Final Class

17-313 Spring 2025

Foundations of Software Engineering

https://cmu-313.github.io

Michael Hilton, Austin Henley, and Nadia Nahar

Administrivia

- Final Exam attendance Mandatory:
  - Monday, Monday, May 5, 2025 01:00pm - 04:00pm
  - **Location WEH 7500**

AMA

Ask the professors any question you want

Michael Hilton

Associate Teaching Professor at CMU

- A.S. Grossmont Community College 1999
- B.S. San Diego State University - 2002
- Software Engineer at DoD - 2002 to 2011
- M.S. Cal Poly San Luis Obispo - 2013
- PhD at Oregon State - 2017
- Internship at Microsoft Research - Summer 2017
- Assistant/Associate Teaching Professor at CMU - Fall 2017 to current

Austin Henley

B.S. Austin Peay State University, 2011

M.S. University of Memphis, 2013

Ph.D. University of Memphis, 2018

Software Engineer Intern @ First Tennessee Bank, 2012-2013

Research Intern @ National Instruments, 2014

Research Intern @ National Instruments, 2015

Research Intern @ Microsoft, 2016

Research Intern @ IBM, 2017

Assistant Professor @ University of Tennessee 2018-2022

Visiting Researcher @ Microsoft, 2019

Senior Researcher @ Microsoft, 2022-2023

CTO @ BYBE, 2023

VP of Engineering @ Swiftly, 2023-2024

Associate Teaching Professor @ CMU, 2024-present

Nadia Nahar

B.S. University of Dhaka, 2014

M.S. University of Dhaka, 2016

Senior Software Engineer, Icebreakers, 2016 – 2017

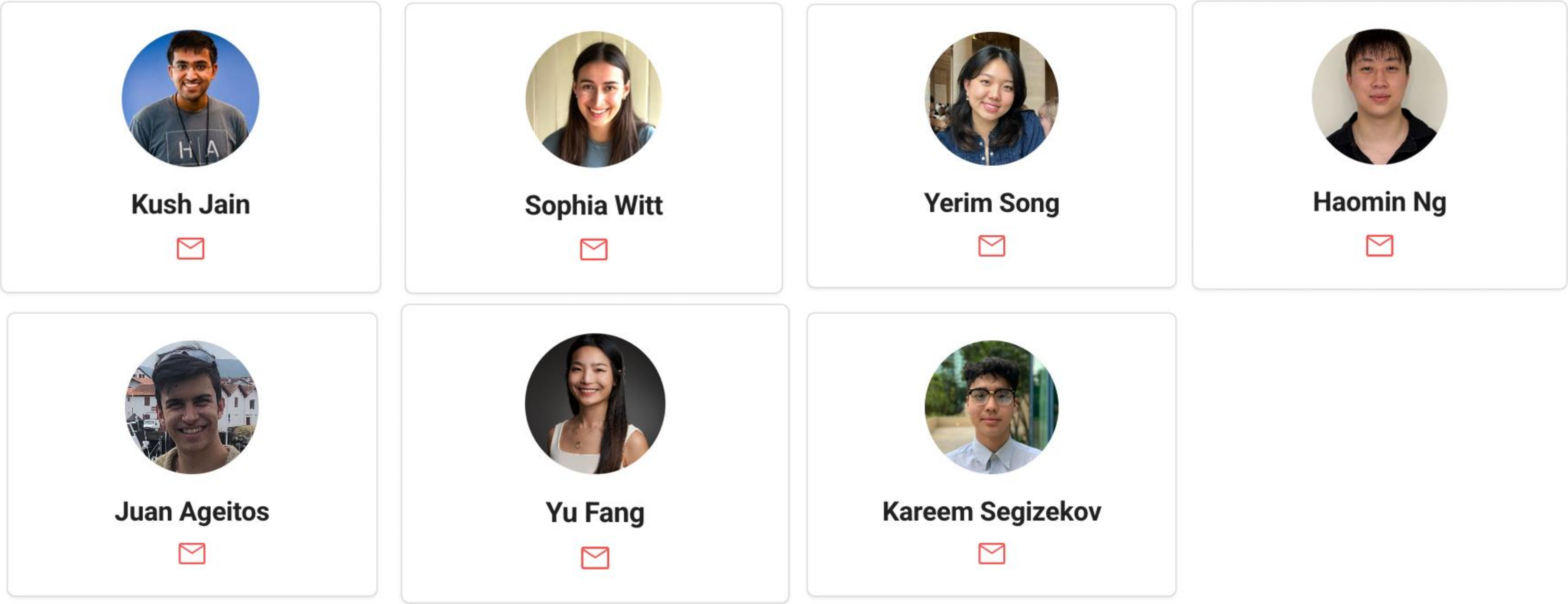
Lecturer @ University of Dhaka, 2017 – 2020

PhD, Carnegie Mellon University, 2020 – Ongoing

Software Engineering Intern @ Microsoft – Summer 2022

arch Int crosoft nmer 2024

Teaching Assistants



Kush Jain ✉

Sophia Witt ✉

Yerim Song ✉

Haomin Ng ✉

Juan Ageitos ✉

Yu Fang ✉

Kareem Segizekov ✉

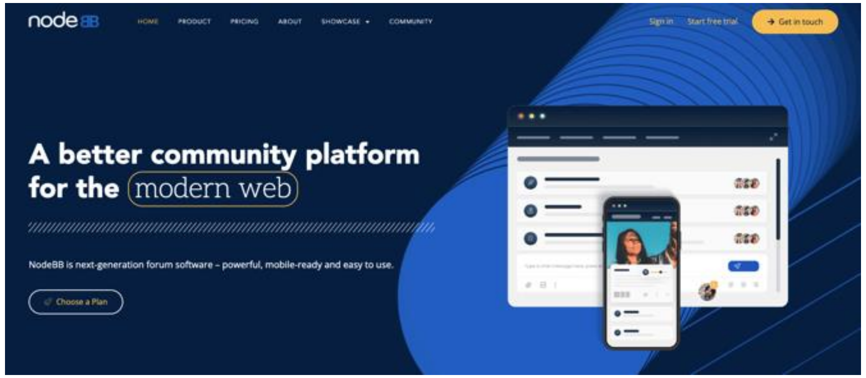
Software is everywhere

Vasa

Smoking Section

- Last full row

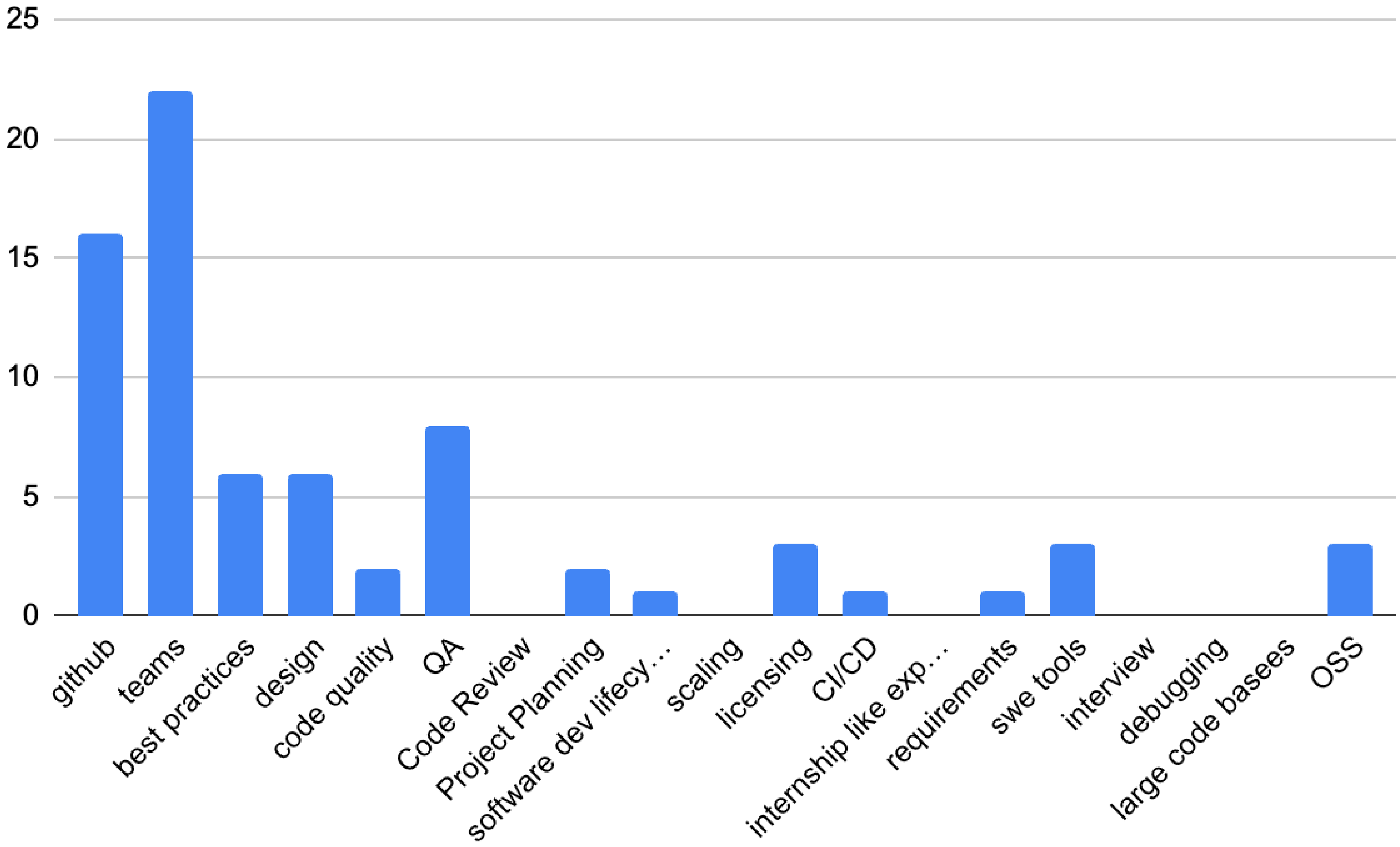
Project P1 posted online



A better community platform for the modern web

NodeBB is next-generation forum software – powerful, mobile-ready and easy to use.

- P1A: Checkpoint due this Friday (January 17th, 11:59pm)
  - Only 5% of total P1 points – meant to ensure you start on time
  - Only need to be able to install and run NodeBB locally
- P1B: Due next week on Thursday (January 23rd, 11:59PM)
  - Refactor code in a single file to address code quality warnings.
  - Validate change via test coverage and manual testing
  - Expect to be **technically challenging** for non-experts; purpose is to learn new things and engage with a large code base without much hand-holding.

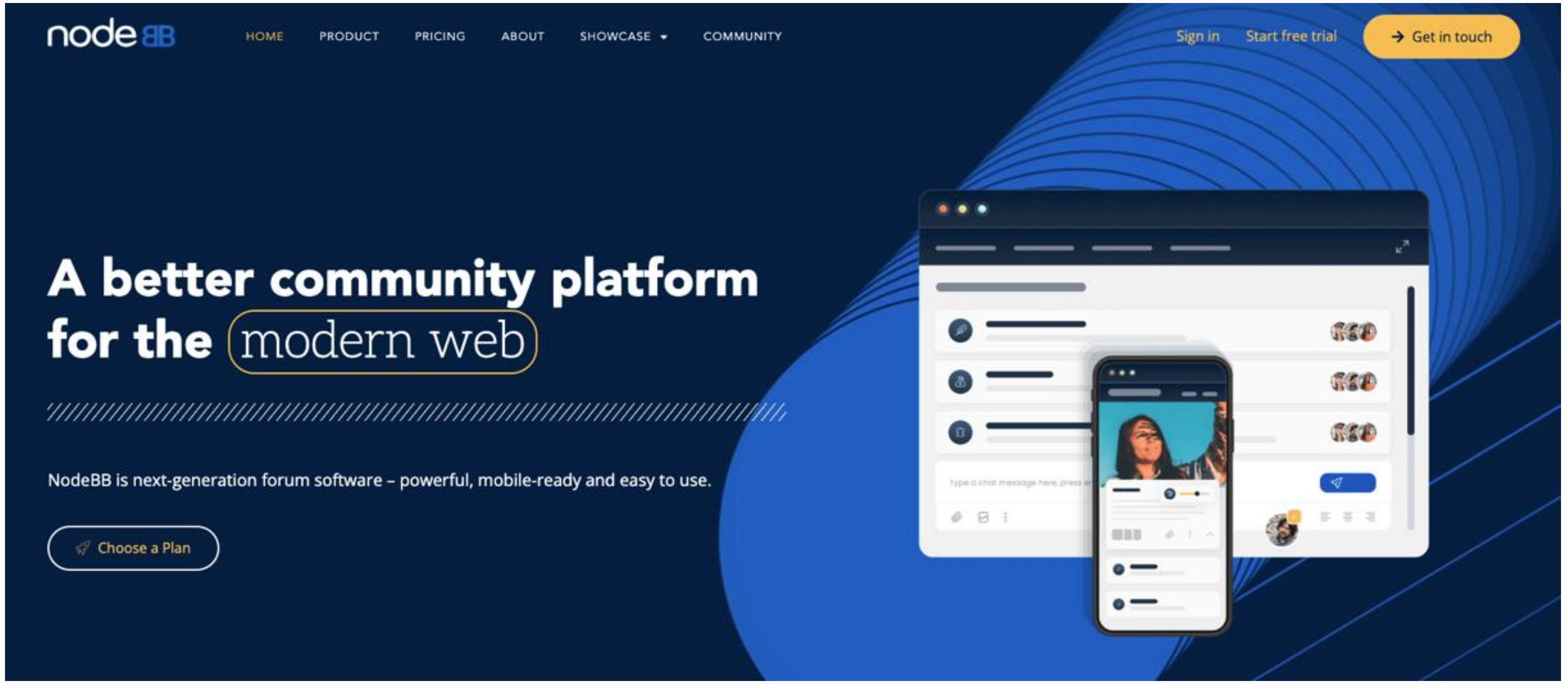

25
20
15
10
5
0
github
teams
best practices
design
code quality
QA
Code Review
Project Planning
software dev lifecy…
scaling
licensing
CI/CD
internship like exp…
requirements
swe tools
interview
debugging
large code basees
OSS

Discussion

THE VERGE
BOEING
REDLINE
The many human errors that brought down the Boeing 737 Max

Context: big ole pile of code

- … do something with it!



A better community platform for the modern web

NodeBB is next-generation forum software – powerful, mobile-ready and easy to use.

Steps to Understand a New Codebase

- Look at README.md
- Clone the repo.
- Build the codebase.
- Figure out how to make it run.
- What do you want to mess with?
- Traceability - Attach a debugger
  - View Source
  - Find the logs.
  - Search for constants (strings, colors, weird integers (#DEADBEEF))

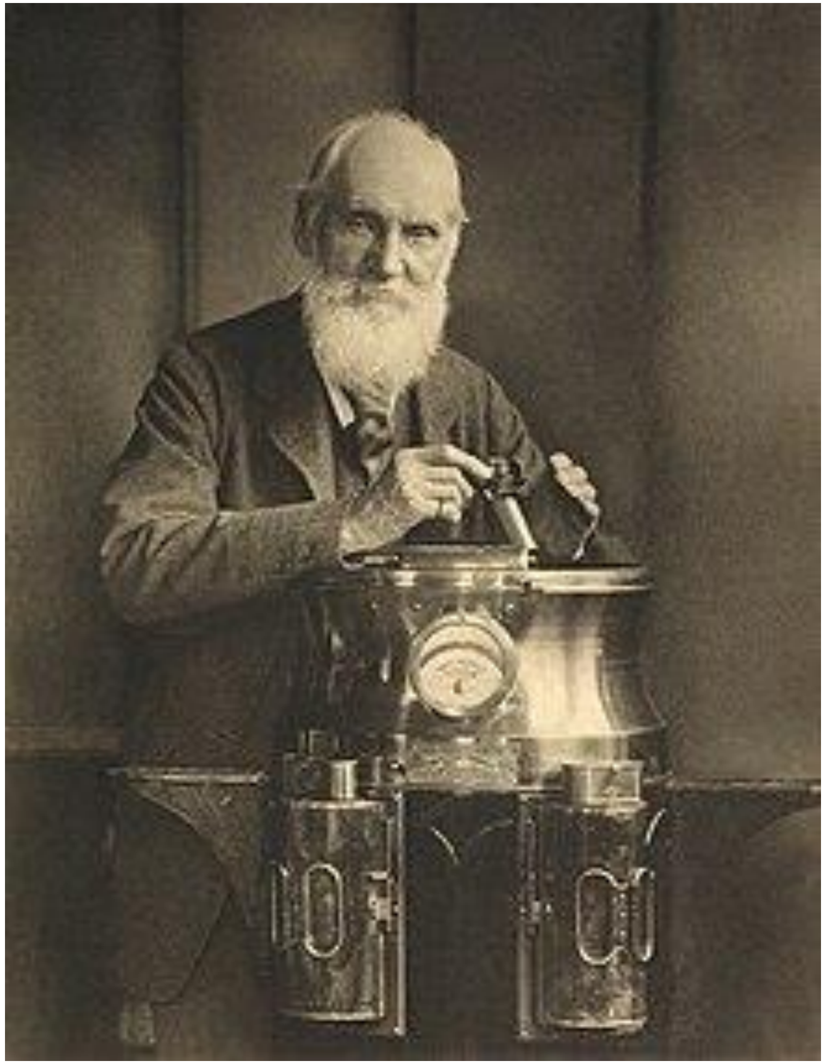
My experiences (headaches) at companies

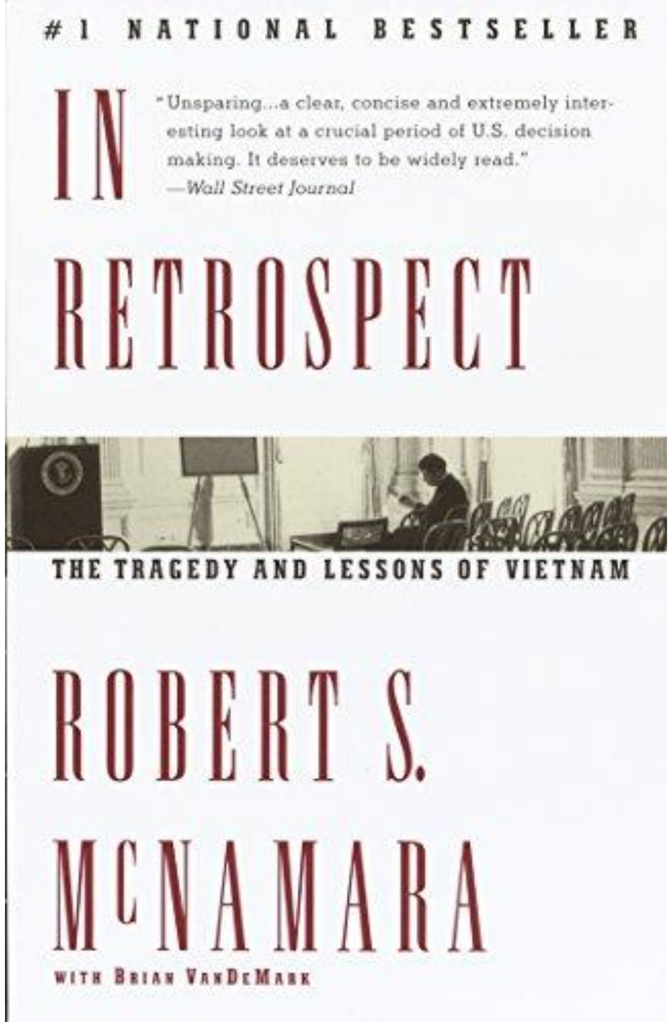
- Documentation was **ALWAYS** out of date—often the core devs didn't know
- Had to ask someone to ask someone to help me get the project building (i.e., sit beside me for hours)
- Better take notes… not unusual to break something and need to do it all again
- Often the authors are no longer there
- So many design decisions are never written down, or they are trapped in old Jira tickets, commit messages, and emails

“To measure is to know;
if you can not measure it,
you can not improve it”

William Thomson, Lord Kelvin

$$K = \left(\frac{5}{9}(F - 32)\right) + 273.15$$





#1 NATIONAL BESTSELLER

IN RETROSPECT

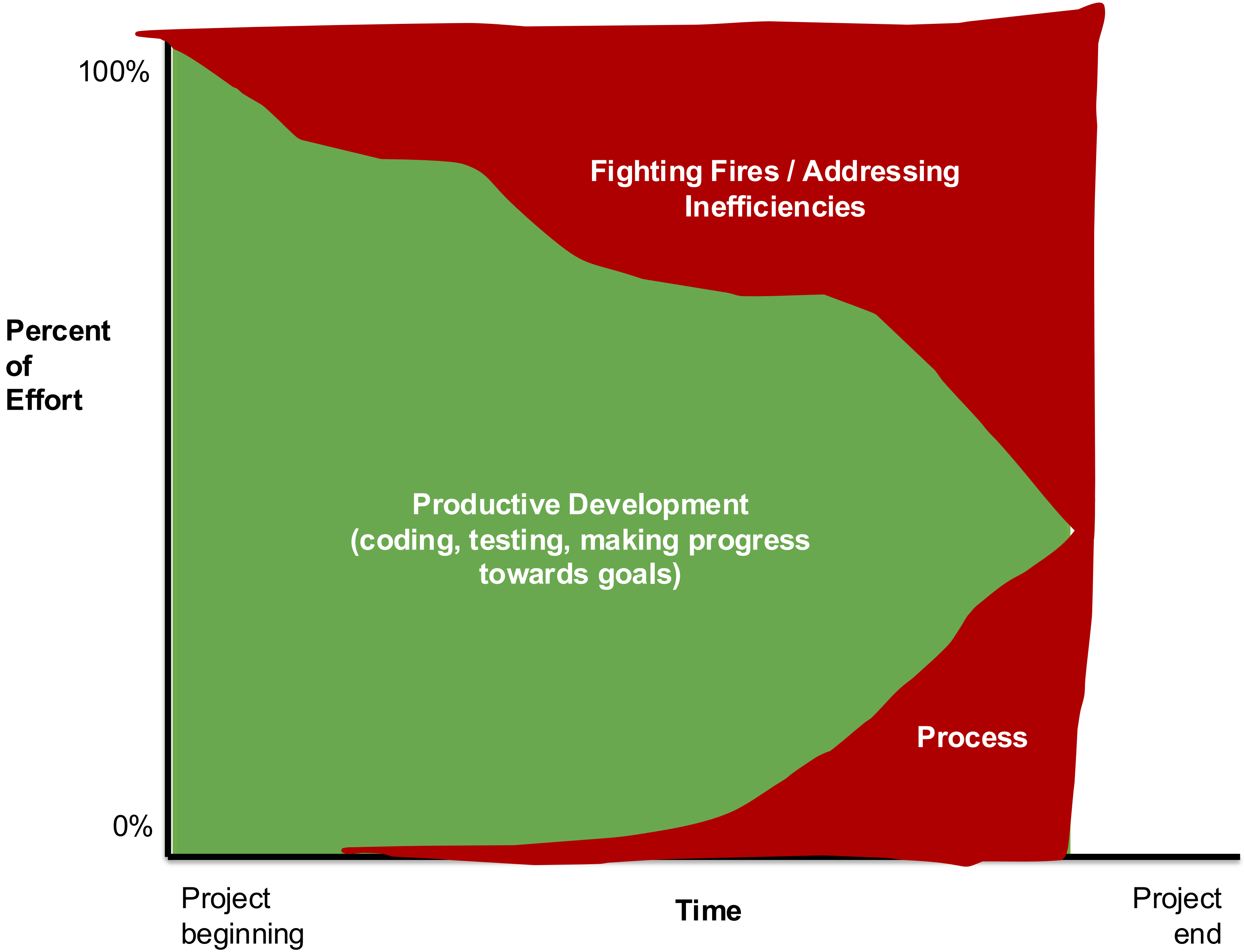
"Unsparing...a clear, concise and extremely interesting look at a crucial period of U.S. decision making. It deserves to be widely read."
—*Wall Street Journal*

THE TRAGEDY AND LESSONS OF VIETNAM

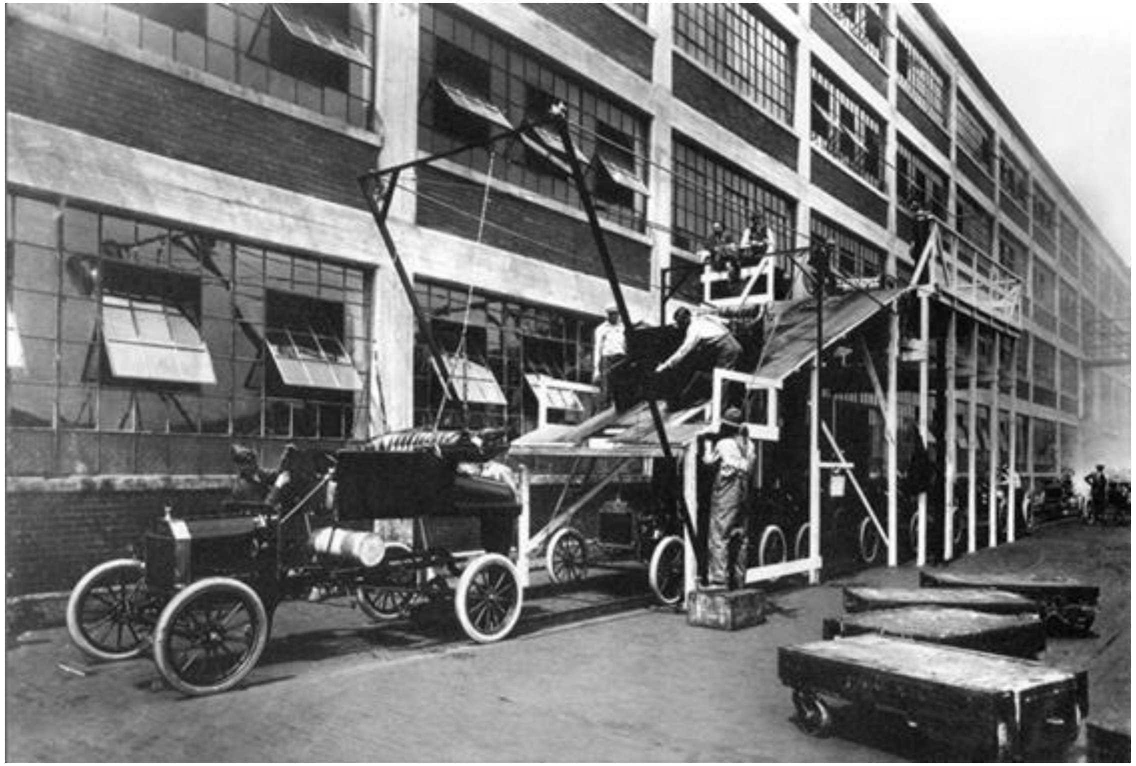
ROBERT S. McNAMARA

WITH BRIAN VANDEMARK

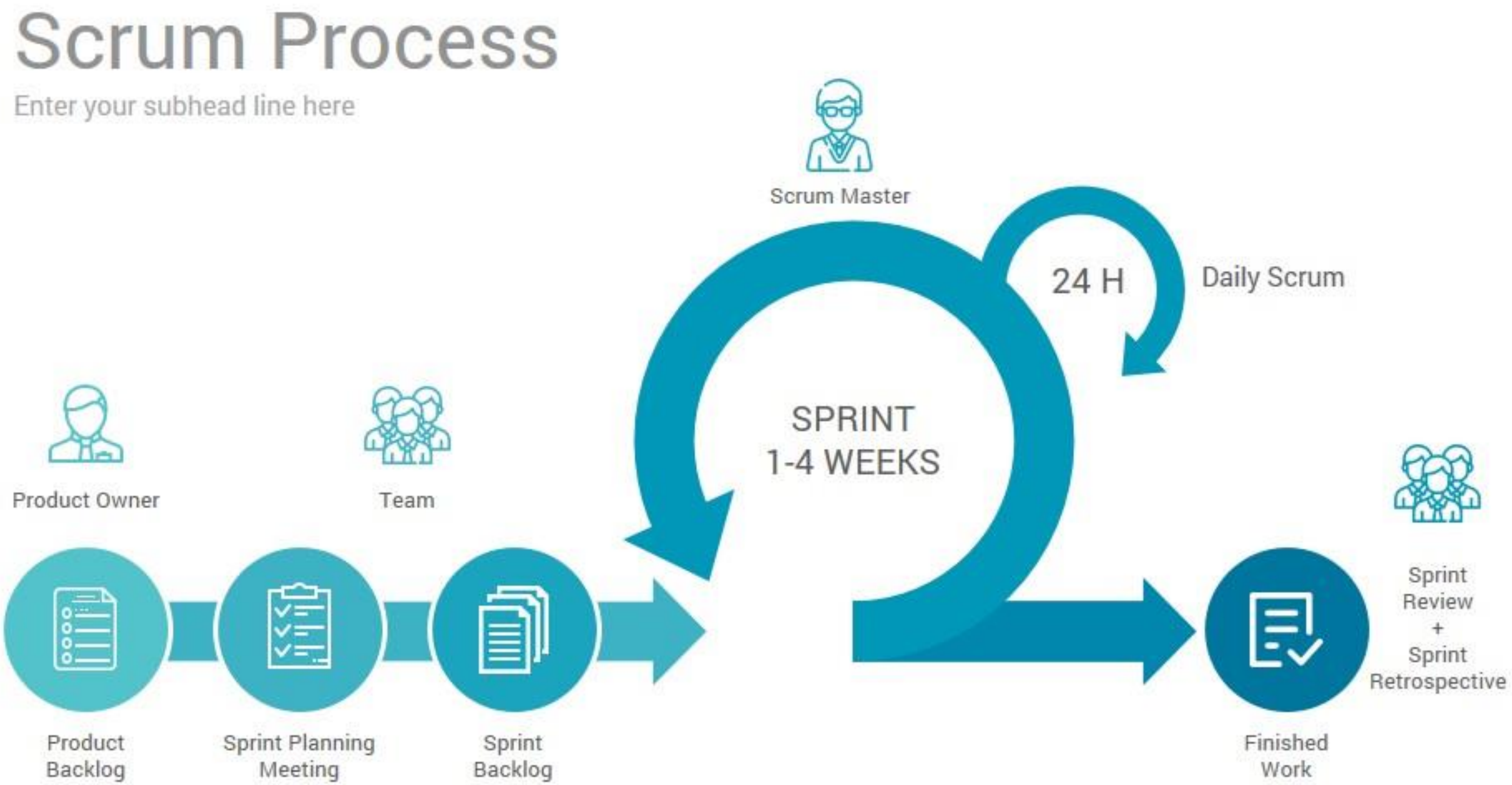
FROM THE DIRECTOR OF "THE THIN BLUE LINE" AND "GATES OF HEAVEN"
"IF THERE IS ONE MOVIE THAT OUGHT TO BE STUDIED BY MILITARY AND CIVILIAN LEADERS AROUND THE WORLD AT THIS TREACHEROUS HISTORICAL MOMENT, IT IS 'THE FOG OF WAR', ERROL MORRIS'S PORTRAIT OF FORMER UNITED STATES DEFENSE SECRETARY, ROBERT S. MCNAMARA."
"SMART AND COMPLETELY FASCINATING!"
"STUNNING! SUPERBLY MADE!"
"SPLENDID! A MASTERPIECE!"
THE FOG OF WAR
BEST DOCUMENTARY FEATURE
BEST ORIGINAL SCORE
BEST EDITING
2003 Official Selection AFI Film Festival - Fri, Nov. 14, 2003 7:30pm


100%
Percent of Effort
0%
Fighting Fires / Addressing Inefficiencies
Productive Development (coding, testing, making progress towards goals)
Process
Project beginning
Time
Project end

… akin to processes pioneered in mass manufacturing (e.g., by Ford)



Elements of Scrum



Scrum Process

Enter your subhead line here

Scrum Master

24 H

Daily Scrum

SPRINT
1-4 WEEKS

Product Owner

Team

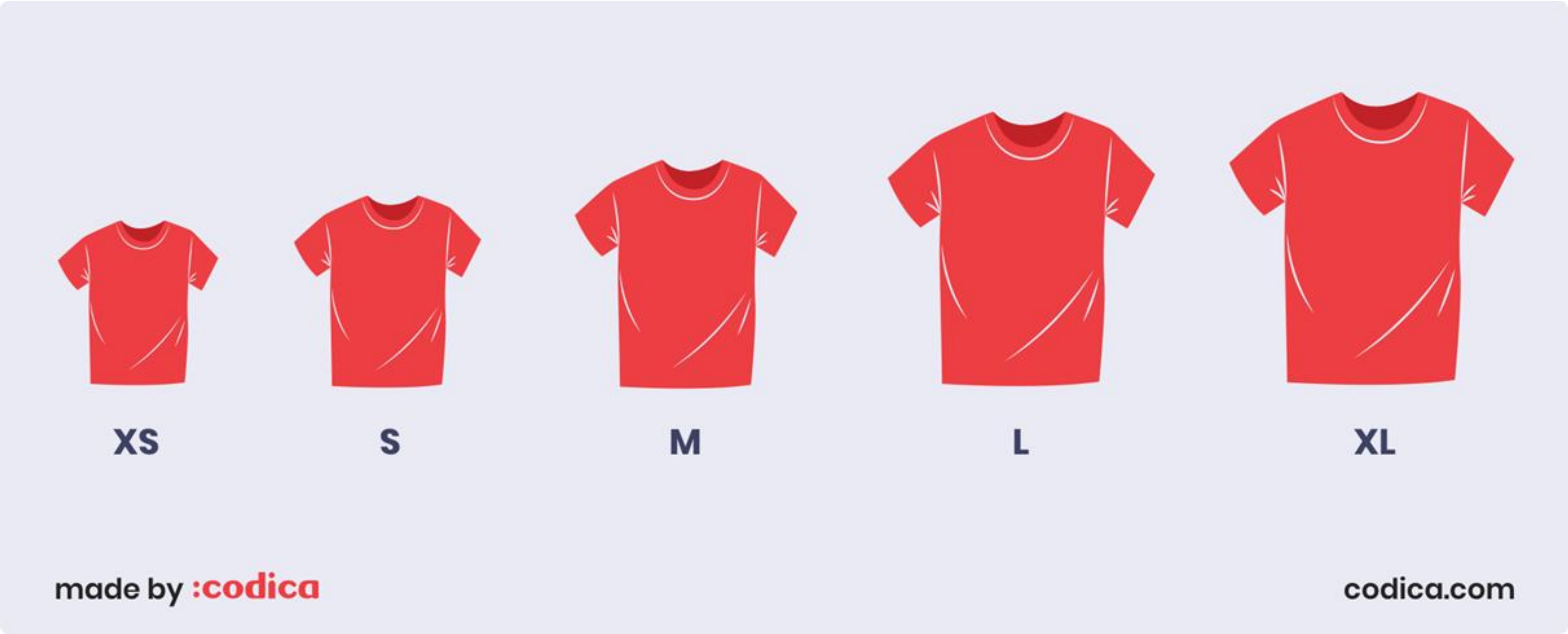
Product Backlog

Sprint Planning Meeting

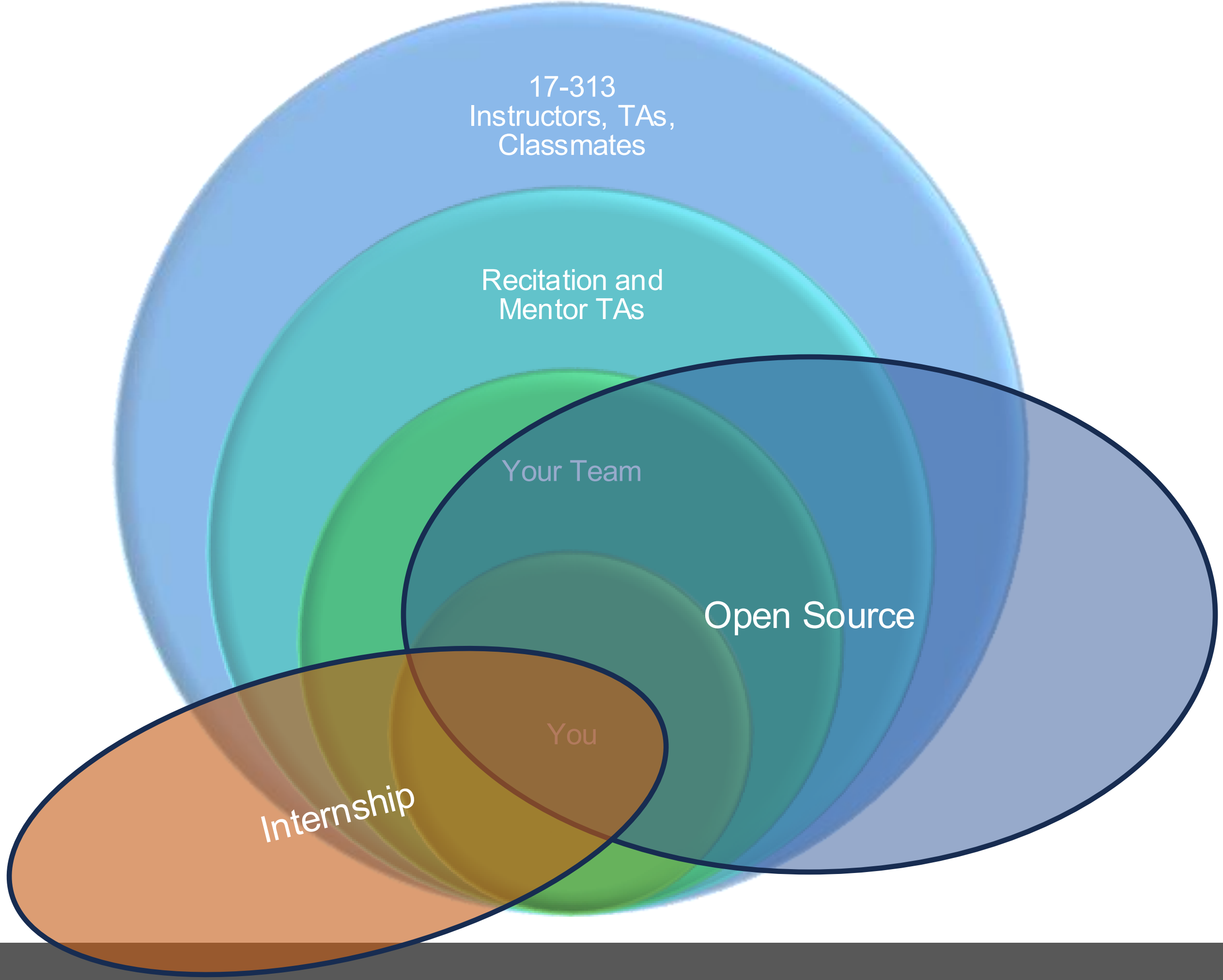
Sprint Backlog

Finished Work

Sprint Review
+
Sprint Retrospective

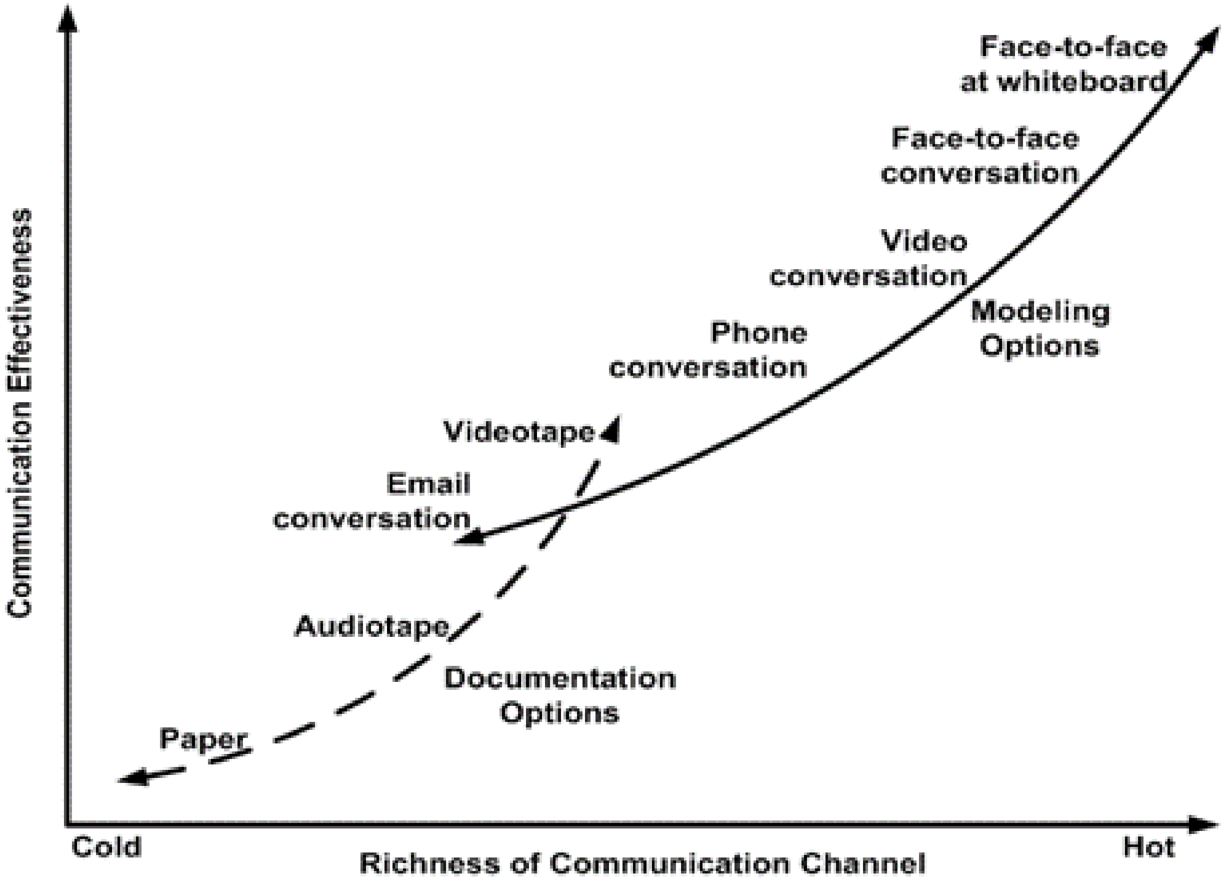

XS
S
M
L
XL
made by :codica
codica.com

We all work in a team



Ambler, S. (2002). Agile modeling: effective practices for extreme programming and the unified process. John Wiley & Sons.

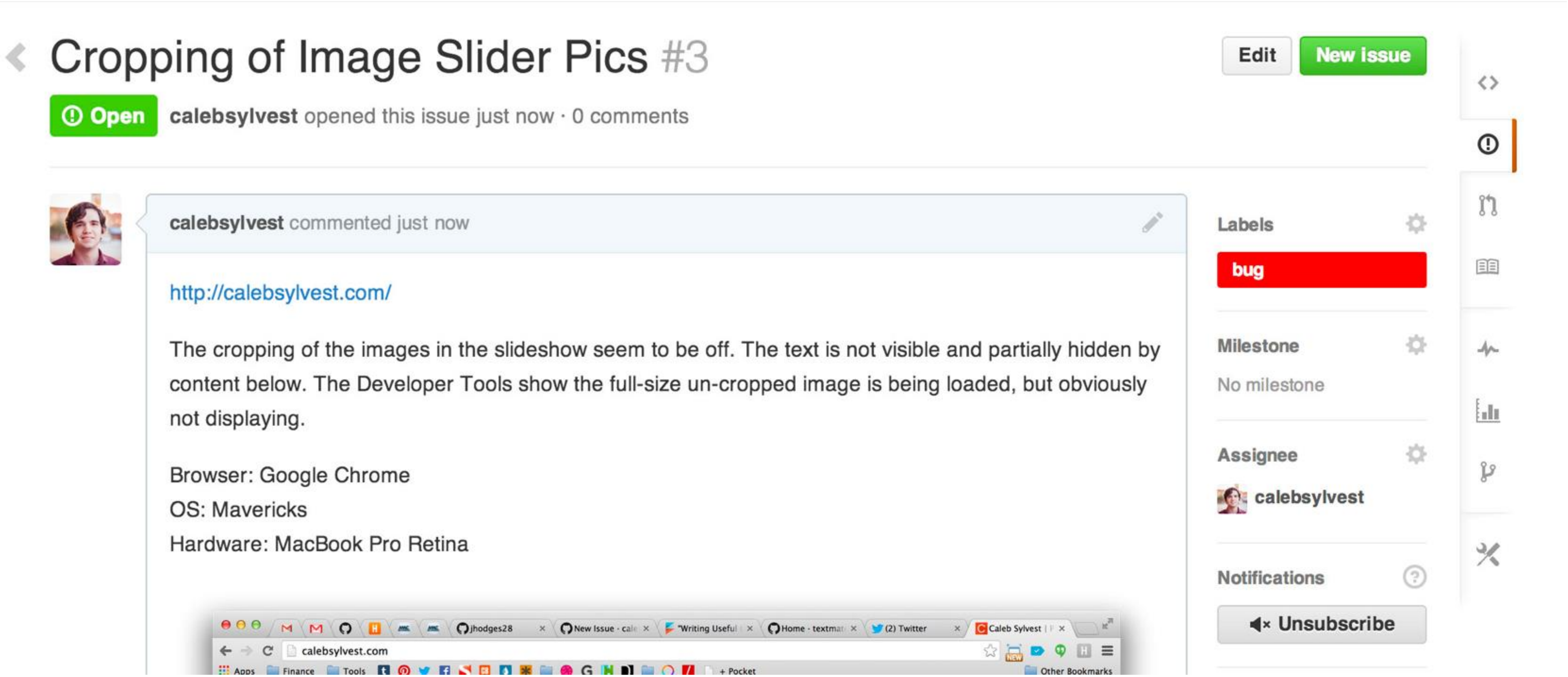
Select the right comm. tools



Copyright 2002-2005 Scott W. Ambler
Original Diagram Copyright 2002 Alistair Cockburn

https://upthemes.com/blog/2014/02/writing-useful-github-issues/

Writing useful Github issues



Cropping of Image Slider Pics #3

Edit | New issue

Open **calebsylvest** opened this issue just now · 0 comments

calebsylvest commented just now

http://calebsylvest.com/

The cropping of the images in the slideshow seem to be off. The text is not visible and partially hidden by content below. The Developer Tools show the full-size un-cropped image is being loaded, but obviously not displaying.

Browser: Google Chrome
OS: Mavericks
Hardware: MacBook Pro Retina

Labels: bug

Milestone: No milestone

Assignee: calebsylvest

Notifications

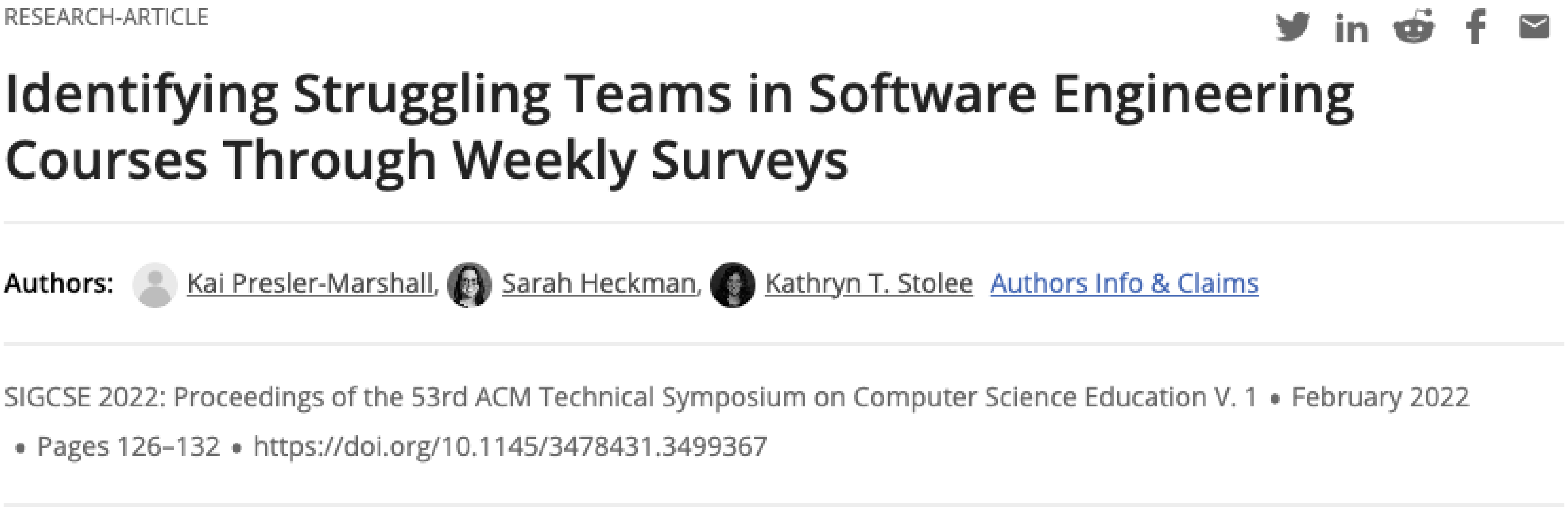
Make it easy for people to help you

- I am trying to ___, so that I can ___.
  I am running into ___.
  I have looked at ___ and tried ___.
- + I'm using this tech stack: ___.
- + I'm getting this error/result: ___.
- + I think the problem could be ___.

http://kwugirl.blogspot.com/2014/04/how-to-be-better-junior-developer_25.html

Https://techtonica.org/

Team survey



RESEARCH-ARTICLE

Identifying Struggling Teams in Software Engineering Courses Through Weekly Surveys

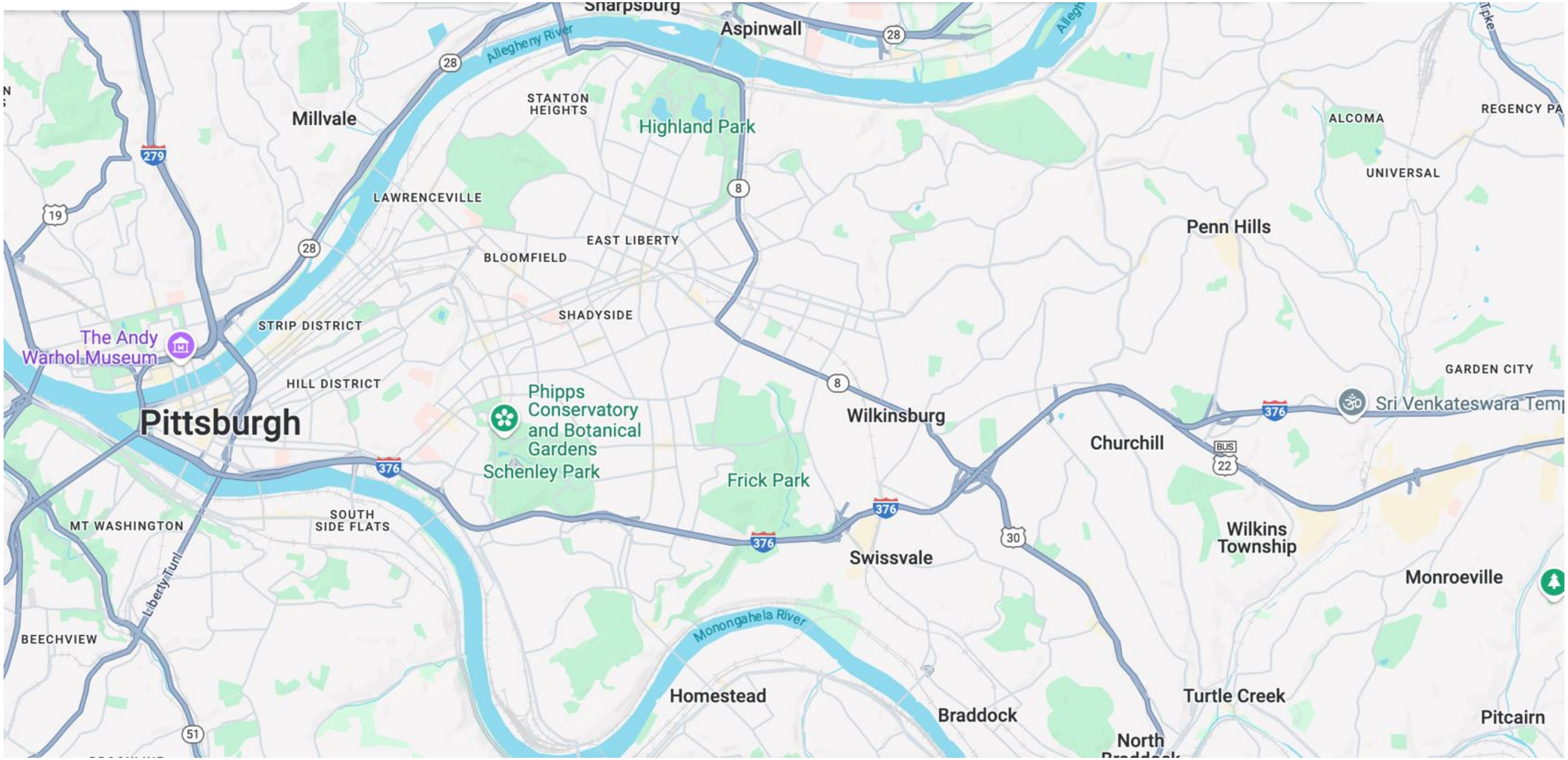
Authors: Kai Presler-Marshall, Sarah Heckman, Kathryn T. Stolee Authors Info & Claims

SIGCSE 2022: Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 1 • February 2022 • Pages 126–132 • https://doi.org/10.1145/3478431.3499367

Project 2: Collaborative Development

Learning Goals

- Translating requirements into actionable user stories
- Practice getting to know a pre-existing code base and developing new features for it using previously unfamiliar technology
- Practice version control and development best practices within the context of a group assignment
- Plan and schedule projects in terms of tasks, milestones, and time estimations, and re-plan as required
- Make initial decisions on a team process, and reflect on your experience with the process
- Effectively coordinate among team members and conduct team meetings
- Meaningfully reflect on the experience of working in teams


Sharpsburg
Aspinwall
Allegheny River
Millvale
Stanton Heights
Highland Park
Lawrenceville
East Liberty
Bloomfield
Shadyside
Strip District
The Andy Warhol Museum
Hill District
Pittsburgh
Phipps Conservatory and Botanical Gardens
Schenley Park
Frick Park
Wilkinsburg
Swissvale
Mt Washington
South Side Flats
Beechview
Liberty Tunl
Monongahela River
Homestead
Braddock
North Braddock
Turtle Creek
Pitcairn
Monroeville
Wilkins Township
Churchill
Penn Hills
Alcoma
Universal
Regency Pa
Garden City
Sri Venkateswara Temp
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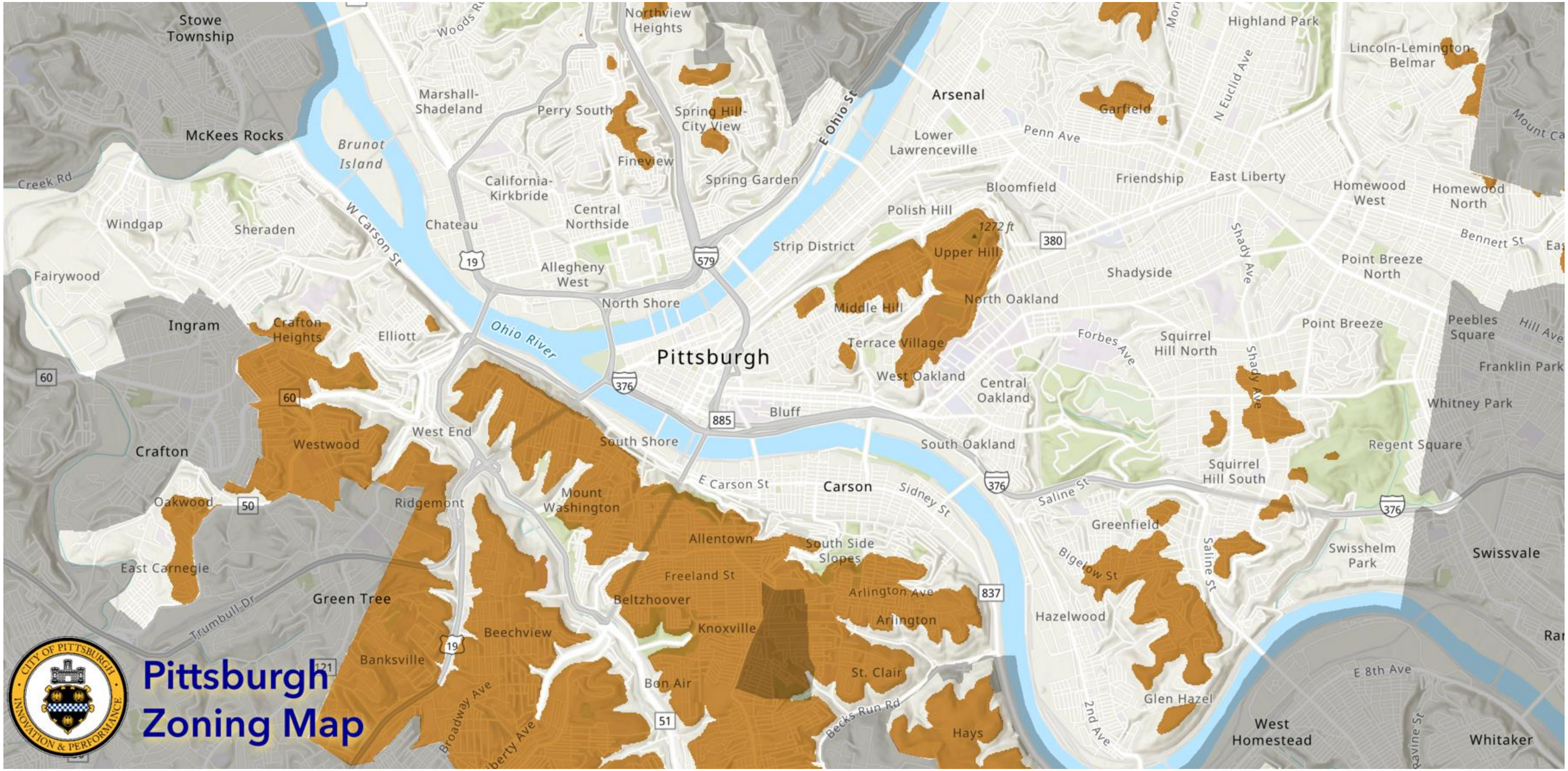
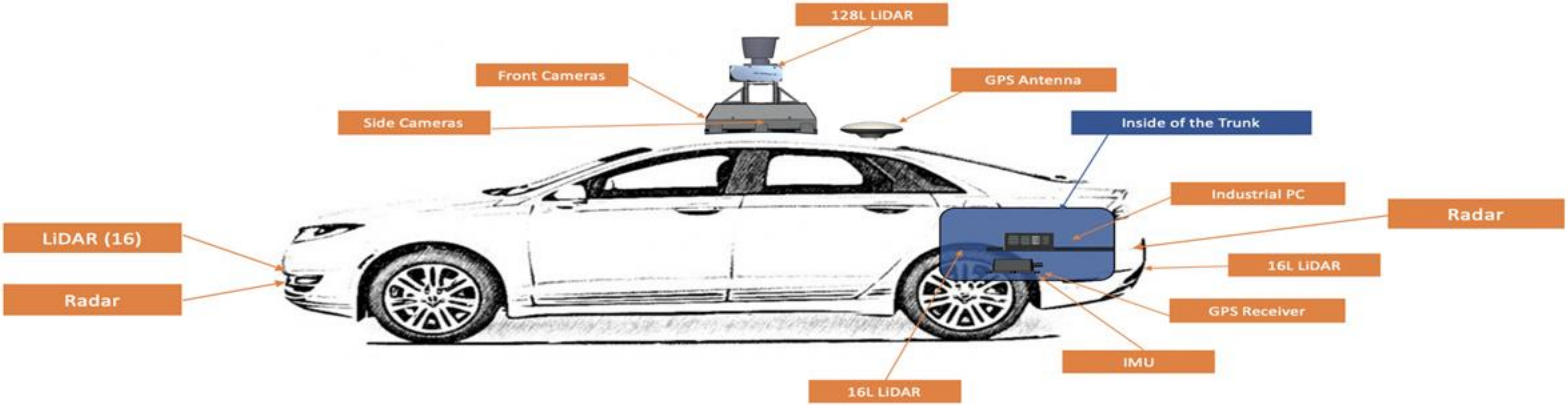


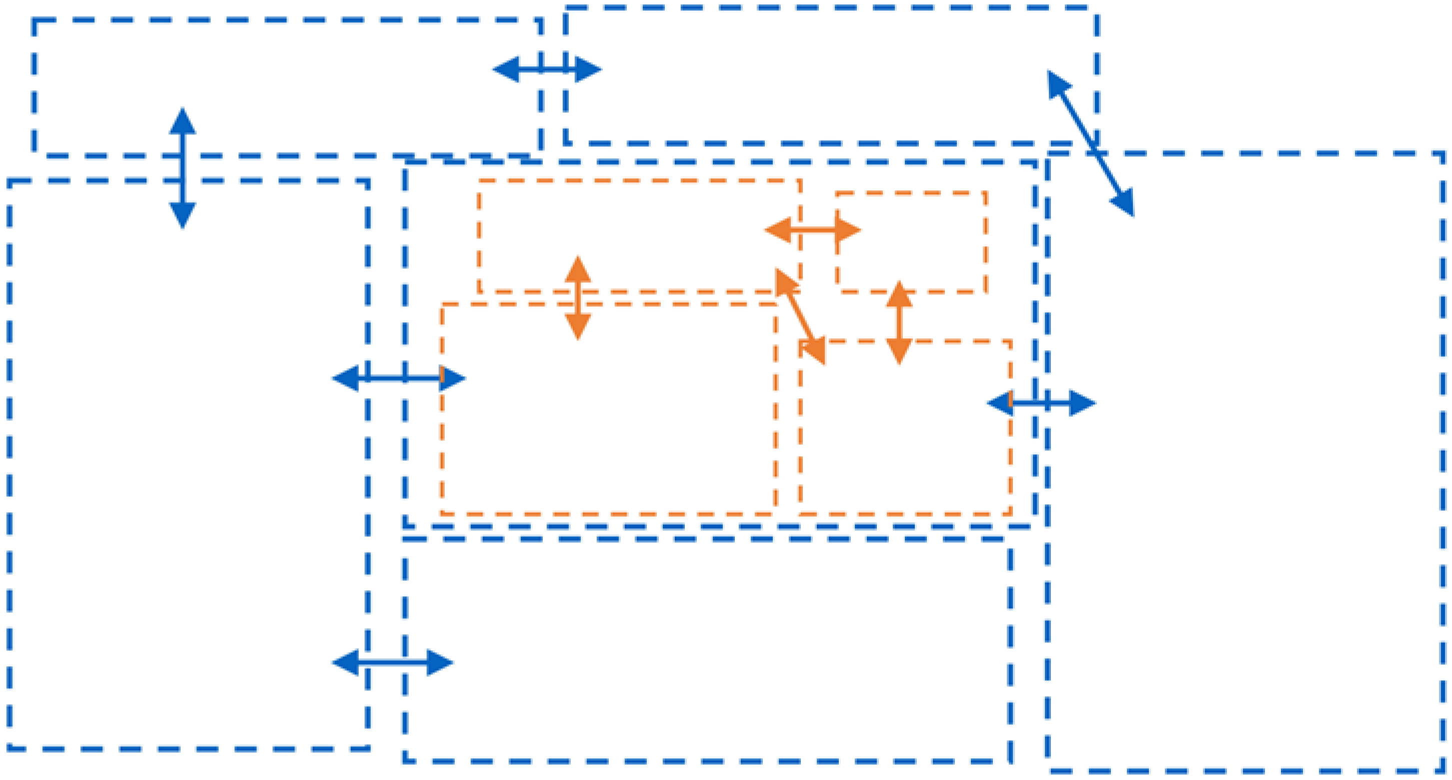
Pittsburgh Zoning Map

Apollo Hardware/Vehicle Overview



Source: https://github.com/ApolloAuto/apollo/blob/v6.0.0/README.md

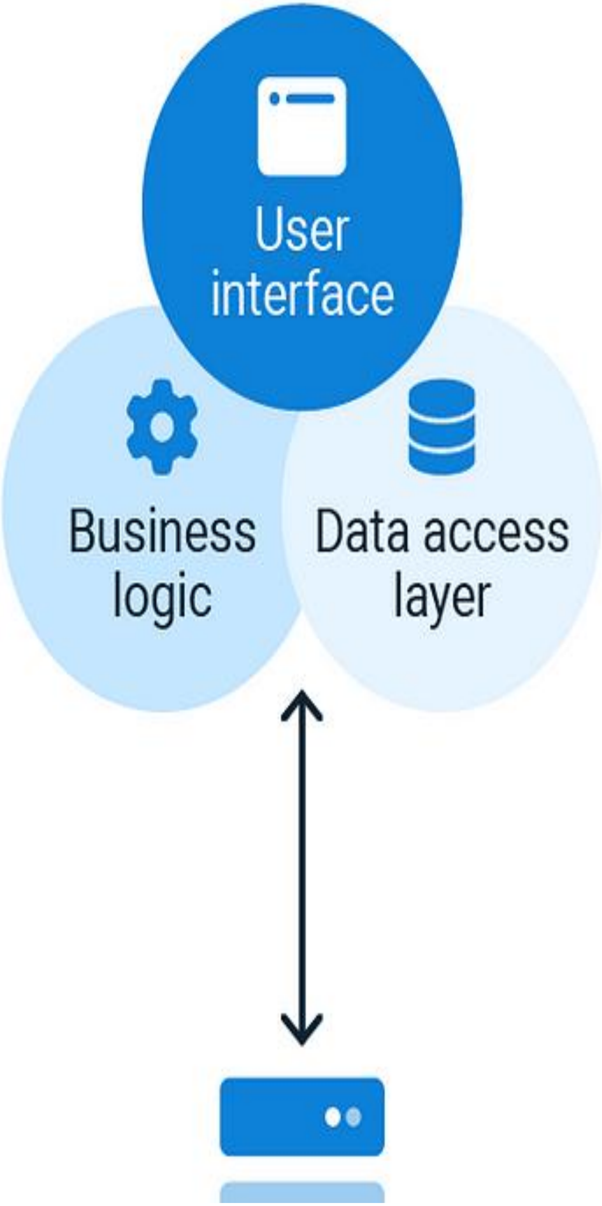
Architecture

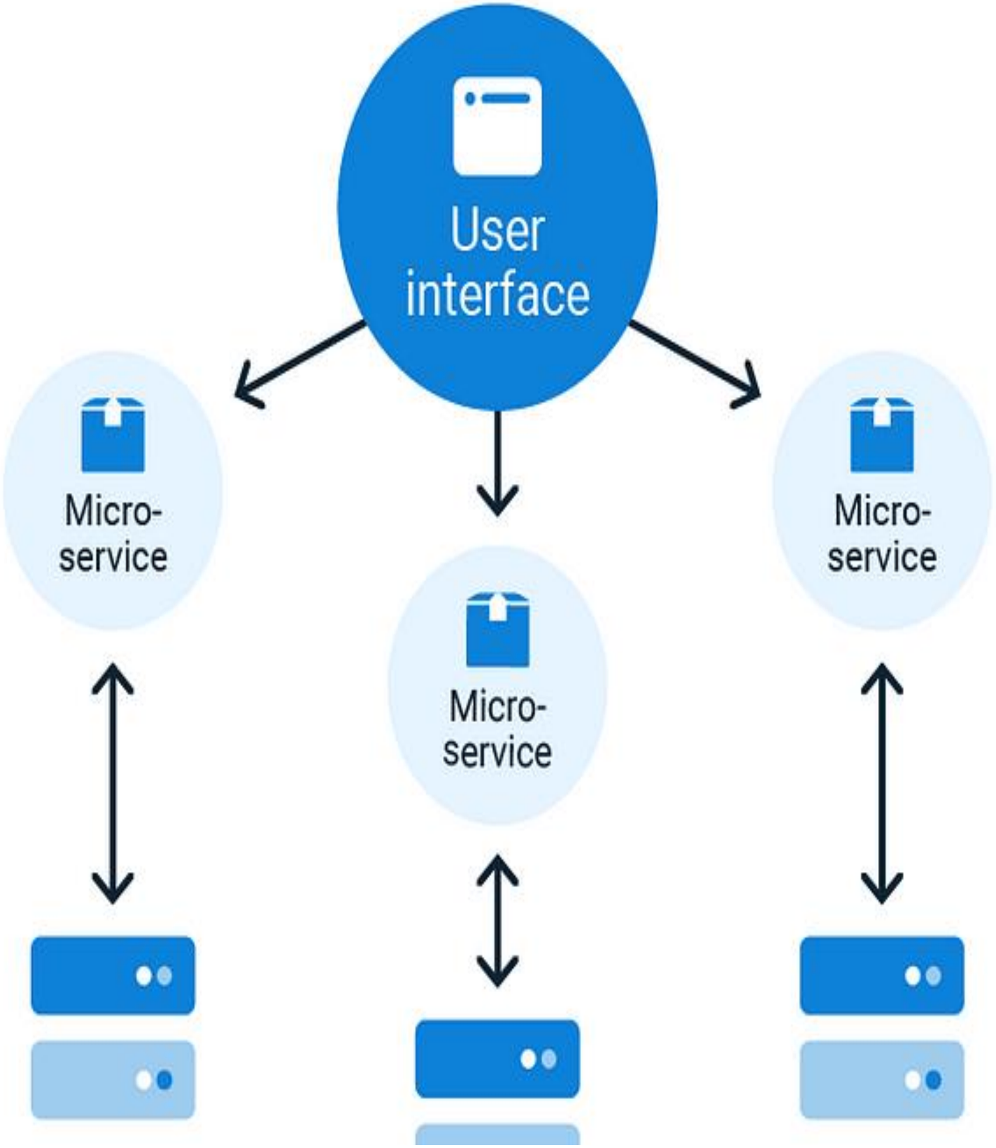


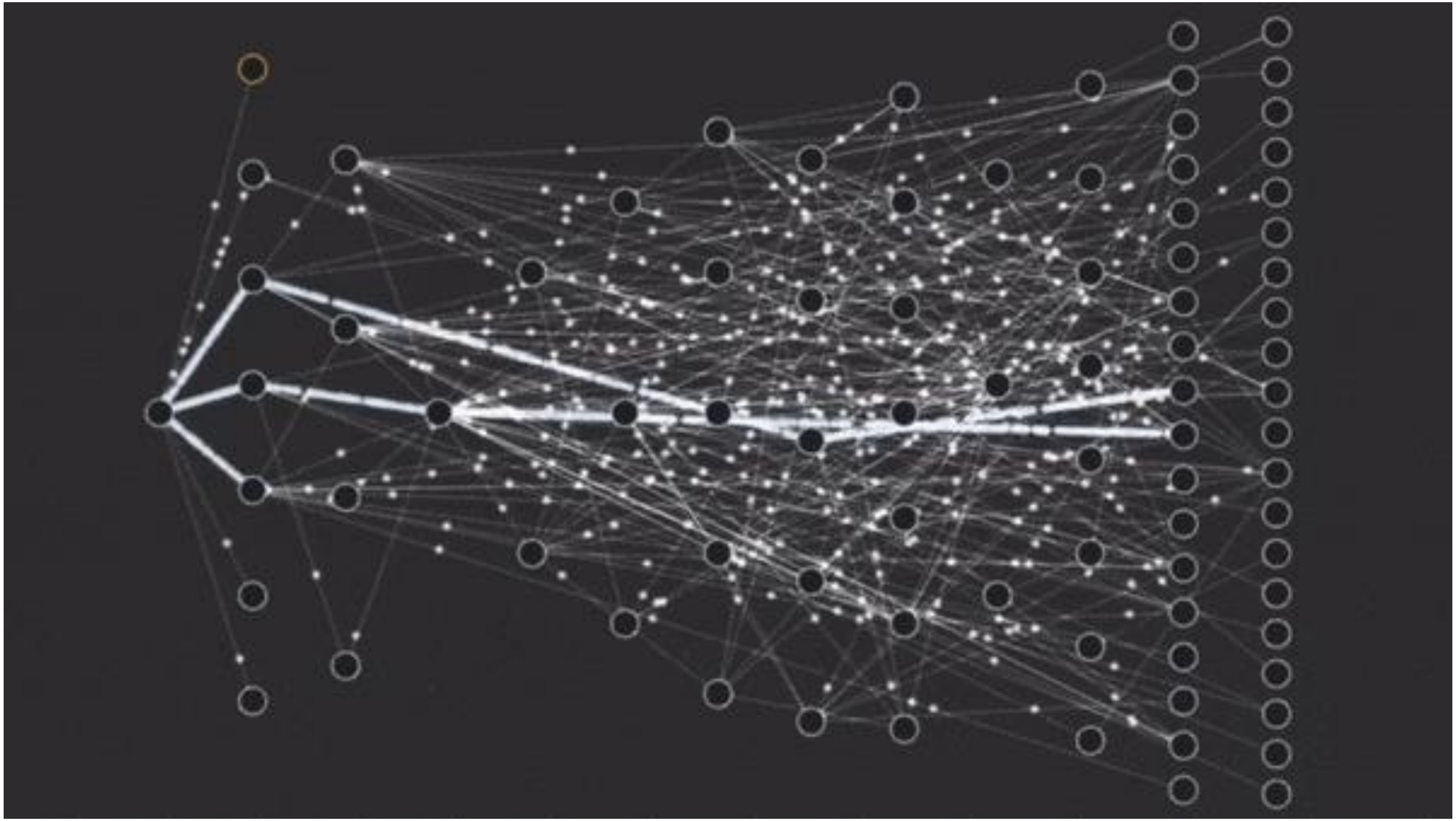
https://www.archdaily.com/

https://www.instagram.com/architectanddesign

https://www.mykonosceramica.com/


User interface
Business logic
Data access layer

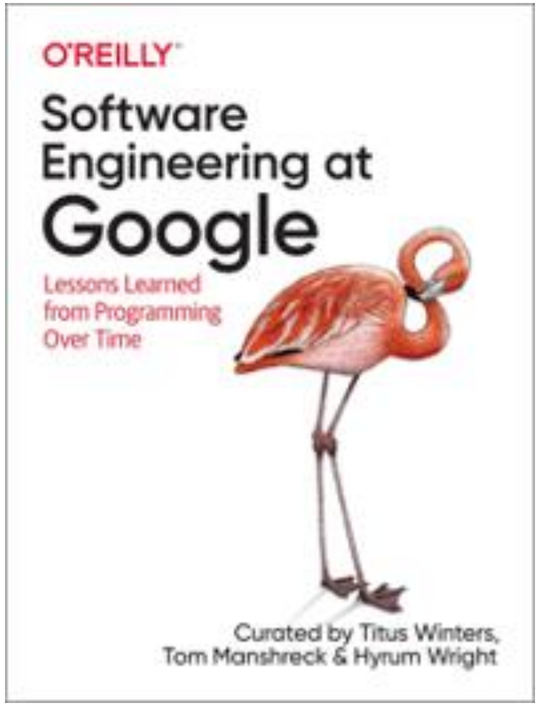

User interface
Micro-service
Micro-service
Micro-service



https://www.youtube.com/watch?v=V_oxbj-a1wQ

Design documents

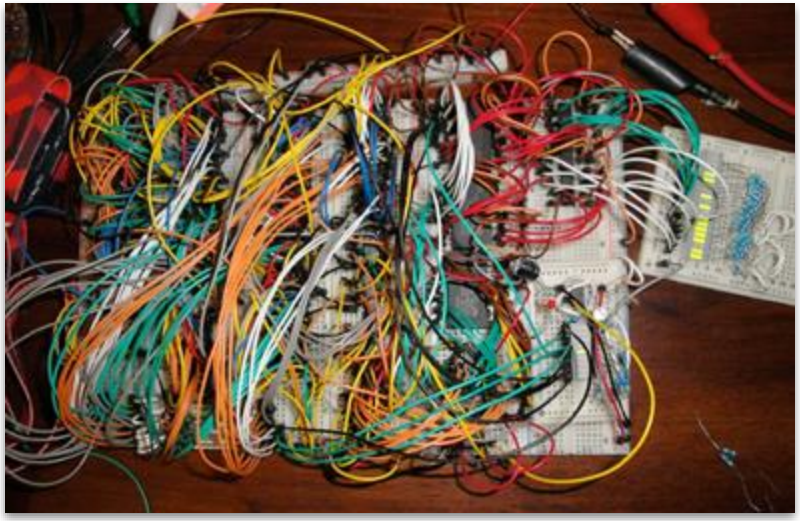
- **Code review before there is code!**
- Collaborative (Google Docs)
- Ensure various concerns are covered, such as: security implications, internationalization, storage requirements, and privacy concerns.
- A good design doc should cover
  - Goals and use cases for the design
  - Implementation ideas (not too specific!)
  - Propose key design decisions with an emphasis on their individual tradeoffs


O'REILLY
Software Engineering at Google
Lessons Learned from Programming Over Time
Curated by Titus Winters, Tom Manshreck & Hyrum Wright

Time to write our own design docs!

- Divide up into 4 sections –NOTE: you should be signed in w/Andrew to google
- Your mission:
  - Brainstorm a feature to add to a scooter app and write a design spec, together, in real time!
  - Review the design doc, collaborate around text
  - Review another team's design doc, ask questions/leave comments

Internal Quality



- Is the code well structured?
- Is the code understandable?
- How well documented?

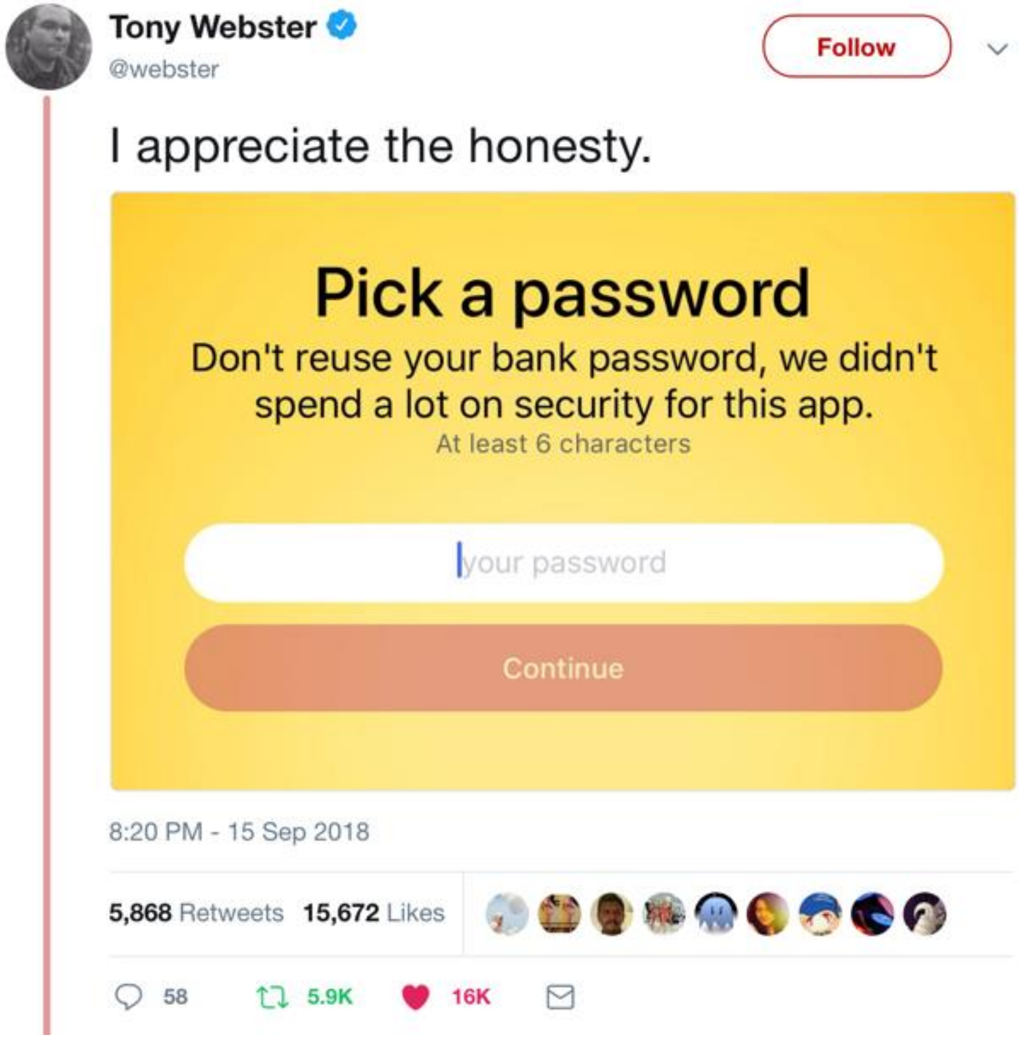
External Quality

- Does the software crash?
- Does it meet the requirements?
- Is the UI well designed?

Technical Debt

TECHNICAL DEBT
I DON'T UNDERSTAND WHY IT TAKES SO LONG TO ADD A NEW WINDOW.
@VINCENTDNL

Risk



Tony Webster
@webster

I appreciate the honesty.

Pick a password

Don't reuse your bank password, we didn't spend a lot on security for this app.

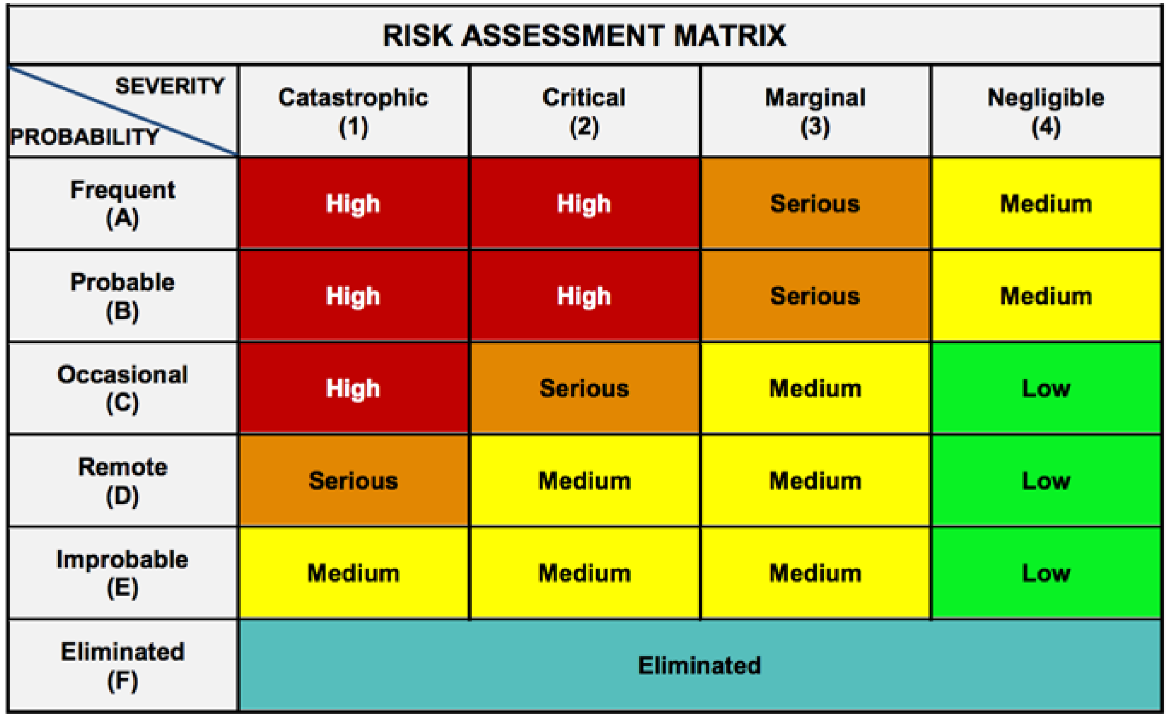
At least 6 characters

8:20 PM - 15 Sep 2018

5,868 Retweets 15,672 Likes

Risk assessment matrix

TABLE III. Risk assessment matrix

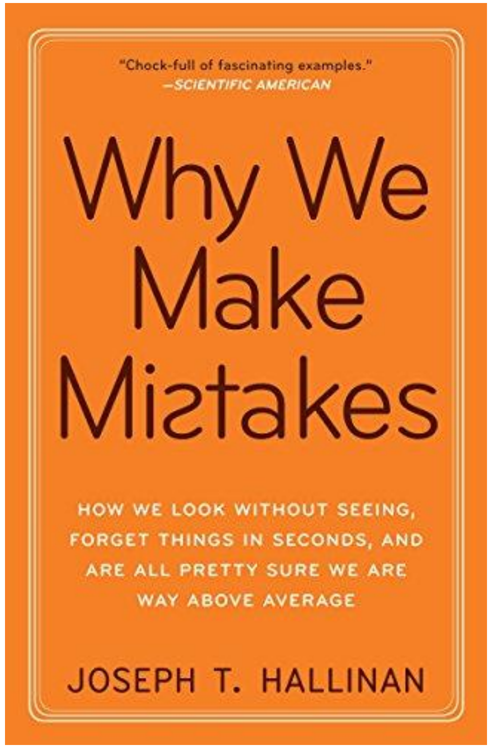


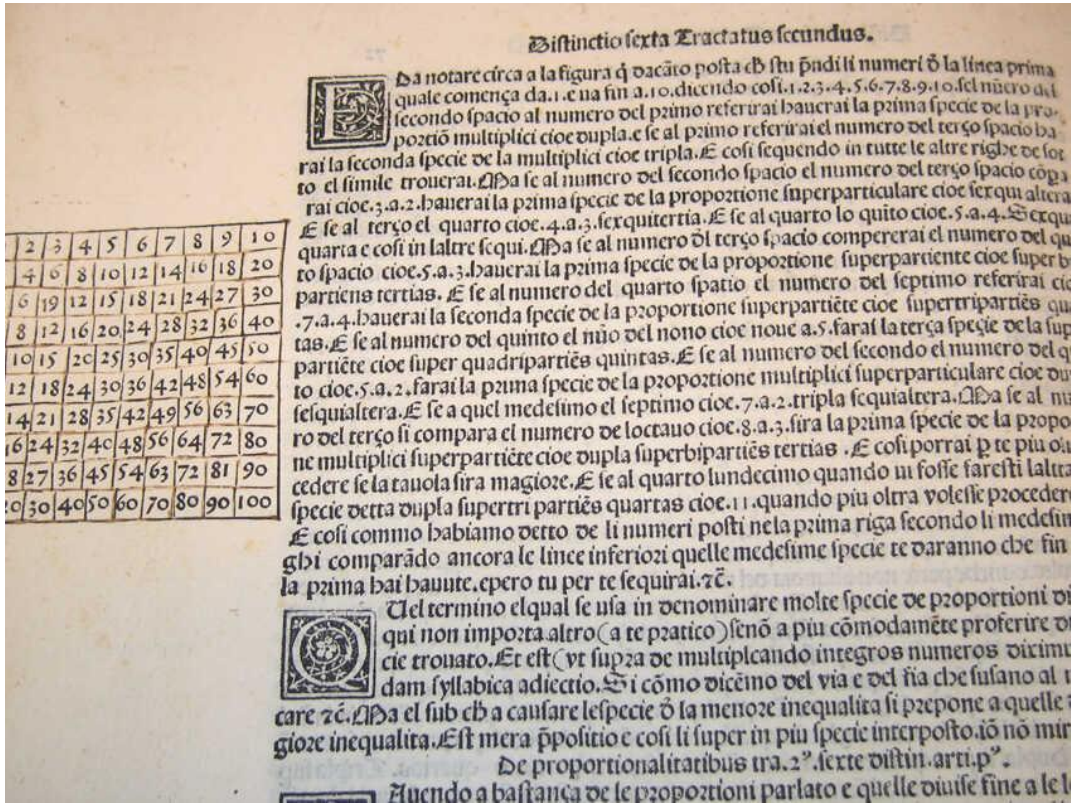
RISK ASSESSMENT MATRIX				
SEVERITY PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

- MIL-STD-882E

https://www.system-safety.org/Documents/MIL-STD-882E.pdf

Why do we make misakes?


"Chock-full of fascinating examples."
—SCIENTIFIC AMERICAN
Why We Make Miztakes
HOW WE LOOK WITHOUT SEEING, FORGET THINGS IN SECONDS, AND ARE ALL PRETTY SURE WE ARE WAY ABOVE AVERAGE
JOSEPH T. HALLINAN



Diſtinctio ſexta Tractatus ſecundus.

Da notare circa a la figura q̃ dacãto poſta cħ ſtu p̄ndi li numeri ȯ la linea prima
quale comença da.1.e ua fin a.10.dicendo coſi.1.2.3.4.5.6.7.8.9.10.ſel nũero del
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portiõ multiplici cioe dupla.e ſe al primo referirai el numero del terço ſpacio ha
rai la ſeconda ſpecie de la multiplici cioe tripla.E coſi ſequendo in tutte le altre righe de ſot
to el ſimile trouerai.Ma ſe al numero del ſecondo ſpacio el numero del terço ſpacio cõpa
rai cioe.3.a.2.hauerai la prima ſpecie de la proportione ſuperparticulare cioe ſexqui altera
E ſe al terço el quarto cioe.4.a.3.ſexquitertia.E ſe al quarto lo quito cioe.5.a.4.Sexqu
quarta e coſi in laltre ſequi.Ma ſe al numero dl terço ſpacio compererai el numero del qu
to ſpacio cioe.5.a.3.hauerai la prima ſpecie de la proportione ſuperpartiente cioe ſuper b
partiens tertias. E ſe al numero del quarto ſpatio el numero del ſeptimo referirai cio
.7.a.4.hauerai la ſeconda ſpecie de la proportione ſuperpartiẽte cioe ſupertripartiẽs qu
tas.E ſe al numero del quinto el nũo del nono cioe noue a.5.farai la terça ſpeçie de la ſup
partiẽte cioe ſuper quadripartiẽs quintas.E ſe al numero del ſecondo el numero del q
to cioe.5.a.2.farai la prima ſpecie de la proportione multiplici ſuperparticulare cioe du
ſeſquialtera.E ſe a quel medeſimo el ſeptimo cioe.7.a.2.tripla ſequialtera.Ma ſe al nu
ro del terço ſi compara el numero de loctauo cioe.8.a.3.ſira la prima ſpecie de la propo
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ſpecie detta dupla ſupertri partiẽs quartas cioe.11.quando piu oltra voleſſe proceder
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ghi comparãdo ancora le linee inferiori quelle medeſime ſpecie te daranno che fin
la prima hai hauute.epero tu per te ſequirai.7c̃.

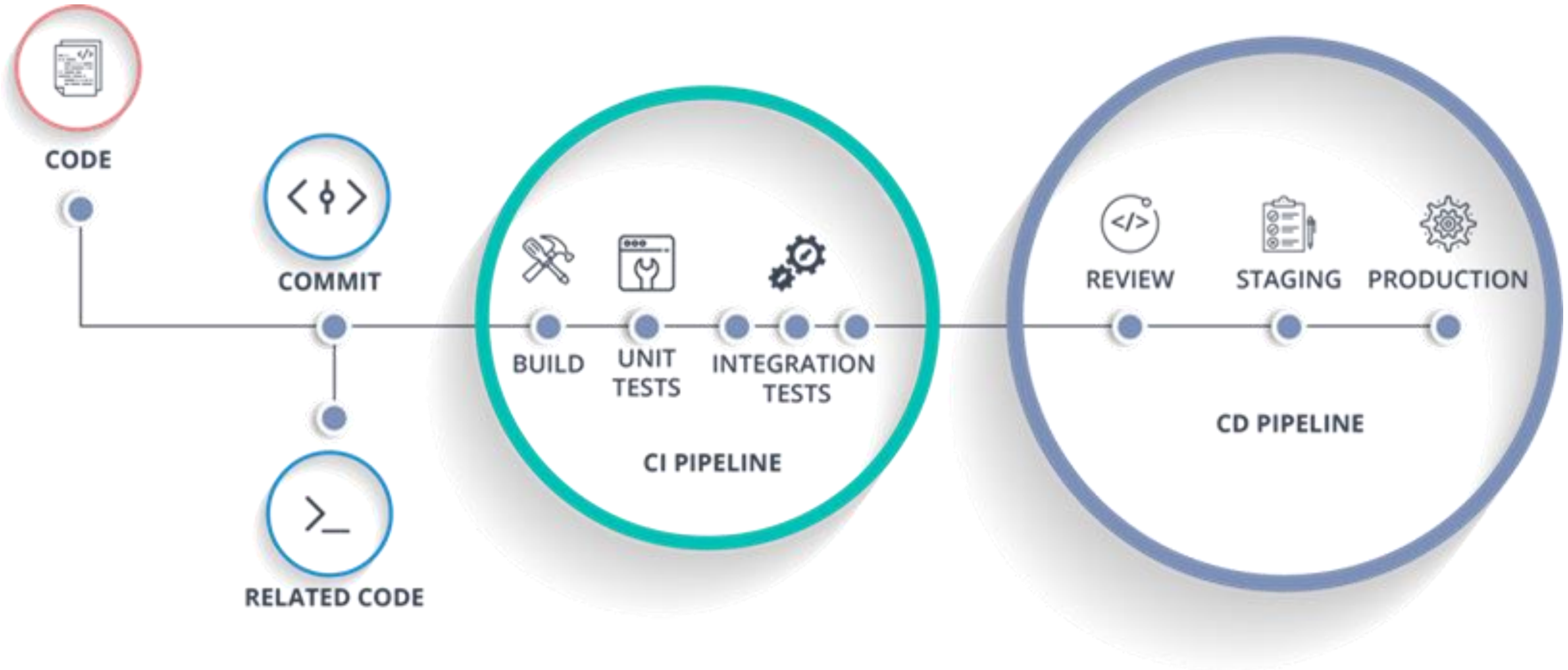
2	3	4	5	6	7	8	9	10
4	6	8	10	12	14	16	18	20
6	19	12	15	18	21	24	27	30
8	12	16	20	24	28	32	36	40
10	15	20	25	30	35	40	45	50
12	18	24	30	36	42	48	54	60
14	21	28	35	42	49	56	63	70
16	24	32	40	48	56	64	72	80
18	27	36	45	54	63	72	81	90
20	30	40	50	60	70	80	90	100

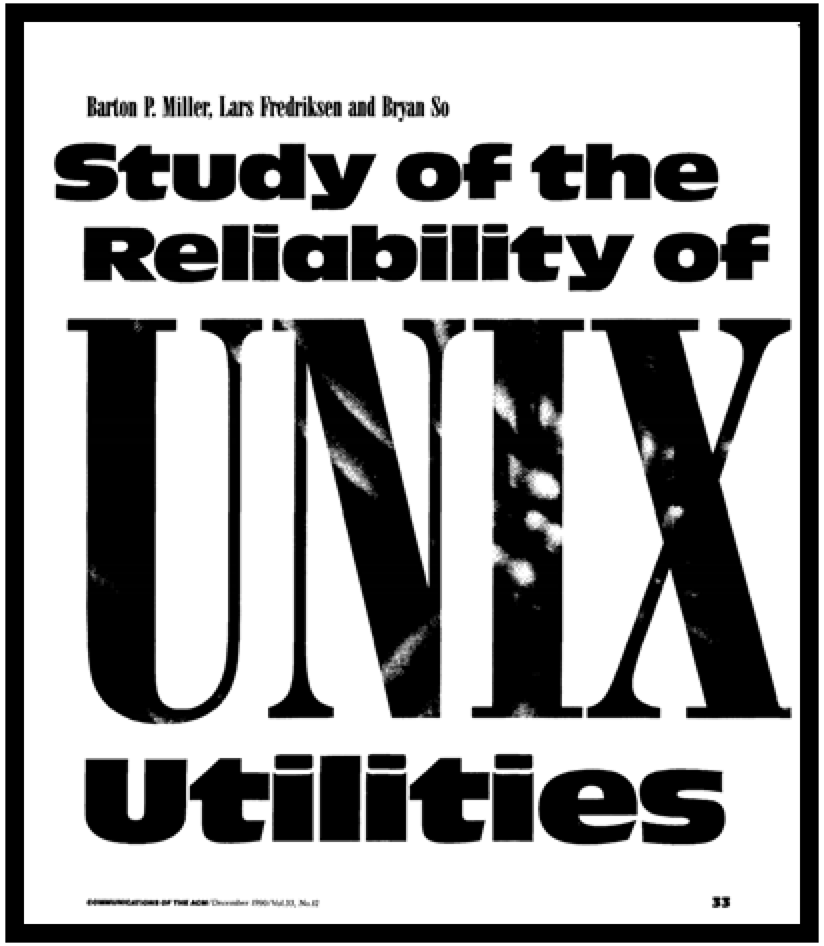
Quel termino elqual ſe uſa in denominare molte ſpecie de proportioni d
qui non importa altro(a te pratico)ſenõ a piu cõmodamẽte proferire d
cie trouato.Et eſt(vt ſupra de multiplcando integros numeros dicimu
dam ſyllabica adiectio.Si cõmo dicẽmo del via e del ſia che ſuſano al
care 7c.Ma el ſub ch a cauſare leſpecie ȯ la menore inequalita ſi prepone a quelle
giore inequalita.Eſt mera p̄poſitio e coſi li ſuper in piu ſpecie interpoſto.iõ nõ mi

De proportionalitatibus tra.2°.ſexte diſtin.arti.p°.

Auendo a baſtança de le proportioni parlato e quelle diuiſe fine a le l

Example CI/CD Pipeline





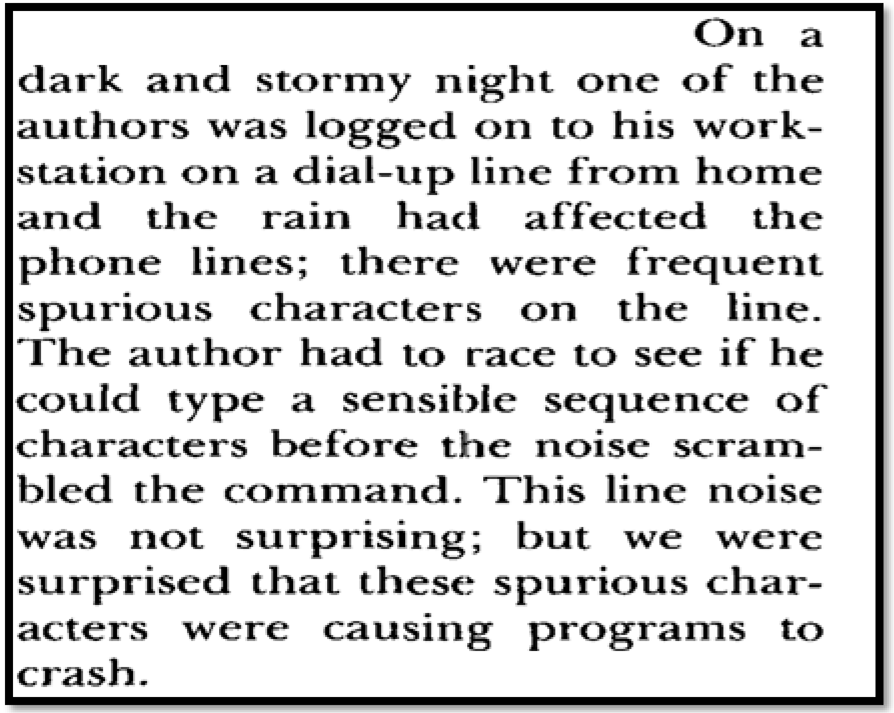
Barton P. Miller, Lars Fredriksen and Bryan So

Study of the Reliability of UNIX Utilities

COMMUNICATIONS OF THE ACM/December 1990/Vol.33, No.12 33

Communications of the ACM (1990)

“

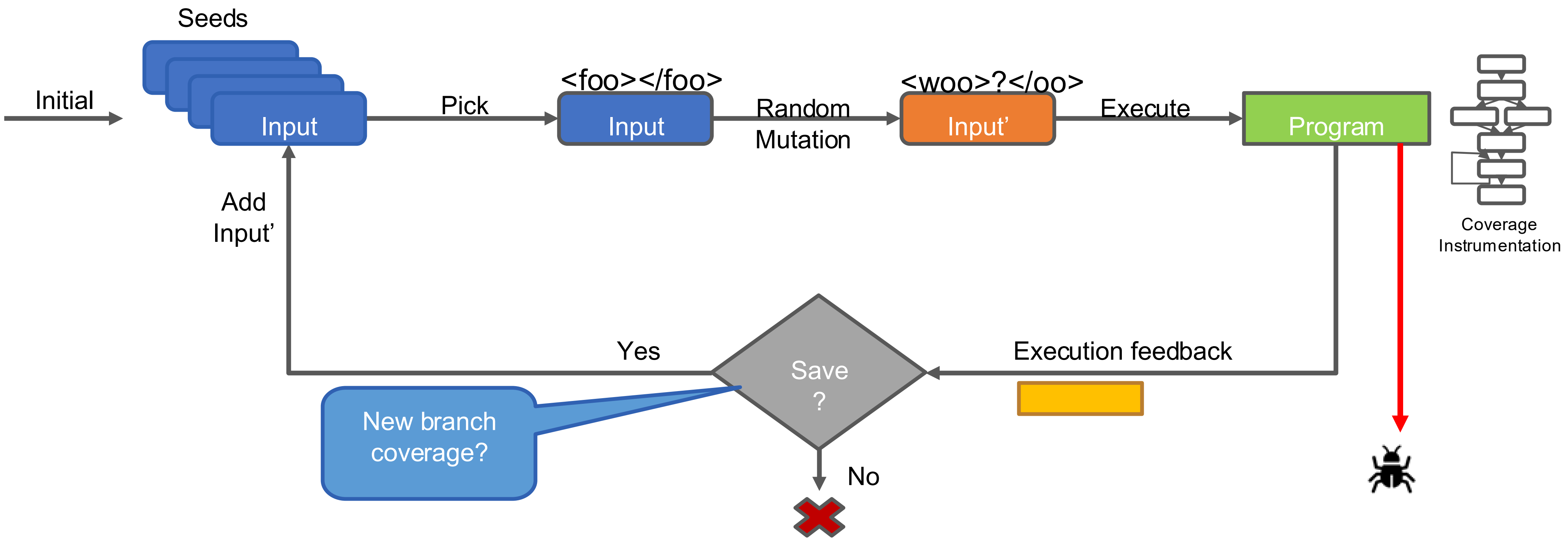


On a dark and stormy night one of the authors was logged on to his workstation on a dial-up line from home and the rain had affected the phone lines; there were frequent spurious characters on the line. The author had to race to see if he could type a sensible sequence of characters before the noise scrambled the command. This line noise was not surprising; but we were surprised that these spurious characters were causing programs to crash.

”

How to identify these bugs?

Coverage-Guided Fuzzing (e.g. AFL)



Example: Netflix

Significant deployment on AWS cloud. Hundreds of updates to microservices and infrastructure through the day.

Chaos Monkey randomly takes down AWS instances or network connections or randomly changes config files.

How to tell ”are we still good?”
Key metric: Stream Starts per Second (SPS)
Measures *availability*

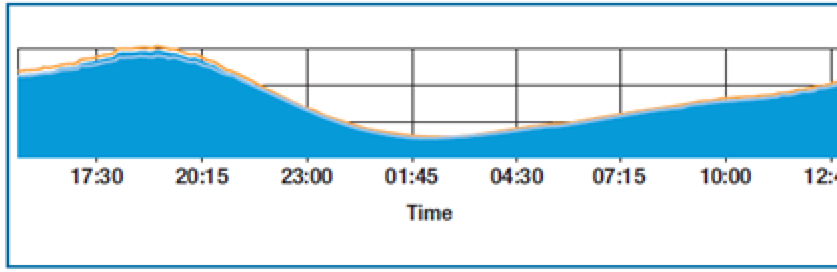
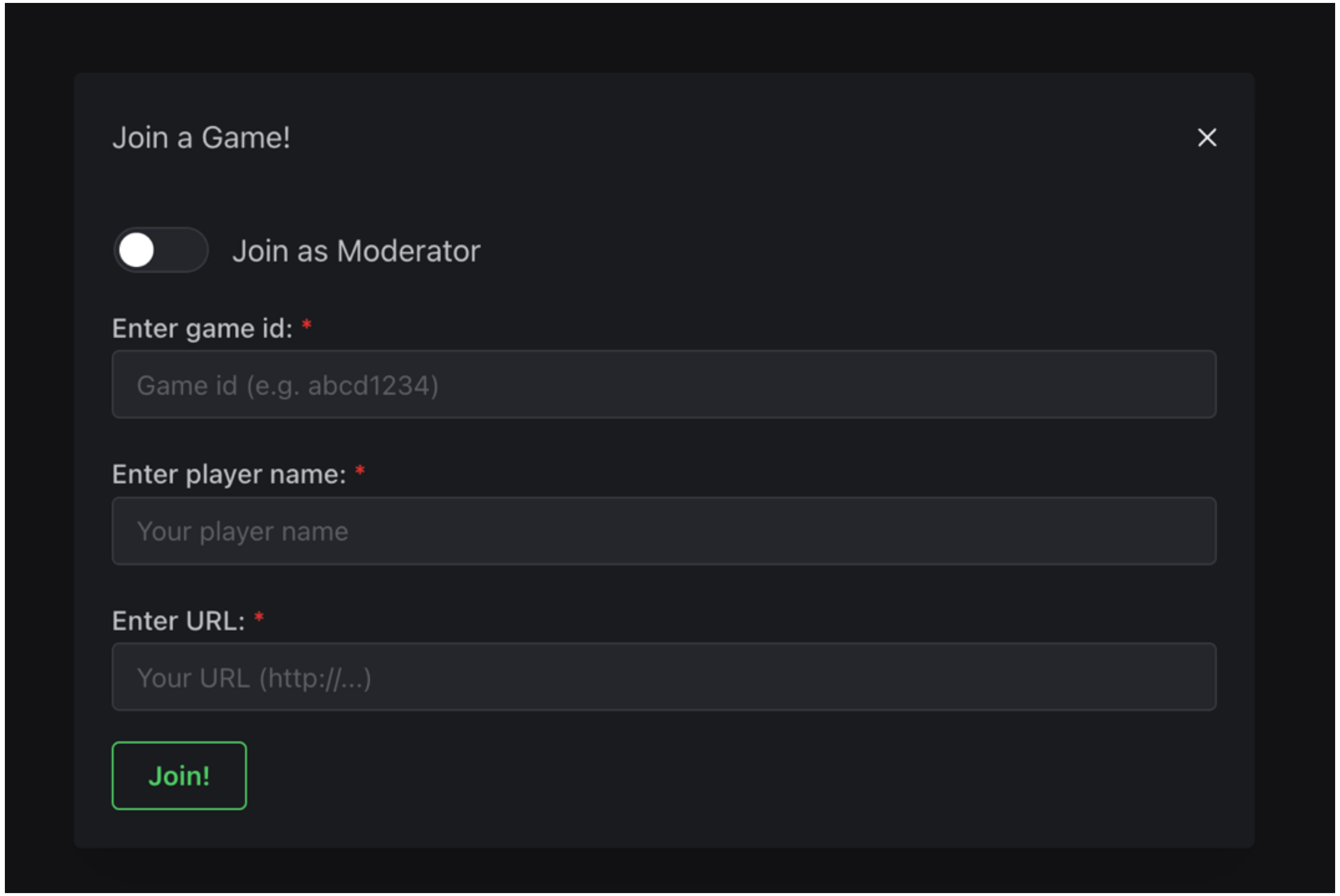


FIGURE 2. A graph of SPS ([stream] starts per second) over a 24-hour perio
metric varies slowly and predictably throughout a day. The orange line shows t
for the prior week. The *y*-axis isn’t labeled because the data is proprietary.

Step 2: Join game

- Game id: from board
- Player Name:
  - Remember what you put in
- URL:
  - IMPORTANT: PASTE YOUR URL BUT ADD '/API'
  - E.g. http://myurl.com/API



Join a Game!

○ Join as Moderator

Enter game id: *

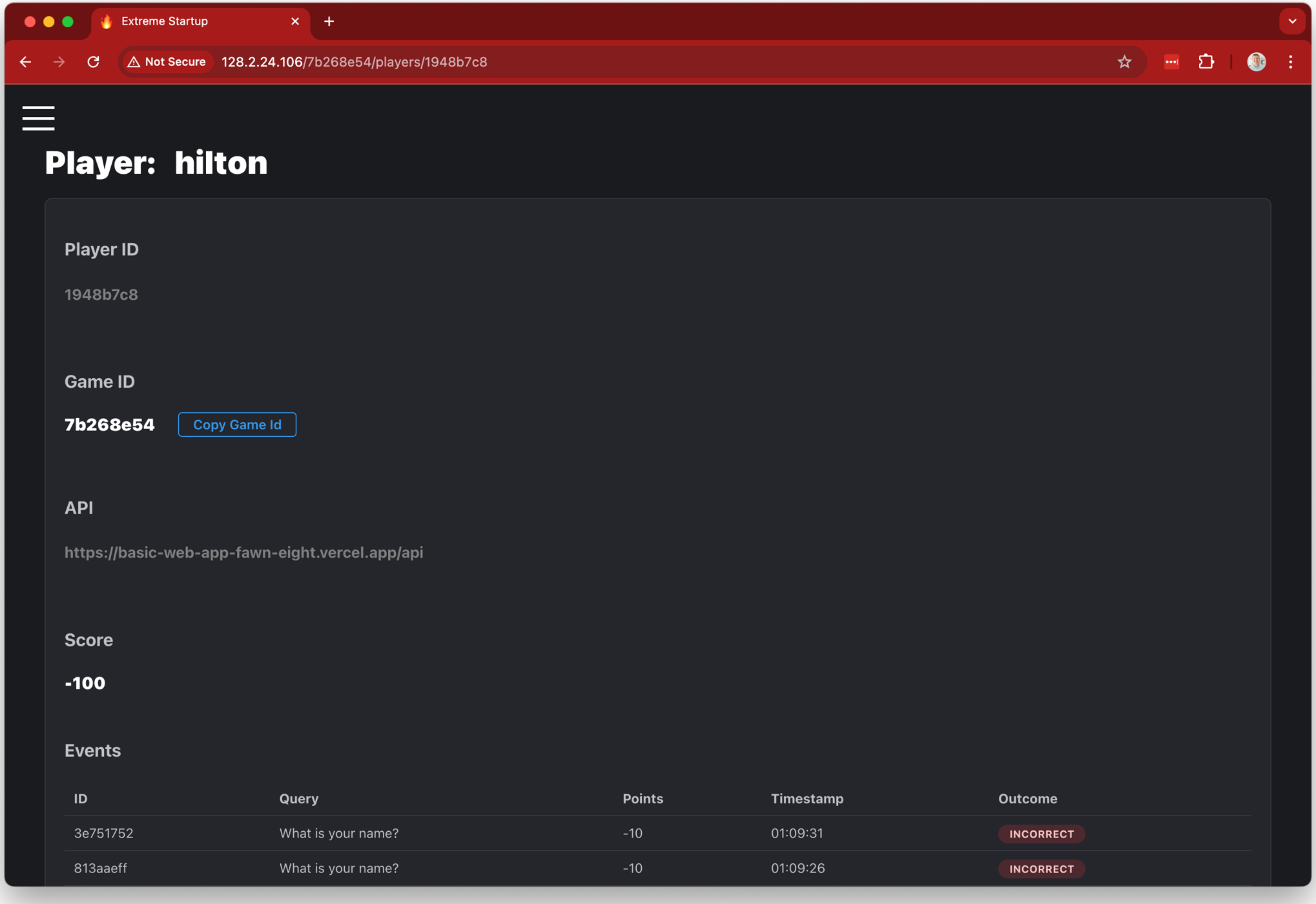
Game id (e.g. abcd1234)

Enter player name: *

Your player name

Enter URL: *

Your URL (http://...)



Player: hilton

Player ID

1948b7c8

Game ID

7b268e54 Copy Game Id

API

https://basic-web-app-fawn-eight.vercel.app/api

Score

-100

Events

ID	Query	Points	Timestamp	Outcome
3e751752	What is your name?	-10	01:09:31	INCORRECT
813aaeff	What is your name?	-10	01:09:26	INCORRECT

Scenario

You work as a lead software engineer at a local Pittsburgh startup called "Grandma-as-a-service", or *Gaas*. *Gaas* was founded when a CMU student was sick, and realized that they didn't have anyone to take care of them. This is a problem for many different people in the Pittsburgh Community. *Gaas* allows you to hire a grandma to come help you recover if you are unwell. *Gaas* are able to come to your house, make fresh, homemade soup, remind you to take your medication, and help with small chores around the house. The app leverages the gig-economy model, so it can hire local Grandmas to help in this role.

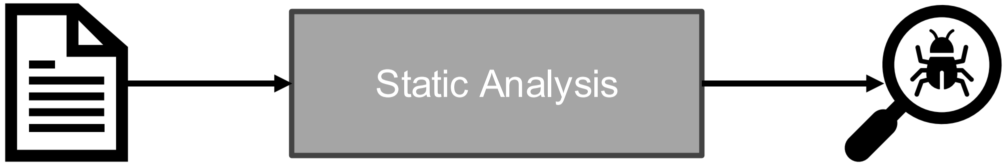
When looking to hire a Grandma, the user logs in to the app and fills our a questionnaire. If their symptoms are too severe, they are instructed to call 911. Once they order a visit from a Grandma, they can choose the type of soup they would like, as well as the time and location of the visit. Additionally, parents who have children in Pittsburgh can order a visit from *Gaas* for their child, if they know they are not feeling well. For Grandmas who are looking for some extra income, they can sign up with the app, and are notified of students looking for visits. They can create a profile based on the types of soup they can make, as well as other factors such as distance and hours available to work. The system is responsible for matching customers with Grandmas.

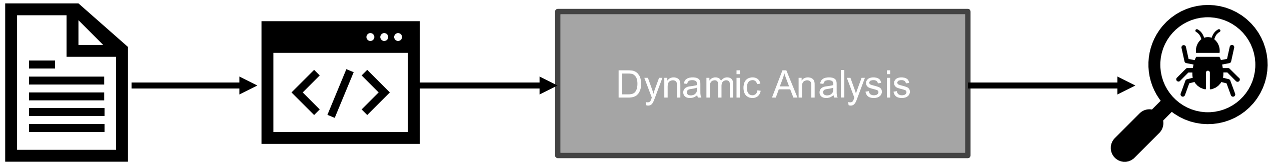
Project 3: Continuous Integration + Deployment

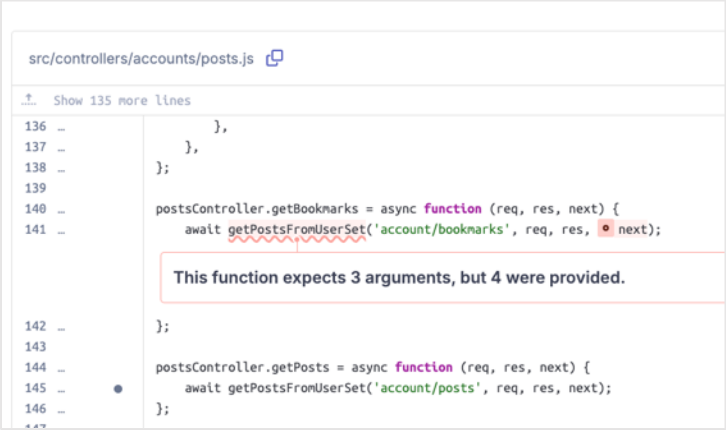
Learning Goals

- Learn how to deploy a full-stack application
- Gain hands-on experience with analysis tools, including setting up, customizing, and using them
- Practically assess and compare the costs and benefits of existing static and dynamic bug-finding tools
- Integrate CI/CD tools into development practice

What are Program Analysis Tools?





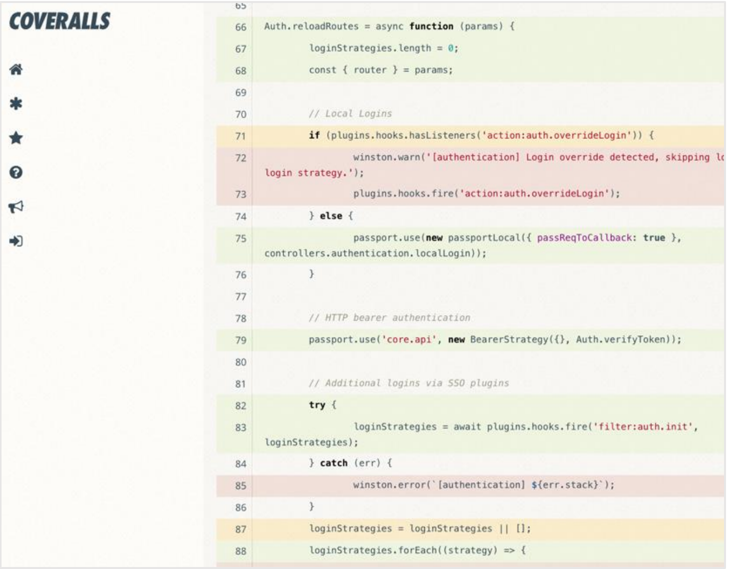

src/controllers/accounts/posts.js

Show 135 more lines

```
            },
        },
    };

    postsController.getBookmarks = async function (req, res, next) {
        await getPostsFromUserSet('account/bookmarks', req, res, ⊗ next);
```

This function expects 3 arguments, but 4 were provided.

```
    };

    postsController.getPosts = async function (req, res, next) {
        await getPostsFromUserSet('account/posts', req, res, next);
    };
```



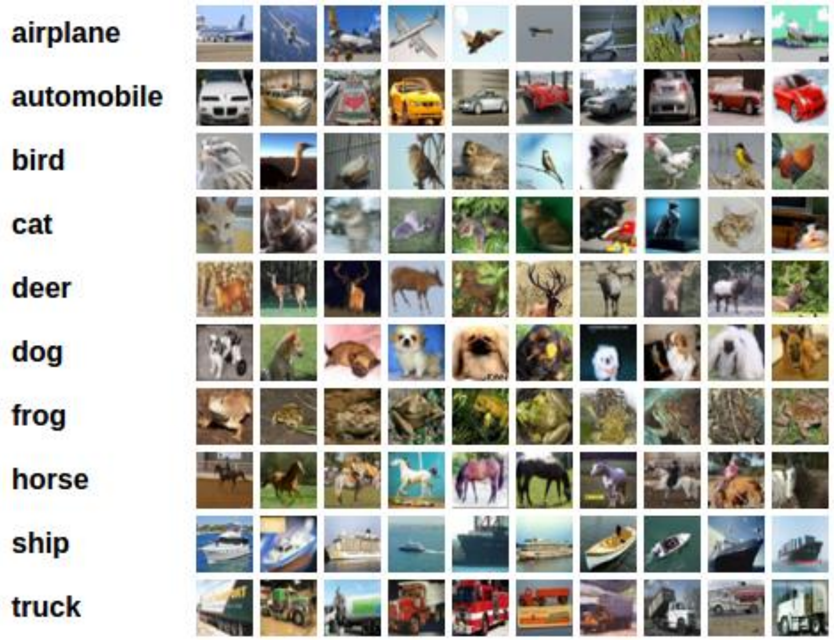
```
Auth.reloadRoutes = async function (params) {
        loginStrategies.length = 0;
        const { router } = params;

        // Local Logins
        if (plugins.hooks.hasListeners('action:auth.overrideLogin')) {
                winston.warn('[authentication] Login override detected, skipping lo
login strategy.');
                plugins.hooks.fire('action:auth.overrideLogin');
        } else {
                passport.use(new passportLocal({ passReqToCallback: true },
controllers.authentication.localLogin));
        }

        // HTTP bearer authentication
        passport.use('core.api', new BearerStrategy({}, Auth.verifyToken));

        // Additional logins via SSO plugins
        try {
                loginStrategies = await plugins.hooks.fire('filter:auth.init',
loginStrategies);
        } catch (err) {
                winston.error(`[authentication] ${err.stack}`);
        }
        loginStrategies = loginStrategies || [];
        loginStrategies.forEach((strategy) => {
```

Tools for Static Analysis

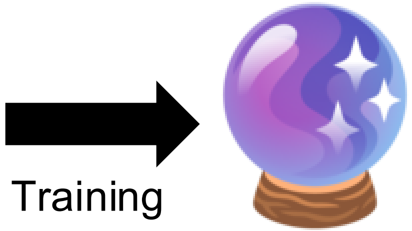
CSi
UNIVERSITY OF MARYLAND
18 56
FindBugs™
because it's easy
: my[py]
snyl
sonarqube
coverity®
SYNOPSYS®
squale

Machine Learning in One Slide

(Supervised)

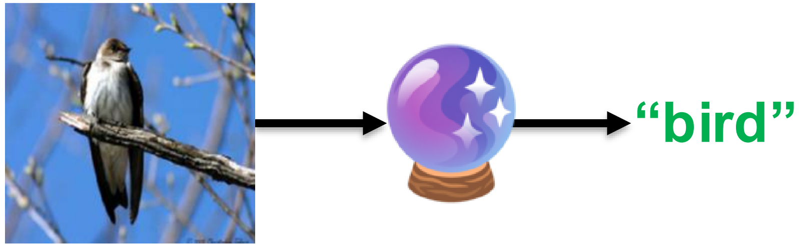


Lots of labelled data
(Inputs, outputs)



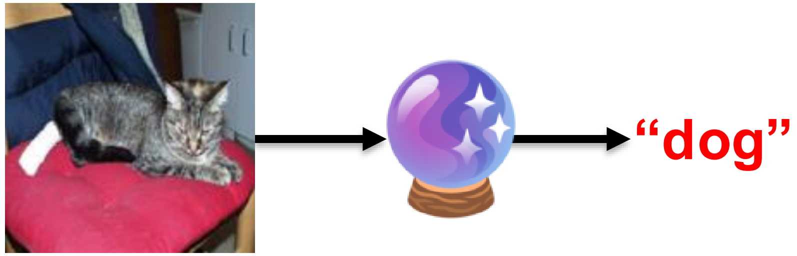
Training

Model



Input

Output

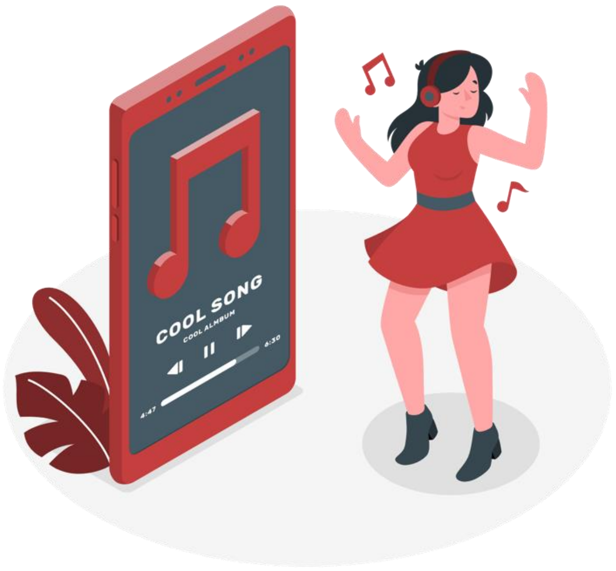


Input

Output

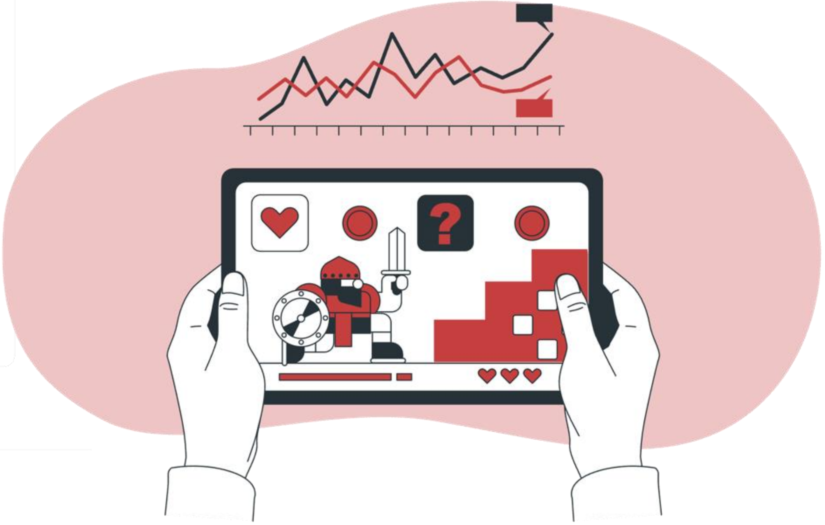
Activity: Choosing the Algorithm

Three Scenarios:



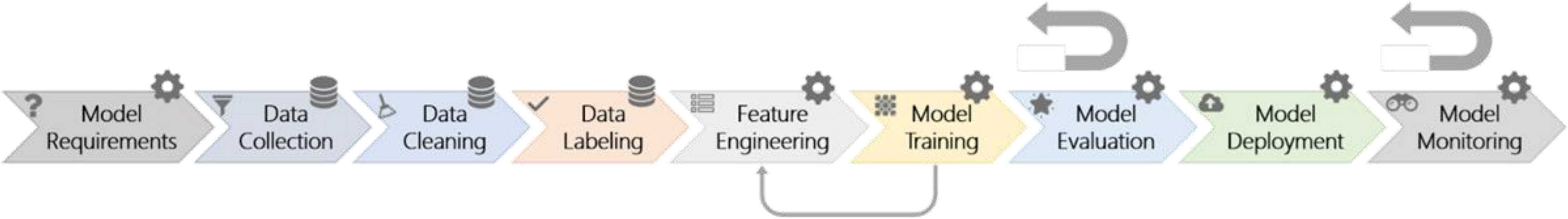
Scenario A: **Music Recommendation App**

Scenario B: **Analyzing Sales Data**



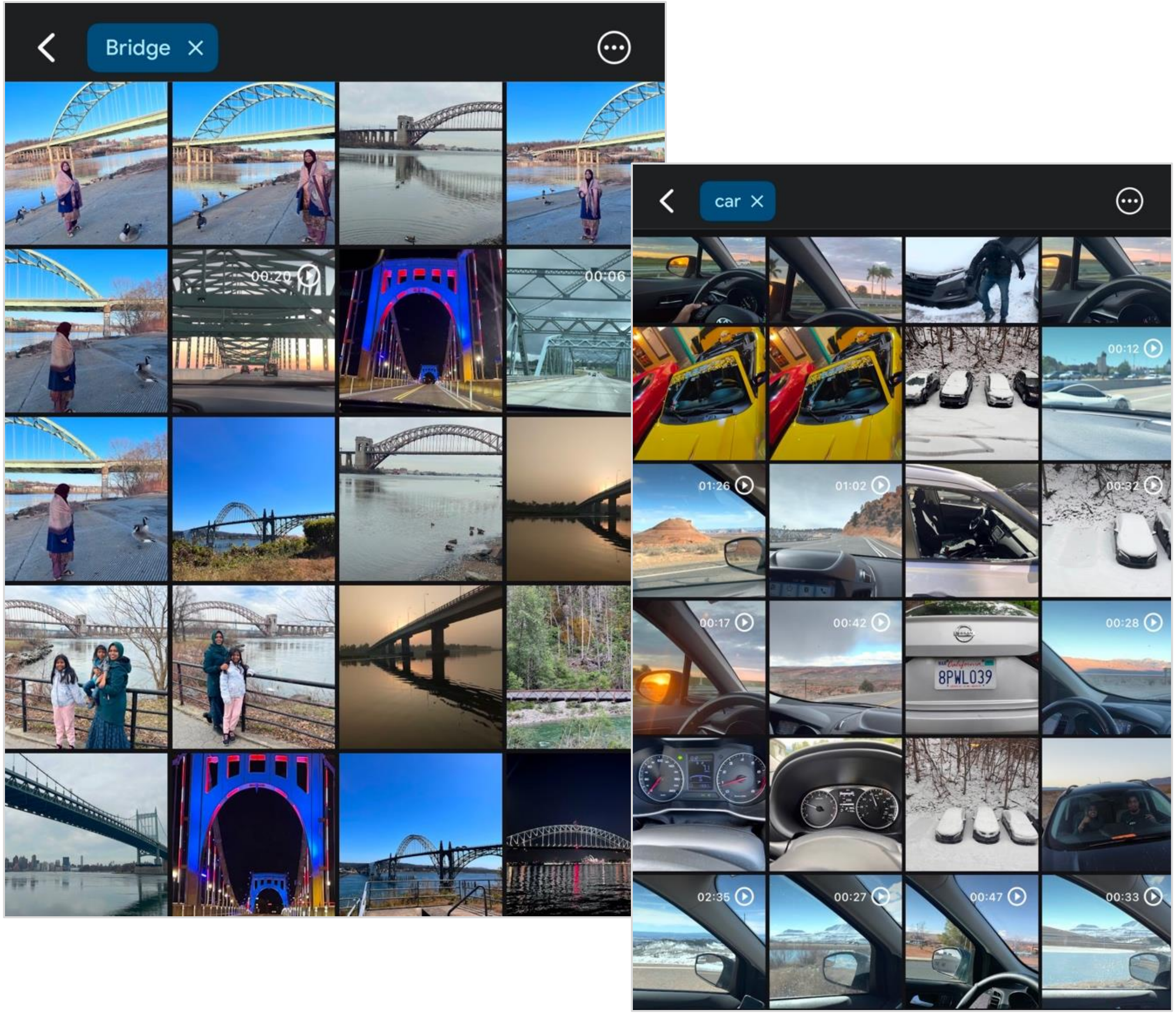
Scenario C: **Adaptive Game Difficulty**

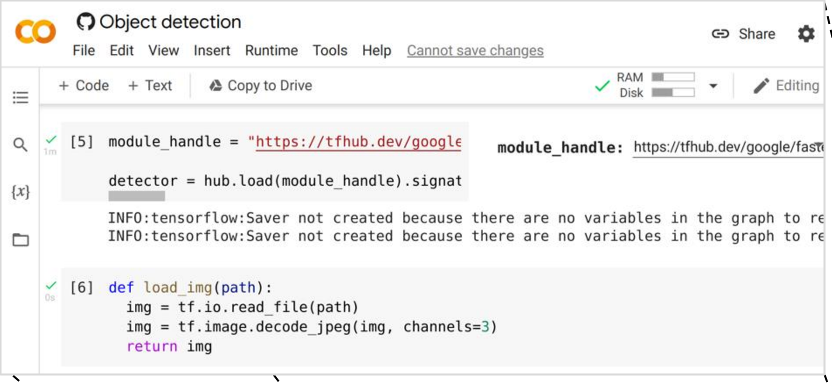
ML Development Process (ML Pipeline)



Source: “Software Engineering for Machine Learning: A Case Study” by Amershi et al. ICSE 2019

ML Model vs. **ML System**

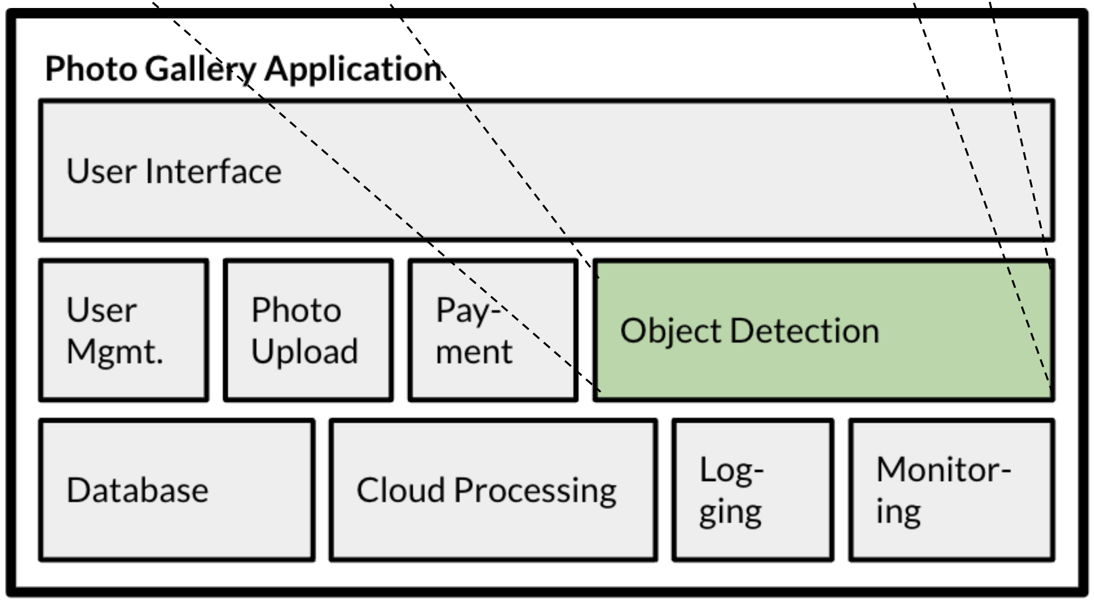




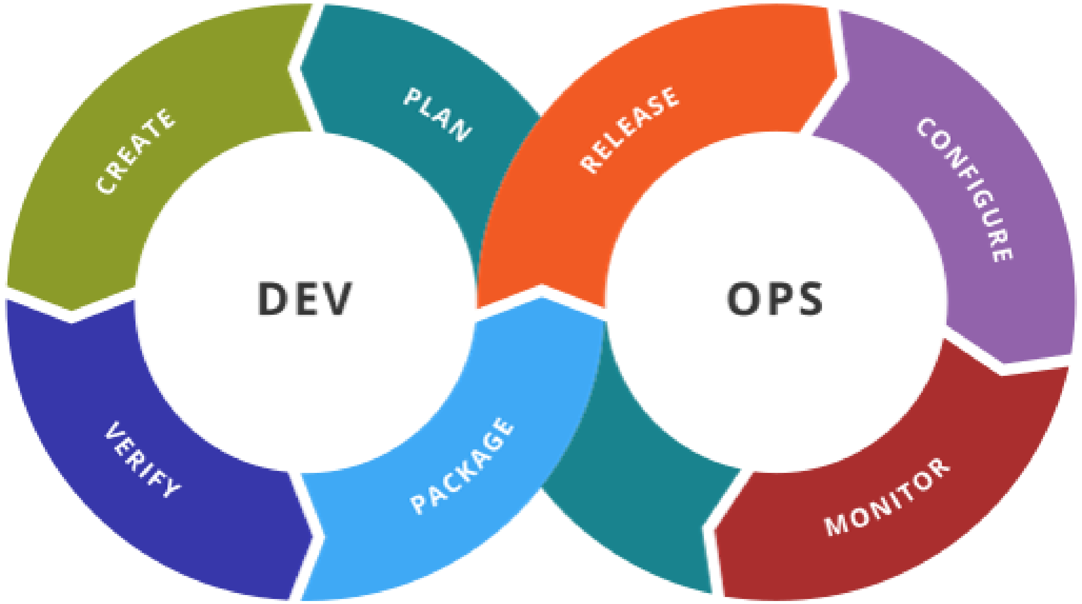
```
[5] module_handle = "https://tfhub.dev/google

    detector = hub.load(module_handle).signat

    INFO:tensorflow:Saver not created because there are no variables in the graph to re
    INFO:tensorflow:Saver not created because there are no variables in the graph to re
```

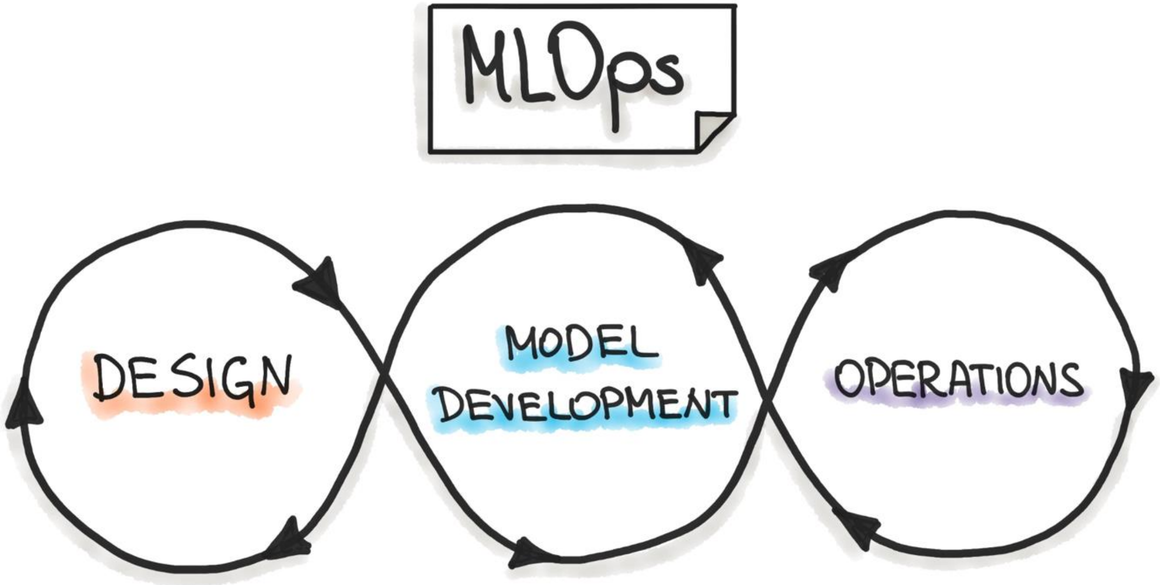
module_handle: https://tfhub.dev/google/fast

```
[6] def load_img(path):
      img = tf.io.read_file(path)
      img = tf.image.decode_jpeg(img, channels=3)
      return img
```



DevOps and MLOps

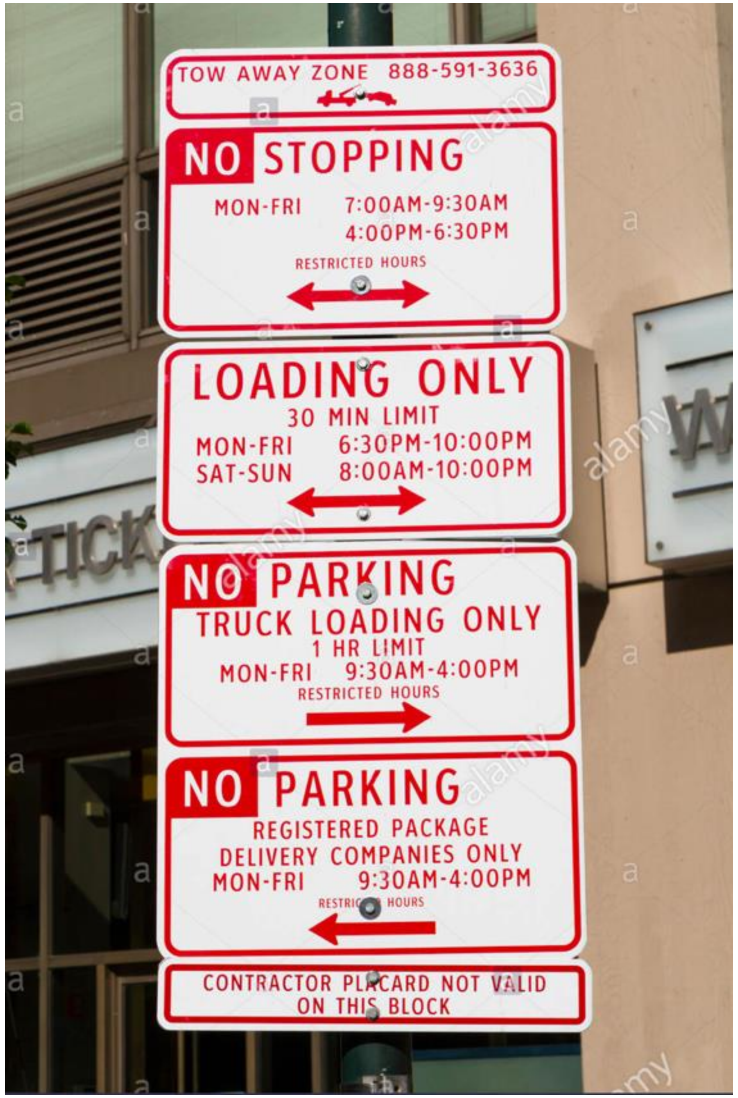


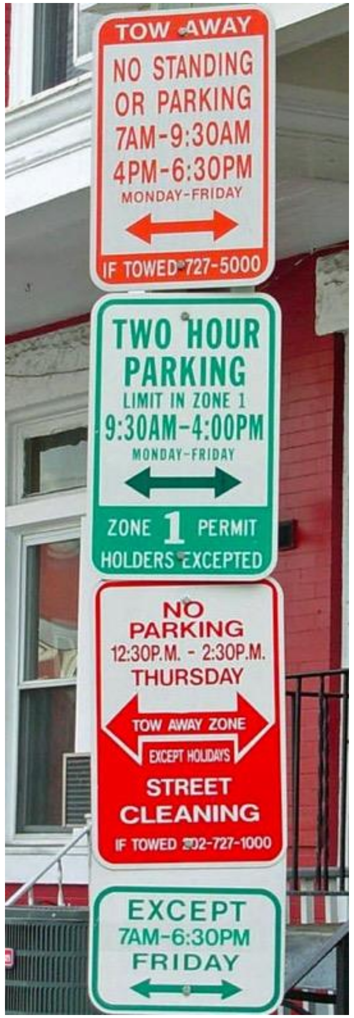


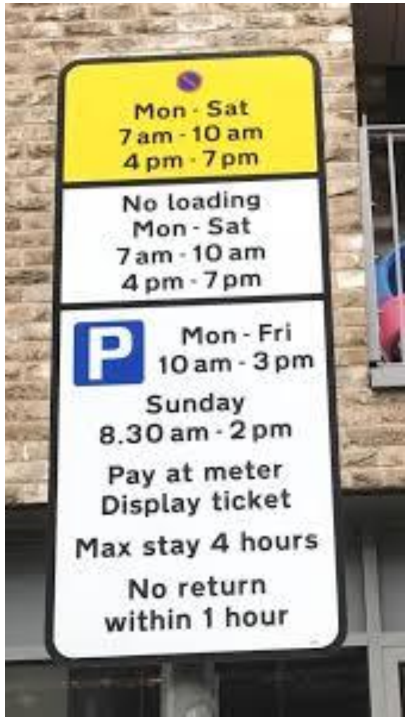
Set of practices for continuous delivery; relies on heavy automation, e.g., continuous delivery, monitoring

Automation around Machine Learning pipeline, including training, evaluation, versioning, and deployment

Think about MLOps as a specialized subset of DevOps for machine learning applications

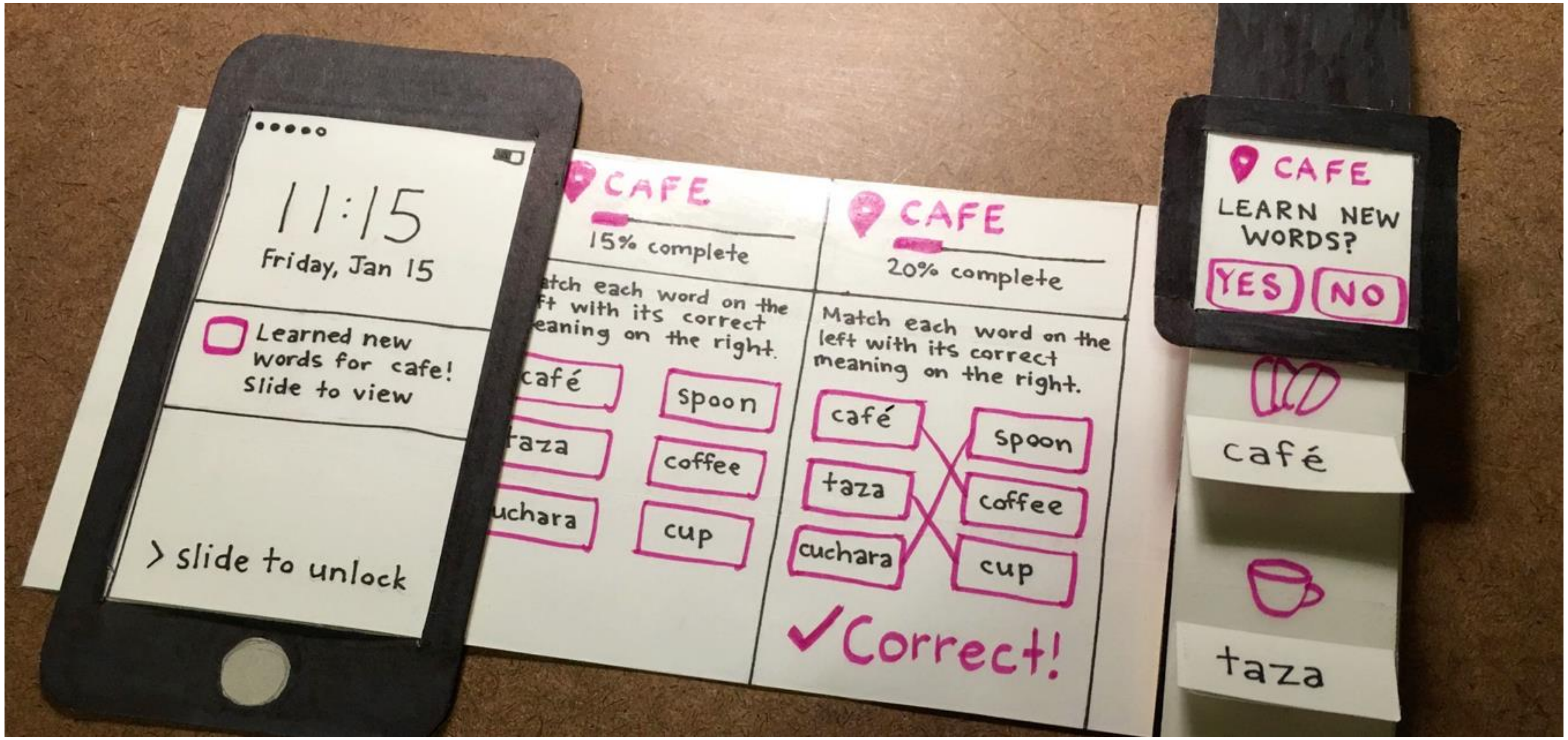

TOW AWAY ZONE 888-591-3636
NO STOPPING
MON-FRI 7:00AM-9:30AM
4:00PM-6:30PM
RESTRICTED HOURS
LOADING ONLY
30 MIN LIMIT
MON-FRI 6:30PM-10:00PM
SAT-SUN 8:00AM-10:00PM
NO PARKING
TRUCK LOADING ONLY
1 HR LIMIT
MON-FRI 9:30AM-4:00PM
RESTRICTED HOURS
NO PARKING
REGISTERED PACKAGE
DELIVERY COMPANIES ONLY
MON-FRI 9:30AM-4:00PM
RESTRICTED HOURS
CONTRACTOR PLACARD NOT VALID
ON THIS BLOCK


TOW AWAY
NO STANDING
OR PARKING
7AM-9:30AM
4PM-6:30PM
MONDAY-FRIDAY
IF TOWED 727-5000
TWO HOUR
PARKING
LIMIT IN ZONE 1
9:30AM-4:00PM
MONDAY-FRIDAY
ZONE 1 PERMIT
HOLDERS EXCEPTED
NO
PARKING
12:30P.M. - 2:30P.M.
THURSDAY
TOW AWAY ZONE
EXCEPT HOLIDAYS
STREET
CLEANING
IF TOWED 202-727-1000
EXCEPT
7AM-6:30PM
FRIDAY


Mon - Sat
7 am - 10 am
4 pm - 7 pm
No loading
Mon - Sat
7 am - 10 am
4 pm - 7 pm
P
Mon - Fri
10 am - 3 pm
Sunday
8.30 am - 2 pm
Pay at meter
Display ticket
Max stay 4 hours
No return
within 1 hour

LEFT
EXIT 70 C
279 NORTH
North Shore
EXIT ONLY
EXIT 70 B
OLD EXIT 6C
Ft Duquesne Blvd
Convention Ctr
Strip District
EXIT ONLY
EXIT 70 A
OLD EXIT 6B
Blvd of Allies
Liberty Ave
PPG Arena
376 EAST
Monroeville

Paper prototype


11:15
Friday, Jan 15
Learned new words for cafe! Slide to view
> slide to unlock
CAFE
15% complete
Match each word on the left with its correct meaning on the right.
café
taza
cuchara
spoon
coffee
cup
CAFE
20% complete
Match each word on the left with its correct meaning on the right.
café
taza
cuchara
spoon
coffee
cup
✓Correct!
CAFE
LEARN NEW WORDS?
YES
NO
café
taza

Project 4: Architecting an LLM Integration

Learning Goals

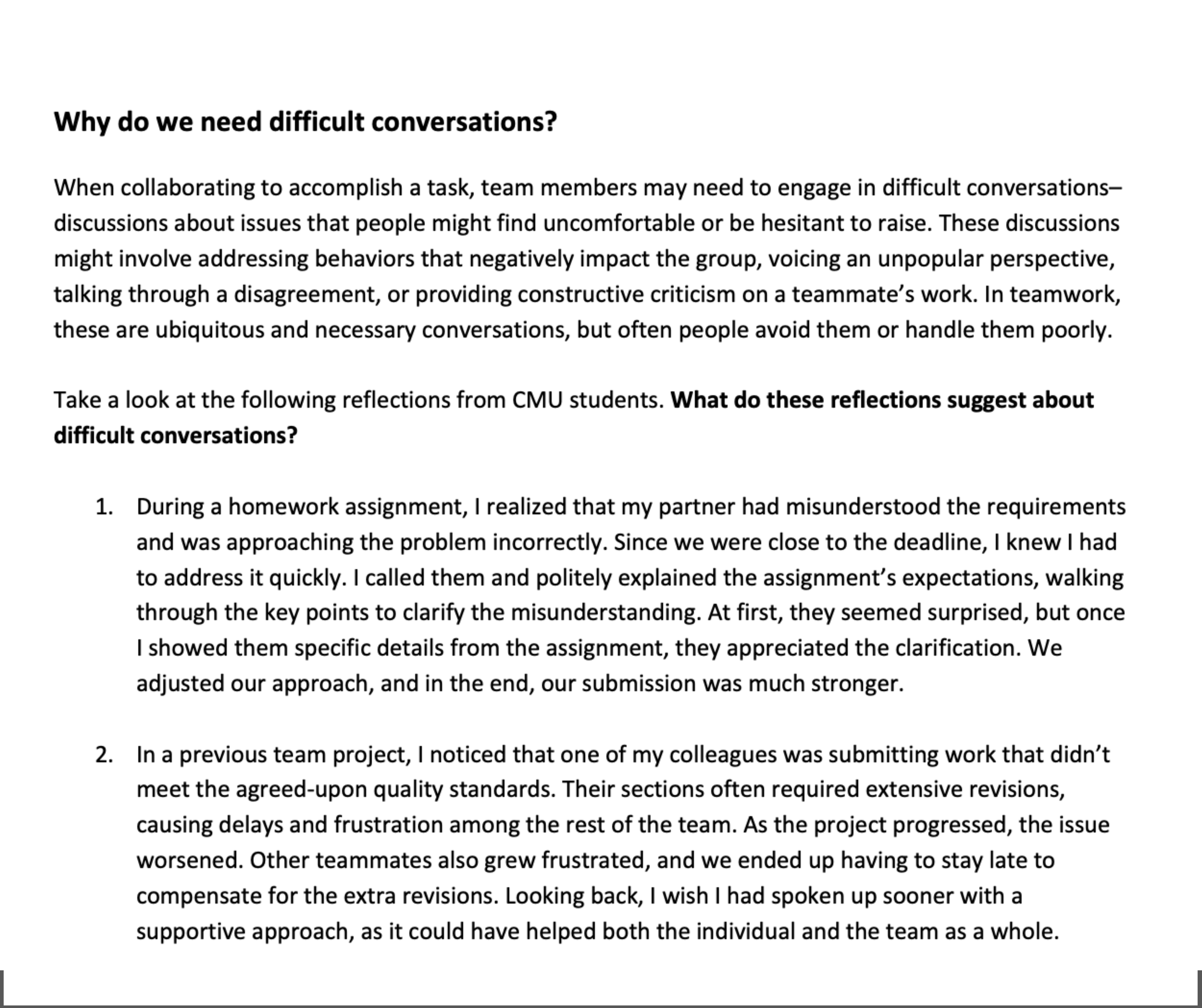
- Design a software architecture for a software system that incorporates a foundational large language model
- Decide the appropriate architecture for a given problem
- Address and describe the tradeoffs of different architectures
- Integrate pre-trained foundational large language models into an existing software system
- Evaluate the performance/quality of LLM powered features
- Design test suites that include unit, integration, and mock testing, to ensure robustness and reliability
- Engineer techniques to improve the performance of pre-trained models on application-specific tasks
- Decide whether an LLM powered solution is production ready

What is Human Flourishing?

According to Harvard's Human flourishing program: Human flourishing is composed of five central domains: **happiness and life satisfaction, mental and physical health, meaning and purpose, character and virtue, and close social relationships.**

Three questions to promote human flourishing

1. Does my software respect the **humanity** of the **users**?
2. Does my software **amplify positive** behavior, or **negative** behavior for users and society at large?
3. Will my software's **quality** impact the **humanity** of others?



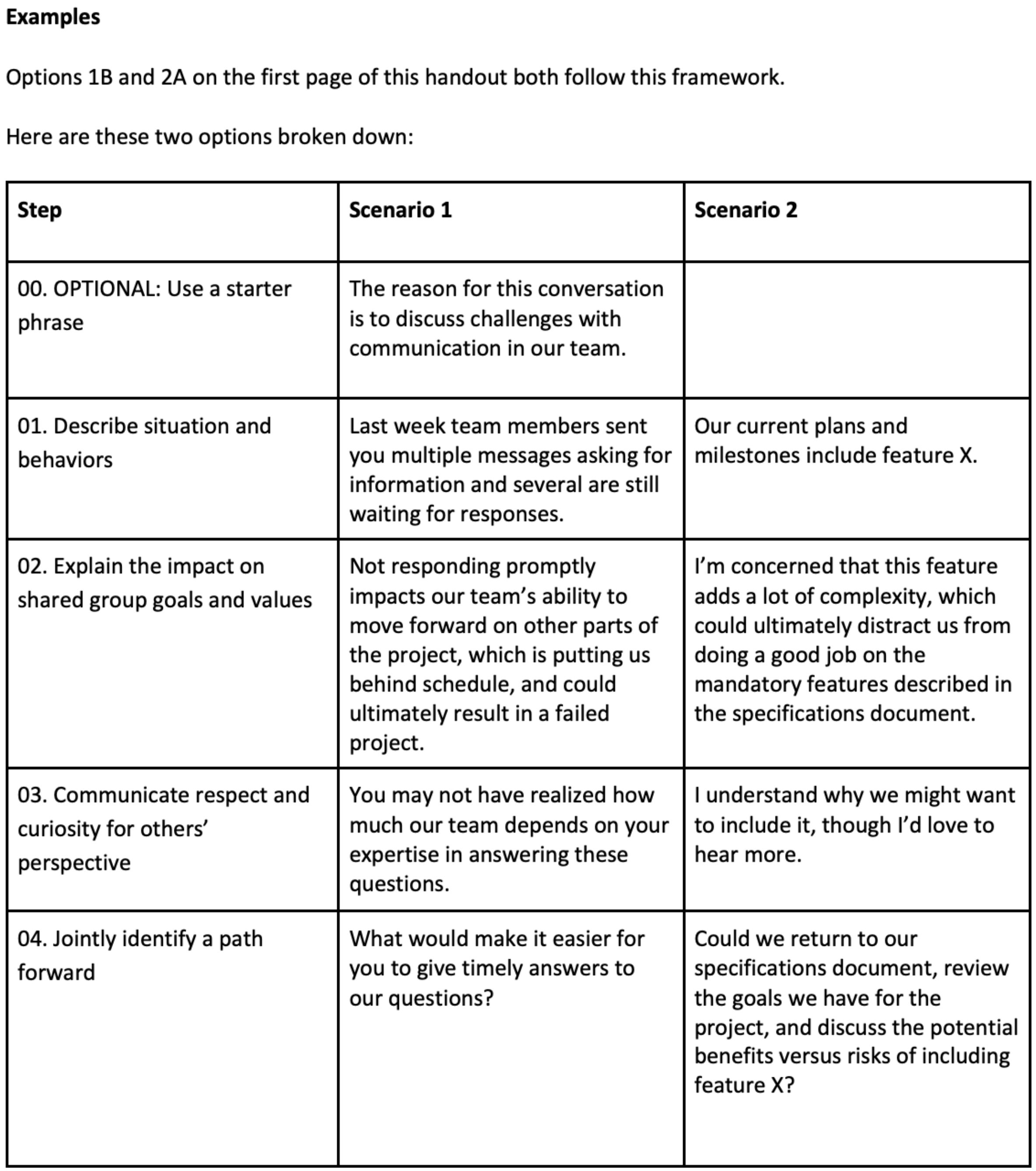
Why do we need difficult conversations?

When collaborating to accomplish a task, team members may need to engage in difficult conversations–discussions about issues that people might find uncomfortable or be hesitant to raise. These discussions might involve addressing behaviors that negatively impact the group, voicing an unpopular perspective, talking through a disagreement, or providing constructive criticism on a teammate's work. In teamwork, these are ubiquitous and necessary conversations, but often people avoid them or handle them poorly.

Take a look at the following reflections from CMU students. **What do these reflections suggest about difficult conversations?**

1. During a homework assignment, I realized that my partner had misunderstood the requirements and was approaching the problem incorrectly. Since we were close to the deadline, I knew I had to address it quickly. I called them and politely explained the assignment's expectations, walking through the key points to clarify the misunderstanding. At first, they seemed surprised, but once I showed them specific details from the assignment, they appreciated the clarification. We adjusted our approach, and in the end, our submission was much stronger.

2. In a previous team project, I noticed that one of my colleagues was submitting work that didn't meet the agreed-upon quality standards. Their sections often required extensive revisions, causing delays and frustration among the rest of the team. As the project progressed, the issue worsened. Other teammates also grew frustrated, and we ended up having to stay late to compensate for the extra revisions. Looking back, I wish I had spoken up sooner with a supportive approach, as it could have helped both the individual and the team as a whole.



Examples

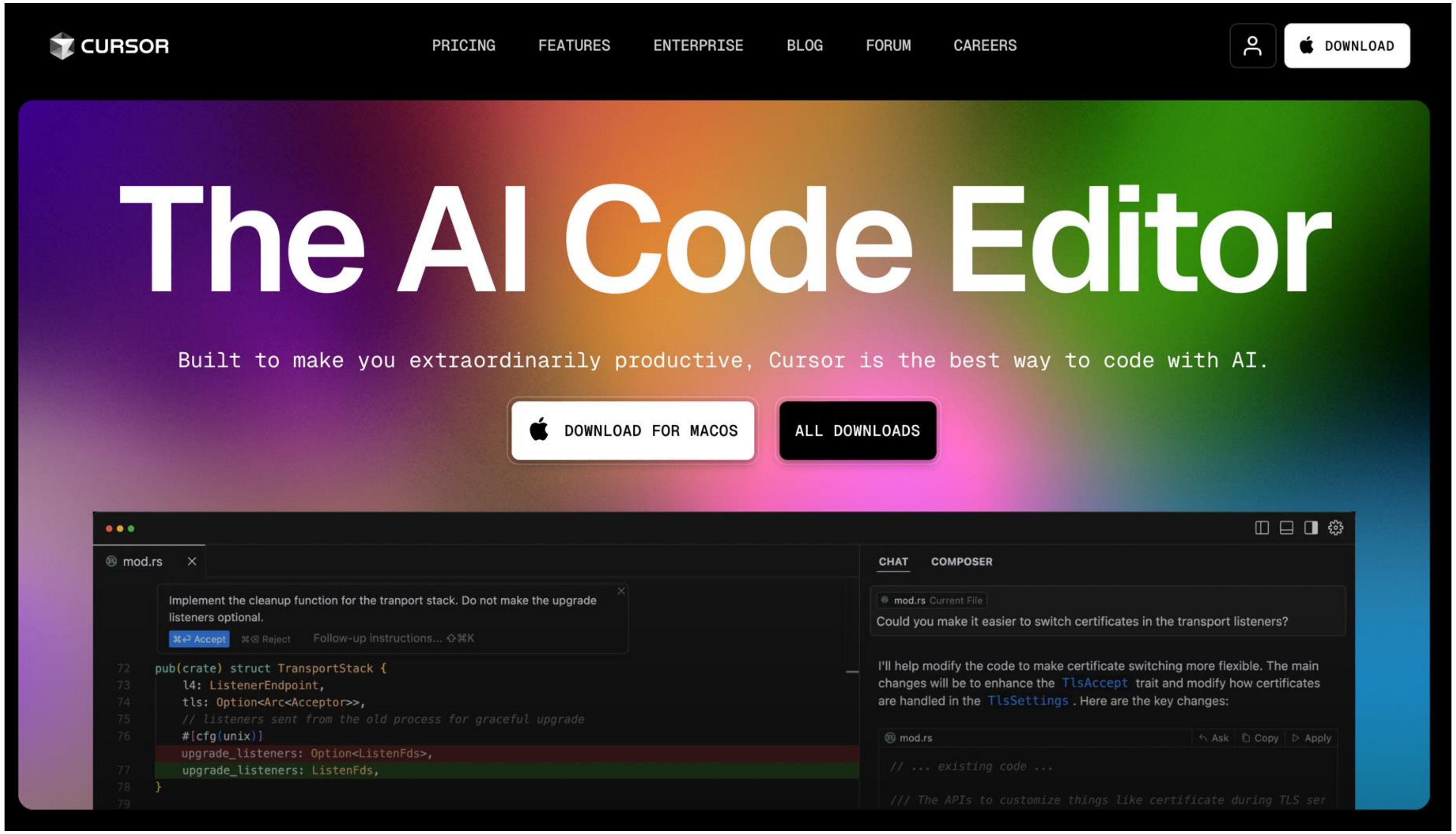
Options 1B and 2A on the first page of this handout both follow this framework.

Here are these two options broken down:

Step	**Scenario 1**	**Scenario 2**
00. OPTIONAL: Use a starter phrase	The reason for this conversation is to discuss challenges with communication in our team.	
01. Describe situation and behaviors	Last week team members sent you multiple messages asking for information and several are still waiting for responses.	Our current plans and milestones include feature X.
02. Explain the impact on shared group goals and values	Not responding promptly impacts our team's ability to move forward on other parts of the project, which is putting us behind schedule, and could ultimately result in a failed project.	I'm concerned that this feature adds a lot of complexity, which could ultimately distract us from doing a good job on the mandatory features described in the specifications document.
03. Communicate respect and curiosity for others' perspective	You may not have realized how much our team depends on your expertise in answering these questions.	I understand why we might want to include it, though I'd love to hear more.
04. Jointly identify a path forward	What would make it easier for you to give timely answers to our questions?	Could we return to our specifications document, review the goals we have for the project, and discuss the potential benefits versus risks of including feature X?

How are you using AI for coding?

Let’s try Cursor: https://www.cursor.com



The AI Code Editor

Built to make you extraordinarily productive, Cursor is the best way to code with AI.

Implement the cleanup function for the tranport stack. Do not make the upgrade listeners optional.

```
pub(crate) struct TransportStack {
    l4: ListenerEndpoint,
    tls: Option<Arc<Acceptor>>,
    // listeners sent from the old process for graceful upgrade
    #[cfg(unix)]
    upgrade_listeners: Option<ListenFds>,
    upgrade_listeners: ListenFds,
}
```

Could you make it easier to switch certificates in the transport listeners?

I'll help modify the code to make certificate switching more flexible. The main changes will be to enhance the `TlsAccept` trait and modify how certificates are handled in the `TlsSettings` . Here are the key changes:

```
// ... existing code ...

/// The APIs to customize things like certificate during TLS ser
```

Reliably Releasing Software

Foundations of Software Engineering

Christopher S. Meiklejohn

Software Engineer, DoorDash

Adjunct Faculty, Carnegie Mellon University

Carnegie Mellon University

Goals

Identify the core challenges with modifying, testing, and deploying applications **safely.**

Describe and **differentiate** the possible techniques for ensuring **reliable** and **safe delivery of software at scale.**

Practice authoring a **safe rollout plan** for a new feature.

Dark Launch

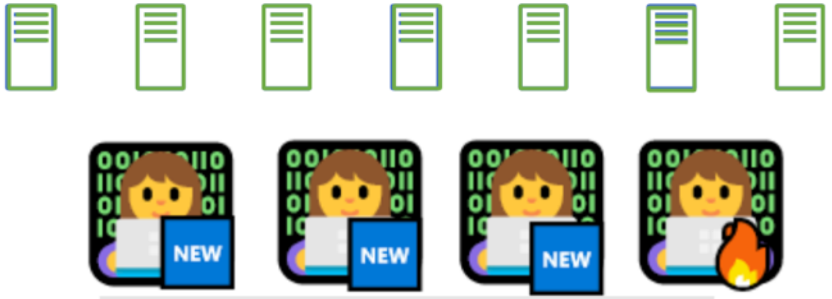
Solution: **Dark Launch**

Rollout with Features Dark
Perform rollout of code at the "same" existing version with all new features turned "off" – no-op rollout.

Incremental Ramp of Flag
Incrementally enable feature to users based on percentage and roll out to employee (or other limited cohort first) for early detection *(i.e., dogfooding.)*

Rollback: First Response
Ensure that code can be rolled back immediately on the first indication of issue.

Rolling Upgrade with Dark Feature



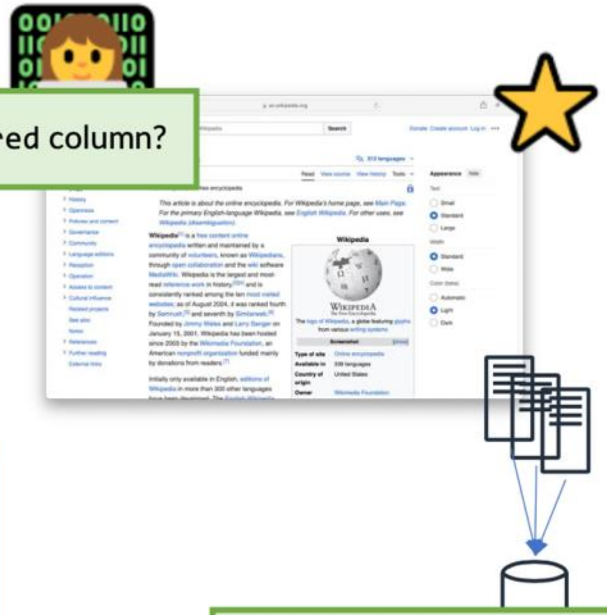
Incremental Feature Release

Remember to write tests with the feature flag = **false and true prior to rollout!**

Databases: What's Hard About This?

We have one database schema, **how do we change it?**
(recall: we have to add a new field called `starred`)

What type is the `starred` column?



No Rolling Upgrades

Can't synchronize rolling upgrade between app + database, no rolling upgrade for DB, even schema changes in distributed databases are atomic across nodes.

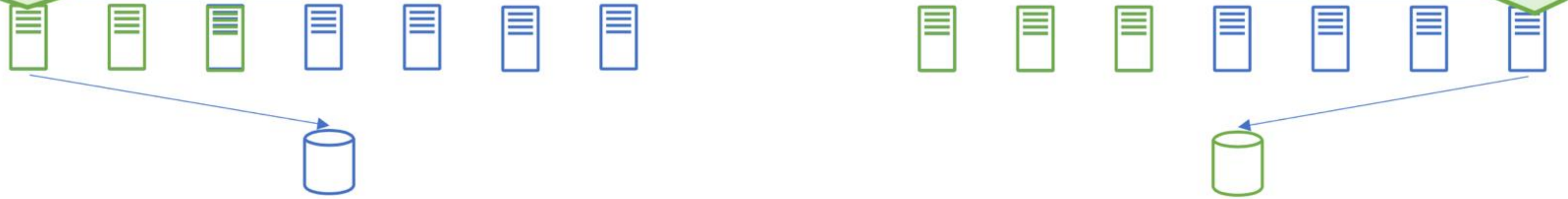
In short: changes are **atomic.**

What type of problems does a **rolling upgrade of our app code** introduce if our DB change takes effect immediately?

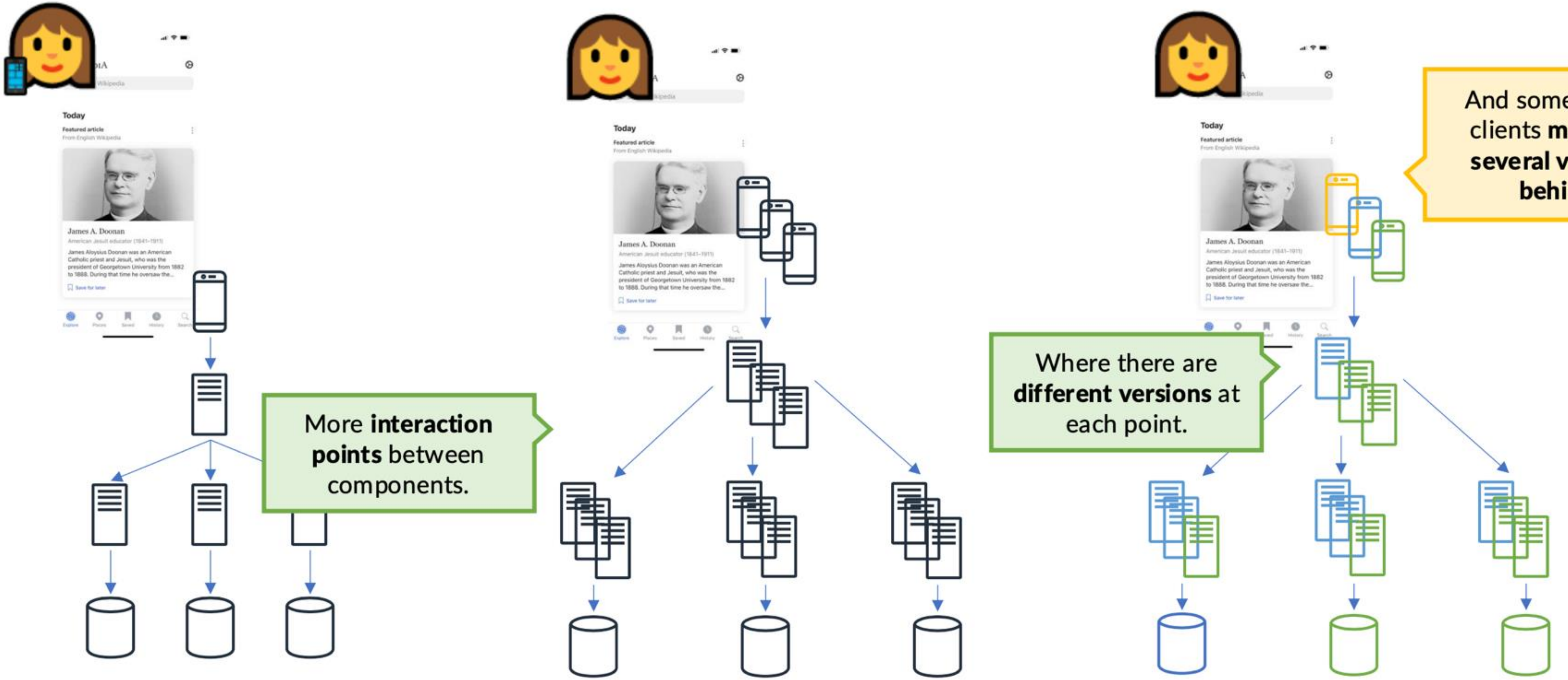
Problems During Rolling Upgrade/Release

New version might be **incompatible with old DB**
(i.e., access starred before there.)

Old version might be **incompatible with new DB version.**
What scenarios might this be?



Revisiting: Wikipedia



James A. Doonan

American Jesuit educator (1841–1911)

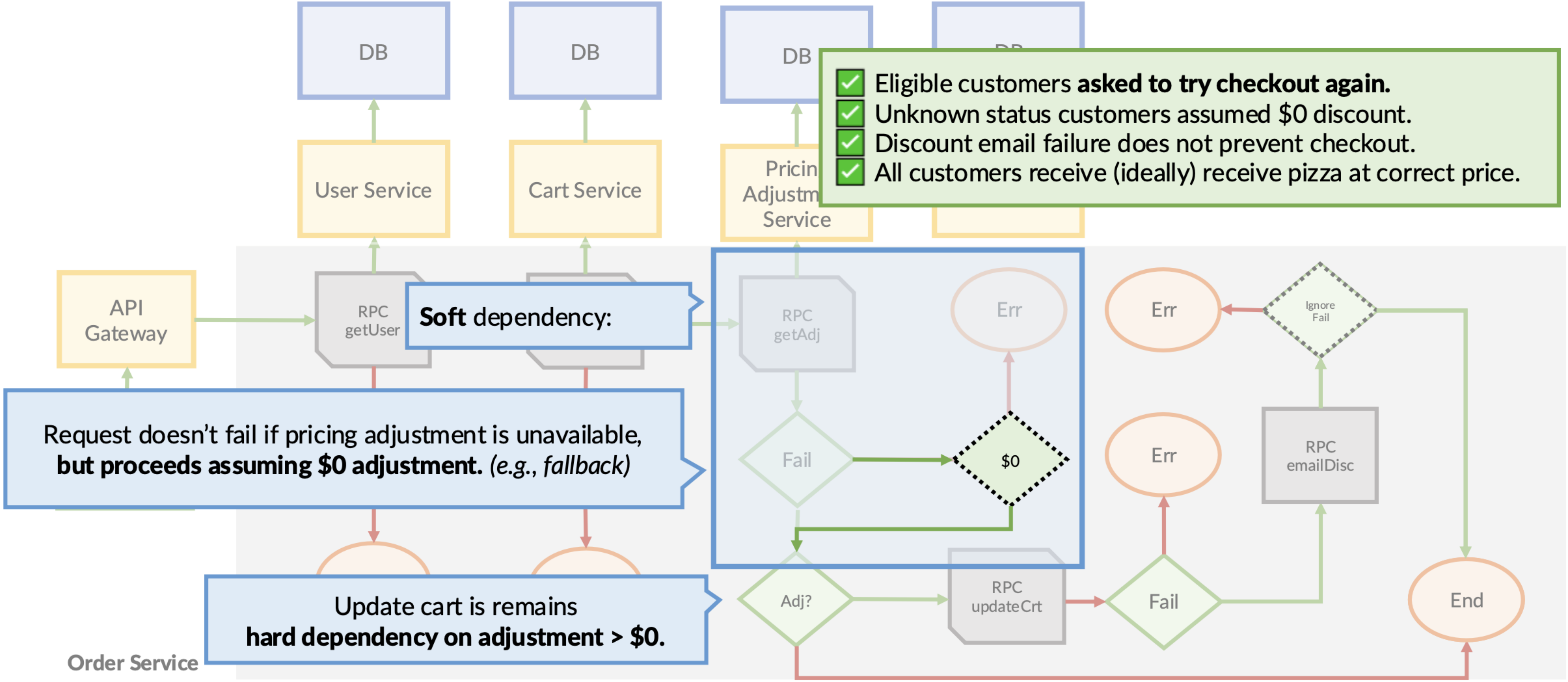
James Aloysius Doonan was an American Catholic priest and Jesuit, who was the president of Georgetown University from 1882 to 1888. During that time he oversaw the...

More **interaction points** between components.

Where there are **different versions** at each point.

And some mobile clients **might lag several versions behind.**

Purchase: Soft Dependencies with Fallbacks

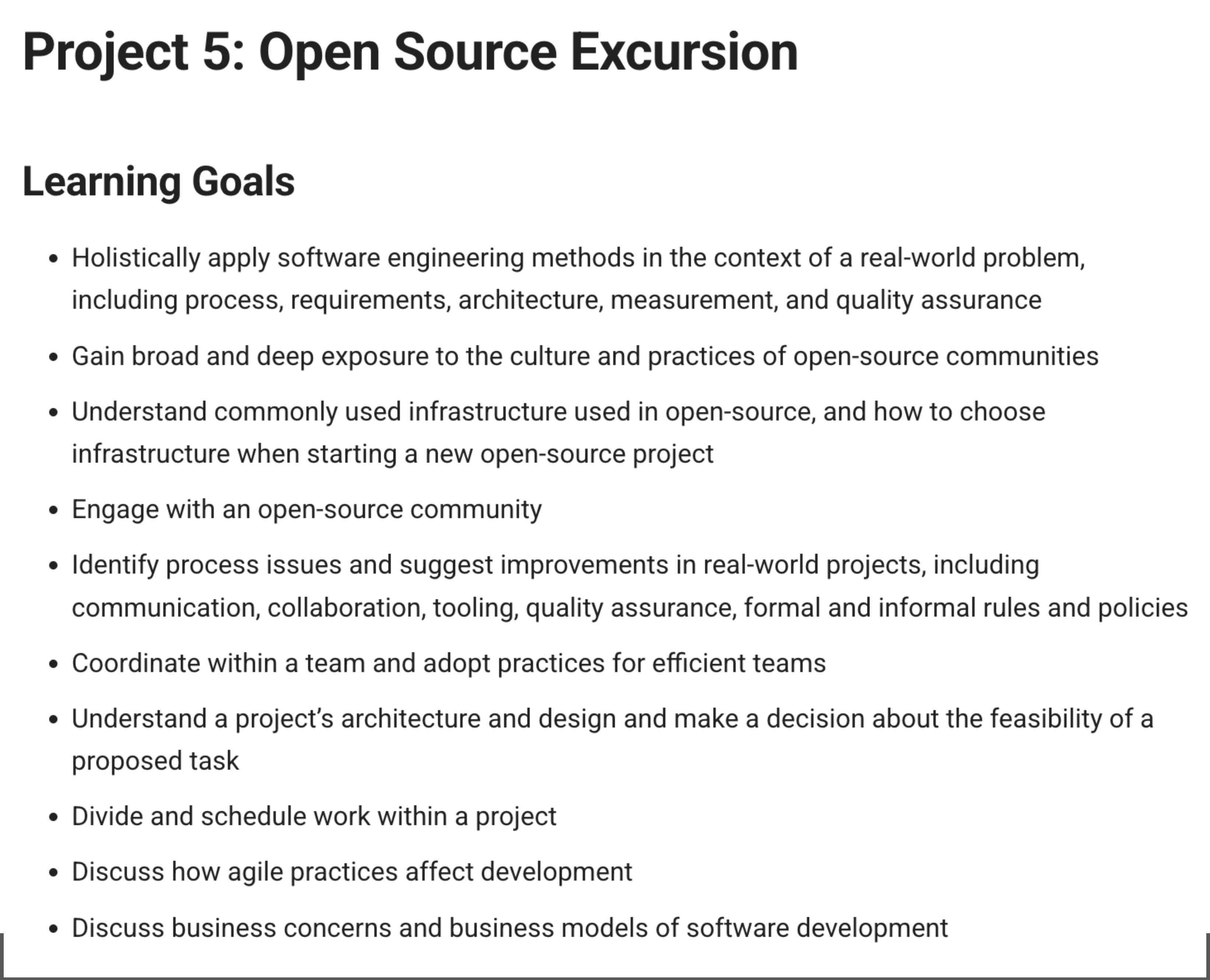


☑ Eligible customers **asked to try checkout again.**
☑ Unknown status customers assumed $0 discount.
☑ Discount email failure does not prevent checkout.
☑ All customers receive (ideally) receive pizza at correct price.

Soft dependency:

Request doesn't fail if pricing adjustment is unavailable, **but proceeds assuming $0 adjustment.** *(e.g., fallback)*

Update cart is remains **hard dependency on adjustment > $0.**

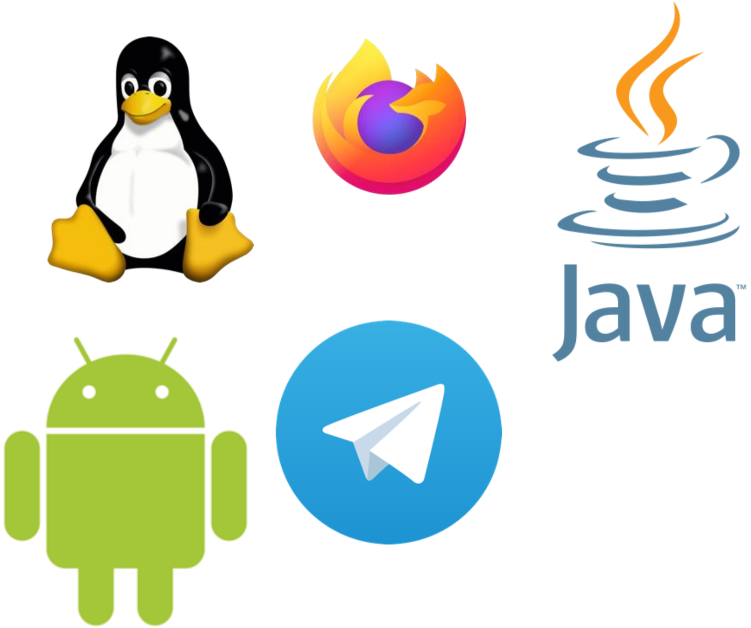


Project 5: Open Source Excursion

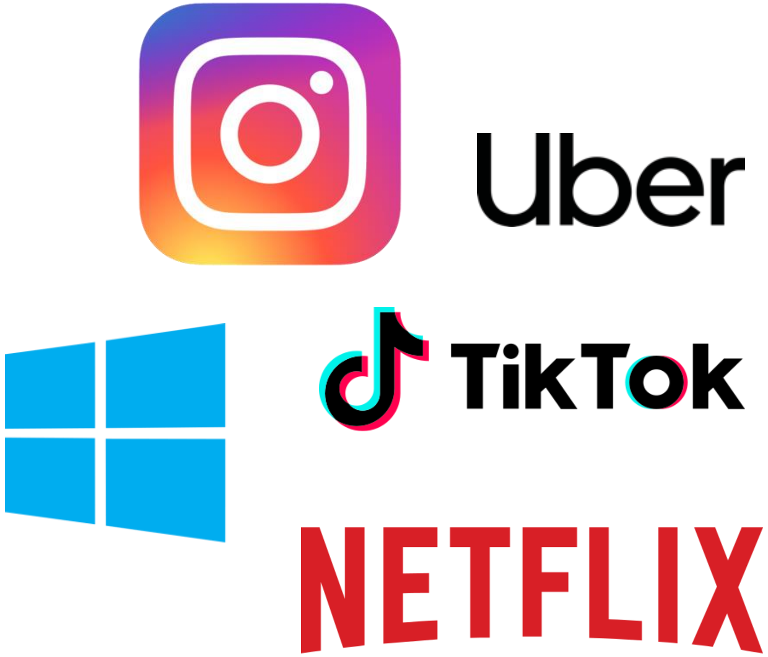
Learning Goals

- Holistically apply software engineering methods in the context of a real-world problem, including process, requirements, architecture, measurement, and quality assurance
- Gain broad and deep exposure to the culture and practices of open-source communities
- Understand commonly used infrastructure used in open-source, and how to choose infrastructure when starting a new open-source project
- Engage with an open-source community
- Identify process issues and suggest improvements in real-world projects, including communication, collaboration, tooling, quality assurance, formal and informal rules and policies
- Coordinate within a team and adopt practices for efficient teams
- Understand a project's architecture and design and make a decision about the feasibility of a proposed task
- Divide and schedule work within a project
- Discuss how agile practices affect development
- Discuss business concerns and business models of software development

Open-source



Proprietary



Free software as a Philosophy

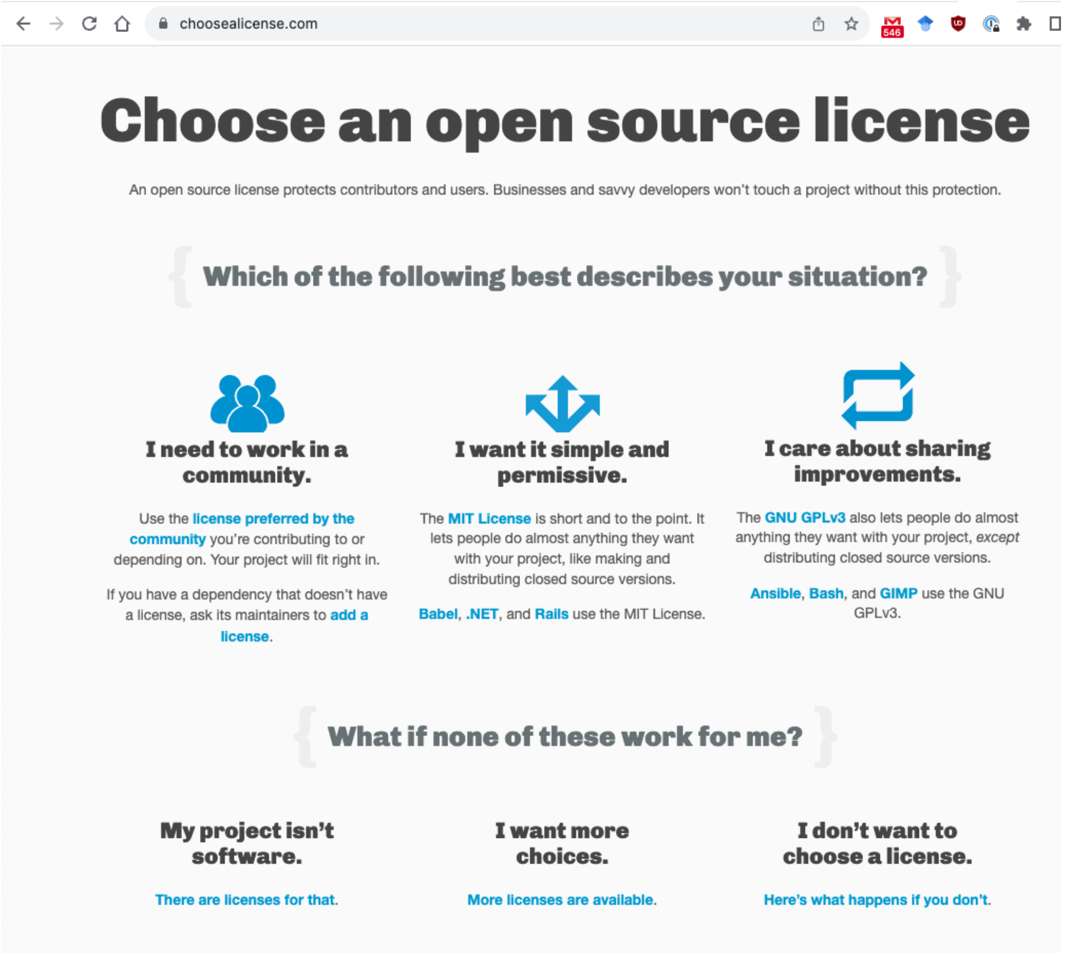
- "Free as in Speech, not as in beer"

Richard Stallman's Free Software Foundation — free as in liberties

  - Freedom 0: *run code as you wish, for any purpose*
  - Freedom 1: *study how code works, and change it as you wish*
  - Freedom 2: *redistributed copies (of original) so you can help others*
  - Freedom 3: *distribute copies of your modified version to others*

Richard M Stallman (Licensed under GFDL)

Which license to choose?



Choose an open source license

An open source license protects contributors and users. Businesses and savvy developers won't touch a project without this protection.

{ Which of the following best describes your situation? }

I need to work in a community.

Use the license preferred by the community you're contributing to or depending on. Your project will fit right in.

If you have a dependency that doesn't have a license, ask its maintainers to add a license.

I want it simple and permissive.

The MIT License is short and to the point. It lets people do almost anything they want with your project, like making and distributing closed source versions.

Babel, .NET, and Rails use the MIT License.

I care about sharing improvements.

The GNU GPLv3 also lets people do almost anything they want with your project, *except* distributing closed source versions.

Ansible, Bash, and GIMP use the GNU GPLv3.

{ What if none of these work for me? }

My project isn't software.

There are licenses for that.

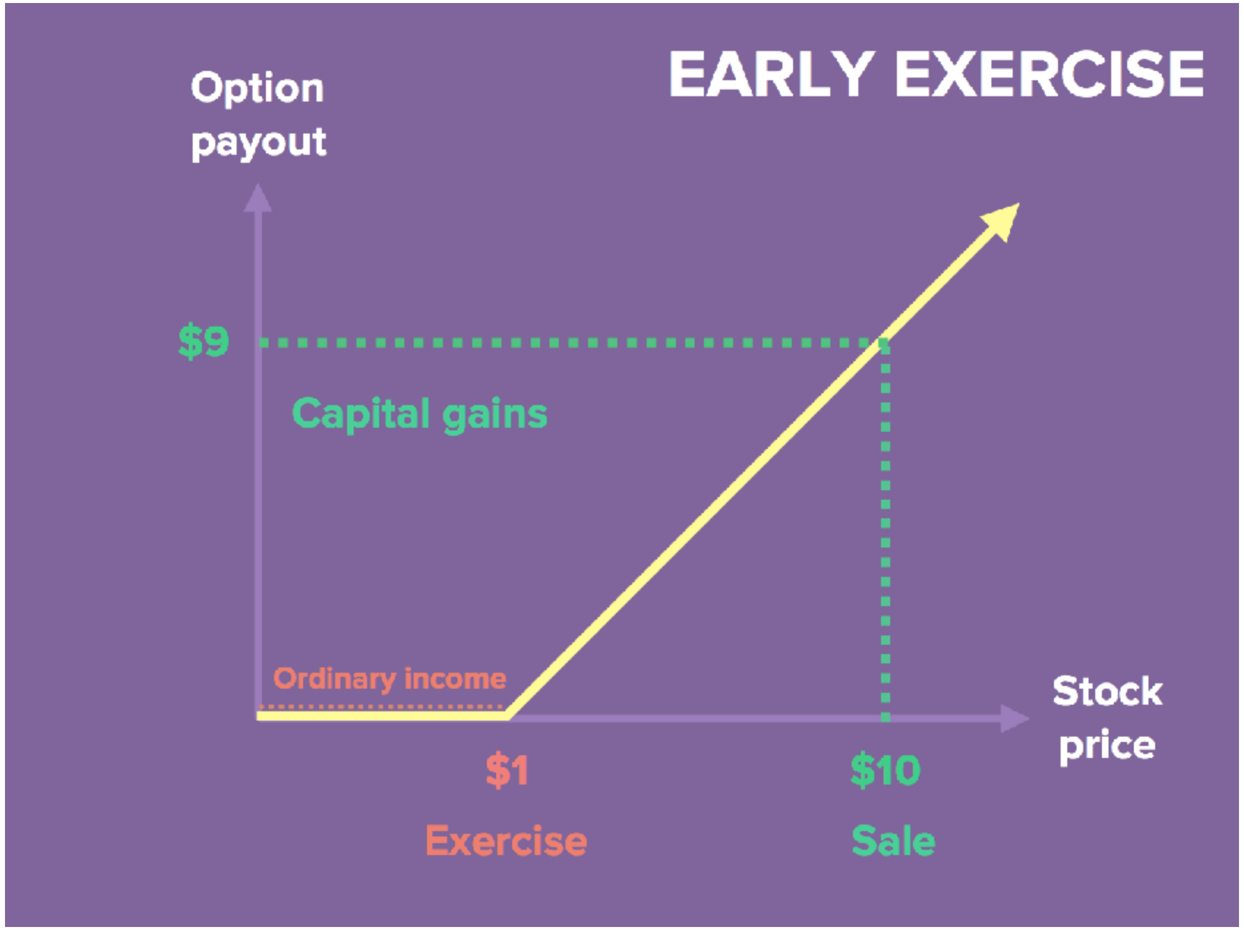
I want more choices.

More licenses are available.

I don't want to choose a license.

Here's what happens if you don't.

Holding periods in Kerri’s example



Risky because:

There is no guarantee that your stock will ever be liquid, so you are paying to buy stock that could one day be worthless.

AMA

Ask the professors any question you want

That's all Folks!