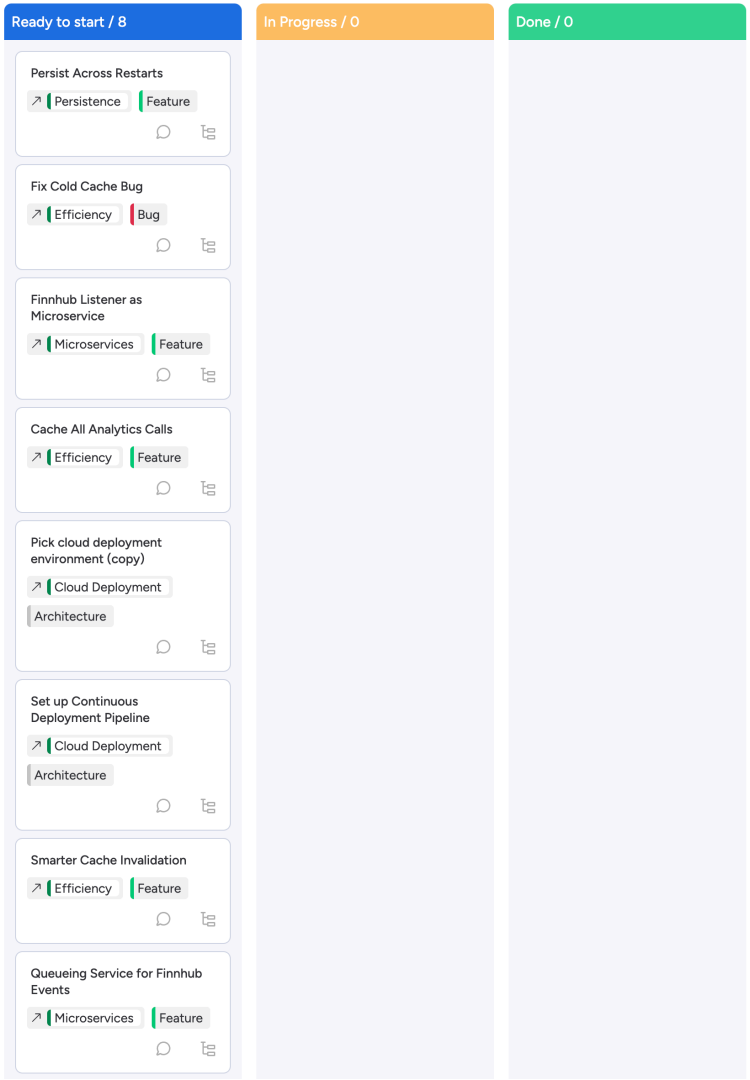


- Originated in manufacturing by Toyota in the 1940's
- Inspired by supermarket inventory practices of visualizing workflow and limiting Work In Progress (WIP)
- Physical Card System Core to the philosophy
- Popularity in software processes rose in the early 2000's
- Integrated into Agile philosophies

Kanban Tenets

- Visualize all work
- Limit Work in Progress
- Keep Increments Small
- Manage flow, not individuals
- Create Feedback Loops
- Make Process Policies Explicit via Working Agreements
- Improve Collaboratively
- Celebrate Small Wins





Kanban Board

- Only three states that we care deeply about:
  - What work is prioritized and imminently ready for us?
  - What are we working on currently?
  - What did we recently finish?
- Distinguish
  - Bugs
  - Features

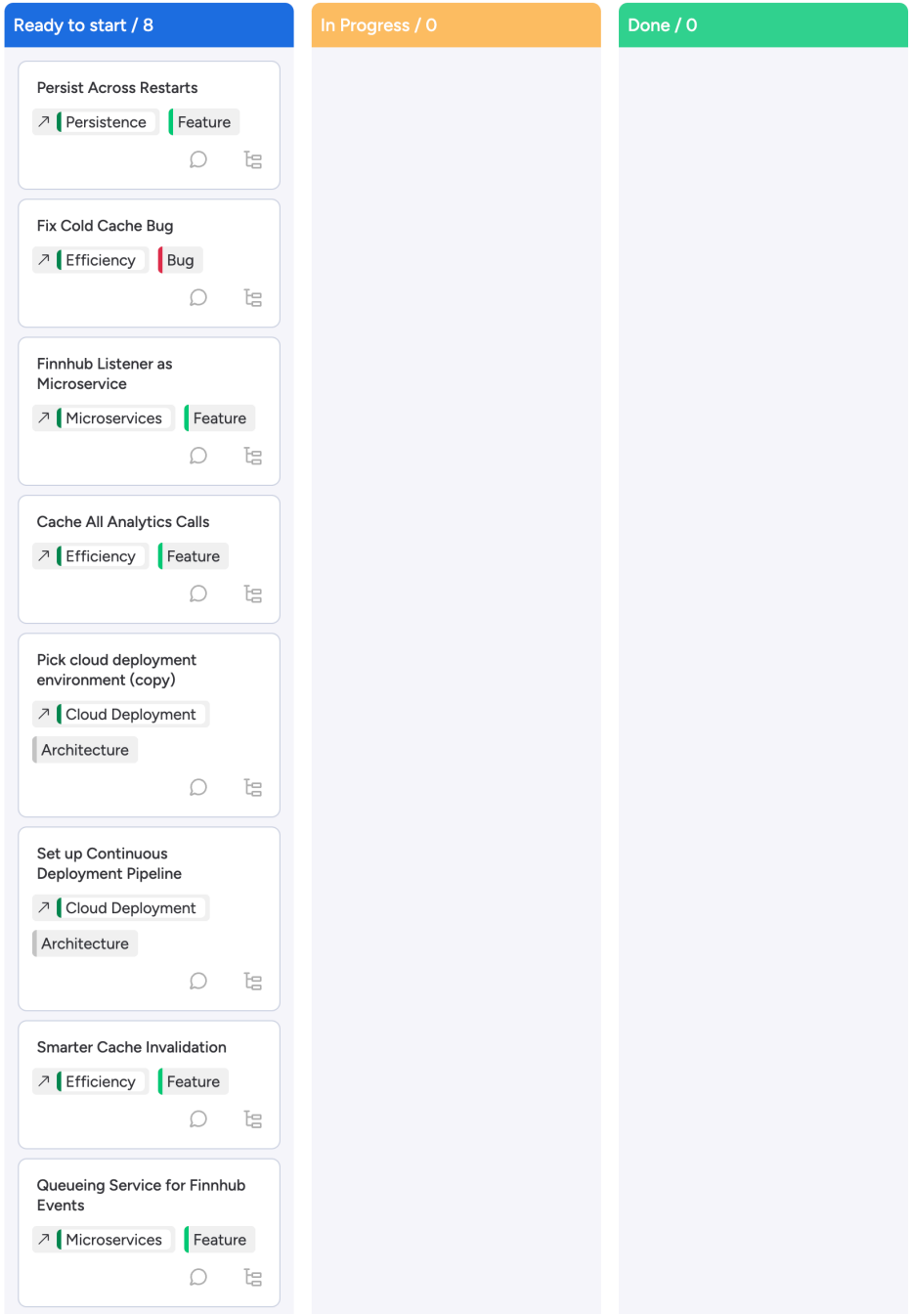
Shar

Larry

Jane

Jarred

Donna



- team of 5 developers
- Mentioned WIP (work in progress) limit earlier.
- **What is a reasonable limit for a team of 5?**

BU Departmen

BOSTON UNIVERSITY

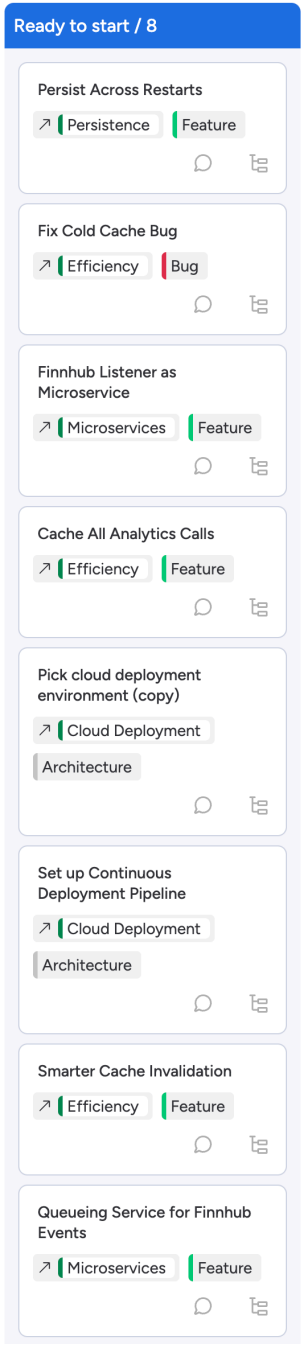
Shar

Larry

Jane

Jarred

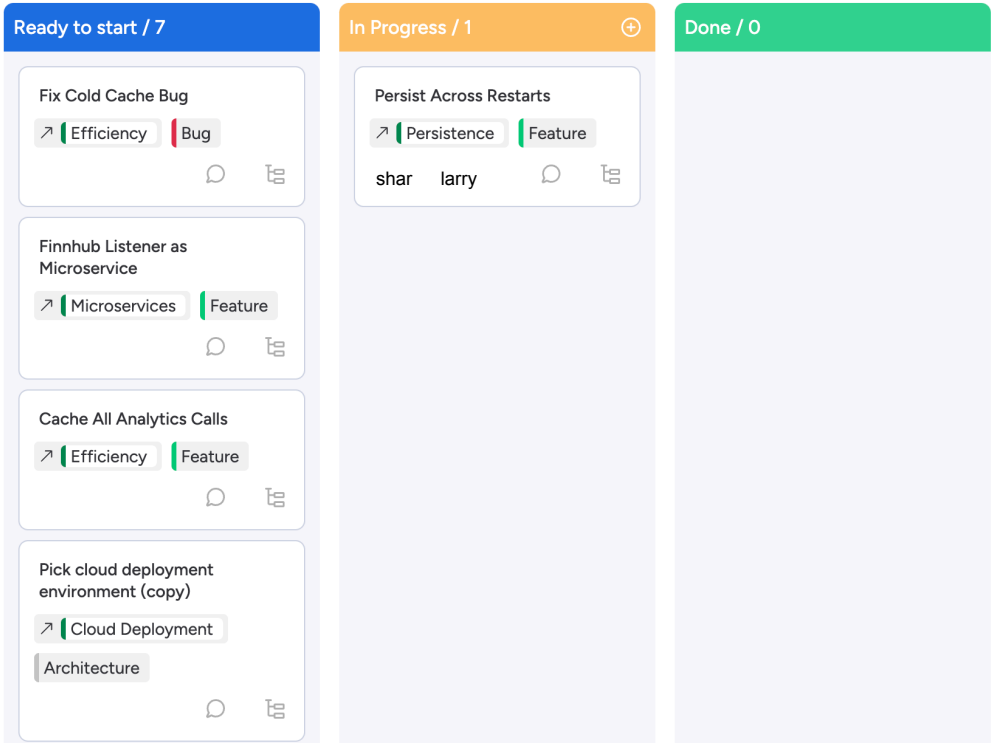
Donna



- team of 5 developers
- starting with this prioritized roadmap
- question to ask:
  - who should start work on highest priority task?

BU Departmen

BOSTON UNIVERSITY

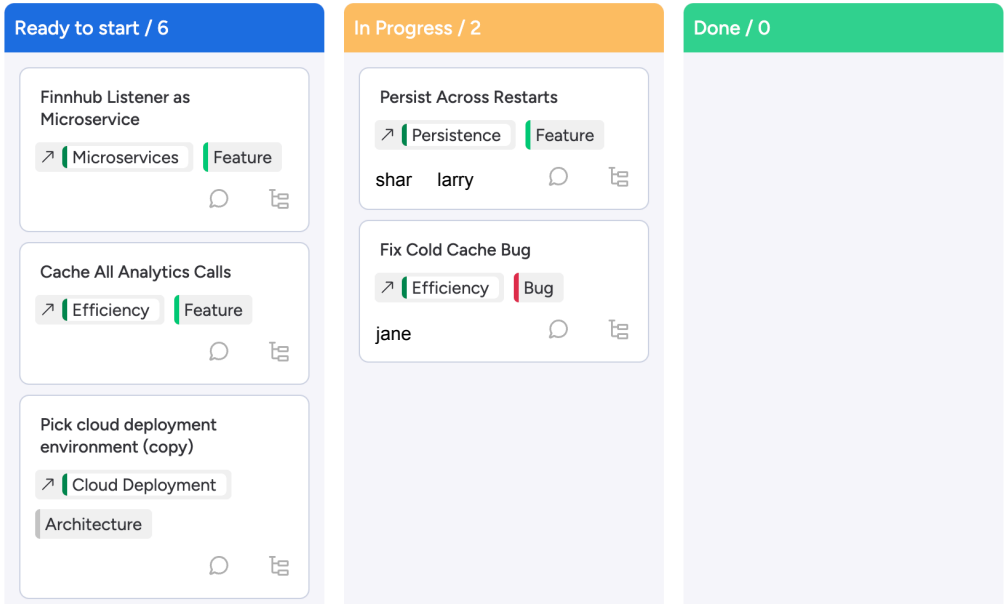


Jane

Jarred

Donna

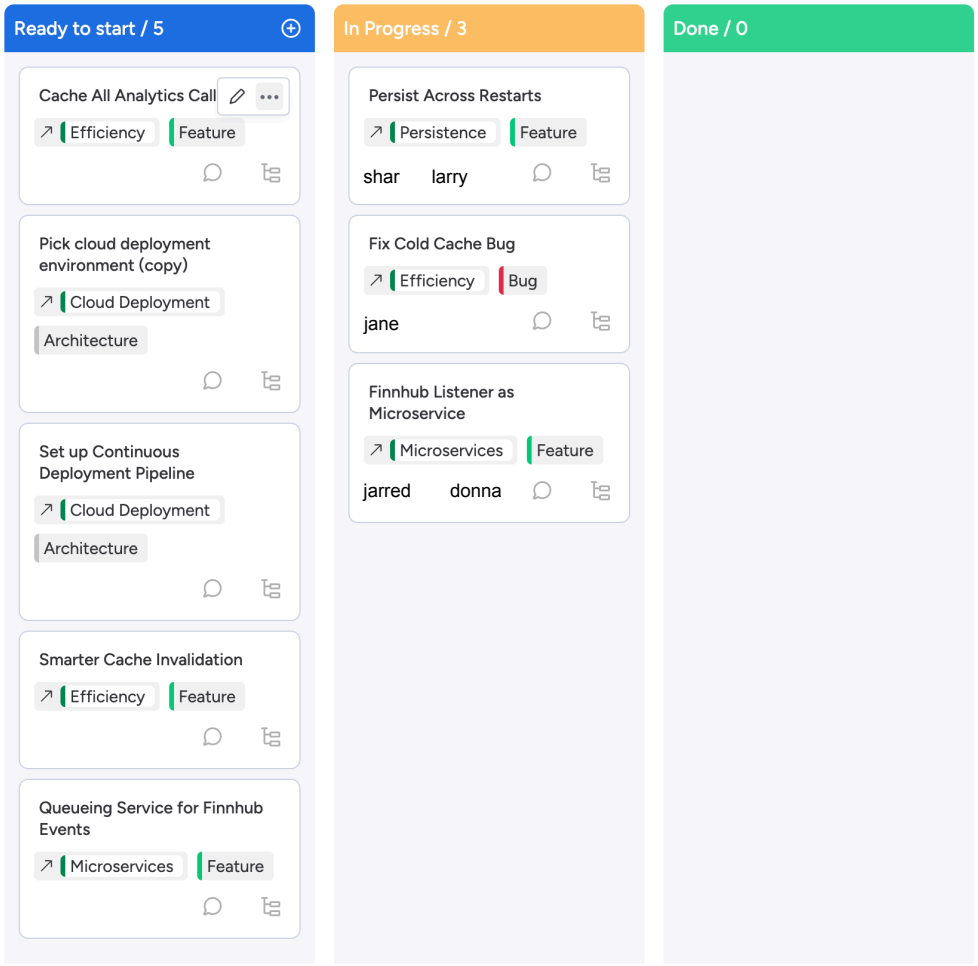
- Shar & Larry start work on persisting state across StockApp restarts.
- Still have 3 free engineers, what should they do?



Jarred

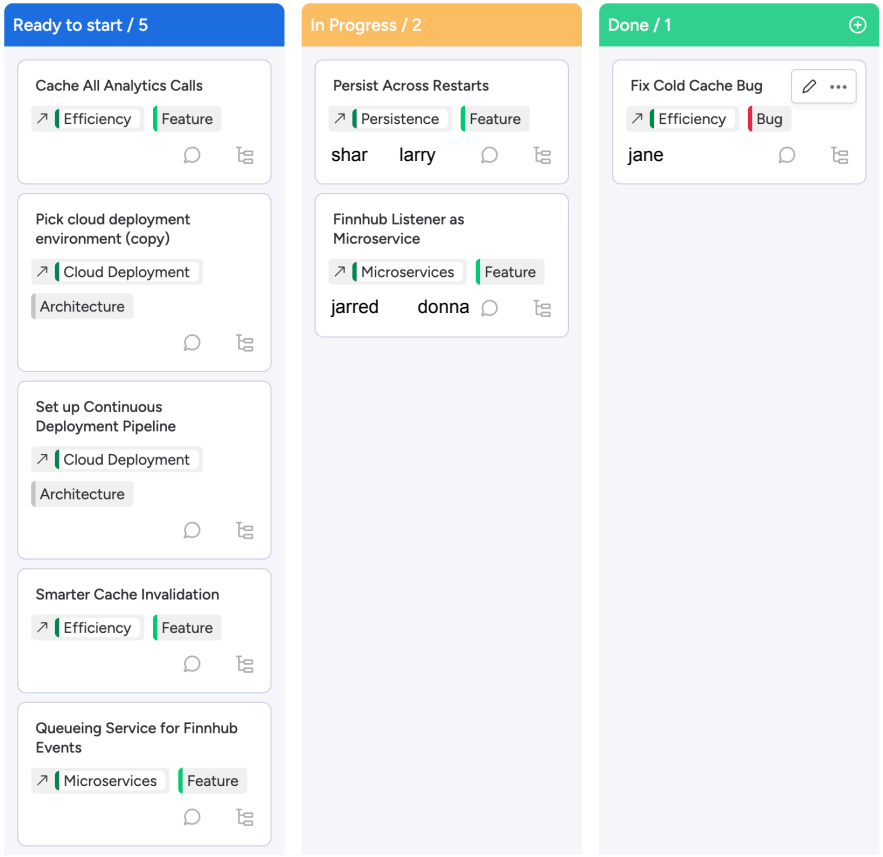
Donna

- Jane has some background on caching and volunteers to take a look at the bug
- We avoid anyone working alone on a feature, but for smaller bugs its ok for Jane to look at this on her own
- What do Jarred and Donna do?

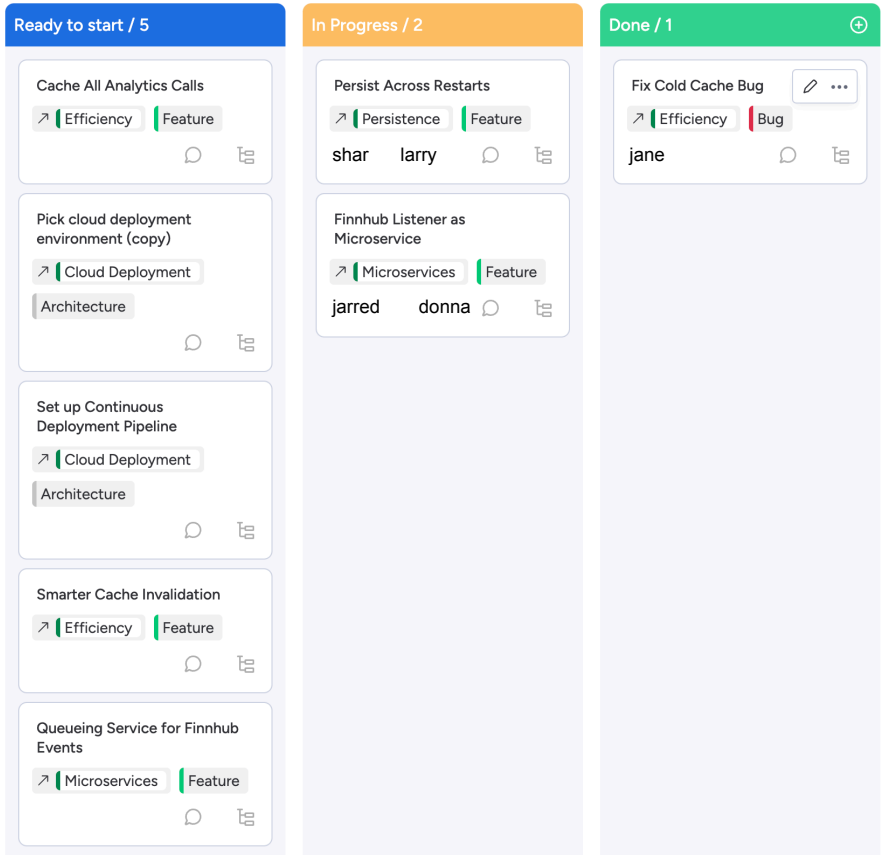


- Jarred and Donna pick up the Finnhub Listener as Microservice work and now our team are all making progress towards our highest priority tasks…

Jane



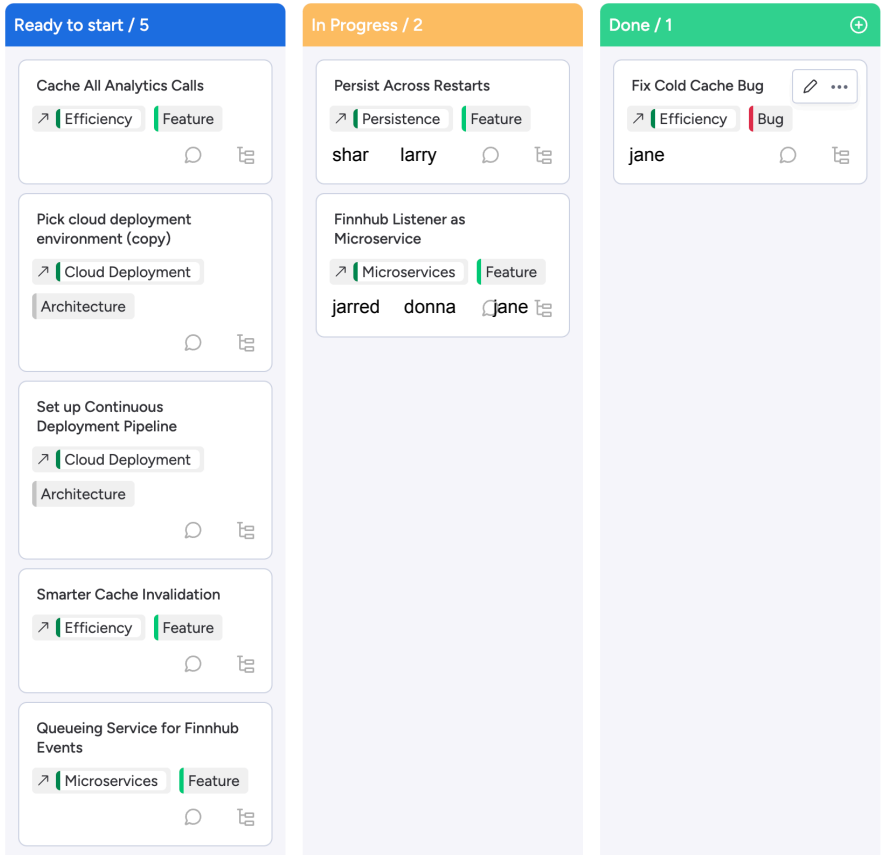
- One day later…
- Jane ships the cache bug fix (jarred took an interrupt to review her Pull Request)
- Jane has now freed up, what should she do?



Jane

- First, everyone gives Jane a high five for shipping the fix!

- Pulling a new feature would push our WIP too high - 3 features across 5 engineers is too much.
- Jane should ask Shar & Larry and Jarred & Donna which team could use more help and join one of the two in progress features based on their response and her skill set.



- Jane has some experience with WebSockets and Jarred and Donna tell her that there is plenty of work left to do on their project, so she joins their team.

Kanban Tenets

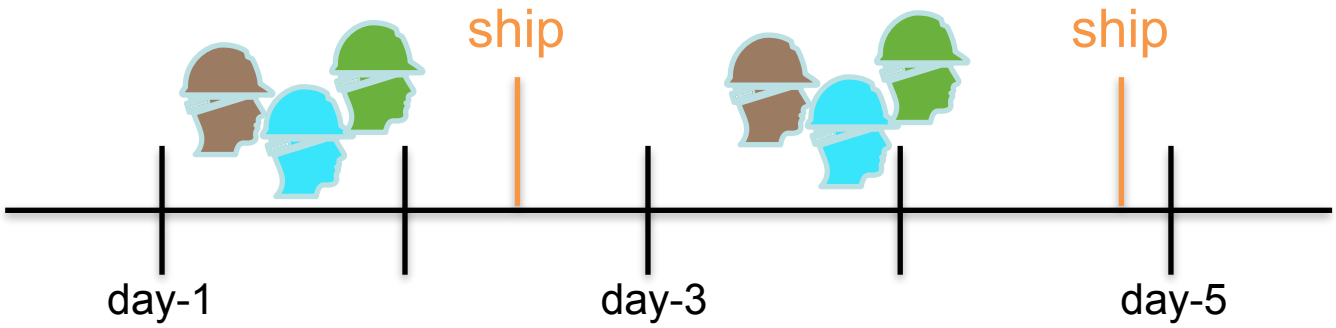
- Visualize all work
- Limit Work In Progress
- Keep Increments Small

Merging of Roles

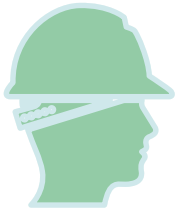

developer


quality assurance


release engineer



- two factors pushing for the merging of these 3 roles:
  - automation of testing and integration + deployment
  - compressed time frames & iterations
- resulting in …
  - DevOps!



Day 2 Hands-on Exercise 5

- Work in Teams of 4 or 5 - people at your table are a great group to work with!
- Pick one of your repos as the one to use for your final project and:
  - Set up a Kanban board in your GitHub Repo
  - Invite others from your team to that repo
- Given that you have access to Lambda functions and S3, think about what kind of interesting / useful function - API based application you could build in one day
  - Add tasks to your Kanban board to reflect this and plan the implementation.