Software Archaeology and Anthropology

17-313 Fall 2023

Foundations of Software Engineering

https://cmu-313.github.io

Michael Hilton and Eduardo Feo Flushing

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
- COVID or other health issues? Please stay home.

Smoking Section

- Last full row

Homework

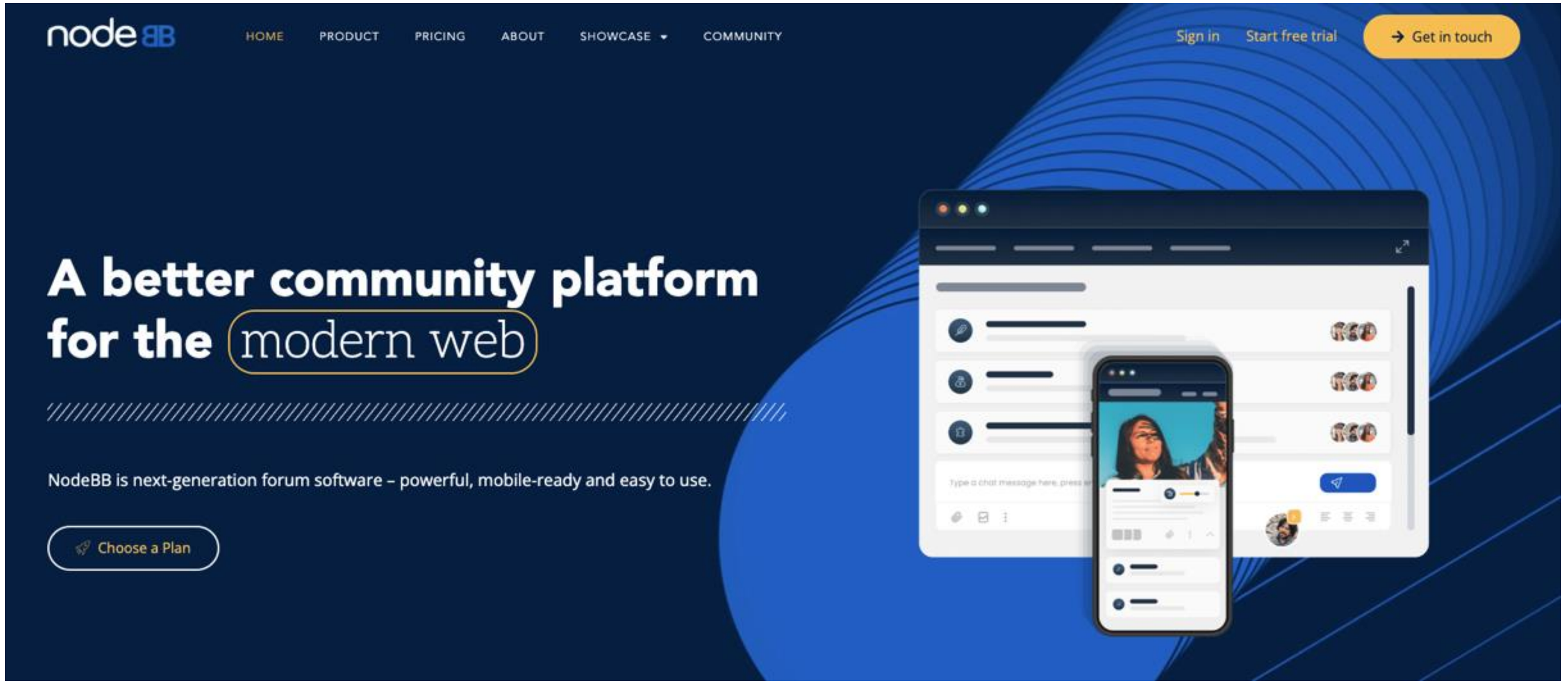
- Homework 1 is released.
  - Part (a) is due Friday Jan 18th, 11:59 pm. That’s tomorrow!
  - Part (b) is due Thursday, Jan 25th, 11:59pm.
  - This is an individual assignment; we will compose groups next week. **PLEASE FILL OUT TEAMWORK SURVEY**
  - Get started early, ask for help, and check the #technical-questions channel; chances are your questions have been asked by others!

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!

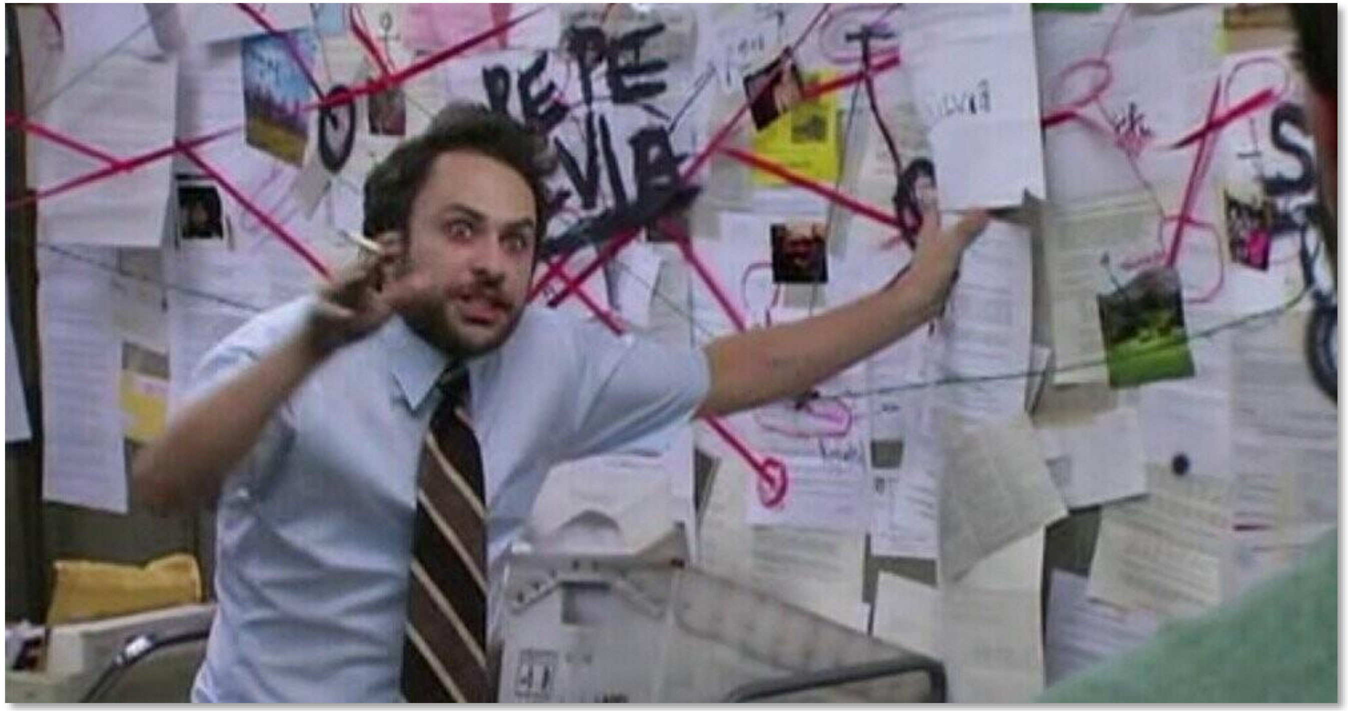


A better community platform for the modern web

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

You will never understand the entire system!

Challenge: How do I tackle this codebase?

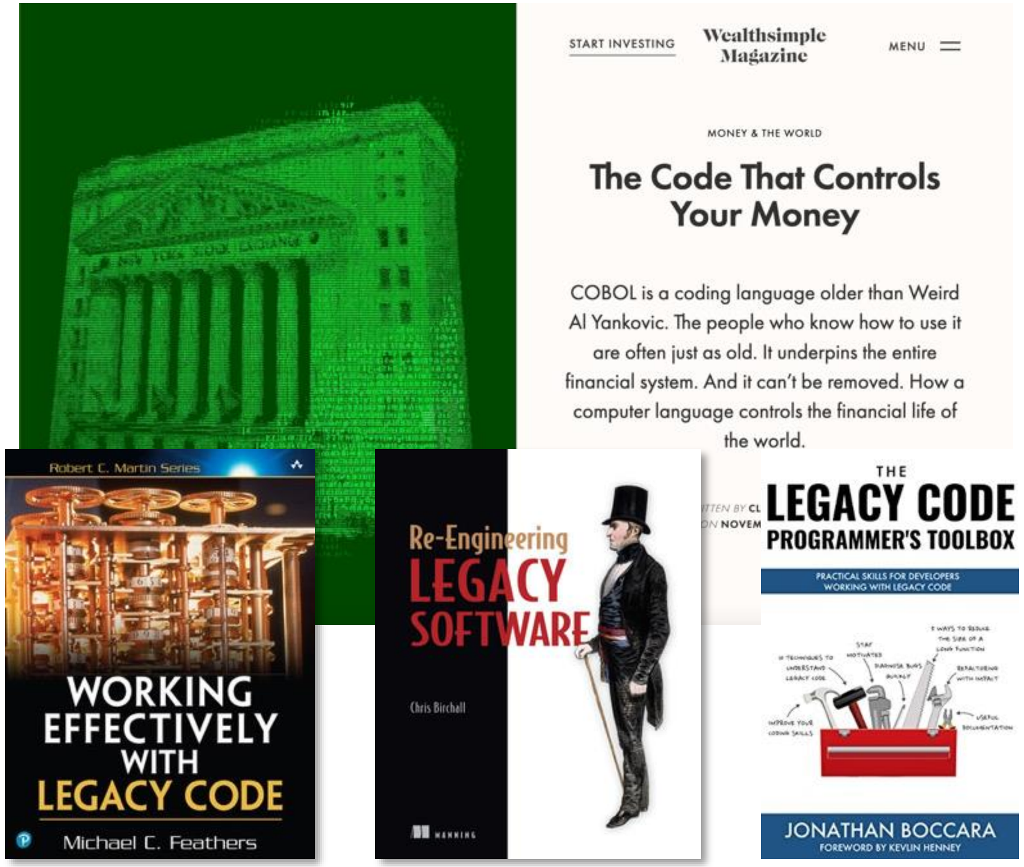


Challenge: How do I tackle this codebase?

- 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.



START INVESTING

Wealthsimple Magazine

MENU

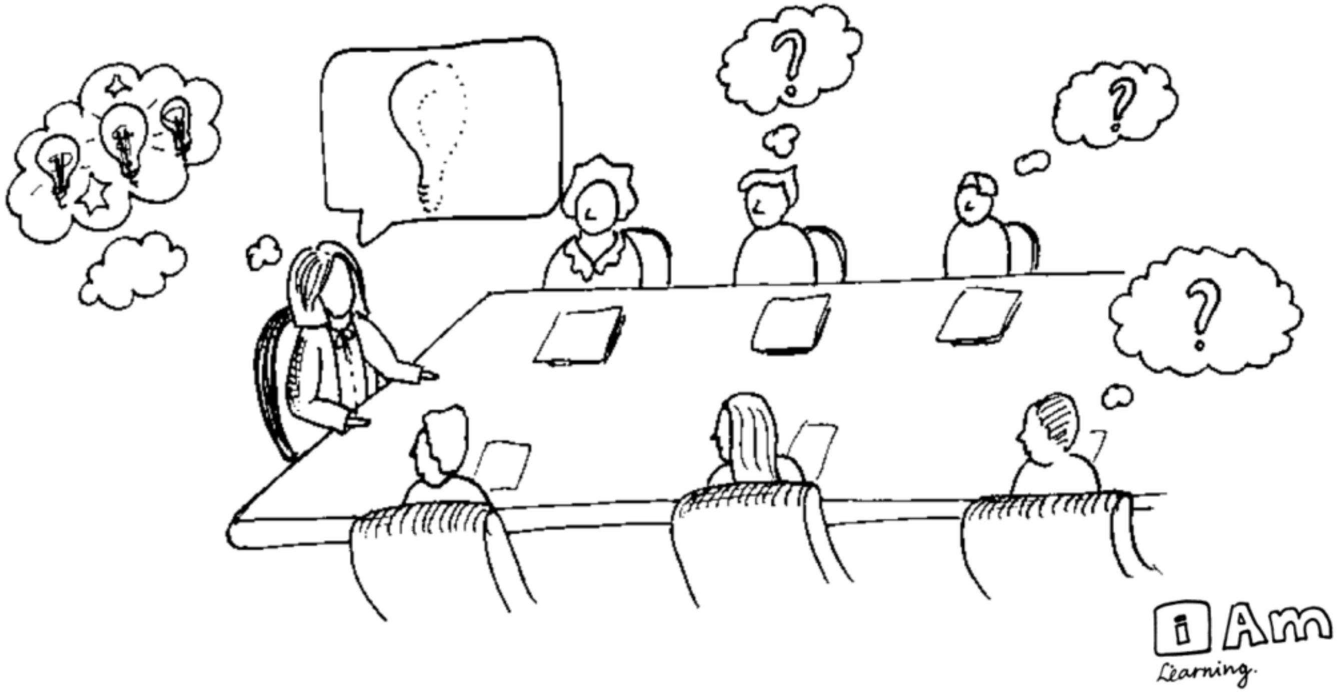
MONEY & THE WORLD

The Code That Controls Your Money

COBOL is a coding language older than Weird Al Yankovic. The people who know how to use it are often just as old. It underpins the entire financial system. And it can't be removed. How a computer language controls the financial life of the world.

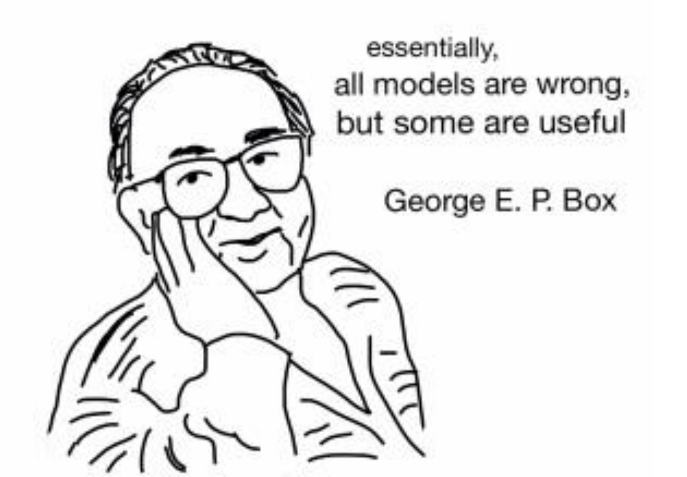
Robert C. Martin Series
WORKING EFFECTIVELY WITH LEGACY CODE
Michael C. Feathers
Re-Engineering LEGACY SOFTWARE
Chris Birchall
MANNING
THE LEGACY CODE PROGRAMMER'S TOOLBOX
PRACTICAL SKILLS FOR DEVELOPERS WORKING WITH LEGACY CODE
JONATHAN BOCCARA
FOREWORD BY KEVLIN HENNEY

Why? Because of Tacit Knowledge



Today: How to tackle codebases

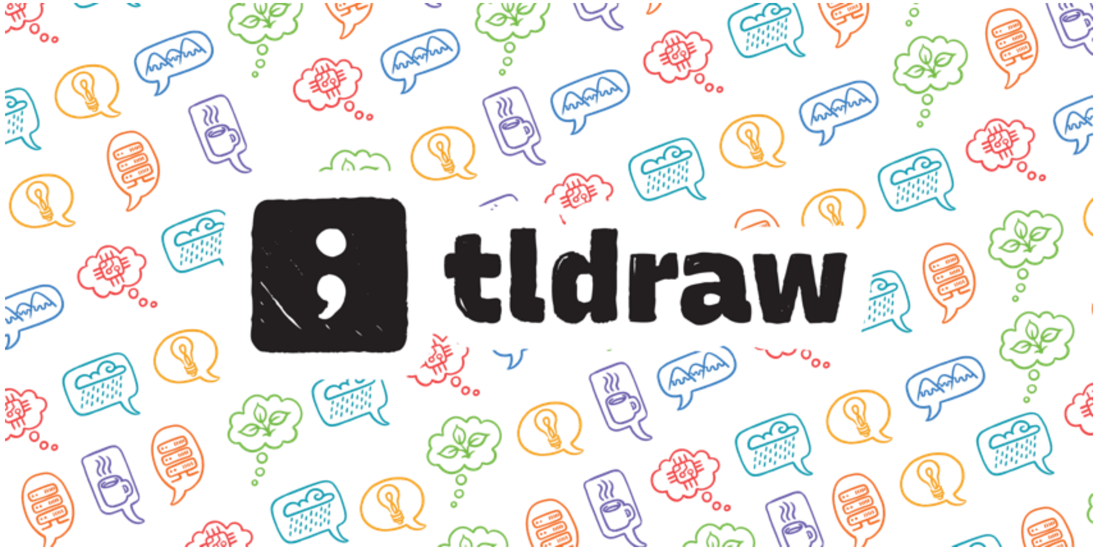
- Goal: develop and test a working model or set of working hypotheses about how (some part of) a system works
- Working model: an understanding of the pieces of the system (components), and the way they interact (connections)
- Focus: Observation, probes, and hypothesis testing
  - Helpful tools and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



essentially,
all models are wrong,
but some are useful

George E. P. Box

Live Demonstration: tldraw



https://github.com/tldraw/tldraw

Steps to Understand a New Codebase

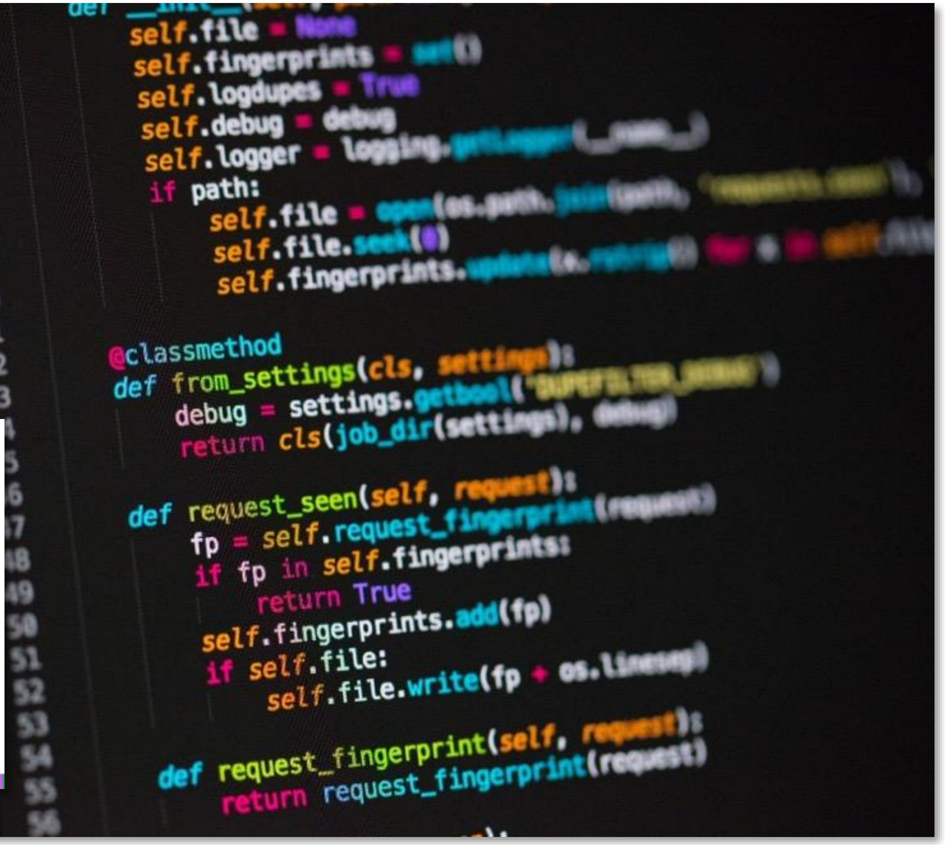
- Look at README.md
- Clone the repo.
- Build the codebase.
- Figure out how to make it run.
- What do you want to mess with?
  - Clone and own
- Traceability - Attach a debugger
  - View Source
  - Find the logs.
  - Search for constants (strings, colors, weird integers (#DEADBEEF))

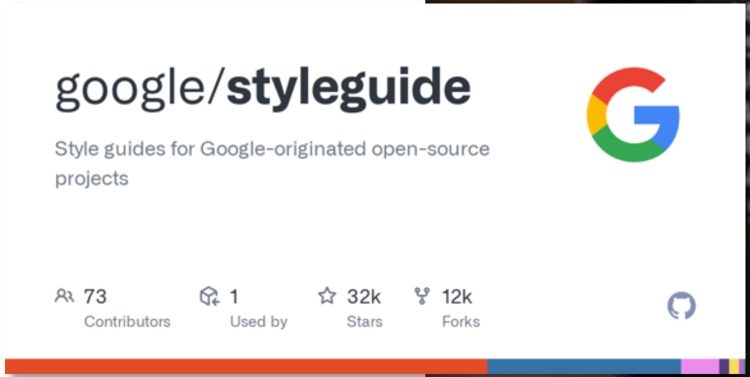
Participation Activity

- Take out a piece of paper. (we have extra if you need)
- 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!
- Write your own andrewID on the paper, leave it at the end of class.

Observation: Software is full of patterns

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





google/**styleguide**

Style guides for Google-originated open-source projects

73 Contributors

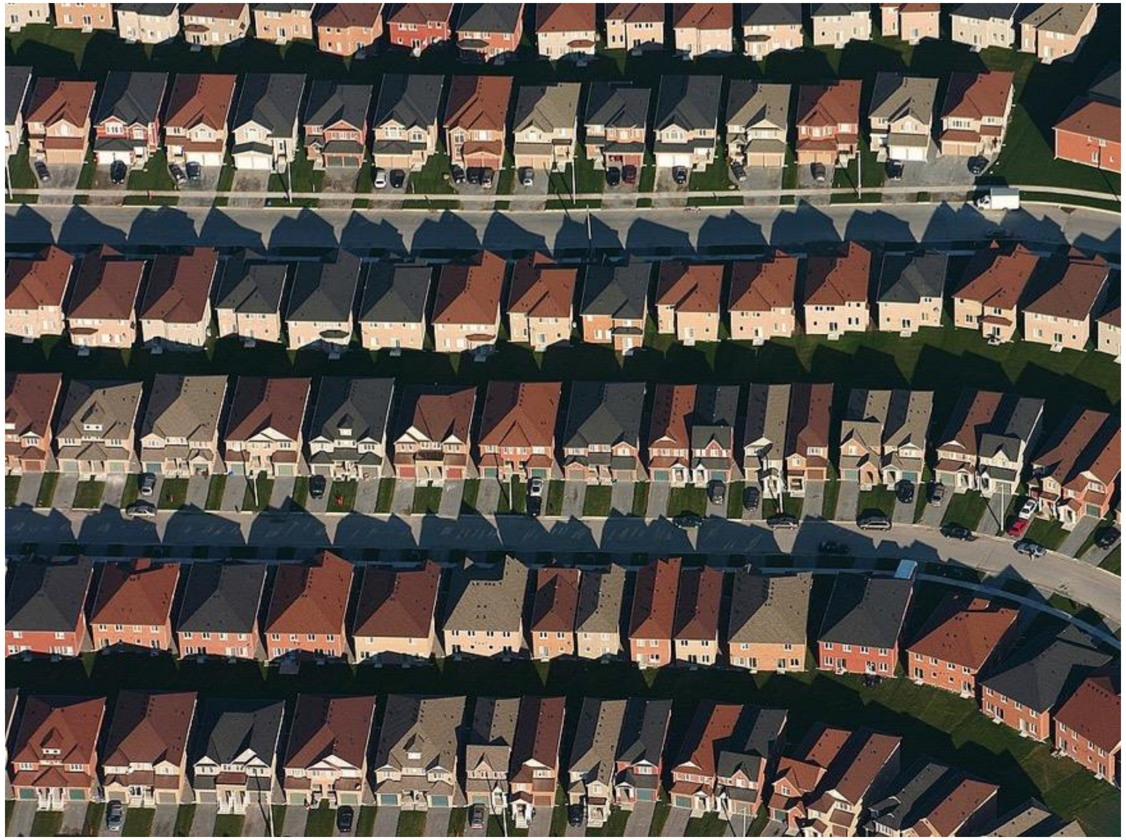
1 Used by

32k Stars

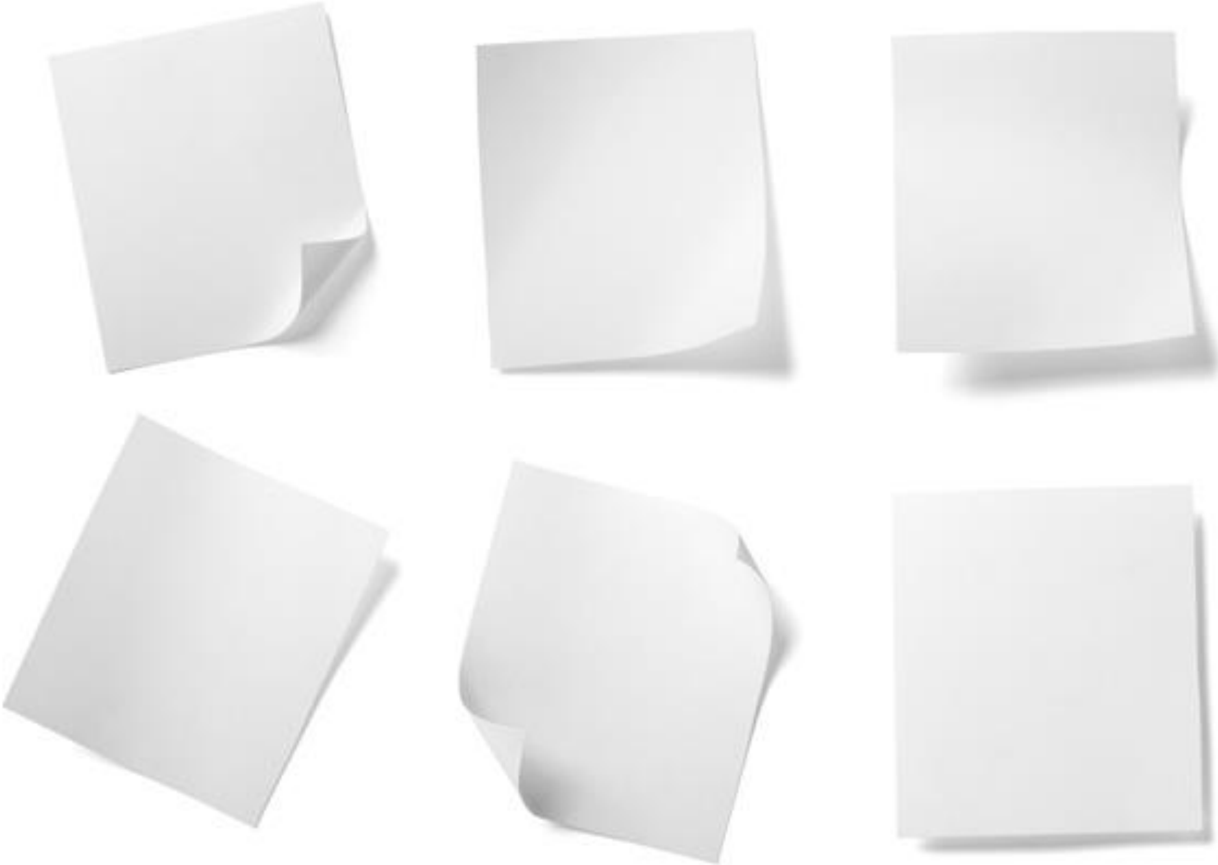
12k Forks

Observation: Software is massively redundant

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

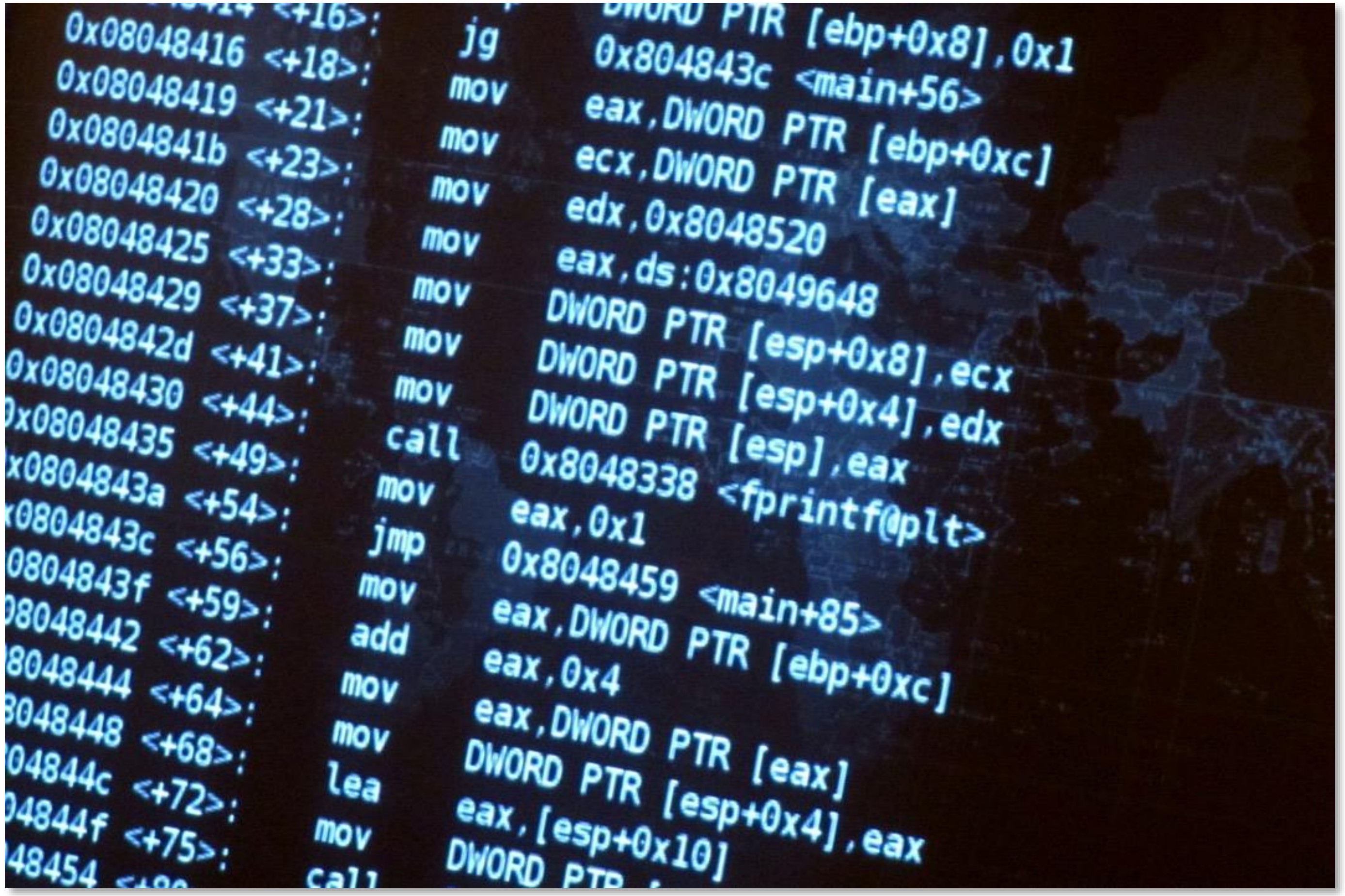


Observation: Code must run to do stuff!



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

Observation: If code runs, it must exist…



```
           <+16>:                DWORD PTR [ebp+0x8],0x1
0x08048416 <+18>:    jg     0x804843c <main+56>
0x08048419 <+21>:    mov    eax,DWORD PTR [ebp+0xc]
0x0804841b <+23>:    mov    ecx,DWORD PTR [eax]
0x08048420 <+28>:    mov    edx,0x8048520
0x08048425 <+33>:    mov    eax,ds:0x8049648
0x08048429 <+37>:    mov    DWORD PTR [esp+0x8],ecx
0x0804842d <+41>:    mov    DWORD PTR [esp+0x4],edx
0x08048430 <+44>:    mov    DWORD PTR [esp],eax
x08048435 <+49>:     call   0x8048338 <fprintf@plt>
x0804843a <+54>:     mov    eax,0x1
0804843c <+56>:      jmp    0x8048459 <main+85>
0804843f <+59>:      mov    eax,DWORD PTR [ebp+0xc]
08048442 <+62>:      add    eax,0x4
8048444 <+64>:       mov    eax,DWORD PTR [eax]
8048448 <+68>:       mov    DWORD PTR [esp+0x4],eax
04844c <+72>:        lea    eax,[esp+0x10]
04844f <+75>:        mov    DWORD PTR
48454                call
```

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

Source code built locally

(P+U+E)

Translucent

Binaries running locally

Open source

(P+U)

Closed source

(P)

Opaque

Server-side apps running remotely

Open source

(U)

Closed source

(Talk to NSA)

Creating a model of unfamiliar code

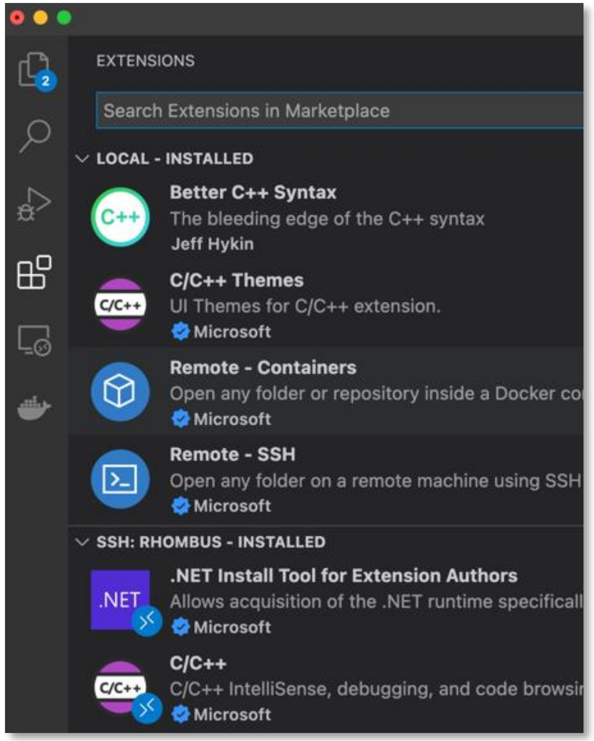
Source code built locally

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



LOCAL - INSTALLED

Better C++ Syntax
The bleeding edge of the C++ syntax
Jeff Hykin

C/C++ Themes
UI Themes for C/C++ extension.
Microsoft

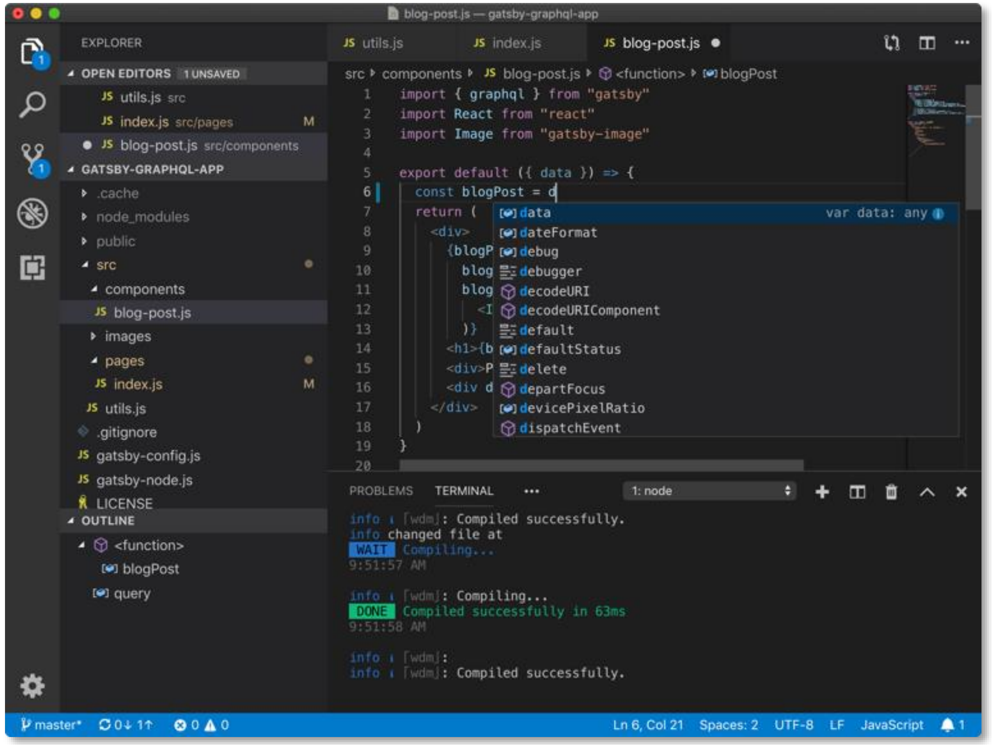
Remote - Containers
Open any folder or repository inside a Docker co
Microsoft

Remote - SSH
Open any folder on a remote machine using SSH
Microsoft

SSH: RHOMBUS - INSTALLED

.NET Install Tool for Extension Authors
Allows acquisition of the .NET runtime specificall
Microsoft

C/C++
C/C++ IntelliSense, debugging, and code browsi
Microsoft



```
import { graphql } from "gatsby"
import React from "react"
import Image from "gatsby-image"

export default ({ data }) => {
  const blogPost = d
  return (
    <div>
      {blogP
        blog
        blog
          <I
        )}
      <h1>{b
      <div>P
      <div d
    </div>
  )
}
```

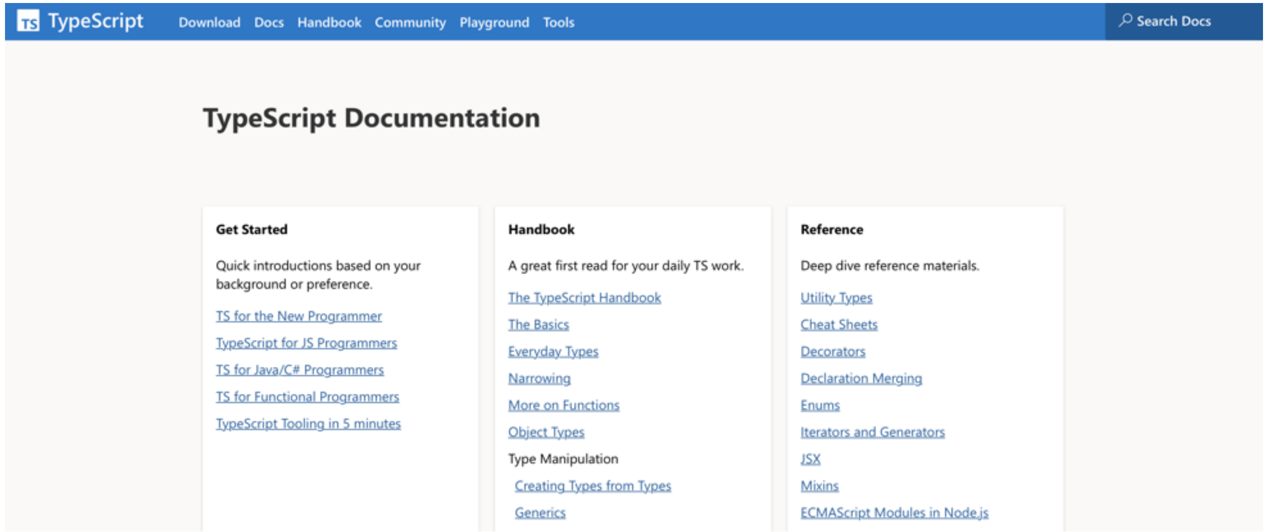
```
info ℹ ｢wdm｣: Compiled successfully.
info changed file at
WAIT Compiling...
9:51:57 AM

info ℹ ｢wdm｣: Compiling...
DONE Compiled successfully in 63ms
9:51:58 AM

info ℹ ｢wdm｣:
info ℹ ｢wdm｣: Compiled successfully.
```

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



TypeScript Documentation

Get Started

Quick introductions based on your background or preference.

- TS for the New Programmer
- TypeScript for JS Programmers
- TS for Java/C# Programmers
- TS for Functional Programmers
- TypeScript Tooling in 5 minutes

Handbook

A great first read for your daily TS work.

- The TypeScript Handbook
- The Basics
- Everyday Types
- Narrowing
- More on Functions
- Object Types
- Type Manipulation
  - Creating Types from Types
  - Generics

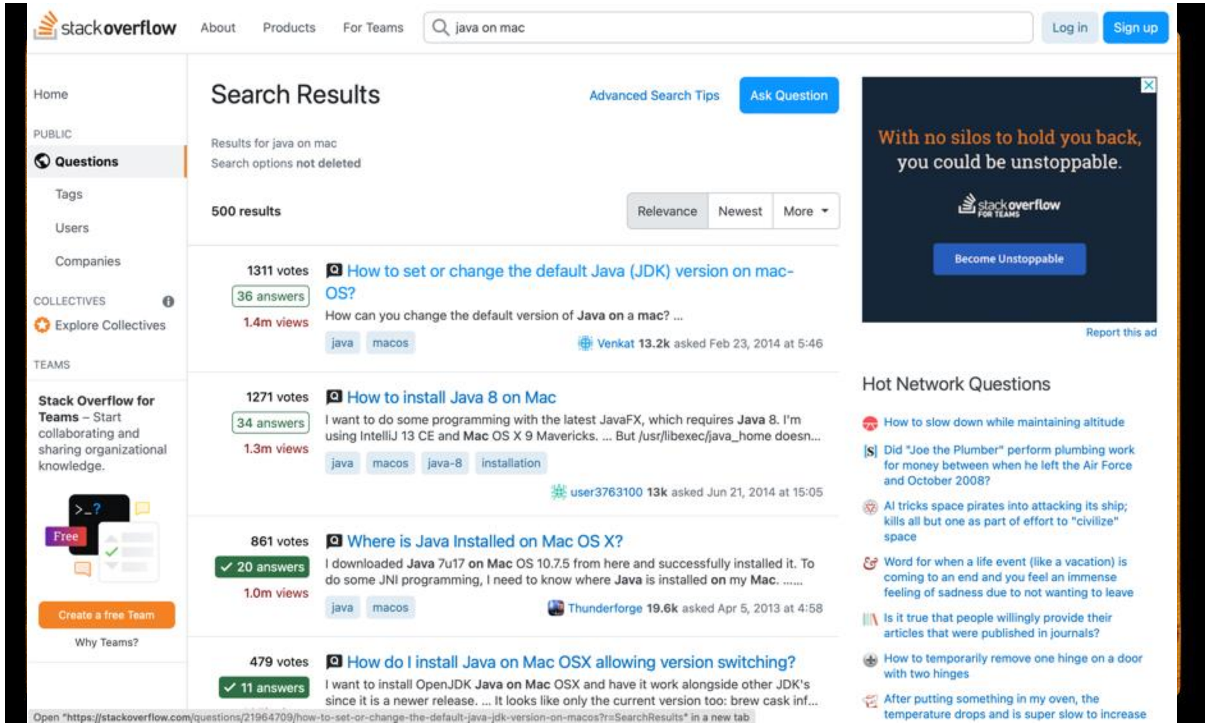
Reference

Deep dive reference materials.

- Utility Types
- Cheat Sheets
- Decorators
- Declaration Merging
- Enums
- Iterators and Generators
- JSX
- Mixins
- ECMAScript Modules in Node.js

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.



Stack Overflow for Teams – Start collaborating and sharing organizational knowledge.

Search Results

Results for java on mac

Search options **not deleted**

500 results

1311 votes · 36 answers · 1.4m views

How to set or change the default Java (JDK) version on mac-OS?

How can you change the default version of **Java on a mac**? ...

java · macos

Venkat **13.2k** asked Feb 23, 2014 at 5:46

1271 votes · 34 answers · 1.3m views

How to install Java 8 on Mac

I want to do some programming with the latest JavaFX, which requires **Java** 8. I'm using IntelliJ 13 CE and **Mac** OS X 9 Mavericks. ... But /usr/libexec/java_home doesn...

java · macos · java-8 · installation

user3763100 **13k** asked Jun 21, 2014 at 15:05

861 votes · ✓ 20 answers · 1.0m views

Where is Java Installed on Mac OS X?

I downloaded **Java** 7u17 **on Mac** OS 10.7.5 from here and successfully installed it. To do some JNI programming, I need to know where **Java** is installed **on** my **Mac**. ......

java · macos

Thunderforge **19.6k** asked Apr 5, 2013 at 4:58

479 votes · ✓ 11 answers

How do I install Java on Mac OSX allowing version switching?

I want to install OpenJDK **Java on Mac** OSX and have it work alongside other JDK's since it is a newer release. ... It looks like only the current version too: brew cask inf...

Open "https://stackoverflow.com/questions/21964709/how-to-set-or-change-the-default-java-jdk-version-on-macos?r=SearchResults" in a new tab

Hot Network Questions

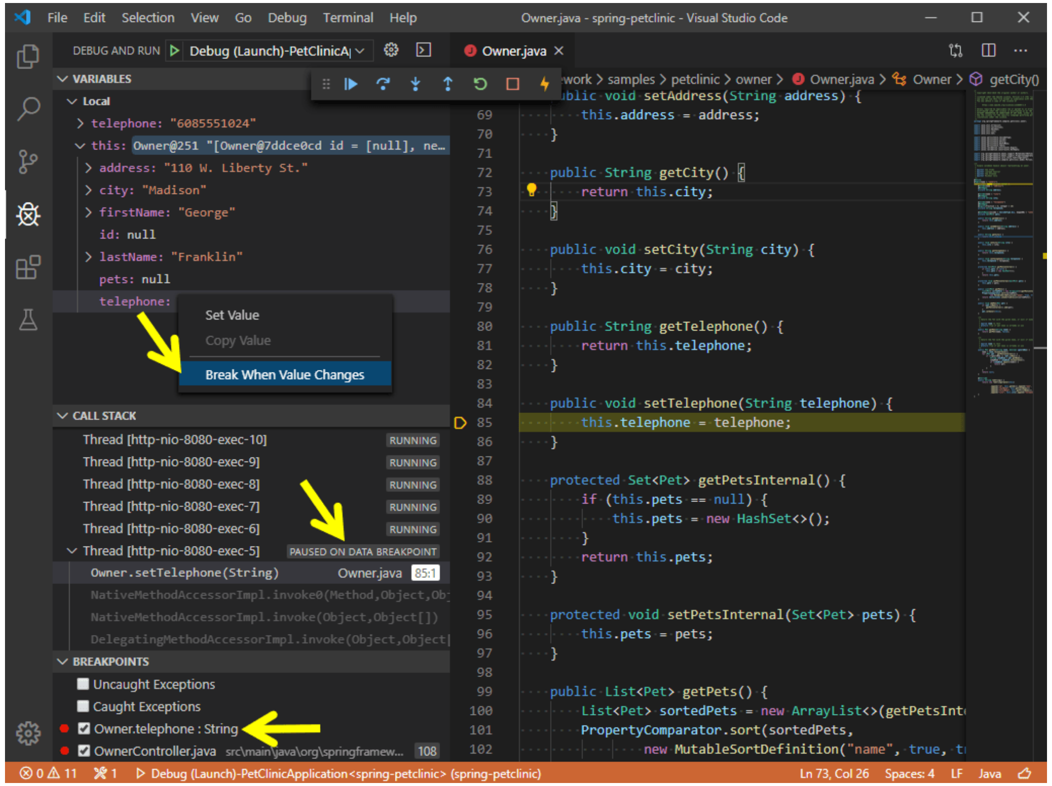
- How to slow down while maintaining altitude
- Did "Joe the Plumber" perform plumbing work for money between when he left the Air Force and October 2008?
- AI tricks space pirates into attacking its ship; kills all but one as part of effort to "civilize" space
- Word for when a life event (like a vacation) is coming to an end and you feel an immense feeling of sadness due to not wanting to leave
- Is it true that people willingly provide their articles that were published in journals?
- How to temporarily remove one hinge on a door with two hinges
- After putting something in my oven, the temperature drops and is super slow to increase

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


File Edit Selection View Go Debug Terminal Help
Owner.java - spring-petclinic - Visual Studio Code
DEBUG AND RUN
Debug (Launch)-PetClinicA|
Owner.java
work > samples > petclinic > owner > Owner.java > Owner > getCity()
VARIABLES
CALL STACK
BREAKPOINTS
Set Value
Copy Value
Break When Value Changes

```
Local
  > telephone: "6085551024"
  v this: Owner@251 "[Owner@7ddce0cd id = [null], ne…
    > address: "110 W. Liberty St."
    > city: "Madison"
    > firstName: "George"
      id: null
    > lastName: "Franklin"
      pets: null
      telephone:
```

```
Thread [http-nio-8080-exec-10]                RUNNING
Thread [http-nio-8080-exec-9]                 RUNNING
Thread [http-nio-8080-exec-8]                 RUNNING
Thread [http-nio-8080-exec-7]                 RUNNING
Thread [http-nio-8080-exec-6]                 RUNNING
Thread [http-nio-8080-exec-5]   PAUSED ON DATA BREAKPOINT
  Owner.setTelephone(String)             Owner.java 85:1
  NativeMethodAccessorImpl.invoke0(Method,Object,Ob
  NativeMethodAccessorImpl.invoke(Object,Object[])
  DelegatingMethodAccessorImpl.invoke(Object,Object|
```

□ Uncaught Exceptions
□ Caught Exceptions
● ☑ Owner.telephone : String
● ☑ OwnerController.java src\main\java\org\springframew... 108

```
ublic void setAddress(String address) {
        this.address = address;
    }

    public String getCity() {
        return this.city;
    }

    public void setCity(String city) {
        this.city = city;
    }

    public String getTelephone() {
        return this.telephone;
    }

    public void setTelephone(String telephone) {
        this.telephone = telephone;
    }

    protected Set<Pet> getPetsInternal() {
        if (this.pets == null) {
            this.pets = new HashSet<>();
        }
        return this.pets;
    }

    protected void setPetsInternal(Set<Pet> pets) {
        this.pets = pets;
    }

    public List<Pet> getPets() {
        List<Pet> sortedPets = new ArrayList<>(getPetsInt
        PropertyComparator.sort(sortedPets,
                new MutableSortDefinition("name", true, t
```

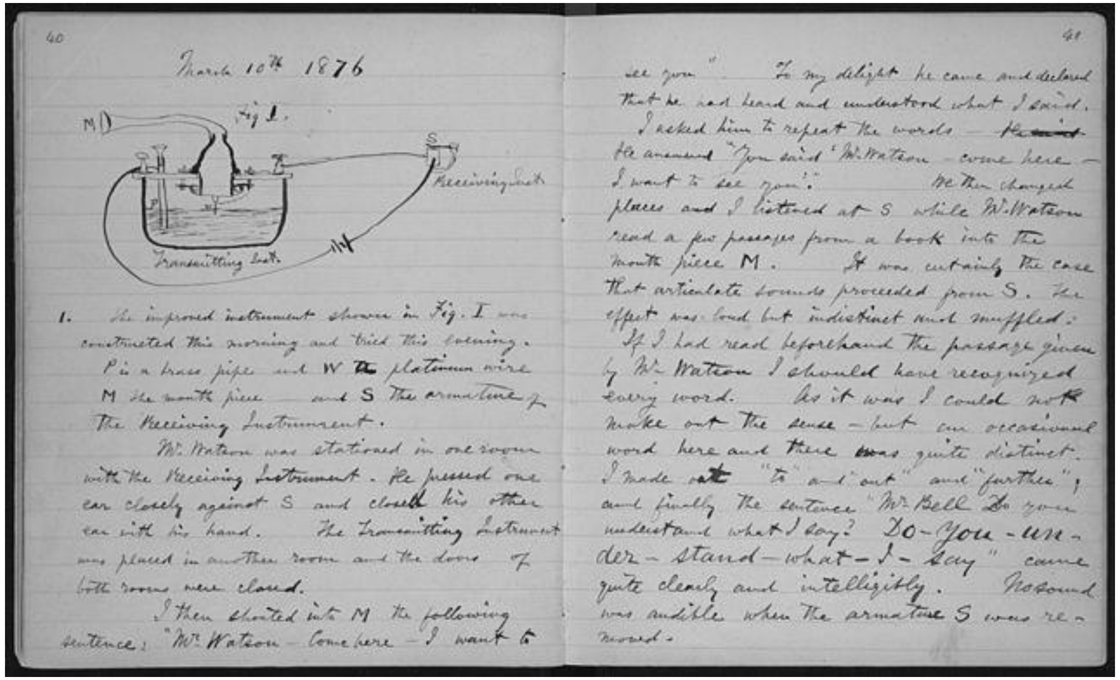
⊗ 0 ⚠ 11   1   Debug (Launch)-PetClinicApplication<spring-petclinic> (spring-petclinic)   Ln 73, Col 26   Spaces: 4   LF   Java

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.
M
S
P
W
Receiving Inst.
Transmitting Inst.

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.

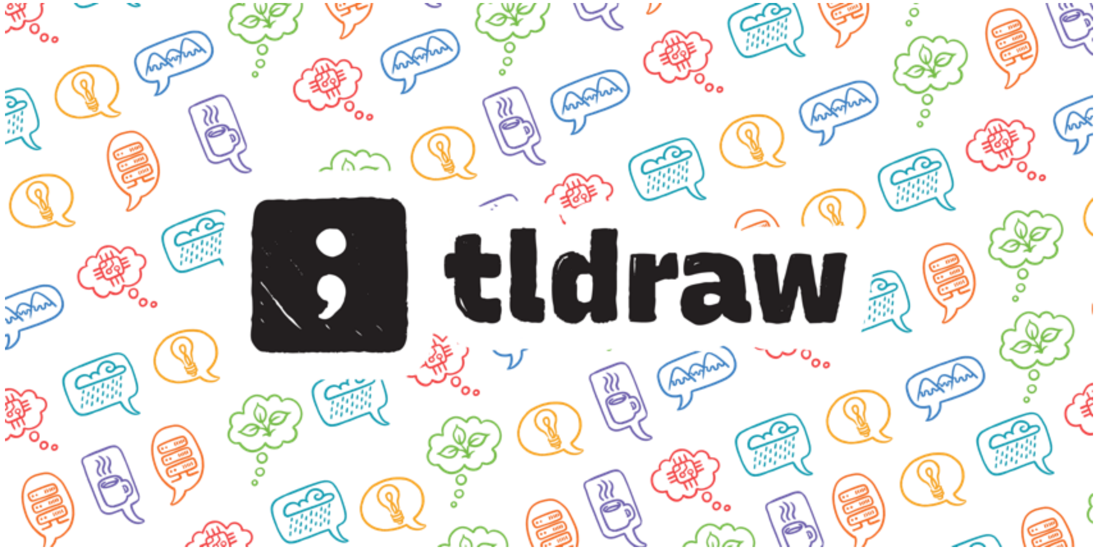
I then shouted into M the following sentence: "Mr. Watson – Come here – I want to

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 said~~ He answered "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~~ 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-Under-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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