Software Archaeology and Anthropology

17-313 Fall 2023

Foundations of Software Engineering

https://cmu-313.github.io

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Administrivia

- Slack
  - Please add a profile picture.
  - Ask questions in #general or #technical-questions. Please use threads.
- Office hours can be found on the course home page: http://cmu-313.github.io
- For those of you who requested to swap recitations, stay tuned.
- COVID or other health issues? Please stay home.

Smoking Section

- Last full row

Homework

- Homework 1 is released.
  - Part (a) is due Friday Sept 1, 11:59 pm. That's tomorrow!
  - Part (b) is due Thursday, Sept 7, 11:59pm.
  - This is an individual assignment; we will compose groups next week.
  - Get started early, ask for help, and check the #technical-questions channel; chances are your questions have been asked by others!

Team Formation Survey Due Friday

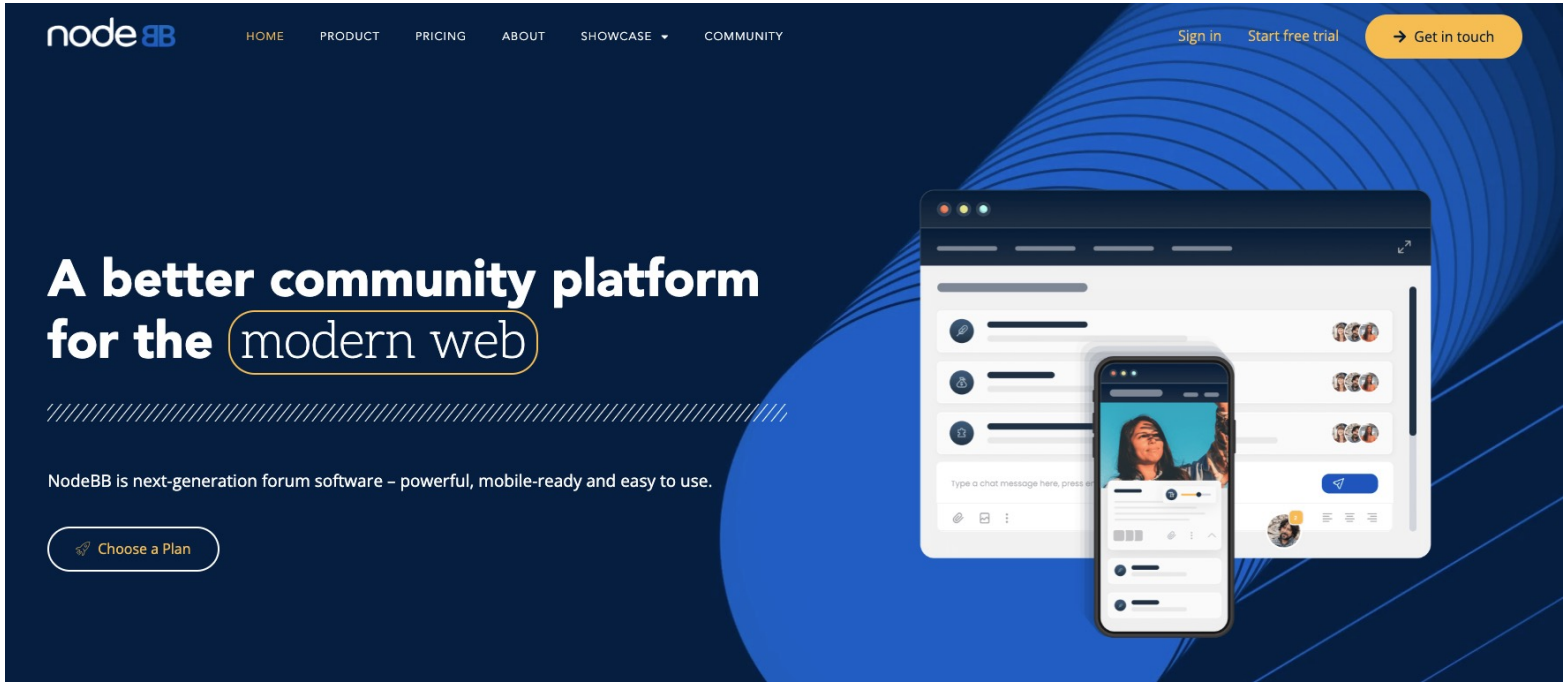
- Team formation survey is posted on Canvas and in Slack #announcements.
- Please fill in by TONIGHT!

Learning Goals

- Understand and scope the task of taking on and understanding a new and complex piece of existing software
- Appreciate the importance of configuring an effective IDE
- Contrast different types of code execution environments including local, remote, application, and libraries
- Enumerate both static and dynamic strategies for understanding and modifying a new codebase

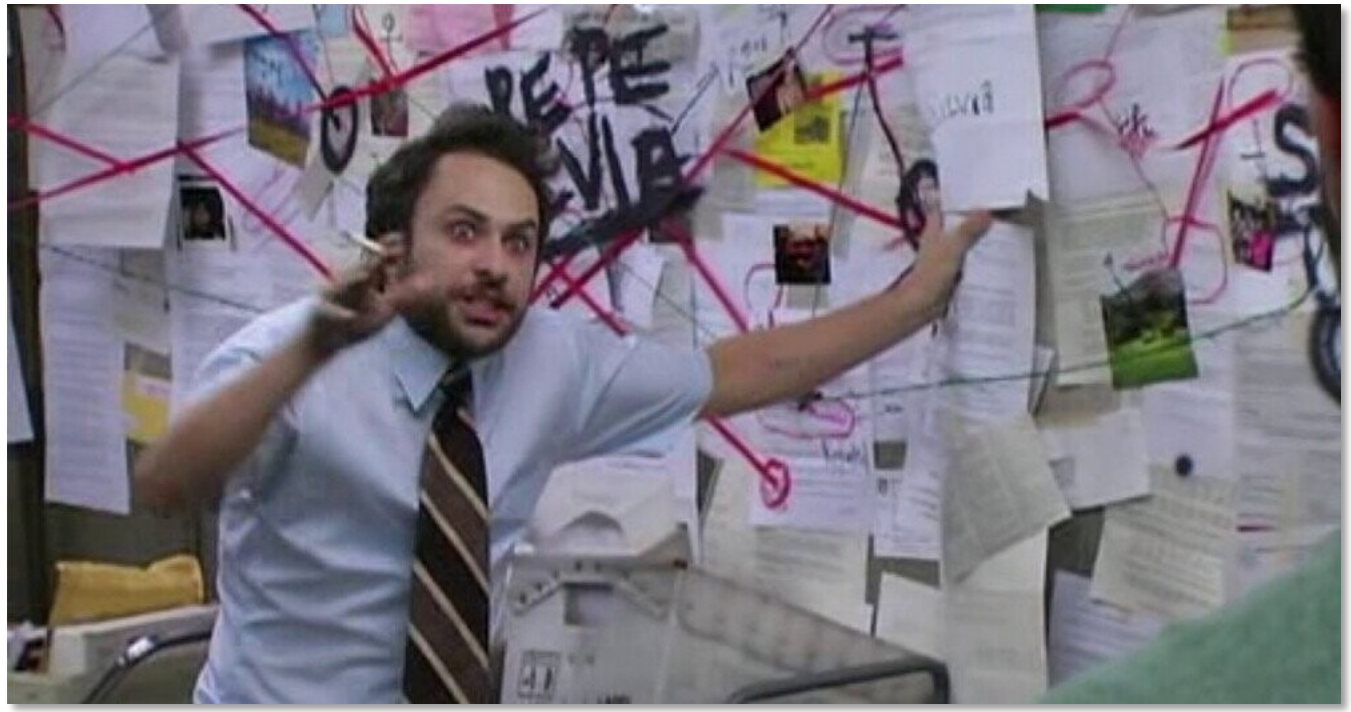
Context: big ole pile of code

- … do something with it!



You will never understand the entire system!

Challenge: How do I tackle this codebase?

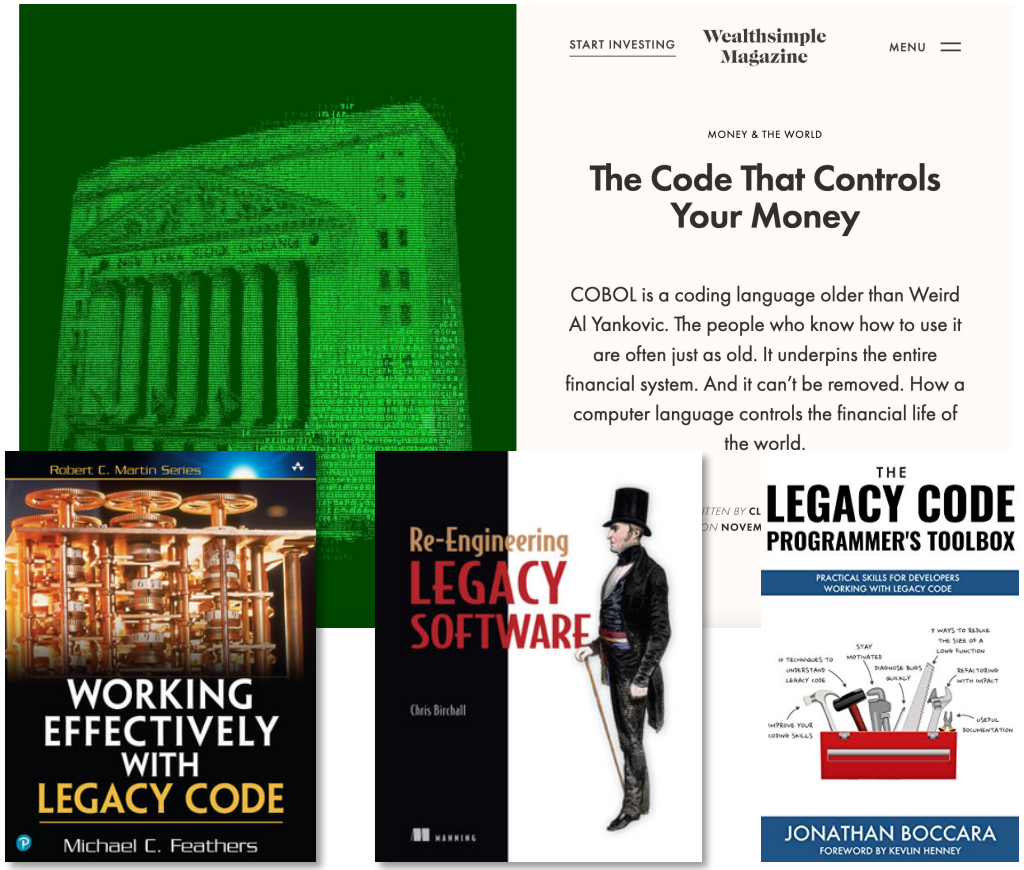


Challenge: How do I tackle this codebase?

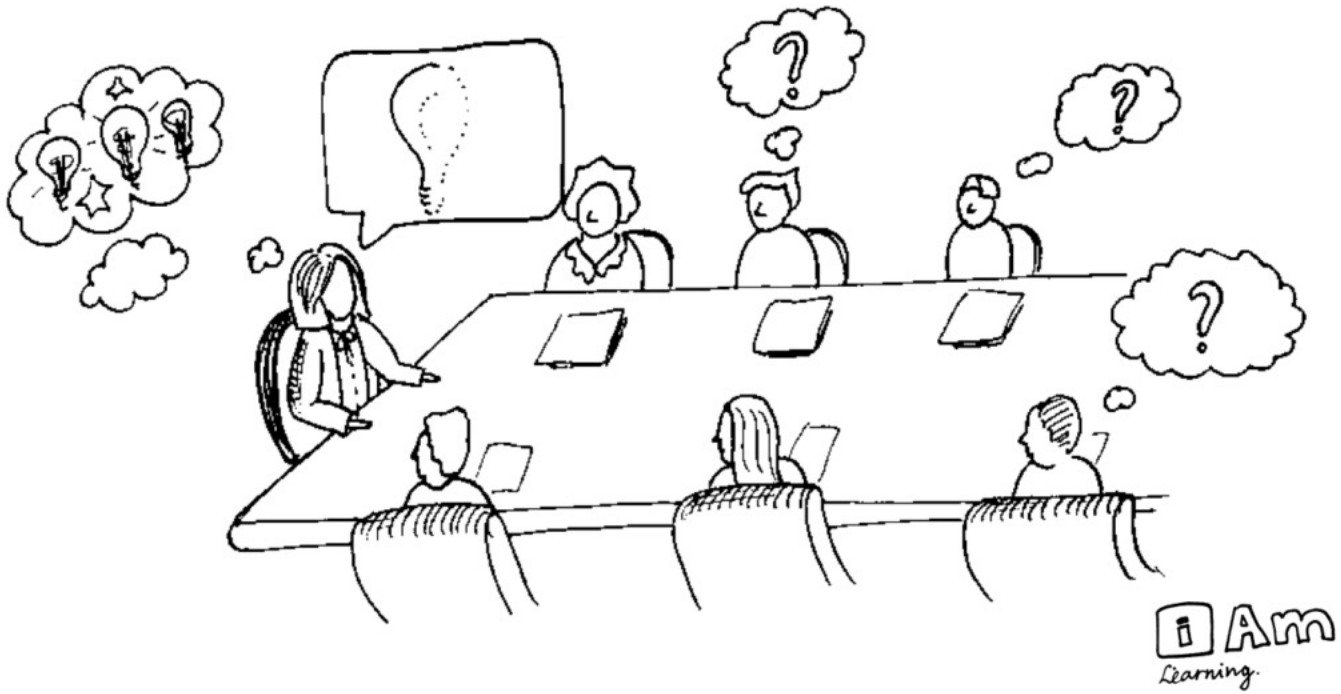
- Leverage your previous experiences (languages, technologies, patterns)
- Consult documentation, whitepapers
- Talk to experts, code owners
- Follow best practices to build a working model of the system

Bad news: There are few helpful resources!

- **Working Effectively with Legacy Code.**
  Michael C. Feathers. 2004.
- **Re-Engineering Legacy Software.**
  Chris Birchall. 2016.
- **The Legacy Code Programmer's Toolbox.**
  Jonathan Boccara. 2019.

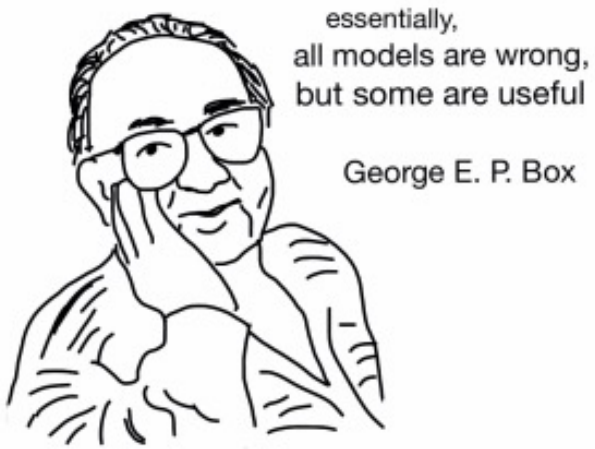


Why? Because of Tacit Knowledge

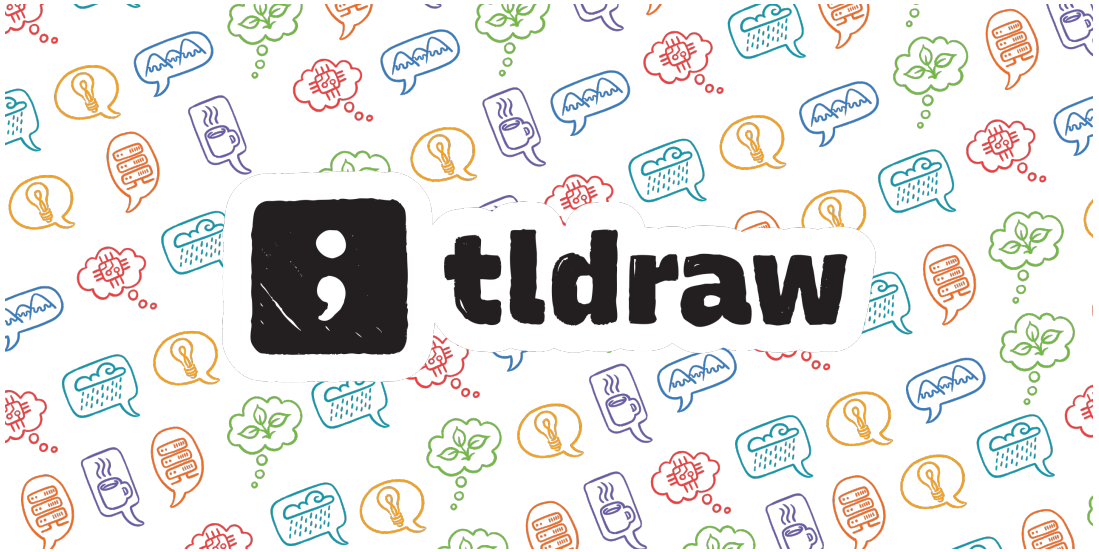


Today: How to tackle codebases

- Goal: develop and test a working model or set of working hypotheses about how (some part of) a system works
- Working model: an understanding of the pieces of the system (components), and the way they interact (connections)
- Focus: Observation, probes, and hypothesis testing
  - Helpful tools and techniques!



Live Demonstration: tldraw



https://github.com/tldraw/tldraw

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?
  - Clone and own
- Traceability - Attach a debugger
  - View Source
  - Find the logs.
  - Search for constants (strings, colors, weird integers (#DEADBEEF))

Participation Activities

- Pull out your phone.
- Download the Gradescope app.
- Log into Gradescope.
  - Use email login, not SSO.
- Click “+” button to add 17-313.
  - Entry Code: G24487

Download Gradescope for iPhone

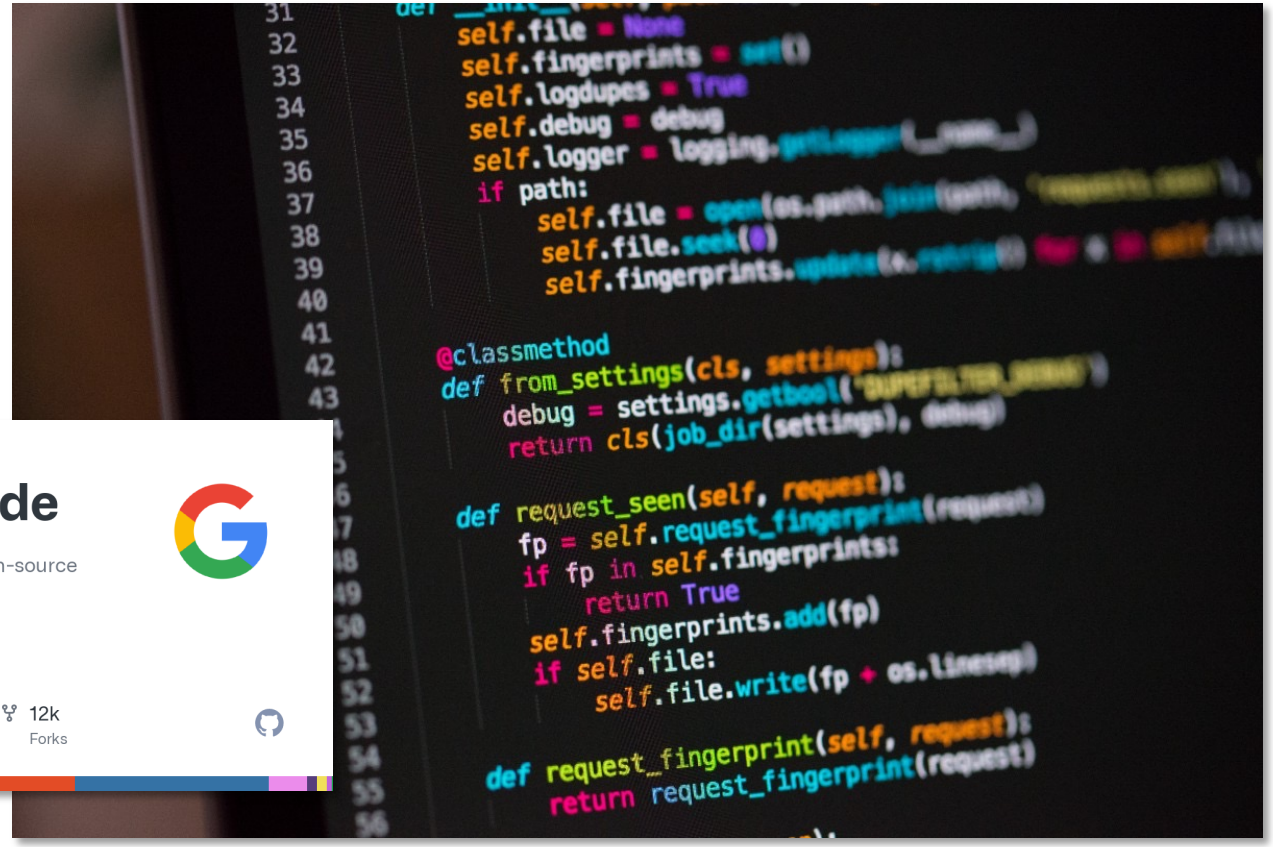
Download Gradescope for Android

Participation Activity

- Take out a piece of paper.
- Write down one pro and one con about trying to understand a new codebase by compiling and building it vs. just reading the code.
- Pair with your neighbor and discuss your answers. Do you agree?
- Share with the class!
- Submit it on Gradescope by the end of class.
  - Under Not Submitted (Assignments), click on August 31 Activity.
  - Take a picture of your paper.
  - Assign the picture to Question 1.
  - Submit.

Observation: Software is full of patterns

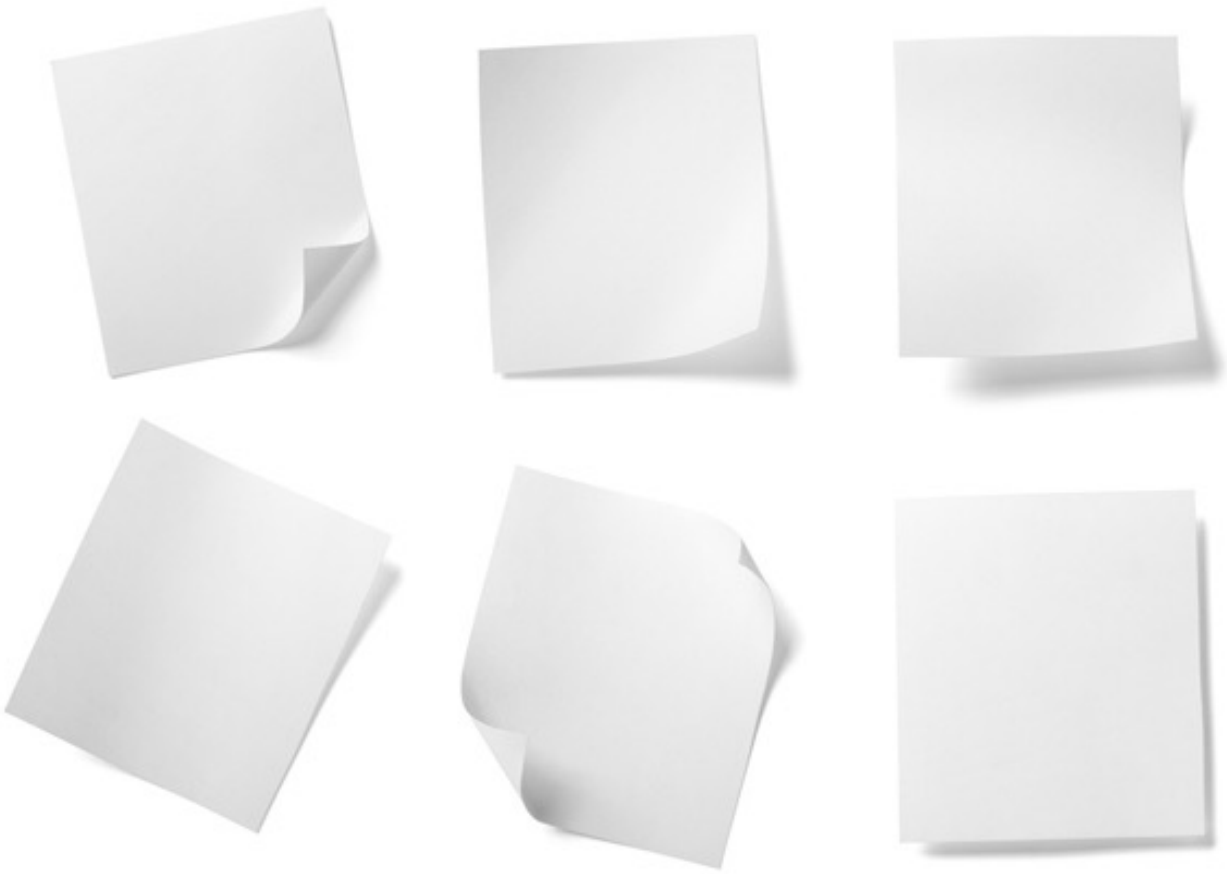
- File structure
- System architecture
- Code structure
- Names
- …



Observation: Software is massively redundant

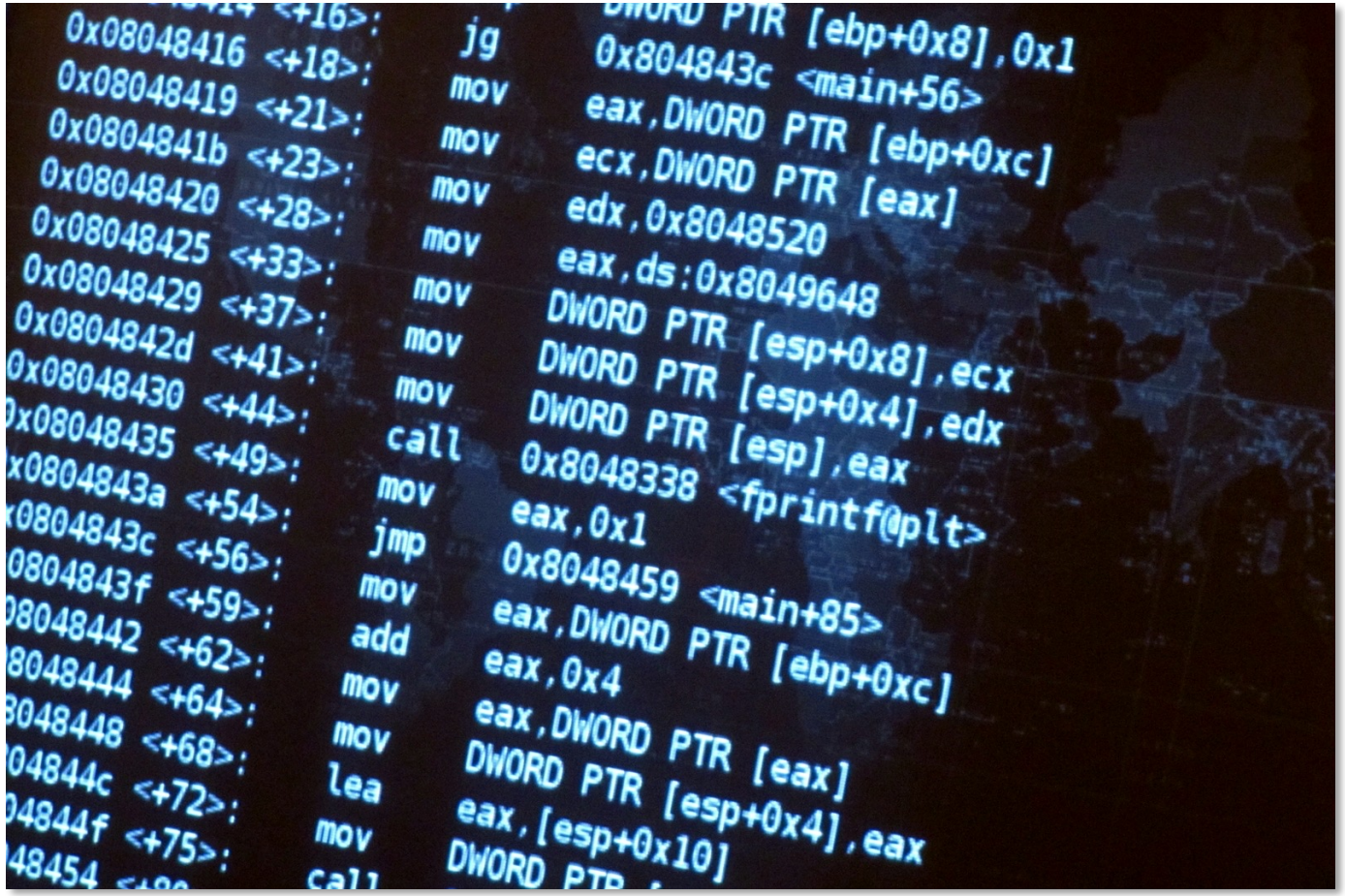
- There's always something to copy/use as a starting point!

Observation: Code must run to do stuff!



Observation: If code runs, it must have a beginning…

Observation: If code runs, it must exist…



The Beginning: Entry Points

- Locally installed programs: run cmd, OS launch, I/O events, etc.
- Local applications in dev: build + run, test, deploy (e.g., docker)
- Web apps server-side: Browser sends HTTP request (GET/POST)
- Web apps client-side: Browser runs JavaScript, event handlers

Code must exist. But where?

- Locally installed programs: run cmd, OS launch, I/O events, etc.
  - Binaries (machine code) on your computer
- Local applications in dev: build + run, test, deploy (e.g., docker)
  - Source code in repository (+ dependencies)
- Web apps server-side: Browser sends HTTP request (e.g., GET, POST)
  - Code runs remotely (you can only observe outputs)
- Web apps client-side: Browser runs JavaScript, event handlers
  - Source code is downloaded and run locally (see: browser dev tools!)

Can running code be Probed/Understood/Edited?

Transparent	Translucent	Opaque
		
Source code built locally	Binaries running locally	Server-side apps running remotely
	Open source / Closed source	Open source / Closed source
(P+U+E)	(P+U) / (P)	(U) / (Talk to NSA)

Creating a model of unfamiliar code

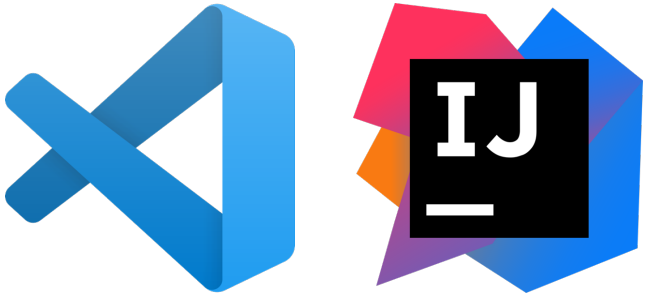
Source code built locally

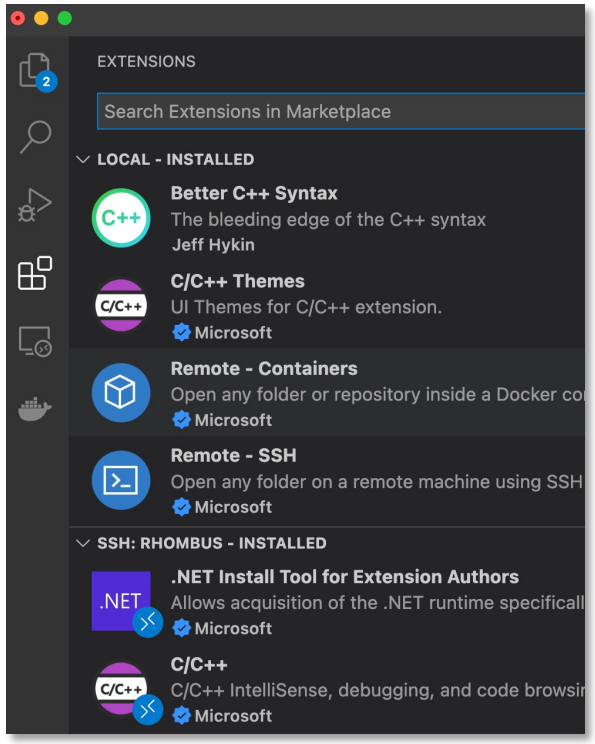
Information Gathering

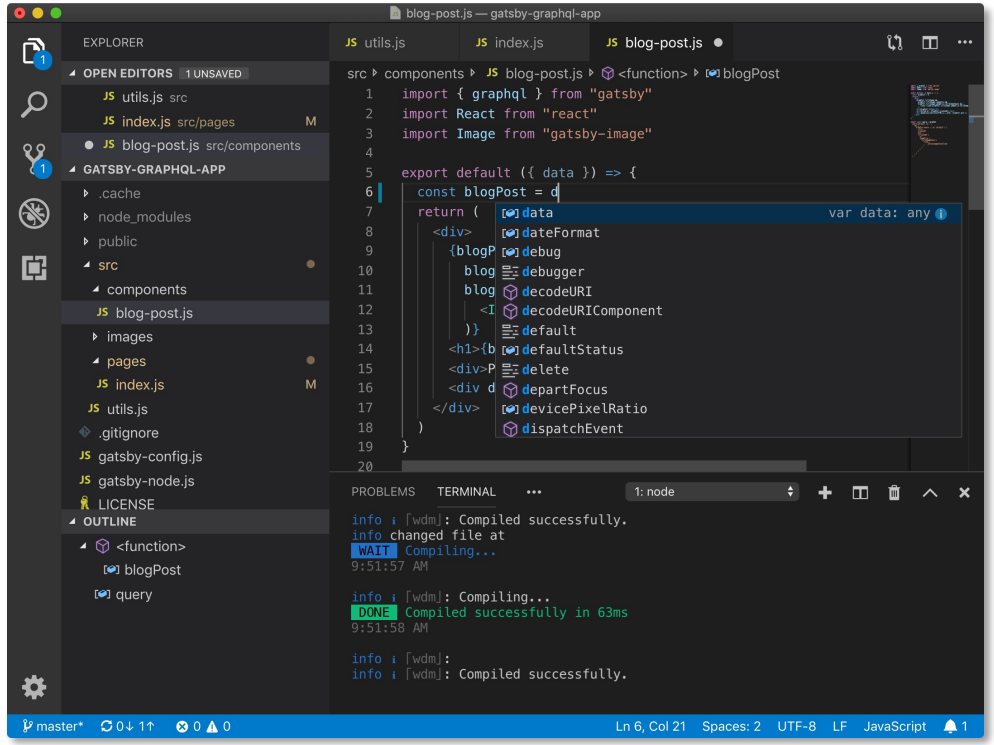
- Basic needs:
  - Code/file search and navigation
  - Code editing (probes)
  - Execution of code, tests
  - Observation of output (observation)
- Many choices here on tools! Depends on circumstance.
  - grep/find/etc. Knowing Unix tools is invaluable
  - A decent IDE
  - Debugger
  - Test frameworks + coverage reports
  - Google (or your favorite web search engine)
  - ChatGPT or LaMA

At the command line: **grep** and **find**!
(Google for tutorials)

Static Information Gathering: Use an IDE!
Real software is too complex to keep in your head

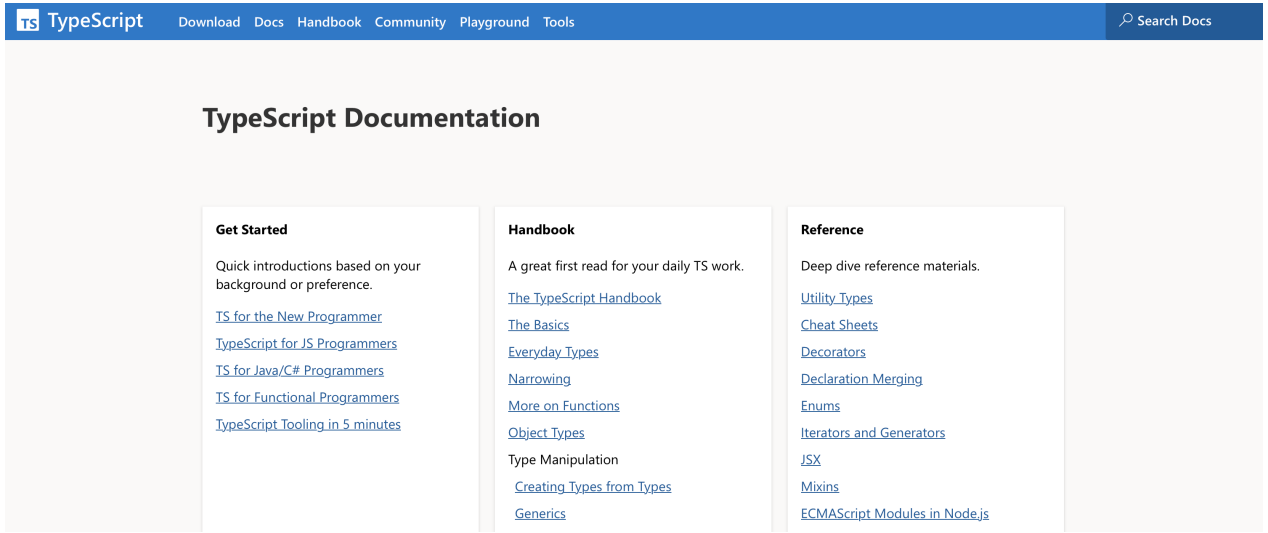






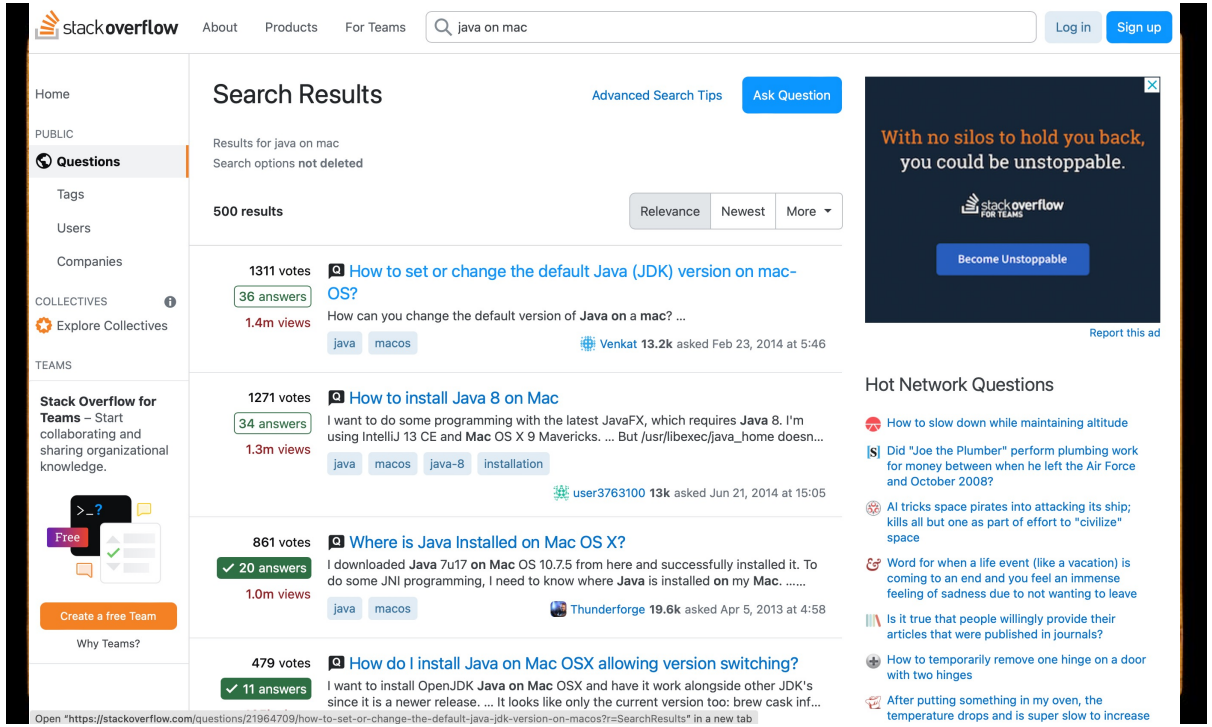
Consider documentation and tutorials judiciously

- Great for discovering entry points!
- Can teach you about general structure, architecture (more on this later in the semester)
- Often out of date.
- As you gain experience, you will recognize more of these, and you will immediately know something about how the program works
- Also: discussion boards; issue trackers



Discussion Boards and Issue Trackers

- Software is written by people.
- How can we talk to them?
- Fortunately, they probably aren't dead.
- So, you can report problems on GitHub.
- Or, ask them questions on StackOverflow.

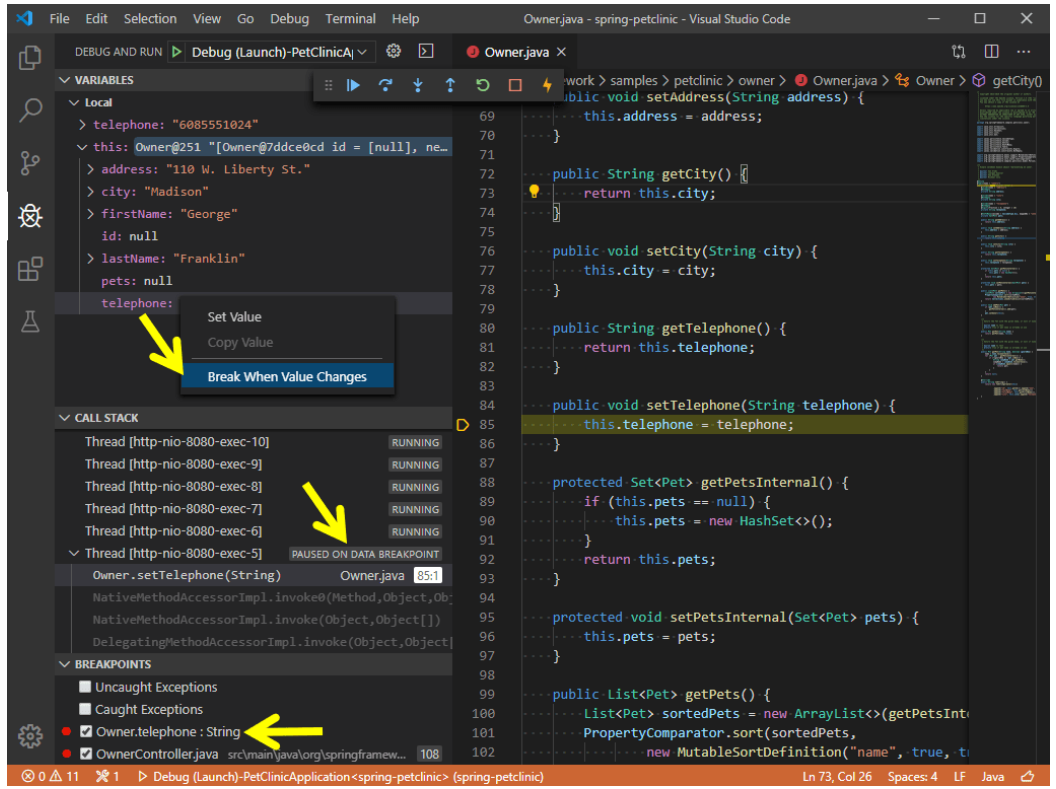


Dynamic Information Gathering
Change helps to inform and refine mental models

- Build it.
- Run it.
- Change it.
- Run it again.
- How did the behavior change?

Probes: Observe, control or “lightly” manipulate execution

- print(“this code is running!”)
- Structured logging
- Debuggers
  - Breakpoint, eval, step through / step over
  - (Some tools even support remote debugging)
- Delete debugging
- Chrome Developer Tools



Step 0: Sanity check basic model + hypotheses

- Confirm that you can build and run the code.
  - Ideally both using the tests provided, and by hand.
- Confirm that the code you are running is the code you built
- Confirm that you can make an externally visible change
- How? Where? Starting points:
  - Run an existing test, change it
  - Write a new test
  - Change the code, write or rerun a test that should notice the change
- Ask someone for help

Document and share your findings!

- Update README and docs
  - Or better: use a Developer Wiki
  - Use Mermaid for diagrams
- Screencast on Twitch
- Collaborate with others
- Include negative results, too!

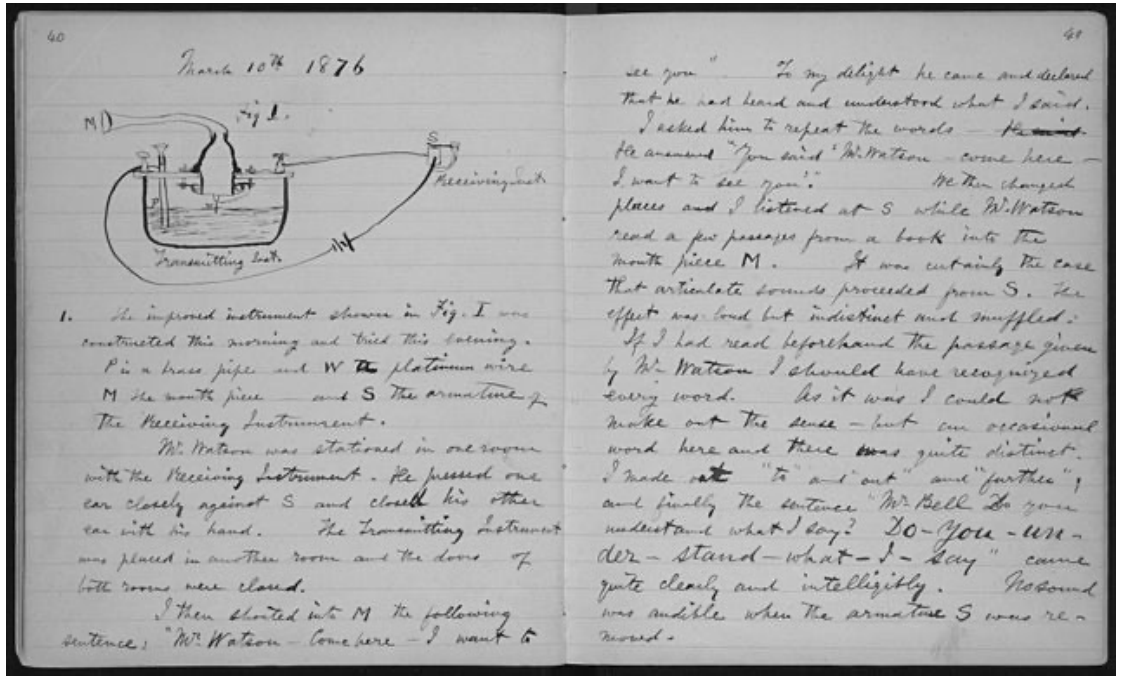

March 10th 1876

Fig. 1.

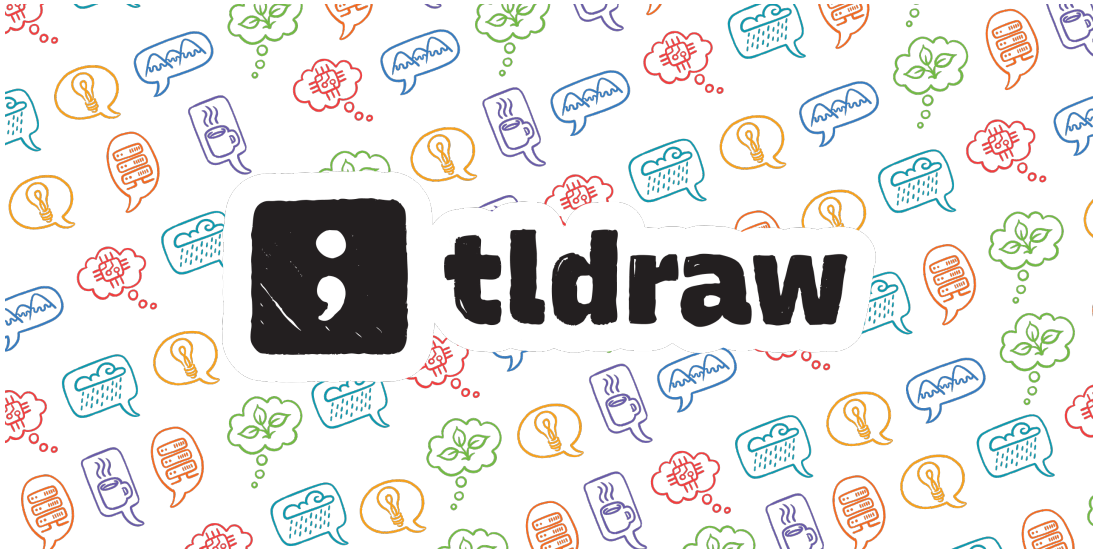
1. The improved instrument shown in Fig. I was constructed this morning and tried this evening. P is a brass pipe and W the platinum wire M the mouth piece and S the armature of the Receiving Instrument.

Mr Watson was stationed in one room with the Receiving Instrument. He pressed one ear closely against S and closed his other ear with his hand. The Transmitting Instrument was placed in another room and the doors of both rooms were closed.

I then shouted into M the following sentence: "Mr Watson – Come here – I want to see you". To my delight he came and declared that he had heard and understood what I said.

I asked him to repeat the words – He amended "You said 'Mr Watson – come here – I want to see you'". We then changed places and I listened at S while Mr Watson read a few passages from a book into the mouth piece M. It was certainly the case that articulate sounds proceeded from S. The effect was loud but indistinct and muffled. If I had read beforehand the passage given by Mr Watson I should have recognized every word. As it was I could not make out the sense – but an occasional word here and there was quite distinct. I made out "to" and "out" and "further", and finally the sentence "Mr Bell do you understand what I say? Do-you-un-der-stand-what-I-say" came quite clearly and intelligibly. No sound was audible when the armature S was removed.

Let’s try some of these techniques again…



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