



AAE2004 Introduction to Aviation Systems

AAE

Design of Path Planning Algorithm for Aircraft Operation

First Week

Dr Li-Ta Hsu and Dr Kam Hung NG
Assisted by
Miss Hiu Yi HO (Queenie), Miss Yan Tung LEUNG (Nikki)

Lecturer's Information

- Instructor: Dr Li-Ta HSU
- Office: QR828
- Phone: 3400-8061
- Email: lt.hsu@polyu.edu.hk
- Office Hour: by appointment
- Expertise: GPS navigation, Autonomous driving, Pedestrian localization using Smartphone, Sensor Integration

Li-Ta HSU

1985.08 – Born in a fish farmer family in Tainan, Taiwan

2003.06 – Graduated from Kang Ming Senior High School, Taiwan

2007.06 – Bachelor of NCKU Department of Aeronautics and
Astronautics (DAA), Taiwan

2010.09 – Ph.D. Candidate of NCKU DAA, Taiwan

2012.02 – Visiting Researcher
in University College London, UK

2012.06 – Part-time Consultant for Spirent, UK

2013.07 – Visiting Researcher
in Tokyo Marine University, Japan

2013.12 – Ph.D. of NCKU DAA, Taiwan

2014.04 – Postdoctoral Researcher in the
University of Tokyo , Japan

2017.05 – Assistant Professor
in AAE of PolyU, Hong Kong

2021.07 – Associate Professor
in AAE of PolyU, Hong Kong



Ground Rules

For students

- Try to speak as much English as possible.
- Participate the class activates assigned.

For teaching staffs

- Reply your email with 3 working day.
- Open to any question regards to the subject

For us!

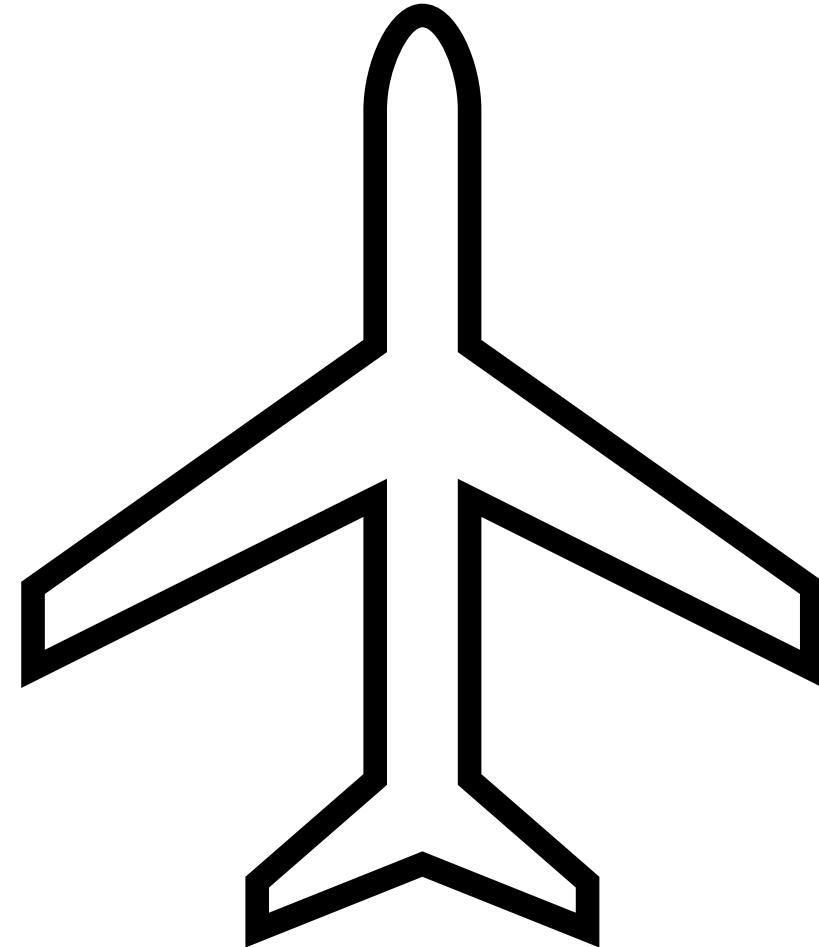
- Keep an open mind—enter the classroom dialogue with the expectation of learning something new. Look forward to learning about—and being challenged by—ideas, questions, and points of view that are different than your own.
- Arrive on time to the class and finish the class on time

Necessary Information

- Course Repository link: [https://github.com/IPNL-POLYU/PolyU AAE2004 Github Project](https://github.com/IPNL-POLYU/PolyU_AAE2004_Github_Project)
- TA Information & Contact:
 - Group 1-5: Queenie Ho (hiu-yi.ho@connect.polyu.hk)
 - Group 6-10: Nikkie Leung (yan-tung.leung@connect.polyu.hk)

Week 1 Content

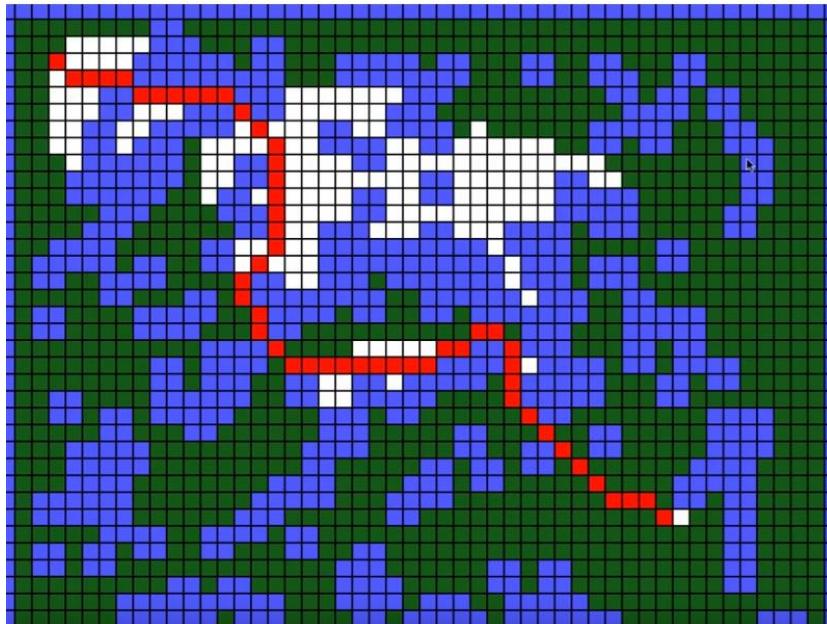
1. Introduction to Path Planning
2. Introduction to GitHub
(Background)
3. Introduction to GitHub Operations
4. Software Installation and setup
Guide



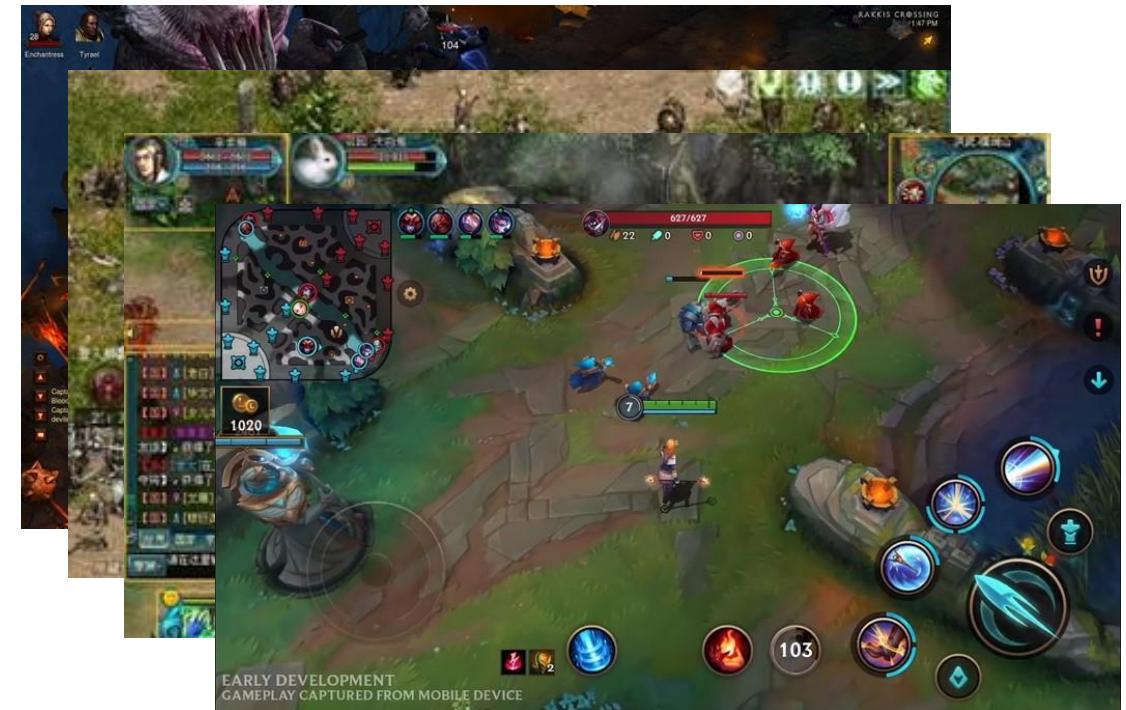
Introduction to Path Planning

What is Path Planning?

- **Path planning** (also known as the **navigation problem**) is computational problem to find a sequence of valid configurations that moves the object from the source to destination. The term is used in **aviation, robotics and computer games**.

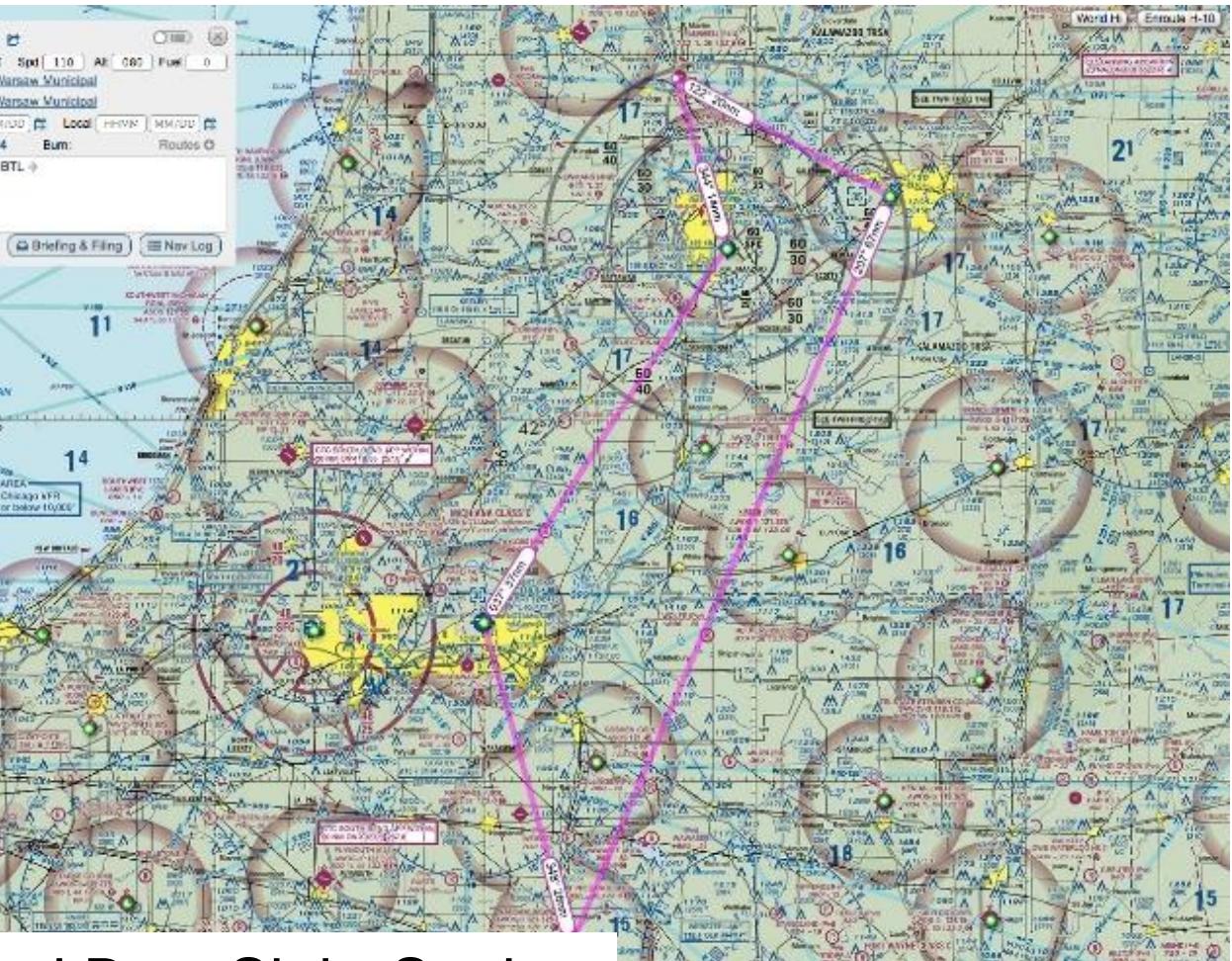
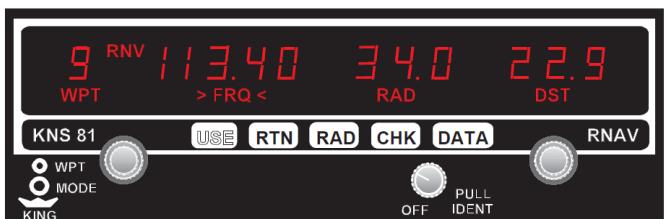
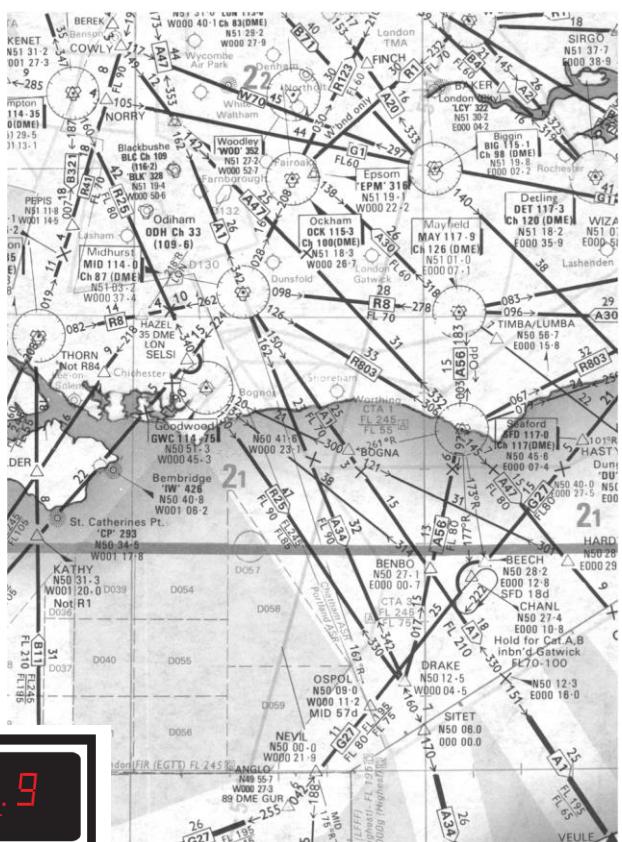
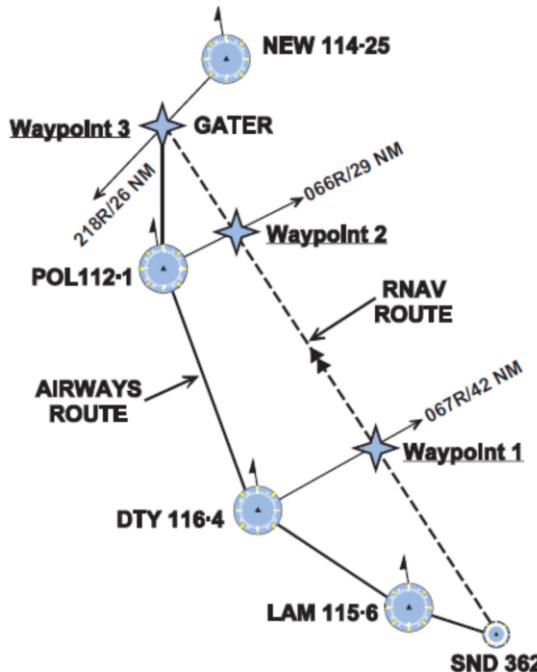


How to go from A to B considering factors!



How is Path Planning important to Aviation Engineering?

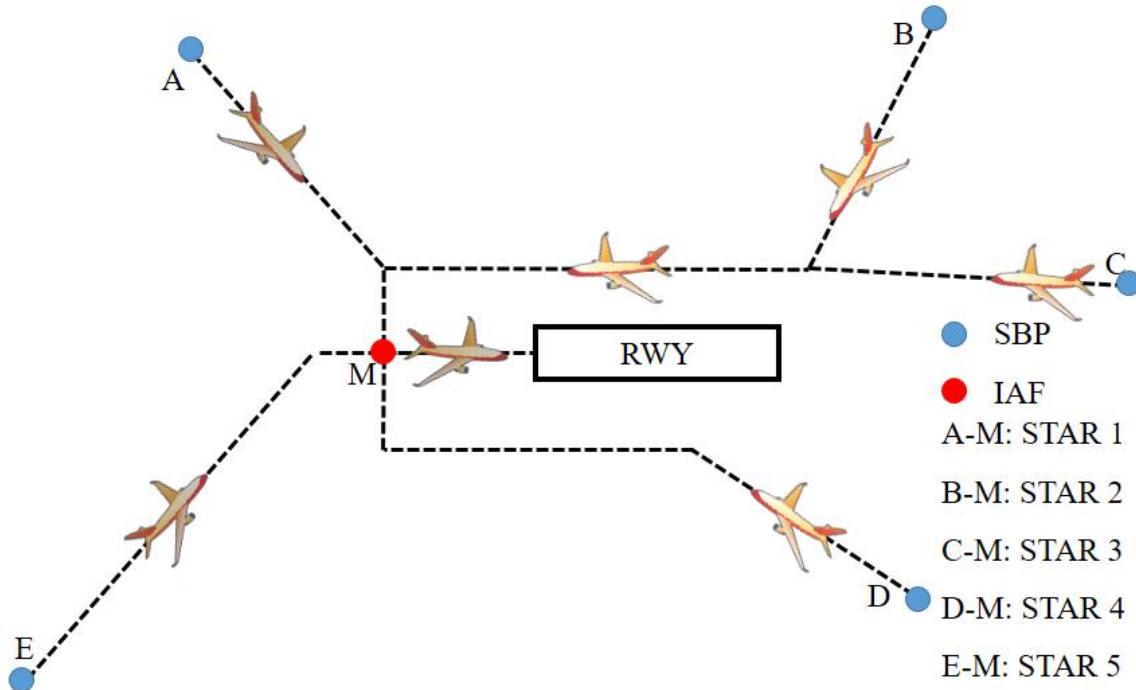
- Private pilots do the path plan before the flight to make sure the navigation aid is available



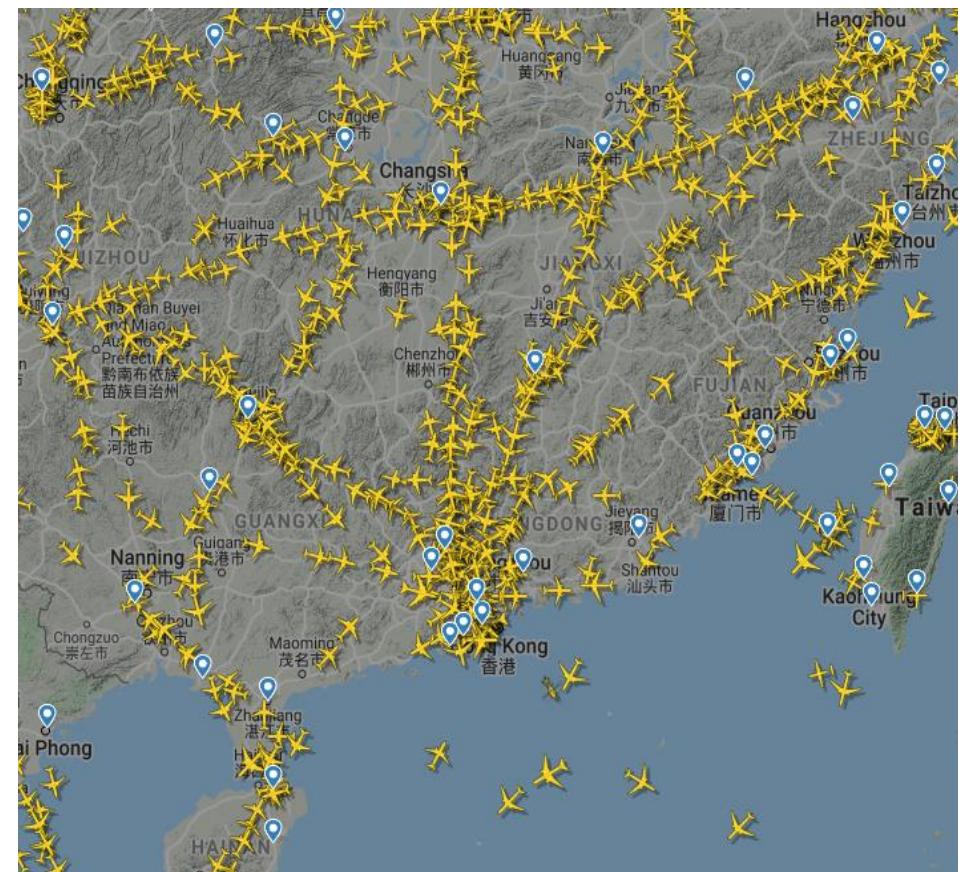
Objective: Safe and Best Sight Seeing

How is Path Planning important to Aviation Engineering?

- For ATC near airports, collaborative path planning is required to make the best use of the crowded airspace



Objective: Safe and least delay

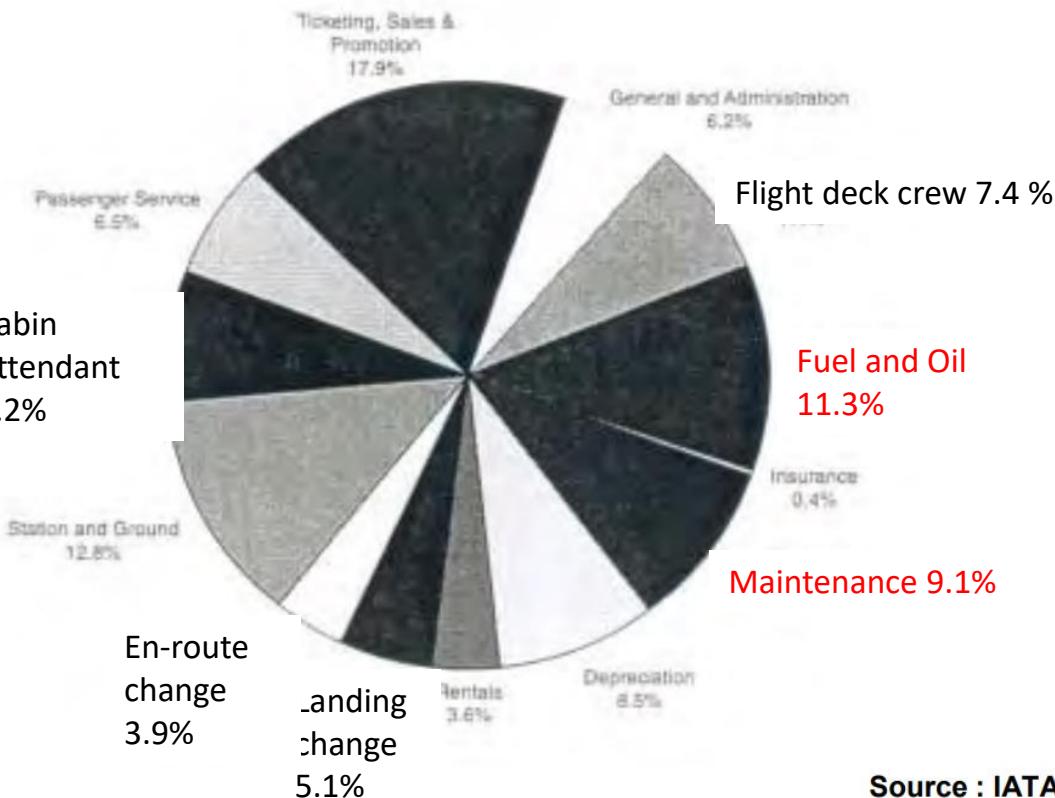


How is Path Planning important to Aviation Engineering?

- Commercial pilot follow the path that plan based on different cost index designed by airlines.

Objective: Safe and Minimum Cost

Figure 2. Distribution of operating costs



Source : IATA

<https://ansperformance.eu/library/airbus-cost-index.pdf>

2.1 Trip cost

Without having to resort to complicated mathematics we can readily appreciate that the total cost of a specific trip is the sum of fixed and variable costs :

$$C = C_F \times \Delta F + C_T \times \Delta T + C_c$$

with C_F = cost of fuel per kg
 C_T = time-related cost per minute of flight
 C_c = fixed costs independent of time
 ΔF = trip fuel
 ΔT = trip time

In order to minimize C or the total trip cost we therefore need to minimize the variable cost :

$$C_F \times \Delta F + C_T \times \Delta T$$

Cost-Index Published by Aircraft Manufacturer

Flight Operations Support & Line Assistance

getting to grips with the cost index

Issue II - May 1998

Customer Services

AIRBUS



3.1 A300/A310 Family

Considering, with good approximation, that the following range of time-related costs cover the maintenance cost difference between A300 and A310 as well as the cabin crew contingent (plus or minus two) difference, the following cost brackets result :

6 < Hourly maintenance cost < 12 (US\$/min)

+ 7 < Crew cost < 14 (US\$/min)

13 < Time-related cost < 26 (US\$/min)

NB : Crew composition = 2 cockpit crews + 8 (± 2) cabin crews.

In turn, the following cost index tables reflect these cost ranges for the A300 and for the A310.

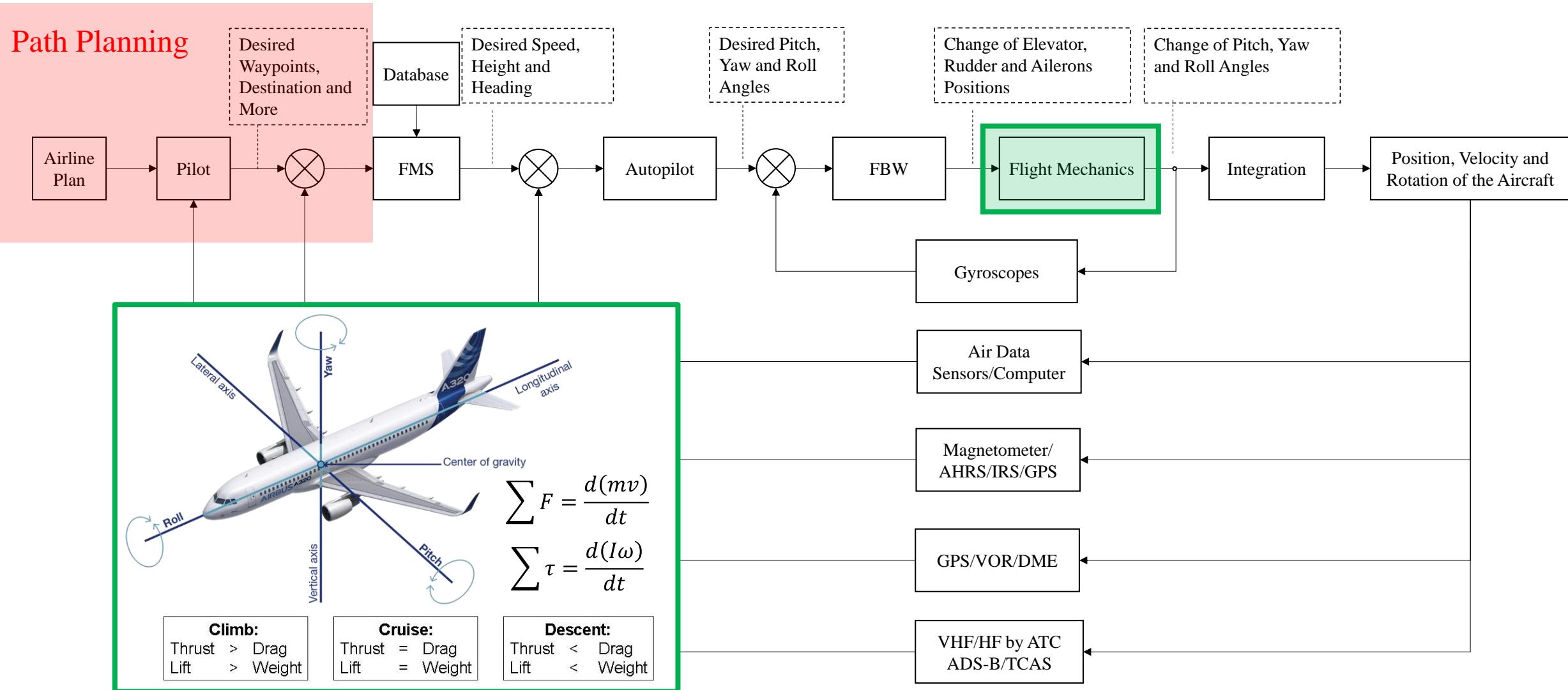
Table 1. A300/A310 cost index

(kg/min)
(Honeywell FMS)

TIME COST (US\$/min)\ FUEL COST (US\$/USG)	LOW	MEDIUM	HIGH
LOW < 0.7	65	85	100
MEDIUM 0.7 < < 0.9	50	65	80
HIGH > 0.9	40	55	65

<https://ansperformance.eu/library/airbus-cost-index.pdf>

Aircraft Operation in Flight Control System



How is the Freshman Project related to the AE programme study?

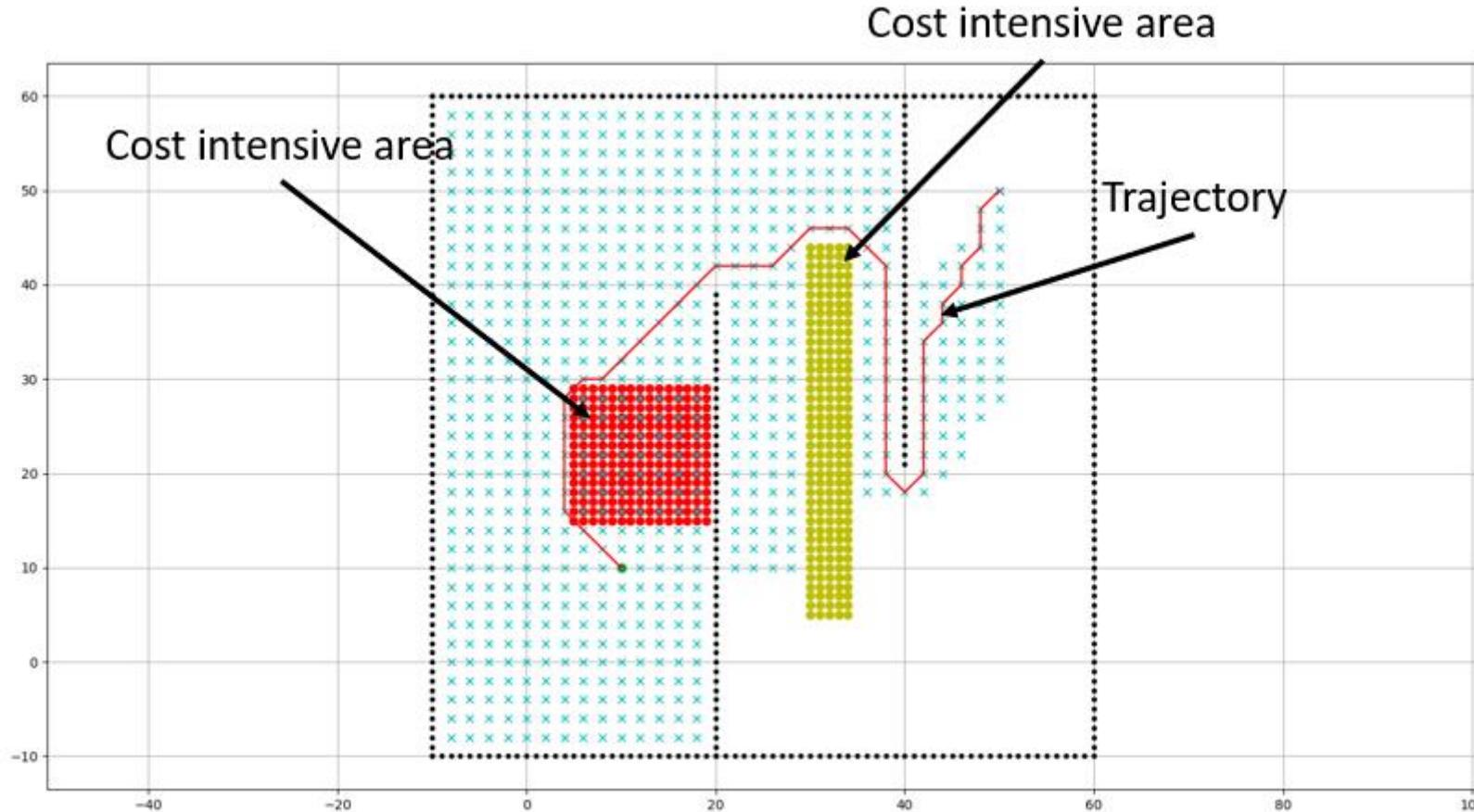
- Mathematics & Physics
- Computer Science
- Aeronautical and Aviation
- The plan should be planned considering the physical limitation (dynamics) of the aircraft

Year 1 (33 + 4 training credits)					
Semester 1 (15 + 2 training credits)		Semester 2 (18 +2 training credits)			
AAE2001	Introduction to Aircraft and Aviation Systems	AMA1120	Basic Mathematics II		
AMA1110	Basic Mathematics I	AP10006	Physics II		
AP10005	Physics I	APSS1L01	Tomorrow's Leaders		
ENG1003	Freshman Seminar for Engineering	ENG2003	Information Technology		
LCR I (English)		LCR II (English)			
		CAR I ^			
Healthy Lifestyle (non-credit bearing) ^					
IC2105 Engineering Communication and Fundamentals (4 training credits) or IC2133 Aircraft Manufacturing and Maintenance Fundamentals (4 training credits)					
Year 2 (30 + 3 training credits)					
Semester 1 (15 credits)		Semester 2 (15 + 3 training credits)			
AMA2111	Mathematics I	AMA2112	Mathematics II		
ENG2001	Fundamentals of Materials Science and Engineering / Biology / Chemistry	EE2902S	Fundamentals of Electrical and Electronic Engineering		
ENG2002	Computer Programming	ME33001	Mechanics of Materials		
ME23001	Engineering Mechanics	LCR III (Chinese)			
CAR II^		CAR III^			
IC381	Appreciation of Aircraft Manufacturing Processes (3 training credits)				
Year 3 (32 + 3 training credits)					
Semester 1 (17 + 1.5 training credits)		Semester 2 (15 + 1.5 training credits)			
AAE3001	Fundamentals of Aerodynamics	AAE3003	Aircraft Propulsion Systems		
AAE3002	Aircraft Structures and Materials	AAE4006	Flight Mechanics and Control Systems		
AAE3004	Dynamical Systems and Control	AAE4301	Avionics Systems		
ELC3531	Professional Communication In English For Engineering Students (2 credits)	AF3625	Engineering Economics		
CAR IV ^		ISE3009	Aviation Safety and Reliability		
Service Learning ^					
IC388 Aircraft Manufacturing and Maintenance practice (3 training credits)					

Path Planning

- Optimization Problem:
- To optimize a path that fulfilling all the constrains and by a set of certain criteria.
- Goal of this project, ***to select the best aircraft models with an optimized route that minimized the cost of the aircraft operation under given scenario.***
- ***Design the cost of the aircraft operation***
- ***Design an aircraft model (virtually) with different cost coefficients to fly safe and cheapest.***
- ***Design the path planning algorithm considering 3D, 2D + time, scenarios.***

Expected Outcome. Every Group have different scenarios



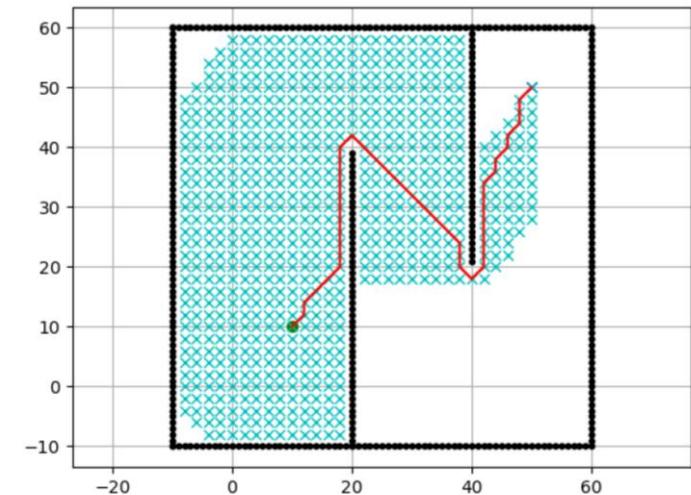
What you are expected to learn?

Academic level of algorithm designs

- Design of a path planning algorithm and aircraft model cost function
 - 2D path planning for simplicity

Make use of the **open-resource** to work on coding-project **remotely**.

- Programming and coding
 - Python
- Online coding collaboration
 - GitHub



python™



GitHub

In this project, students will be acted as

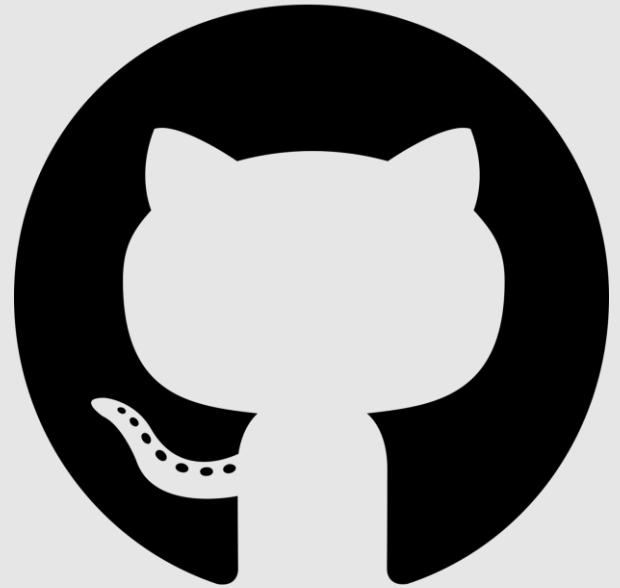
1. Group leader or members to collaborate on an online project,
2. R&D engineers to design and develop path-planning algorithm,
3. Project manager to present the designed code and prepare report.

Assessments

- (30%) Demonstration and Presentation
- (40%) Report & reflective essay – one report per group, with individual reflective essay
- (20%) Log sheet – one per student after the first week
- (10%) Performance/participation in in-class activities (Confidential peer evaluation)

Introduction to GitHub (Background)

What is GitHub?



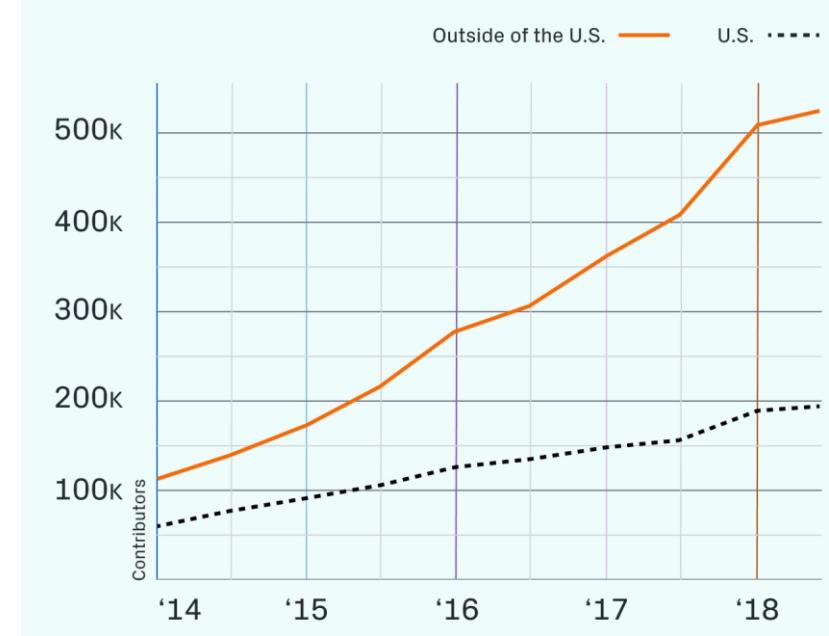
What is Github?



- A social network and platform for software developers
 - Over 65 million users
 - A place to Share, Communicate, Collaborate with others, especially programmers
-

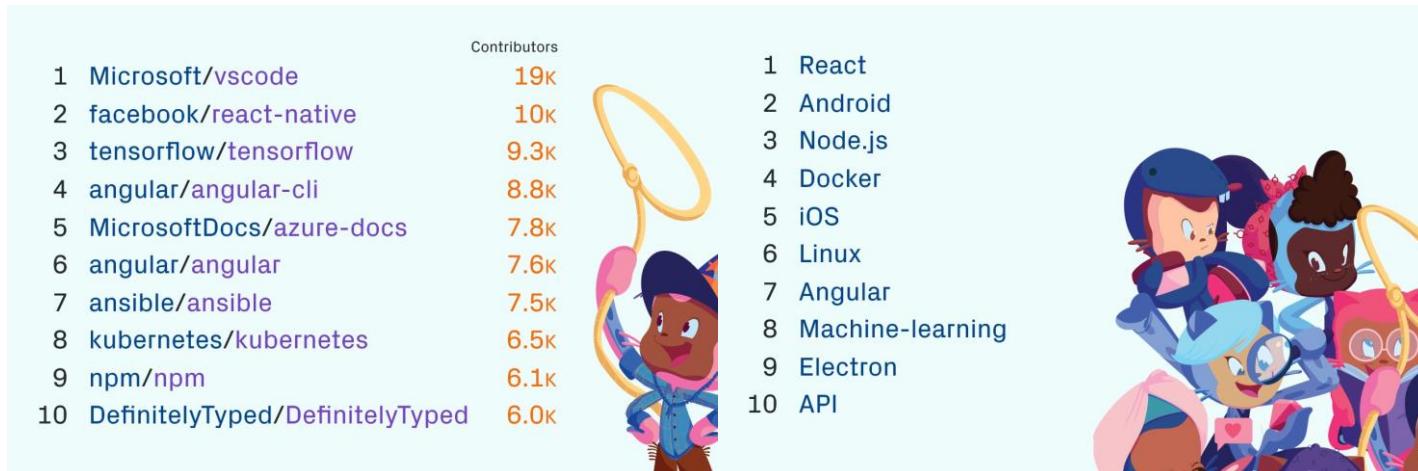
What's on GitHub

- Over 100 million live Projects
- New projects increasing over the years
- Showing the trend of using GitHub for Software development



Variety of GitHub

- Countless topics and projects available for the public
- Encompassing most popular topics nowadays



BIG GitHub Pages

Tesla, Inc.
Open source projects and samples from Microsoft

Microsoft
Open source projects and samples from Microsoft

Graphomer
This is the official implementation for "Do Transformers Really Perform Bad for Graph Representation?"

calculator
Windows Calculator: A simple yet powerful calculator that ships with Windows

v8-jsi
React Native V8 JSI adapter

ts-gyb
Generating native code interfaces from TypeScript

fixed-containers
C++ Fixed Containers

mongo-go-driver
Forked from mongo/mongo-go-driver
The Go driver for MongoDB

coreboot
Coreboot sources

linux
Linux sources

ansible puller

Google
Google ❤️ Open Source

<https://opensource.google/> [@GoogleOSS](#) opensource@google.com [Verified](#)

Repositories 2.1k **Packages** **People** 1.2k **Projects**

closure-compiler-npm
Package for managing and documenting closure-compiler for use via npm

it-cert-automation-practice
Google IT Automation with Python Professional Certificate - Practice files

CFU-Playground
Want a faster ML processor? Do it yourself! -- A framework for playing with custom opcodes to accelerate TensorFlow Lite for Microcontrollers (TFLM).

pytype
A static type analyzer for Python code

trax
Trax — Deep Learning with Clear Code and Speed

pigweed

BIG GitHub Pages

Boeing

Overview Repositories 5 Packages People Projects

Popular repositories

modular_navigation C++ ⭐ 6 📈 6	modular_cartographer C++ ⭐ 5 📈 5
cartographer C++ ⭐ 5 📈 3	math6d Python ⭐ 2 📈 1
image_tran C++	

Airbus Group

We design, manufacture and deliver industry-leading commercial aircraft, helicopters, military transports, satellites and launch vehicles
Toulouse <https://www.airbus.com> Verified

Overview Repositories 2 Packages People Projects

Popular repositories

scikit-decide AI framework for Reinforcement Learning, Automated Planning and Scheduling Python ⭐ 14 📈 10	ED247_LIBRARY Example of ED-247 standard implementation C++ ⭐ 13 📈 7
Repositories Find a repository... Type Language Sort	
ED247_LIBRARY Example of ED-247 standard implementation C++ ⭐ 13 📈 7 ⚡ 3 🔍 1	
scikit-decide AI framework for Reinforcement Learning, Automated Planning and Scheduling Python ⭐ 14 📈 MIT 📈 10 ⚡ 2 🔍 0	

[View all repositories](#)

NASA

Read about NASA's Open Data initiative here: <https://www.nasa.gov/open/> & Members Find Instructions here: <http://nasa.github.io/>
United States of America <https://github.com/nasa/nasa.github.io...> nasa-data@lists.arc.nasa.gov

Repositories 359 Packages People 42 Projects 1

Pinned repositories

[nasa.github.io](#)
<https://github.com/nasa/nasa.github.io/blob/master/docs/INSTRUCTIONS.md>

HTML ⭐ 238 📈 52

Find a repository... Type Language Sort

fprime

F - A flight software and embedded systems framework

raspberry-pi components real-time framework embedded cpp
nasa

C++ Apache-2.0 📈 981 ⚡ 8,370 ⚡ 68 (1 issue needs help) 🔍 7 Updated 34 minutes ago

cumulus-orca

Python 📈 7 ⚡ 7 ⚡ 0 🔍 1 Updated 1 hour ago

ow_autonomy

C++ 📈 4 ⚡ 13 ⚡ 0 🔍 0 Updated 2 hours ago

LHASA

R 📈 7 ⚡ 8 ⚡ 0 🔍 0 Updated 2 hours ago

earthdata-search

Earthdata Search is a web application developed by NASA EOSDIS to enable data discovery, search, comparison, visualization, and access across EOSDIS' Earth Science data holdings.

data-discovery hacktoberfest eosdis earthdata-search
JavaScript 📈 202 ⚡ 618 ⚡ 14 🔍 1 Updated 3 hours ago

Top languages

Python C C++ JavaScript
Jupyter Notebook

Most used topics

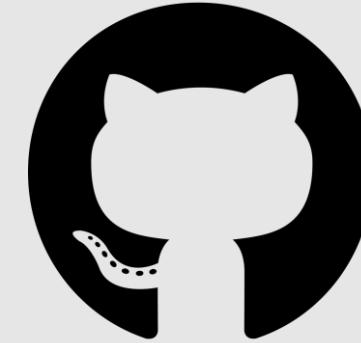
nasa cumulus nasa-cumulus
eosdis satellite

People 42

Developer Program Member

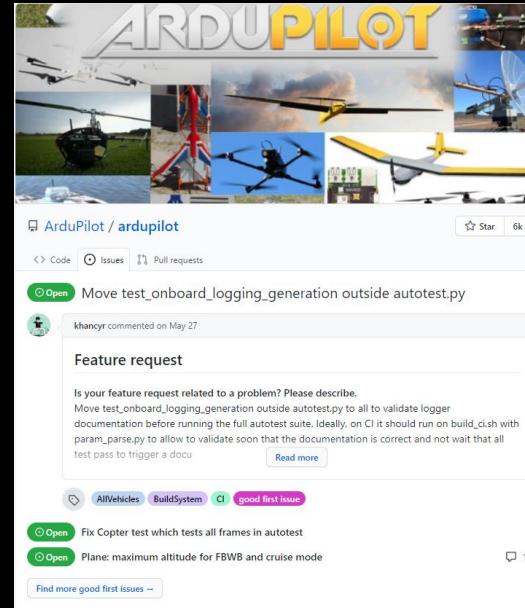
Report abuse

What's on GitHub? How is it related to AAE?



Flight control softwares for UAV

Ardupilot, PX4 and more



The screenshot shows the PX4 GitHub repository page. At the top is a banner with the PX4 logo and several small images of different UAVs. Below the banner, the repository name 'PX4 / PX4-Autopilot' is displayed along with a star icon and '4.7k' stars. A green button labeled 'Open' and the title 'Feature request' are visible. Below the title is a detailed description of the feature request. A section titled 'PX4 Autopilot Software' lists various tags: uav, drone, ros, px4, pixhawk, uas, dronecode, autopilot, mavlink, autonomous, drones, dds, hacktoberfest, ugv, mavros, multicopter, qgroundcontrol, fixed-wing, fast-rtps, avoidance. Below the tags, it says 'Updated 19 minutes ago' and 'C++'.

The screenshot then transitions to the mavlink/qgroundcontrol GitHub repository page. At the top is a banner with the mavlink/qgroundcontrol logo and several small images of different UAVs. Below the banner, the repository name 'mavlink / qgroundcontrol' is displayed along with a star icon and '1.9k' stars. A green button labeled 'Open' and the title 'Cross-platform ground control station for drones (Android, iOS, Mac OS, Linux, Windows)' are visible. Below the title is a detailed description of the repository. A section titled 'Cross-platform ground control station for drones (Android, iOS, Mac OS, Linux, Windows)' lists various tags: qt, uav, drone, px4, pixhawk, uas, mavlink, ardupilot. Below the tags, it says 'Updated 23 hours ago' and 'C++'.

About These Softwares

Ardupilot:

- Open source software suite
- Quadcopters, VTOL and more
- Cross platform
- Over 10 years of development and improvement



PX4:

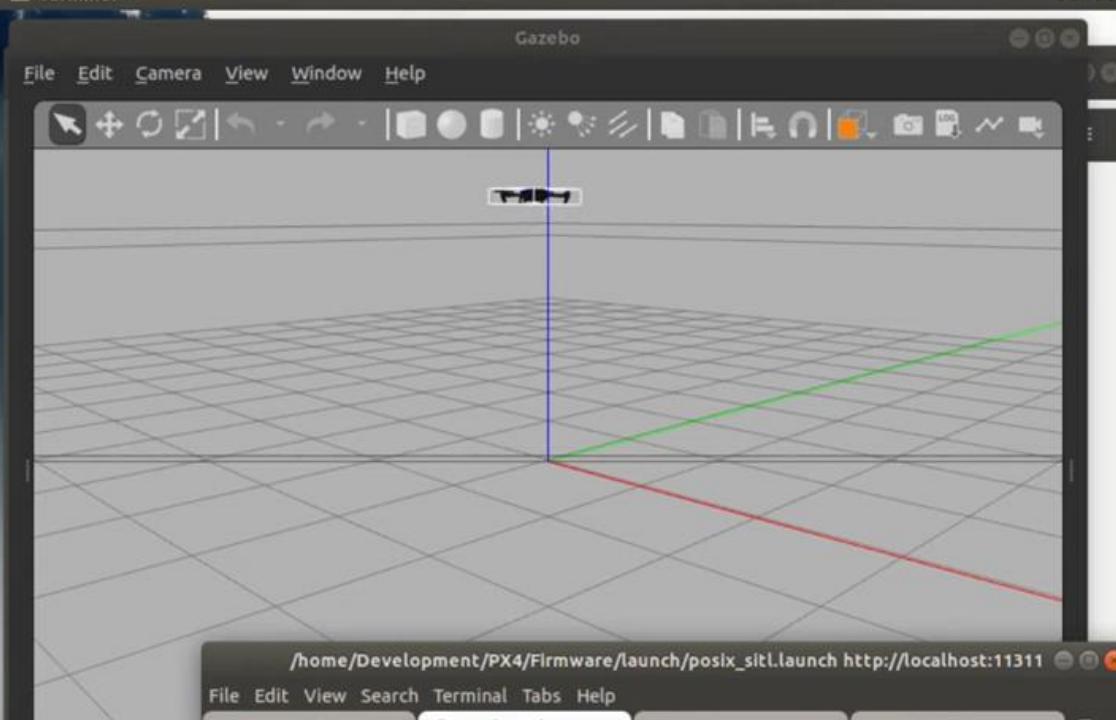
- Also open source
- Works with QGC and MAVLink (Also available in GitHub)



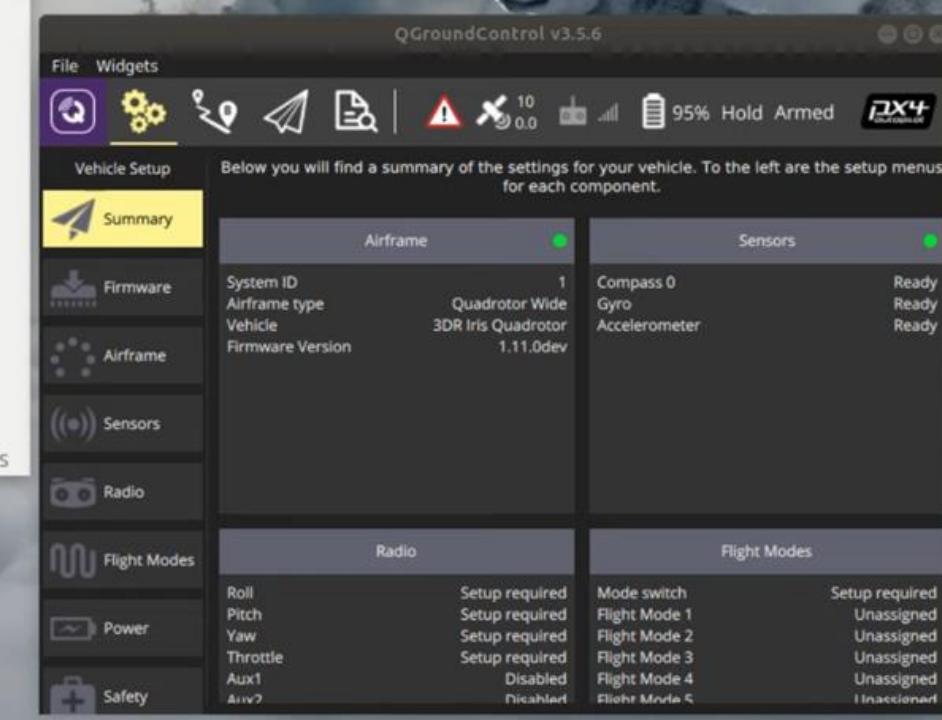
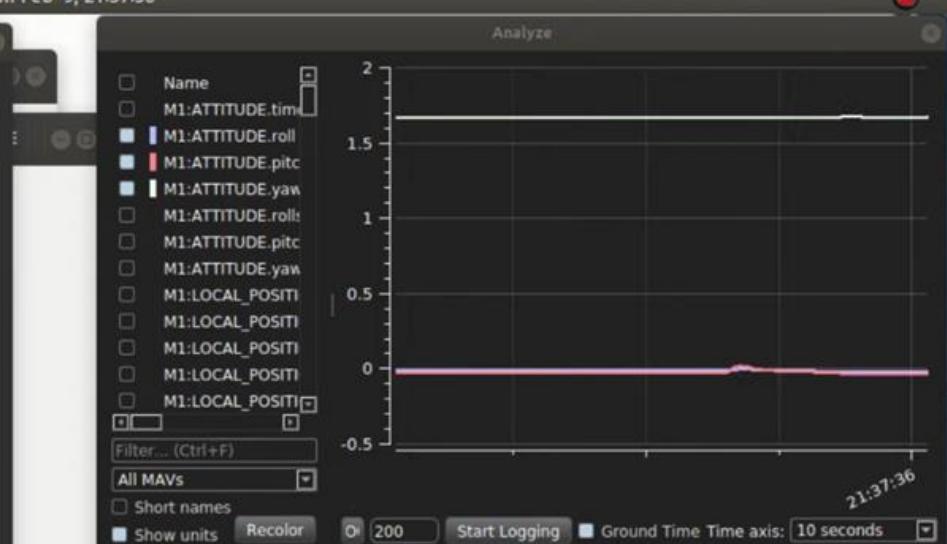
Activities Terminal

Sun Feb 9, 21:37:36

95%



```
/home/Development/PX4/Firmware/launch posix_sitl.launch http://localhost:11311
File Edit View Search Terminal Tabs Help
/gzclient:4781): dconf-WARNING **: 21:35:24.487: failed to commit changes to dco
nf: The connection is closed
(gzclient:4781): dconf-WARNING **: 21:35:24.487: failed to commit changes to dco
nf: The connection is closed
INFO [mavlink] partner IP: 127.0.0.1
INFO [mavlink] partner IP: 127.0.0.1
INFO [ecl/EKF] 468000: EKF aligned, (baro height, IMU buf: 22, OBS buf: 14)
INFO [ecl/EKF] 468000: reset position to last known position
INFO [ecl/EKF] 468000: reset velocity to zero
INFO [ecl/EKF] 644000: GPS checks passed (WGS-84 origin set)
INFO [vehicle_angular_velocity] updating filter, sample rate: 1000.000 Hz -> 25
0.000 Hz
INFO [vehicle_acceleration] updating filter, sample rate: 1000.000 Hz -> 250.00
0 Hz
INFO [ecl/EKF] 5188000: reset position to GPS
INFO [ecl/EKF] 5188000: reset velocity to GPS
INFO [ecl/EKF] 5188000: commencing GPS fusion
pxh>
pxh>
pxh> commander takeoff
pxh> INFO [commander] Takeoff detected
```



Aviation Services Engineering

Logistics and Facility Management
and more

airport

Here are 148 public repositories matching this topic...

Language: All ▾

Sort: Best match ▾

Ysurac / FlightAirMap

Star 388

Code Issues Pull requests

Open source project displaying live aircrafts, ships or trackers on 2D/3D map. Browse through the data based on a particular aircraft, airline, airport, tracker or vessel to search through the database or see extensive statistics. Can use ADS-B in SBS1 format (dump1090, Radarcap...), VRS, VA (VATSIM, IVAO whazzup.txt, phpvms,...), ACARS (acarsdec, acarsdeco2), APRS, AIS as datasource.

tracker cesium crash metar airport airline flight ship vatsim aircraft iavo acars
glidernet phpvms notam modes ads-b sbs vessel 3d-map

Updated on Nov 25, 2020 TSQL

felix-dumit / FSDAirportFlipLabel

Star 83

Code Issues Pull requests

UILabel like old Airport flipping labels

ios label ios-animation airport

Updated on Mar 9, 2018 Objective-C

Ivysauro / CNRT

Star 74

Code Issues Pull requests Discussions

中国轨道交通数据库 (非技术类) - 另一角度看地铁/ Data base of China Rail Transit (Non-tech) - Another view of Rail Transit

bus metro payment railway china airport subway rail-transit

Updated 3 days ago SCSS

gravity-EDDS / EDDS-freeware-releases

Star 57

Code Issues Pull requests

Logistics and Facility Management

- Data analysis resources
- System modelling and simulations
- Logistical models

Machine learning for data analysis

- Faster analysis
- Potential extra self-learning for students
- Extremely beneficial to their careers

The screenshot shows a GitHub repository page for 'LogisticsPipes'. At the top, it displays '4 branches' and '11 tags'. Below the repository name, there's a list of commits from 'Michał-MK' with details like date, file changes, and descriptions. To the right, there are sections for 'Releases' (17), 'Packages' (No packages published), 'Contributors' (60), and 'Languages' (Java 84.4%, Kotlin 15.6%).

The screenshot shows a GitHub search results page for 'Machine Learning'. It includes a sidebar with repository statistics (339K repositories, 8M code, 271K commits, etc.) and a language section (Jupyter Notebook 132,549, Python 72,791, etc.). The main area shows search results for 'Machine Learning' with details like repository name, description, language, and update date.

Aeronautical Engineering

Material, aircraft designs, CFD and more

computational-fluid-dynamics

Here are 198 public repositories matching this topic...

Language: All ▾

Sort: Best match ▾

doyubkim / fluid-engine-dev

Star 1.1k

Code Issues Pull requests

Fluid simulation engine for computer graphics applications

c-plus-plus visual-studio sdk animation computer-graphics physics-engine computational-physics fluid-simulation-engine computational-fluid-dynamics

Updated on Apr 25 C++

CubbyFlow / CubbyFlow

Star 175

Code Issues Pull requests

Voxel-based fluid simulation engine for computer games

cplusplus cpp computer-graphics physics-engine computational-physics cpp17 fluid-simulation-engine computational-fluid-dynamics

Updated 6 days ago C++

AvtechScientific / ASL

Star 153

Code Issues Pull requests

Advanced Simulation Library - hardware accelerated multiphysics simulation platform.

crystallography gpgpu scientific-computing high-performance-computing design-space-exploration computational-fluid-dynamics virtual-sensing image-guided-surgery computer-aided-engineering

Updated on Dec 21, 2018 C++

loliverhennigh / Steady-State-Flow-With-Neural-Nets

Star 119

Code Issues Pull requests

A Tensorflow re-implementation of the paper Convolutional Neural Networks for Steady Flow Approximation

aircraft-design

Here are 21 public repositories matching this topic...

Language: All ▾

Sort: Best match ▾

JSBSim-Team / jsbsim

Star 394

Code Issues Pull requests Discussions

Open XML validation

14

bcoconni commented on Jan 12, 2019

JSBSim provides schemas for XML validation (JSBSim.xsd for flight models, JSBSimScript.xsd for script files and JSBSimSystem.xsd for system files) but they have not been updated for a while so they might reject perfectly valid XML files.

XML files can be tested with xmllint

> xmllint --noout --schema JSBSim.xsd file.xml [Read more](#)

bug help-wanted good-first-issue

Aero Sandbox

by Peter Sharpe



peterdsharpere / AeroSandbox

Sponsor Star 236

Code Issues Pull requests

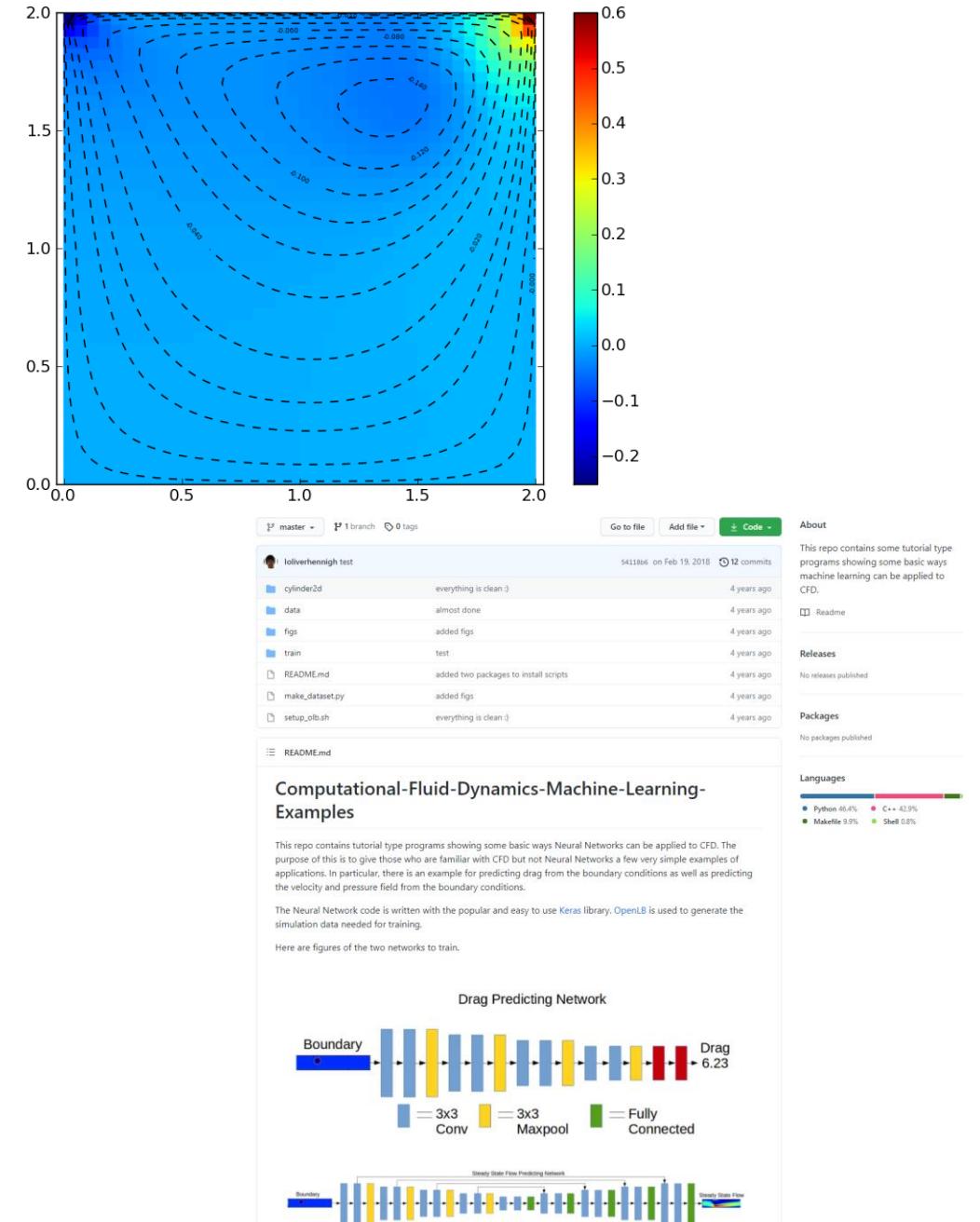
Aircraft design optimization made fast through modern automatic differentiation. Plug-and-play analysis tools for aerodynamics, propulsion, structures, trajectory design, and much, much more.

python analysis optimization aerospace automatic-differentiation airplane cfd aircraft aerodynamics vlm xfoil aircraft-design indra mdao aerodynamic-analysis 3d-panel

Updated 4 days ago Jupyter Notebook

CFD Python

- Full course for CFD Python
- Course Materials (Lectures and video)
- Software resources



Aircraft Maintenance

Propulsion, NDT and more

NASA Jet Propulsion Laboratory
A world leader in the robotic exploration of space
Pasadena, California, US <http://www.jpl.nasa.gov> github@jpl.nasa.gov

Overview Repositories 26 Packages 6 People 6 Projects

Pinned

open-source-rover
A build-it-yourself, 6-wheel rover based on the rovers on Mars!
Gnuplot 6.8k 1.1k

osr-rover-code
Code that runs on the Open Source Rover
Python 267 96

COVID-19-respirators
JPL designed 3D and tested printed respirators to help with the COVID-19 pandemic response.
G-code 104 18

osr-android-app
Android application used to control the Open Source Rover
Java 59 30

SPOC
A website showcasing SPOC (Soil Property and Object Classification), a deep learning-based terrain classifier for Mars rovers
HTML 6 1

spoc_lite
A light-weight, experimental terrain classifier for Mars rovers
C++ 7 4

Repositories

Find a repository... Type Language Sort

itslive
A NASA MEaSUREs project to provide automated, low latency, global glacier flow and elevation change datasets
Jupyter Notebook 4 MIT 0 3 0

LiveViewLegacy
Real-time tools for Imaging Spectroscopy Data
C++ 18 7 0 0 0

open-source-rover
A build-it-yourself, 6-wheel rover based on the rovers on Mars!
Gnuplot 6,785 Apache-2.0 1,104 34 (1 issue needs help) 8

itslive-projects
Jupyter Notebook 0 MIT 0 0 0

sstmp
Solar System Treks Mosaic Pipeline
Python 4 Apache-2.0 0 21 0

jsd
Just SOEM Drivers

Example on NDT

- Resources on the whole conference
 - 20th World Conference on Non-Destructive Testing
- Documentation and software resources
- Applying LSTM to NDT

master 3 branches 0 tags Go to file Add file Code

vewald Merge branch 'master' of https://github.com/xaviergoby/LSTMforSHM 0f00291 on Oct 21, 2020 67 commits

File	Description	Time Ago
configs_and_settings	recent work	10 months ago
literature	non-code commit	13 months ago
results	Merge branch 'master' of https://github.com/xaviergoby/LSTMforSHM	10 months ago
src	recent work	10 months ago
.gitignore	recent work	10 months ago
LICENSE	Initial commit	2 years ago
README.md	Revert "Results Update"	13 months ago
__init__.py	1st commit of og Vicent lstm & my data_loading script w/ data and labels	2 years ago
call_mainscript.py	Update results	10 months ago
main.py	recent work	10 months ago
main_v2.py	Merge branch 'master' of https://github.com/xaviergoby/LSTMforSHM	10 months ago
main_v3_xav.py	recent work	10 months ago
p2atR.jpg	non-code commit	13 months ago
settings.py	recent work	10 months ago

Readme MIT License

Releases No releases published

Packages No packages published

Contributors 2 xaviergoby Alexander Xavier O'Rour... vewald

Environments 1 github-pages Active

Languages Python 100.0%

About Application of LSTM network for Structural Health Monitoring & Non-Destructive Testing

xaviergoby.github.io/convlstm-compu...

computer-vision timeseries tensorflow keras cnn waves lstm supervised-learning classification shm ultrasonic-sensor ndt structural-engineering structural-analysis convlstm structural-health-monitoring lambwaves pzt aircraft-inspection non-destructive-testing

Sequential Modelling in Data-Driven Approach for Structural Health Monitoring by Recurrent Convolutional Neural Networks

Conference: 20th World Conference on Non-Destructive Testing
Location & Date: South Korea, Seoul - June 2020
Co-authors: Ewald V., Goby X., Groves R.M. & Benedictus R.
Labarotory: TU Delft Aerospace NDT Lab

Usage Instruction

In order to make use of this project all you need mainly be concerned with is the main.py Python script. In it you shall (hopefully) find yourself a more than sufficient amount of documentation in order to understand and be able to make use of it!

Dev Progress Log-Journal, Data Characteristics & Background Information

Notes:

Navigation and Positioning

RTKLIB, VINS, ORB_SLAM3, ROS and more

The image displays three GitHub repository pages side-by-side:

- UZ-SLAMLab / ORB_SLAM3**: This page shows the repository's code history. The master branch has 49 commits from richard-elvira. Recent commits include "V0.4: Beta version, 21 April 2021" for Examples, Thirdparty, Vocabulary, evaluation, include, src, .gitignore, CMakeLists.txt, Changelog.md, Dependencies.md, LICENSE, README.md, build.sh, and build_ros.sh. The repository has 165 issues, 27 pull requests, and 1k forks.
- tomojitakasu / RTKLIB**: This page shows the repository's code history. The master branch has 69 commits from tomojitakasu. Recent commits include "rtklib 2.4.2 p13" for app, bin, brd, data, doc, lib, and src. The repository has 303 issues, 39 pull requests, and 290 forks.
- HKUST-Aerial-Robotics / VINS-Mono**: This page shows the repository's code history. The master branch has 76 commits from shaozu. Recent commits include "fix ar_demo image interface" for ar_demo, "another warning" for benchmark_publisher, "add Eigen3 cmake" for camera_model, "Merge branch 'master' of github.com:HKUST-Aerial-Robotics/VINS-Mono" for config, "update docker" for docker, "add realSense config: avoid imu disorder; fix relocalization visualiza..." for feature_tracker, "add docker" for pose_graph, "modify readme" for support_files, "user-friendly updates" for vins_estimator, and "user-friendly updates" for .gitignore, LICENSE, and README.md. The repository has 231 issues, 4 pull requests, and 217 forks.

Repository Examples

- UAV Powering Programmes
- Weather and Traffic Receiver
- Radio demodulator
- Proximity awareness systems
- Traffic visualization
- And more!!
- <https://github.com/topics/aviation>

The screenshot shows the GitHub search interface for the topic '# aviation'. It displays three repository cards:

- generalized-intelligence / GAAS**: A repository for an open-source program designed for fully autonomous VTOL (a.k.a. flying cars) and drones. It stands for Generalized Autonomy Aviation System. The repository has 1.6k stars. It uses C++ and includes tags like aviation, uav, drone, flight-controller, flight, lidar, autonomous, drones, autonomous-quadcopter, autonomous-driving, autonomous-vehicles, vtol, flying-car, evtol, hd-map, e-vtol.
- cyoung / stratus**: A repository for an aviation weather and traffic receiver based on RTL-SDR. It uses C and includes tags like aviation, weather, traffic, rtl-sdr, stratus.
- szpaider / RTLSDR-Airband**: A repository for an RTLSDR-Airband project. It uses C and includes tags like aviation, weather, traffic, rtl-sdr.

Other related Repositories

- UAV simulation platforms
- ADS-B Decoder
- Aircraft design optimization
- Aircraft design toolbox
- <https://github.com/topics/aircraft>

Explore in your free time and you might find out something interesting!

The screenshot shows the GitHub search interface for the topic '# aircraft'. It displays 287 public repositories matching the search term. The first repository listed is `wiedehopf/tar1090`, which provides an improved webinterface for use with ADS-B decoders. The second repository is `JSBSim-Team/jsbsim`, which provides schemas for XML validation. The third repository is `robin-shaun/XTDrone`, which is a UAV Simulation Platform based on PX4, ROS and Gazebo.



What Will You will Learn and Experience?

- Pull Request (Basic Features)
 - Allowing leaders to **double check** modifications done by teammates
- Code Synchronization (Version Control on Web, VS, MATLAB etc)
 - Ensuring everyone is working on the **latest** code version
- Self-learning using GitHub resources
- Look for interesting issues on GitHub

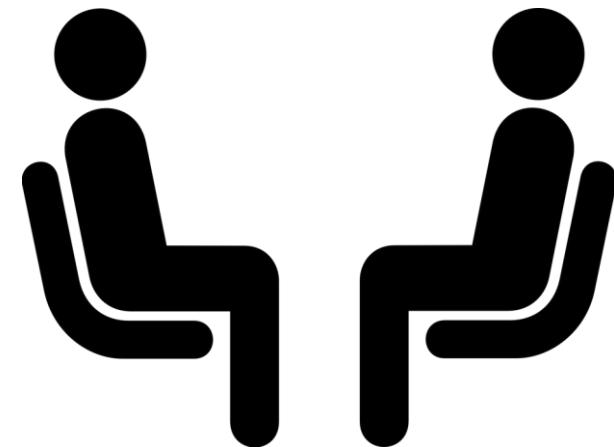


For Your Career

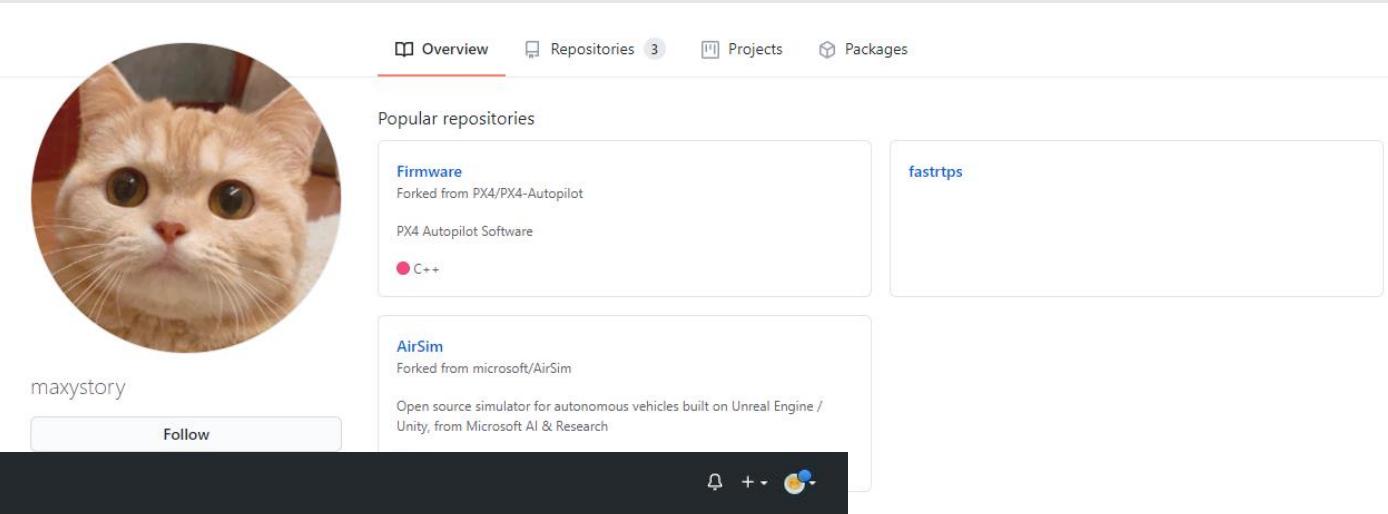


GitHub Facilitated Job Hunting

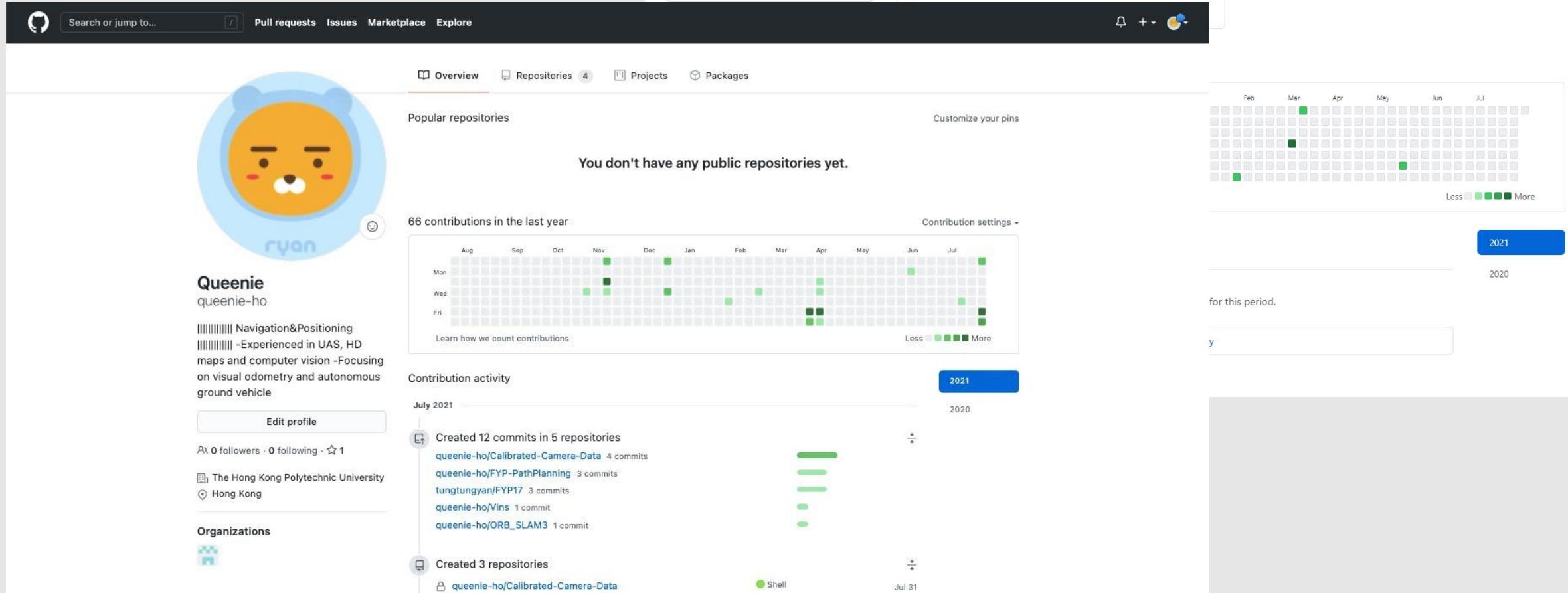
- A online digital profile for students
 - Indicating interests
 - Show past work
 - Roadmap of students' development career
- Let people know that you are looking for a job
- During job hunting
 - Better first impression
 - Better understanding
 - Appears more enthusiastic



Develop Personal Profiles Starting from AAE UG



The screenshot shows a GitHub profile for the user 'maxystory'. The profile picture is a close-up of an orange cat's face. Below the picture, the username 'maxystory' is displayed, along with a 'Follow' button. The top navigation bar includes links for Overview, Repositories (3), Projects, and Packages. The 'Popular repositories' section lists 'Firmware' (forked from PX4/PX4-Autopilot) and 'AirSim' (forked from microsoft/AirSim). The 'Firmware' repository is described as 'PX4 Autopilot Software' in C++.



The screenshot shows a GitHub profile for the user 'queenie-ho'. The profile picture is a cartoon character with a yellow face and blue body. Below the picture, the username 'queenie-ho' is displayed, along with a link to 'Edit profile'. The user has 0 followers, 0 following, and 1 starred repository. The bio mentions experience in UAS, HD maps, and computer vision, focusing on visual odometry and autonomous ground vehicle. The 'Popular repositories' section indicates 'You don't have any public repositories yet.' The 'Contribution activity' section shows a heatmap of contributions over the last year, with 66 contributions in total. The timeline shows contributions from August 2020 to July 2021. The 'Contribution settings' dropdown is open. The 'Contributions' section lists repositories created: 'Created 12 commits in 5 repositories' (queenie-ho/Calibrated-Camera-Data 4 commits, queenie-ho/FYP-PathPlanning 3 commits, tungtungyan/FYP17 3 commits, queenie-ho/Vins 1 commit, queenie-ho/ORB_SLAM3 1 commit) and 'Created 3 repositories' (queenie-ho/Calibrated-Camera-Data, Shell).



B.X.W
baaixw

Follow

Visual SLAM GNSS

At 8 followers · 15 following · ⭐ 42

Intelligent Positioning and Navigation L...
Hong Kong

Achievements



Block or Report

Overview Repositories 33 Projects Packages

Popular repositories

remoteSensing2020

Improved VINS based on the adaptive covariance and adaptive M-estimator

C++ ⭐ 4 2

ios_logger

Forked from Vanvarilos_ios_logger

Application for camera and sensor data logging (IOS)

Objective-C++ ⭐ 1

vins-application

Forked from engcang/vins-application

VINS-Mono and Fusion application of different sets of cameras and imu on different board including desktop and jetson xavier

C++ ⭐ 1

catkin

Original vins-fusion for validation some data. The related path has been revised to ourself path.

C++ ⭐ 1

CV_GNSS

Forked from weisongwen/CV_GNSS

CV Aided GNSS

C++

tutorials

128 contributions in 2020



2021
2020
2019
2018

Activity overview

Contributed to weisongwen/researchTools.

Code review

Up to Phd Studies

Overview Repositories 24 Projects Packages

Pinned

Darren Wong

DarrenWong

Follow

move fast

At 18 followers · 16 following · ⭐ 95

Hong Kong

darrenwongf@gmail.com

Achievements

Organizations

Block or Report

Pinned

e3372-web-management

Getting HUAWEI E3372 info with official API, such as device info, data switch and send sms etc

CSS ⭐ 8 2

protobuf-over-nanomsg-example

Protobuf over nanomsg (C++ as server, and nodejs as client)

C++

weisongwen/UrbanNavDataset

UrbanNav: an Open-Sourcing Localization Data Collected in Asian Urban Canyons, Including Tokyo and Hong Kong

139 32

98 contributions in the last year

A 12x12 grid representing monthly contributions. Contributions are more concentrated in the first half of the year (January to June) and show a significant dip in activity during the second half (July to December). A legend at the bottom right indicates 'Less' (light green), 'More' (dark green), and 'More' (darkest green).

IPNL @IPNL-POLYU @HKUST-Aerial-Robotics

Activity overview

Contributed to IPNL-POLYU/UrbanNavDataset,
IPNL-POLYU/ipnl-sensor-kit,

DarrenWong/benchmark_lo

and 5 other repositories

Code review

100% Commit Issues

2021

2020

2019

2018

2017

2016

2015

2014

2013



Seph Soliman
scarlac

[Follow](#)

Tattoodo, Bitbucket, Konstellation. Software entrepreneur, developer and true full stack developer.

64 followers · 7 following · 71 contributions

[Tesla](#)
San Francisco
<https://www.seph.dk>

Achievements



Organizations


Block or Report

Pinned

- js-stopwatch**
JavaScript Stopwatch class. Output can be controlled using a simple callback.
JavaScript ⭐ 24 ⚡ 7
- drag-check-js**
Library for checking multiple checkboxes by click-and-dragging over them. Paint your selection!
JavaScript ⭐ 21 ⚡ 9
- ClamshellOpen**
App to allow running your laptop in clamshell mode with an open lid for Lion (10.7) and Mountain Lion (10.8)
Objective-C ⭐ 5
- chargenow**
See DriveNow EVs in your area that needs charging. First react project.
JavaScript ⭐ 1
- d3d-strategy**
Exam assignment to write a C# program. I chose to write a Direct 3D Strategy game. Graphics for this game was borrowed from C&C: Red Alert. For legal reasons, they are not included in the repository.
C# ⭐ 1
- lолpause**
MacOS utility app to pause League of Legends GUI Flash client while game is active to lower CPU consumption
Objective-C ⭐ 1

44 contributions in 2021





Jonathan Hall
flimzy

You can also find me on GitLab: <https://gitlab.com/flimzy>

[Follow](#)

139 followers · 32 following · 45 contributions

Amsterdam, NL
<https://jhall.io/>
[@DevOpsHabits](#)

Highlights

* Arctic Code Vault Contributor

Organizations

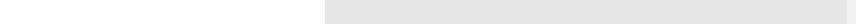




Popular repositories

- anki**
Go library to read Anki *.apk files
Go ⭐ 18 ⚡ 3
- go-pouchdb**
GopherJS bindings for PouchDB ⚠ NOTICE ⚡ this package has been superseded by https://github.com/go-kivik/kivik
Go ⭐ 13 ⚡ 1
- onload**
Onload handler for GopherJS without the bloat of jQuery
Go ⭐ 10 ⚡ 1
- go-sql.js**
GopherJS bindings for SQL.js
Go ⭐ 9
- minimal-pairs**
Tool for finding minimal pairs given a corpus of words
HTML ⭐ 5 ⚡ 1
- jsblob**
GopherJS bindings for JavaScript Blob objects
Go ⭐ 3

977 contributions in the last year





Jonathan Hall
flimzy

You can also find me on GitLab: <https://gitlab.com/flimzy>

[Follow](#)

139 followers · 32 following · 45 contributions

Amsterdam, NL
<https://jhall.io/>
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Organizations





Popular repositories

- anki**
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GopherJS bindings for PouchDB ⚠ NOTICE ⚡ this package has been superseded by https://github.com/go-kivik/kivik
Go ⭐ 13 ⚡ 1
- onload**
Onload handler for GopherJS without the bloat of jQuery
Go ⭐ 10 ⚡ 1
- go-sql.js**
GopherJS bindings for SQL.js
Go ⭐ 9
- minimal-pairs**
Tool for finding minimal pairs given a corpus of words
HTML ⭐ 5 ⚡ 1
- jsblob**
GopherJS bindings for JavaScript Blob objects
Go ⭐ 3

977 contributions in the last year



Making GitHub Part of your Work

Now you have an empty GitHub profile. How do you make it shine?

The following tips are roughly organized according to effort. Practically anyone can implement at least some of them. The later suggestions will be more discretionary, depending on your interests and time.

Star interesting projects

Whenever you run across a GitHub project that piques your interest, "star" it. Your starred projects appear on your public profile, and if nothing else, they provide recruiters and hiring managers an indication of what sorts of projects you find interesting.

Follow interesting people

GitHub also allows you to follow interesting people, and these people will appear on your public profile, as well. In addition to signaling to the world whom you find interesting, when people you follow make contributions to their projects, you will



Introduction to GitHub Operations

Mutual editing on a document with collaborators remotely?

 acceptance	26/3/2021 11:58 AM	File folder	
 final submission	2/8/2021 11:38 AM	File folder	
 ieee_taes_novatel_heatmap	29/7/2020 2:44 PM	File folder	
 My EndNote Library.Data	20/7/2020 9:17 PM	File folder	
 My EndNote Library.enl.unzipped	14/7/2020 9:26 AM	File folder	
 revision 1	28/12/2020 5:31 PM	File folder	
 Artical file (single column).docx	24/8/2020 3:55 PM	Microsoft Word D...	4,036 KB
 Article Processing Charges.pdf	19/4/2021 9:33 AM	Adobe Acrobat D...	118 KB
 cover letter.docx	28/7/2020 12:26 PM	Microsoft Word D...	17 KB
 figure.pptx	22/6/2020 11:11 AM	Microsoft PowerP...	7,122 KB
 ieee_taes_3dma_rtk (20200612 Ivan).docx	22/6/2020 10:12 AM	Microsoft Word D...	4,103 KB
 ieee_taes_3dma_rtk (20200622 GH).docx	22/6/2020 2:52 PM	Microsoft Word D...	4,112 KB
 ieee_taes_3dma_rtk (20200709 WS).docx	9/7/2020 3:38 PM	Microsoft Word D...	4,294 KB
 ieee_taes_3dma_rtk (20200714 LT).docx	15/7/2020 5:47 PM	Microsoft Word D...	4,306 KB
 ieee_taes_3dma_rtk (20200722 lucy).docx	23/7/2020 4:49 PM	Microsoft Word D...	7,319 KB
 ieee_taes_novatel_heatmap.rar	29/7/2020 2:42 PM	WinRAR archive	13,851 KB
 Manuscript_two_columns.docx	13/10/2020 1:45 PM	Microsoft Word D...	4,030 KB
 My EndNote Library.enl	8/1/2021 10:42 AM	EndNote Library	141 KB
 References.docx	14/7/2020 9:16 AM	Microsoft Word D...	18 KB

Download files from various channels, such as mail, whatsapp, etc?

Can we edit the documents online ? Google, Microsoft has the solutions!

Can we edit the “code” online? **Github**

Archive your coding online (in the cloud)

Pull

Pull: *To update local branch with remote, update all remote tracking branches*

Video: **VSC-Git Basic Operations**

Cloud repository (project)

Clone : *To download a repository to your local machine*

Clone/
Fetch

Local repository (project)

Fetch : *To pull a branch to your local machine*

Push

Push: *To upload the commit made on a local branch to GitHub*

Check out to: *Switch to a specific branch*

Open file and
Check out to

Code and Debugger

Commit

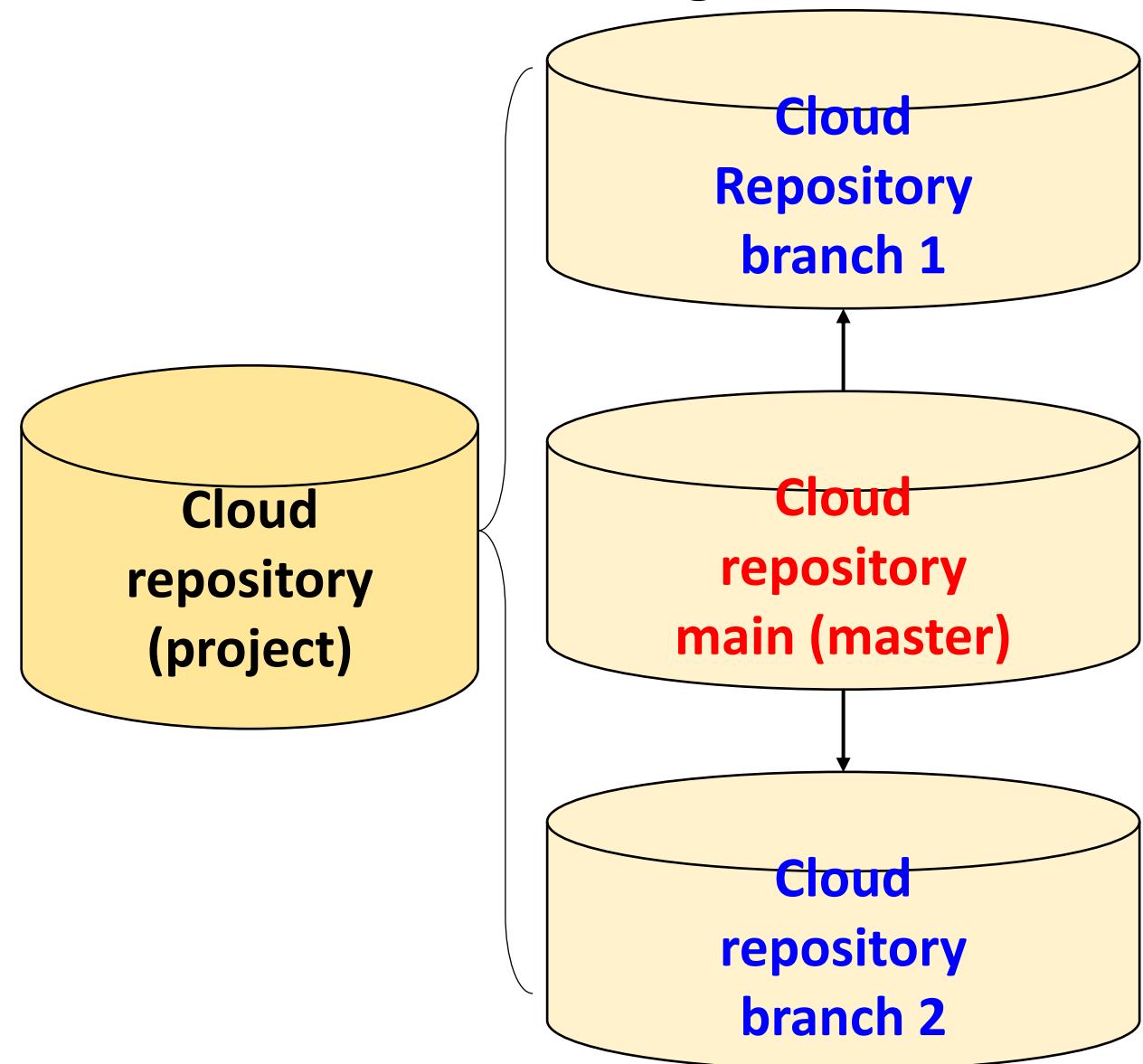
New Version

Add (Stage)

Commit: *To create a snapshot of the repository*

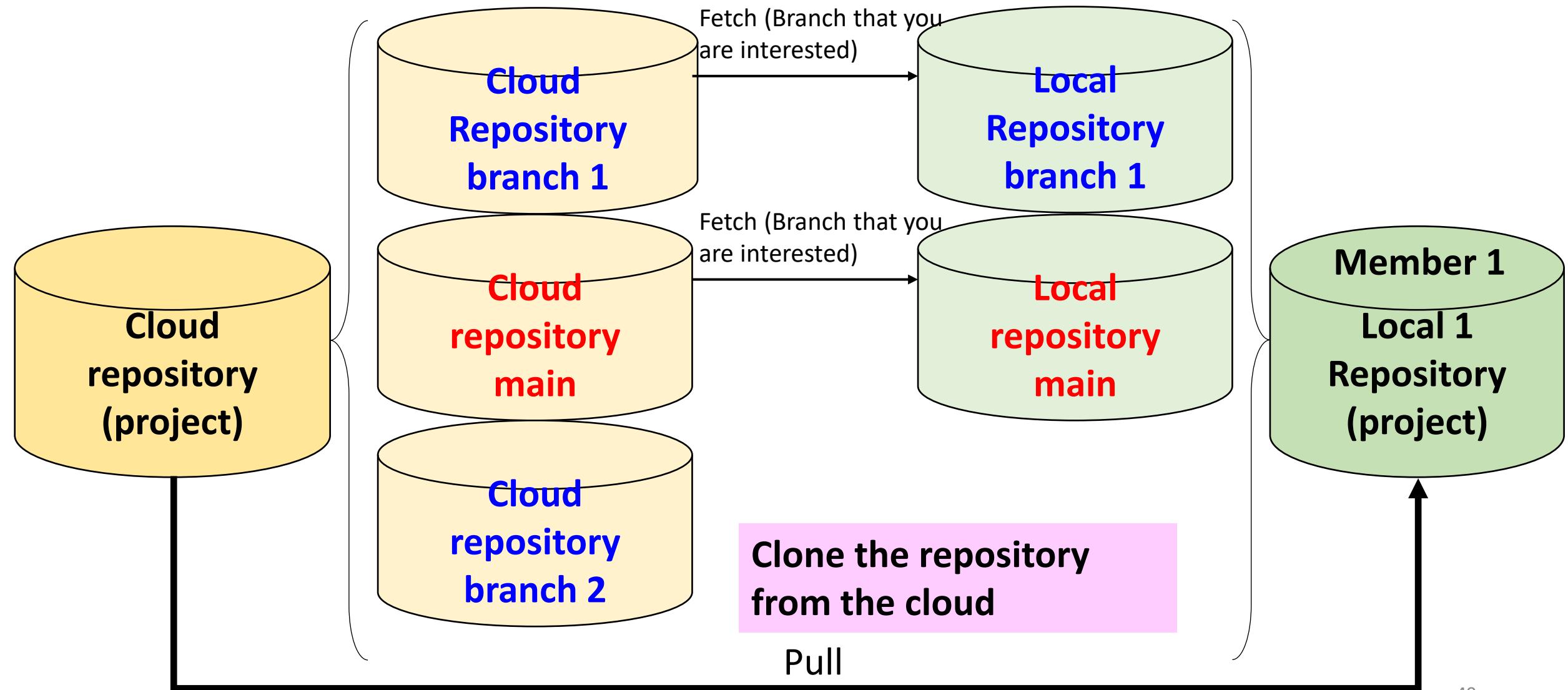
Add (Stage): *To add files or segments in the next commit*

Collaborative coding online – Generate Branch (Member)

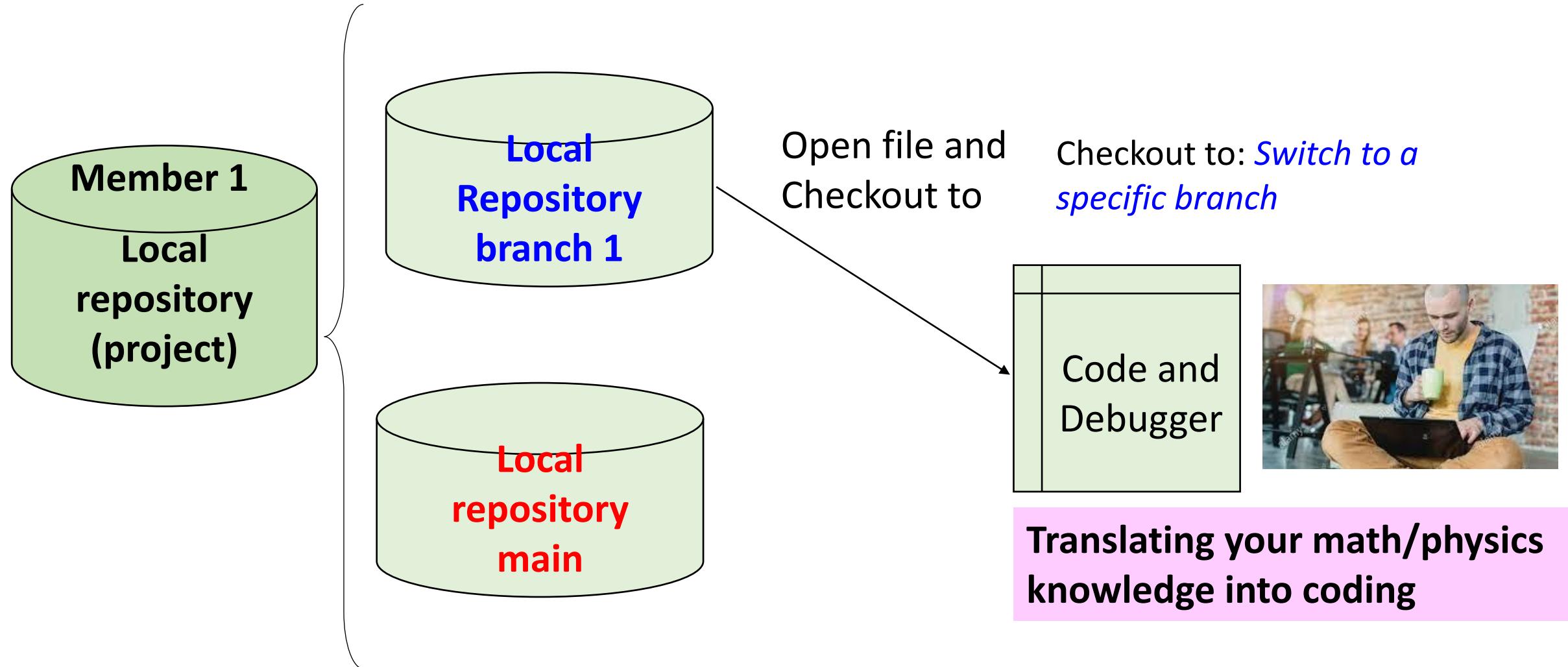


To generate a branch for different member that participant the project, creating a contained area of your repository to develop features, fix bugs and more.

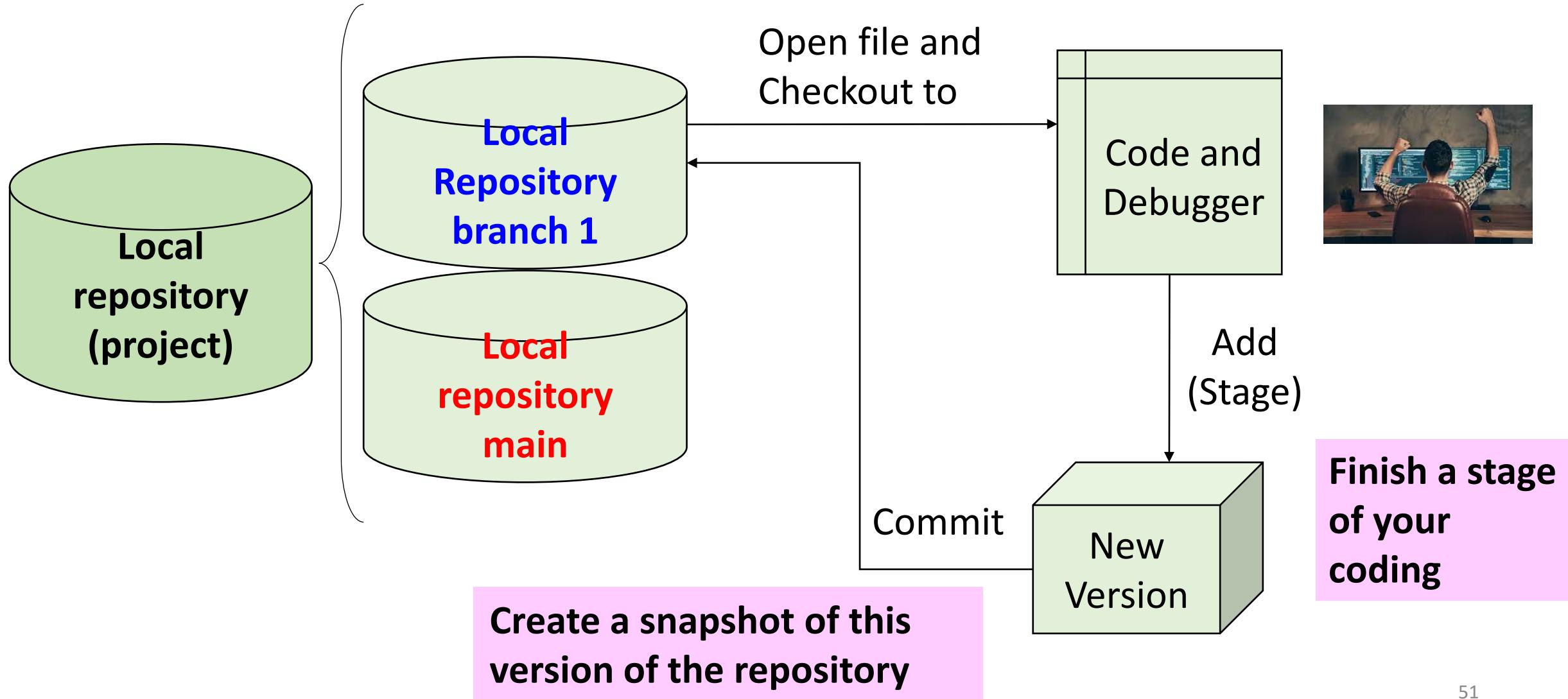
Collaborative coding online – Fetch/Pull Branch from Cloud



Collaborative coding online – Edit the code in the local computer



Collaborative coding online – Edit the code in the local computer

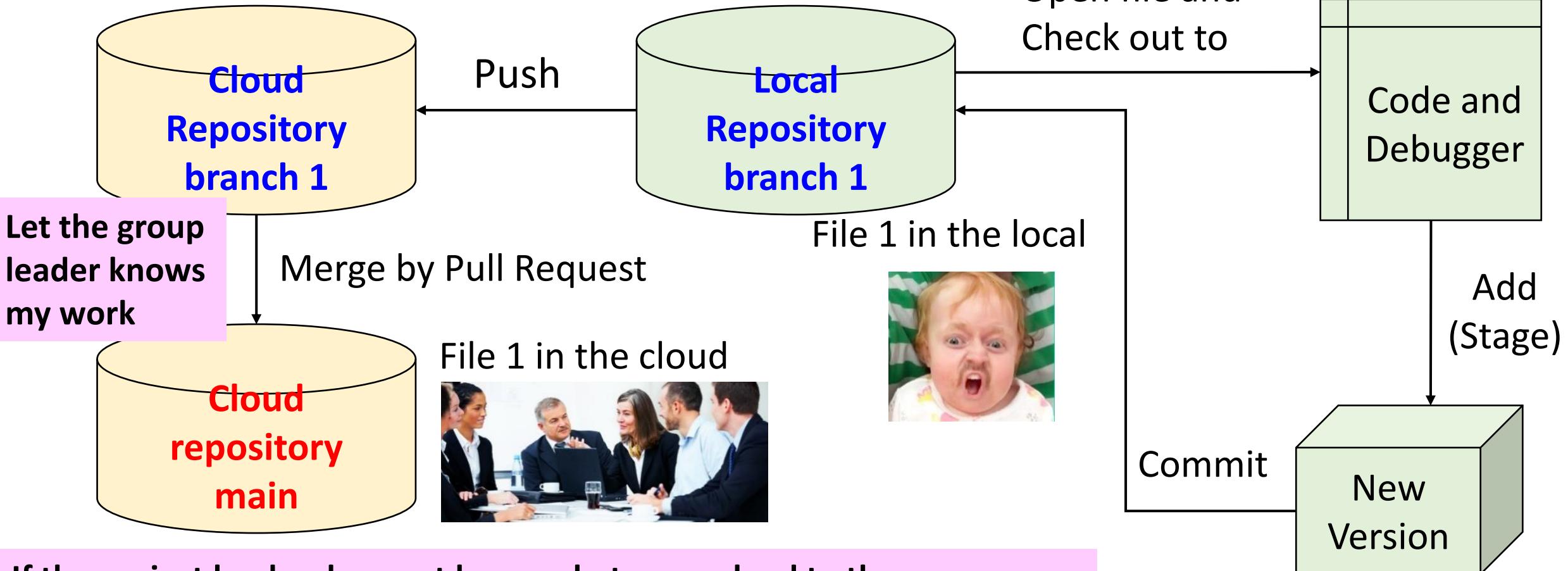


Concept of collaborative coding online

Web based

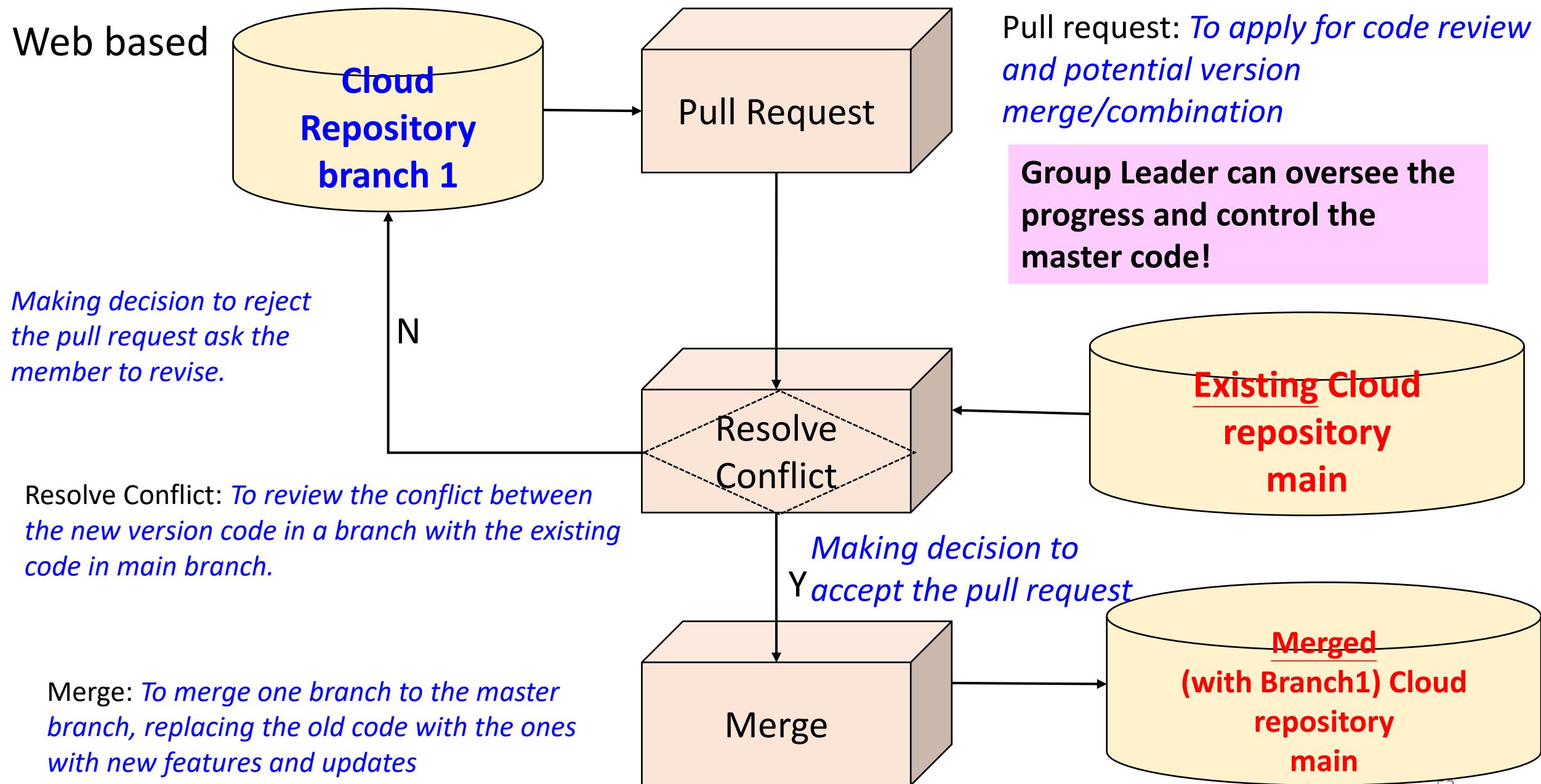
Video: [VSC-Git Branches](#)

Ready to update to the cloud branch!

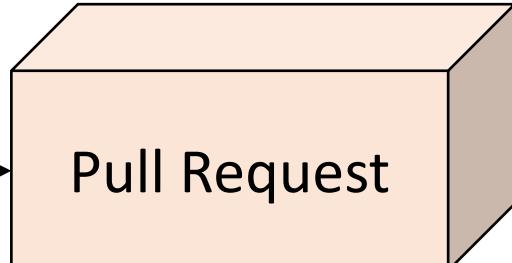
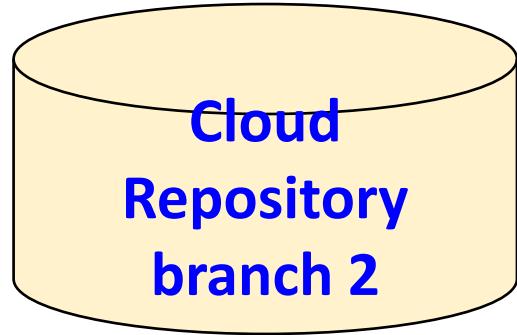


If the project leader does not know what you upload to the source code, you will create a lot of confusions!

Web based



Web based

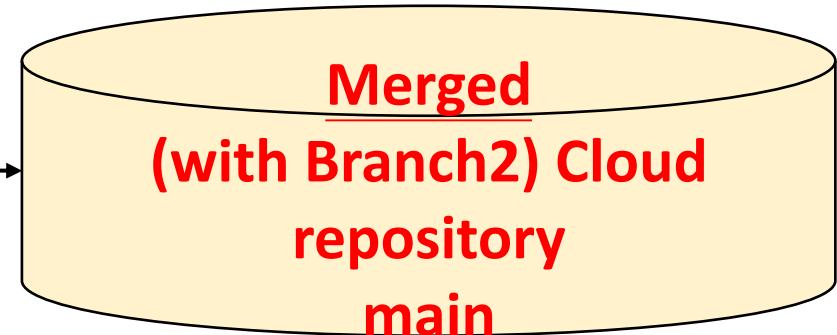
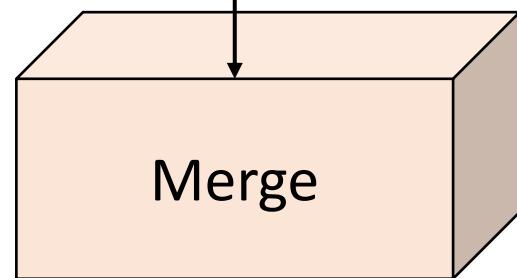
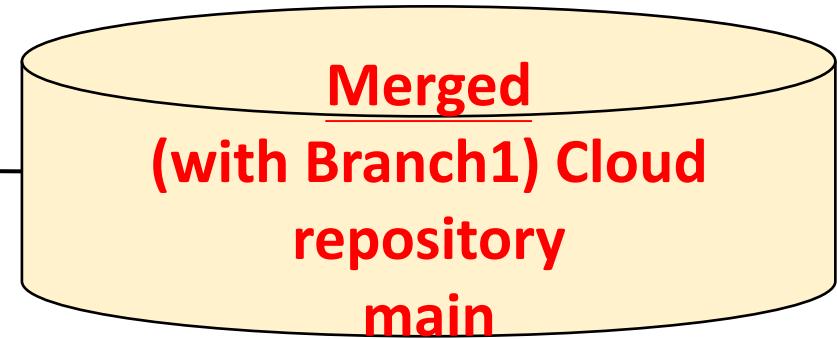
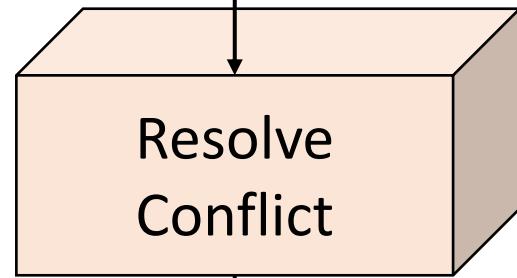


Group Leader can oversee the progress and control the master code!

Resolve Conflict: *To review the conflict between the new version code in a branch with the existing code in main branch.*

[More conflict!](#)

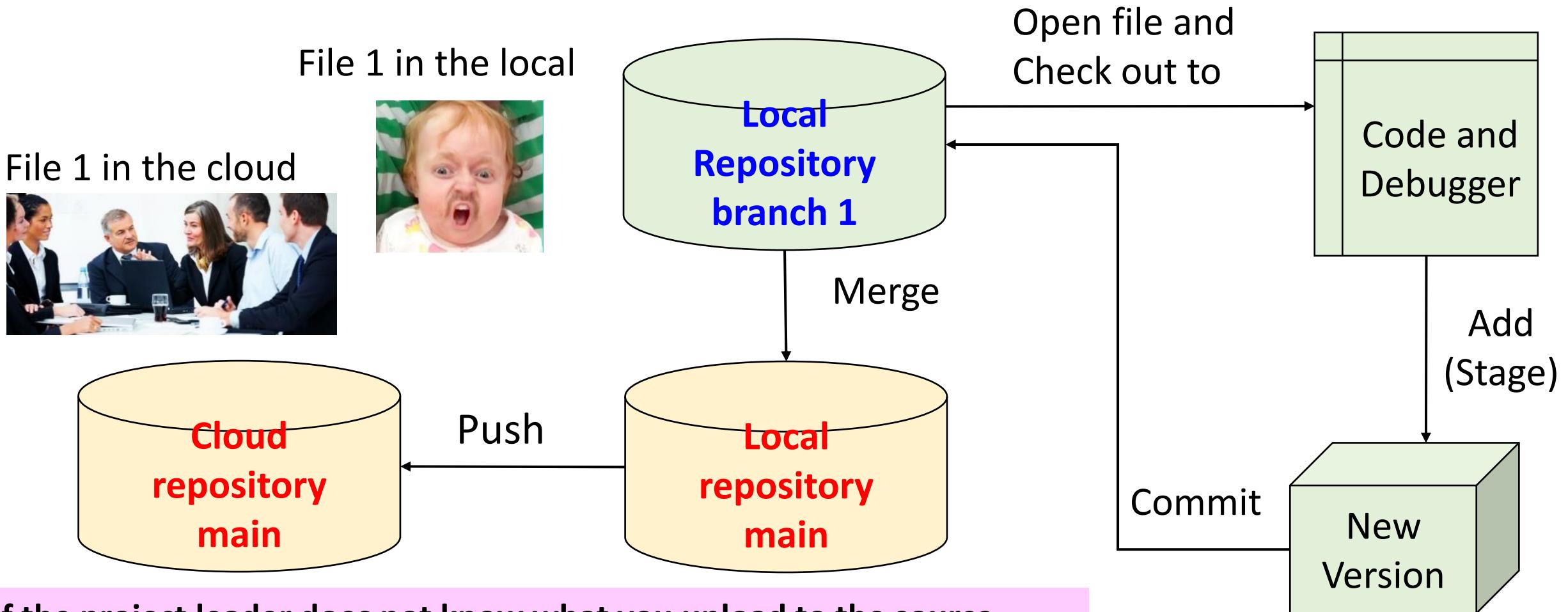
After reviewing, making decision to change or reject the pull request.



Concept of collaborative coding online

VS code based

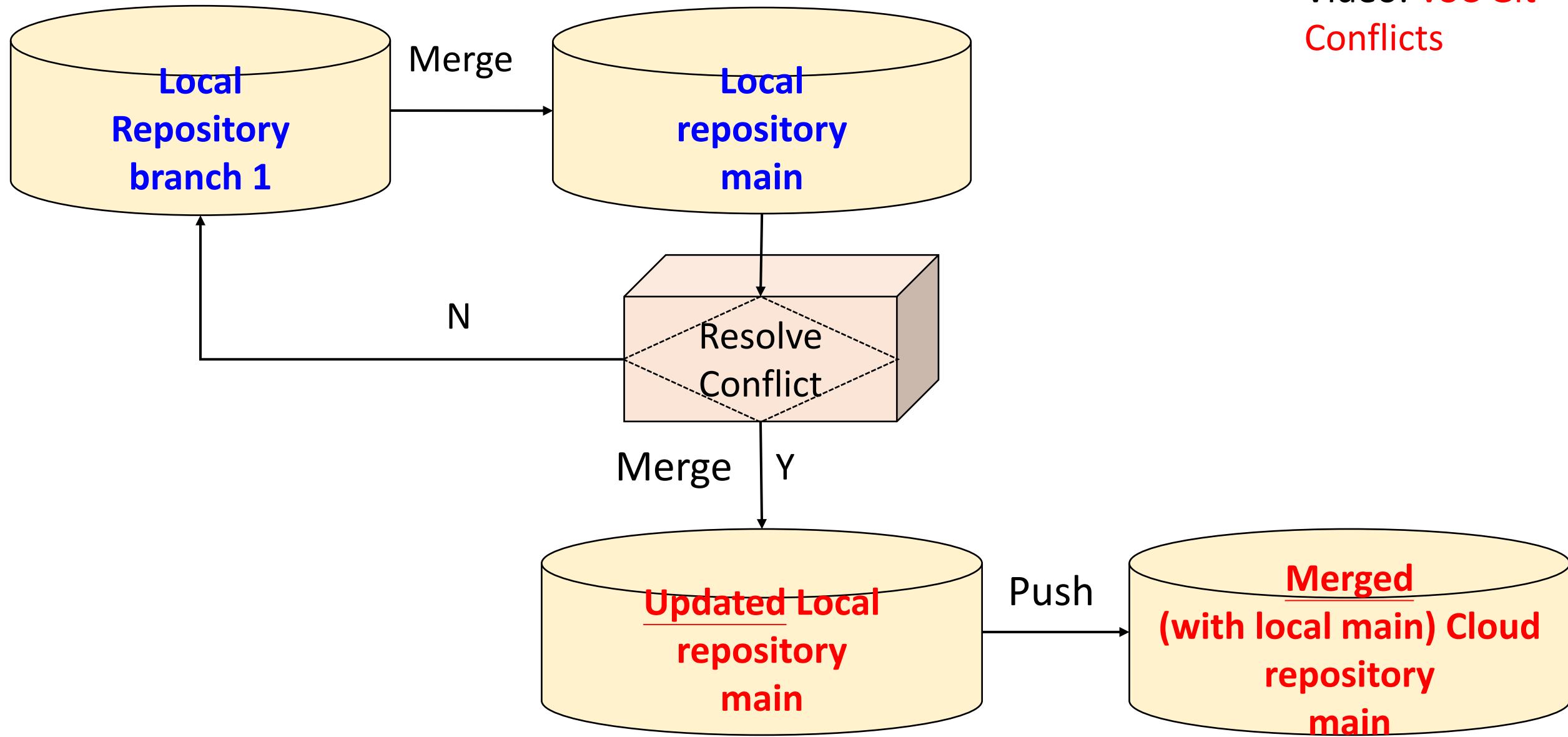
Video: [VSC Git Conflicts](#)



If the project leader does not know what you upload to the source code, you will create a lot of confusions!

VS code based

Video: [VSC Git Conflicts](#)



GitHub Tutorial Videos (Web Version)

- **Signing Up:**
https://www.youtube.com/watch?v=djwgi6YpZWY&ab_channel=POLYUIPNL
- **Group Leader Operations:**
https://www.youtube.com/watch?v=xmy9UaXZqAI&ab_channel=POLYUIPNL
- **Group Member Operations:**
https://www.youtube.com/watch?v=xVtce克斯7EA&ab_channel=POLYUIPNL
- **Creating New Repository + Setup:**
https://www.youtube.com/watch?v=fD6x3wborEI&ab_channel=POLYUIPNL
- **Commit & Merge:**
https://www.youtube.com/watch?v=34bSuMcdHP4&ab_channel=POLYUIPNL
- **Commit & Merge (rejected):**
https://www.youtube.com/watch?v=6zPyvGKE804&ab_channel=POLYUIPNL
- **Searching and Downloading:**
https://www.youtube.com/watch?v=5rtr63yCO0c&ab_channel=POLYUIPNL

GitHub Tutorial Videos (With VS Code)

- **VSC Setup with GitHub:**
https://www.youtube.com/watch?v=GXbxHbjQDc&ab_channel=POLYUIPNL
- **VSC Setup with GitHub (Mac):**
[youtube.com/watch?v=iUyr8iG1G8k&ab_channel=POLYUIPNL](https://www.youtube.com/watch?v=iUyr8iG1G8k&ab_channel=POLYUIPNL)
- **VSC Git Basic Operation:**
[youtube.com/watch?v=juEEJkgq6fI&ab_channel=POLYUIPNL](https://www.youtube.com/watch?v=juEEJkgq6fI&ab_channel=POLYUIPNL)
- **VSC Git Branches:**
https://www.youtube.com/watch?v=5qUDlFg5gAM&ab_channel=POLYUIPNL
- **VSC Git Conflicts:**
https://www.youtube.com/watch?v=4JrCfXhmavg&ab_channel=POLYUIPNL
- **VSC Commits & Pushes with web merges:**
https://www.youtube.com/watch?v=34bSuMcdHP4&ab_channel=POLYUIPNL
- **VSC Pushing (No web):**
https://www.youtube.com/watch?v=dSWB5QCUpE&ab_channel=POLYUIPNL

Software Installation and setup Guide

Install Python in Windows 10

Tutorial Video:

https://www.youtube.com/watch?v=wJEZ08M2j4Q&ab_channel=POLYUIPNL

Step 1: Download Python 3.6.4

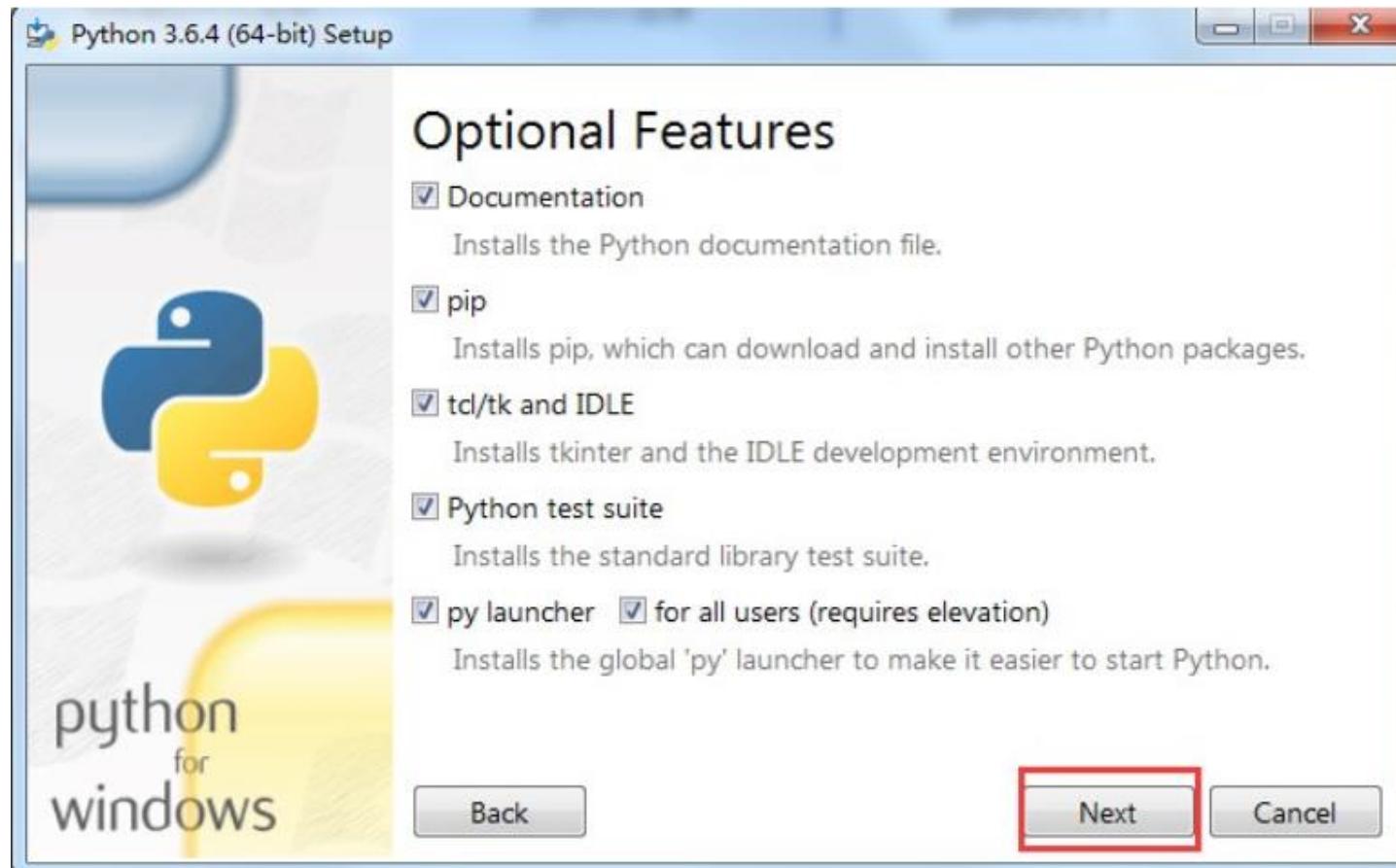
<https://www.python.org/ftp/python/3.6.4/python-3.6.4-amd64.exe>

Step 2: Install Python 3.6.4 in Windows 10



Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace.

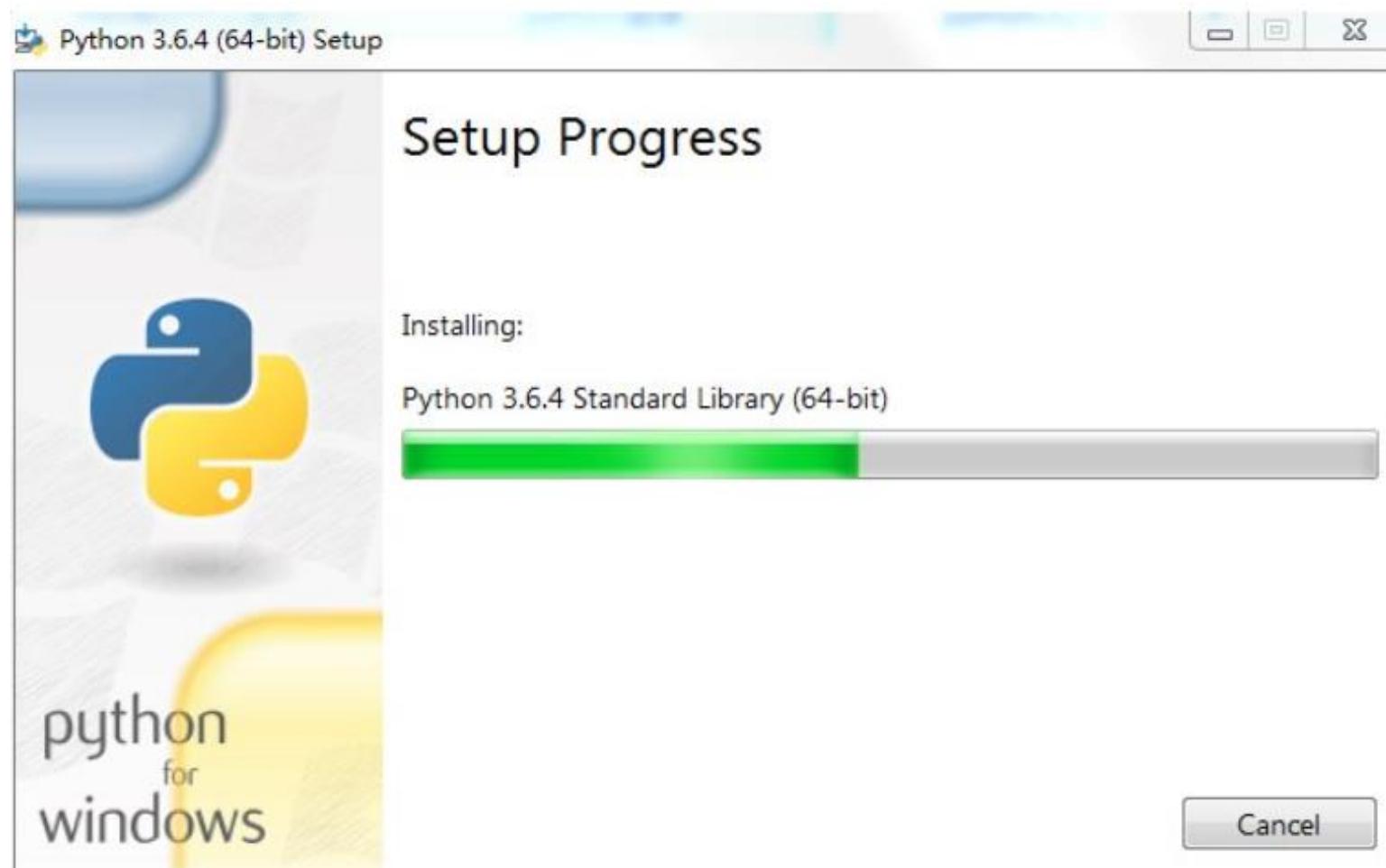
Install Python in Windows 10



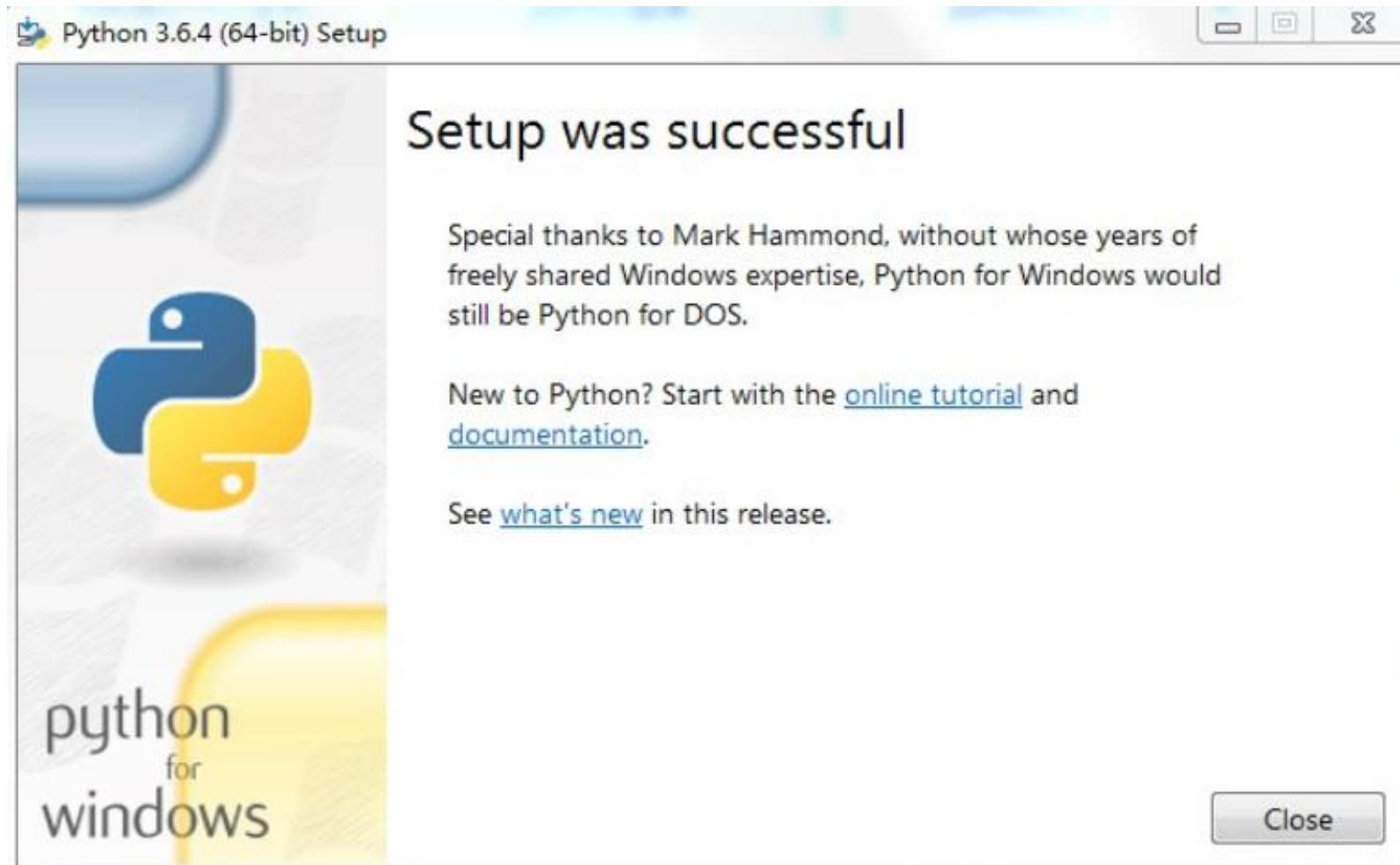
Install Python in Windows 10



Install Python in Windows 10



Install Python in Windows 10



Install VS code in Windows 10

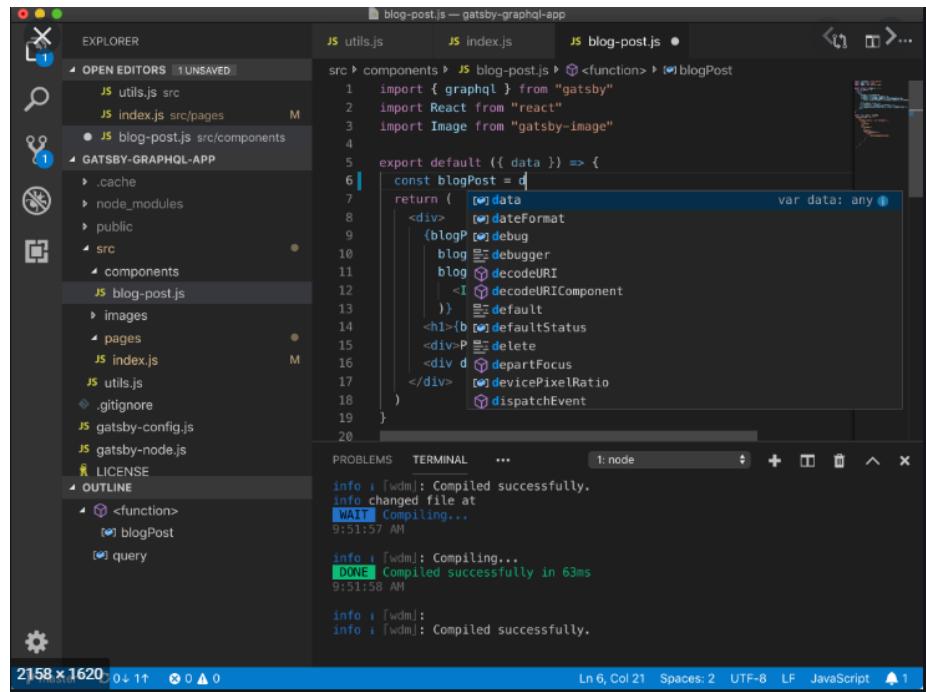
Step 1: Download the latest VS code

<https://code.visualstudio.com/download>

Tutorial Video:

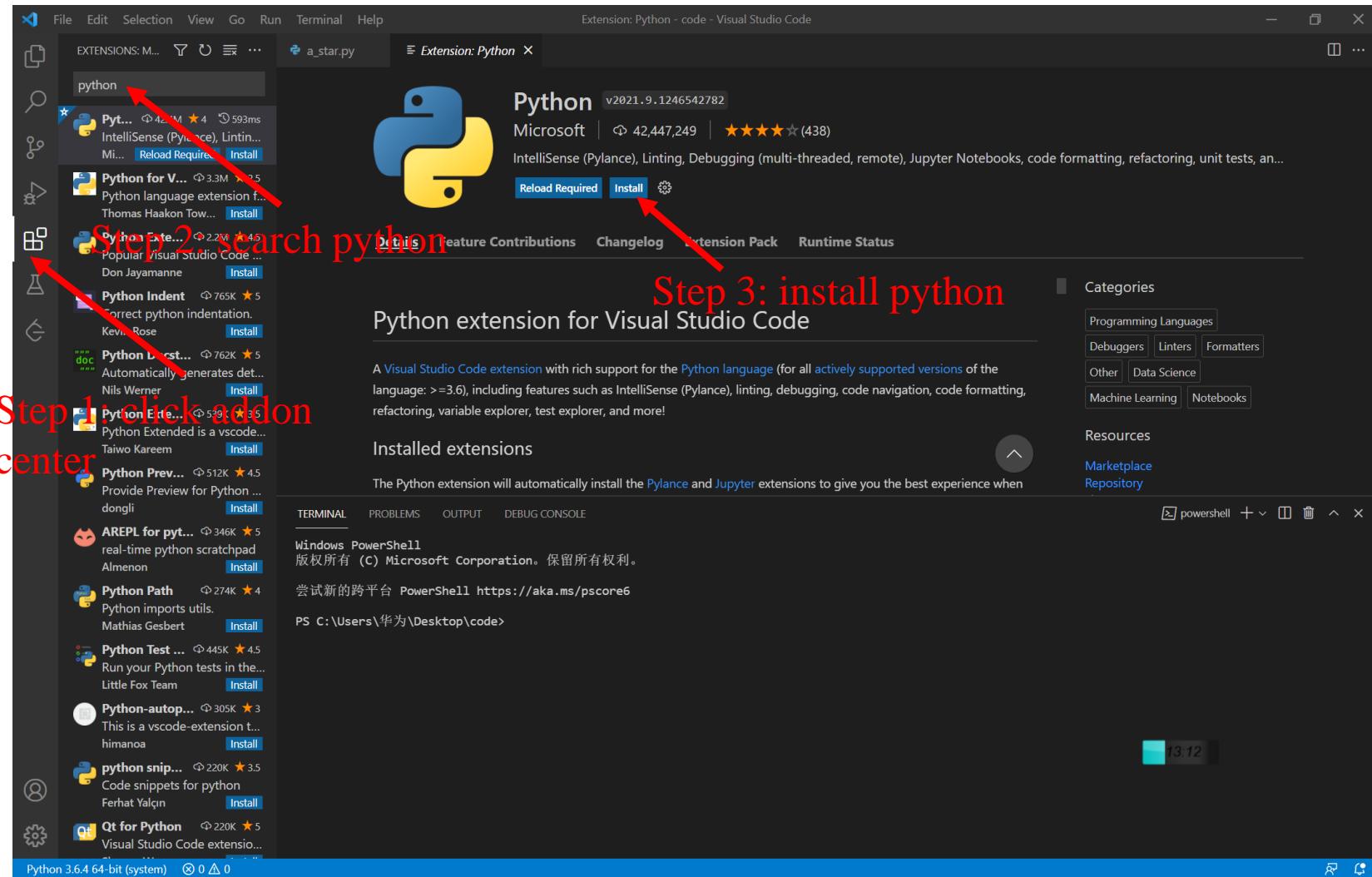
https://www.youtube.com/watch?v=MZzw7VU9T4c&ab_channel=POLYUIPNL

Step 2: Install latest VS code in Windows 10

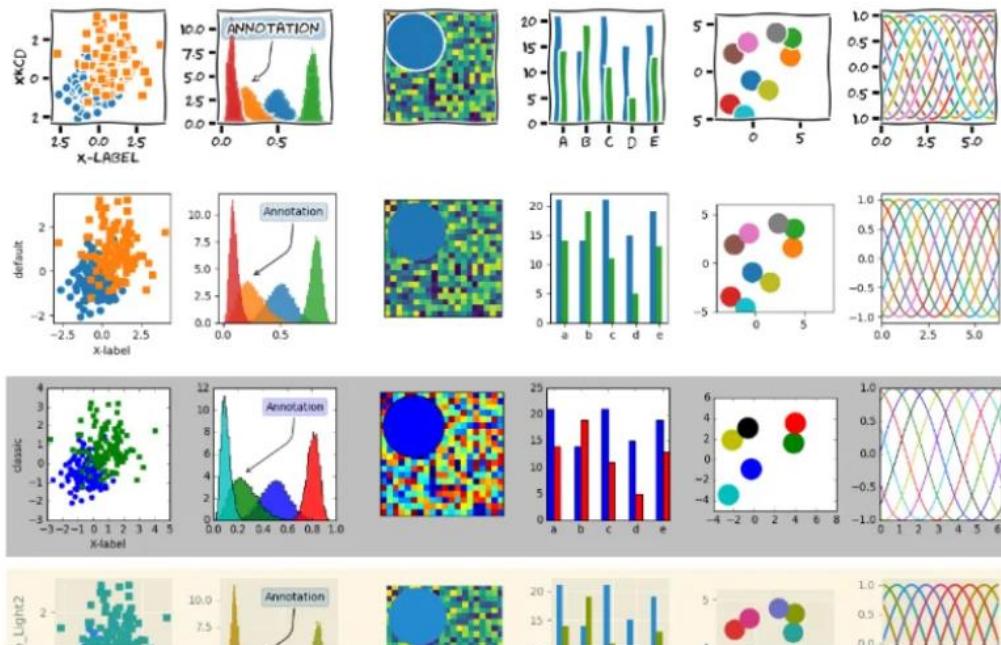


Visual Studio Code is a free source-code editor made by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

Install Python **addon** in VS code in Windows 10



Install matplotlib



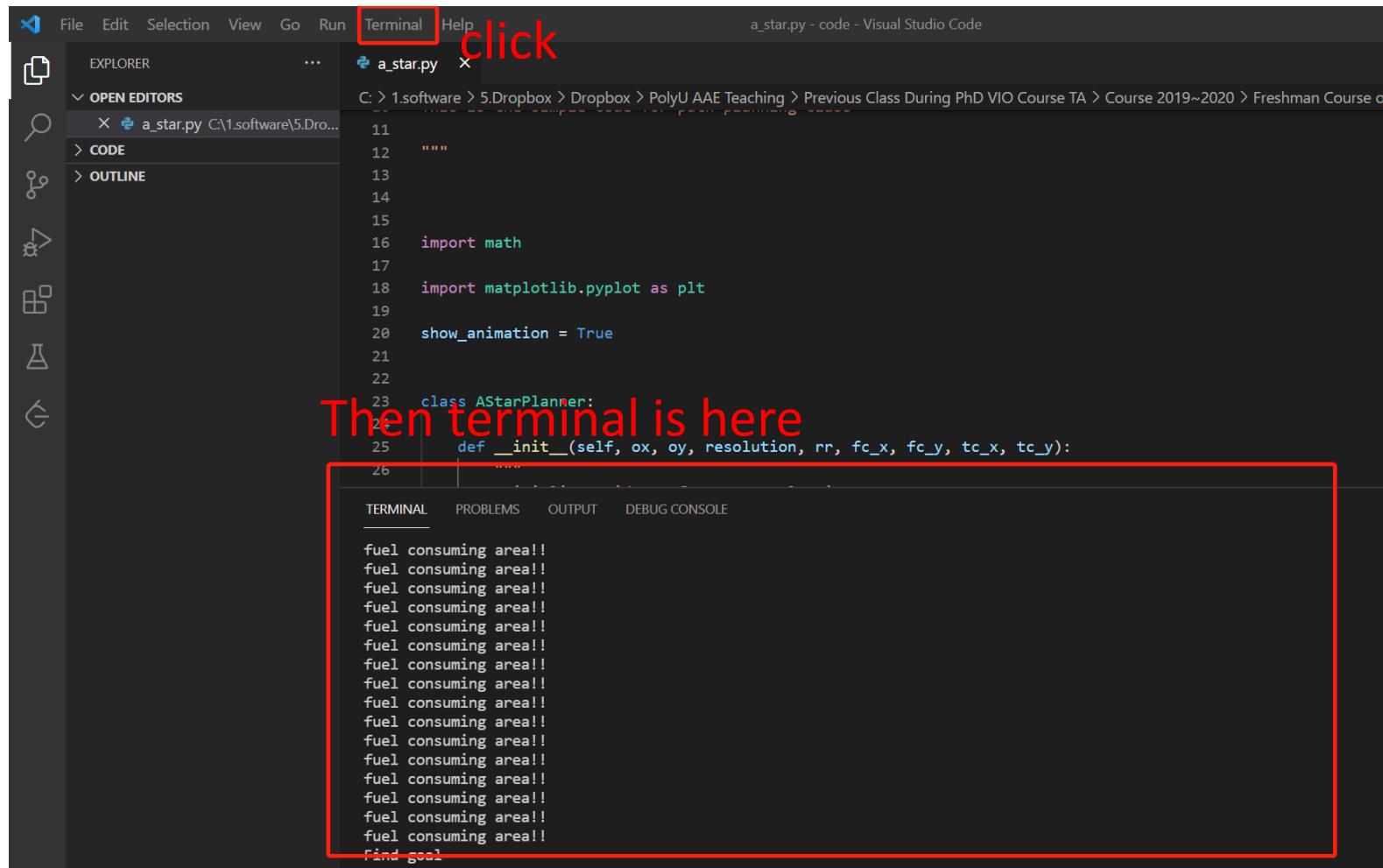
Source:

<https://www.gnuband.org/2017/12/29/gallery-of-xkcd-and-other-python-matplotlib-styles/>

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK+.

Install matplotlib

- step 1: Open VS code, and then click Terminal

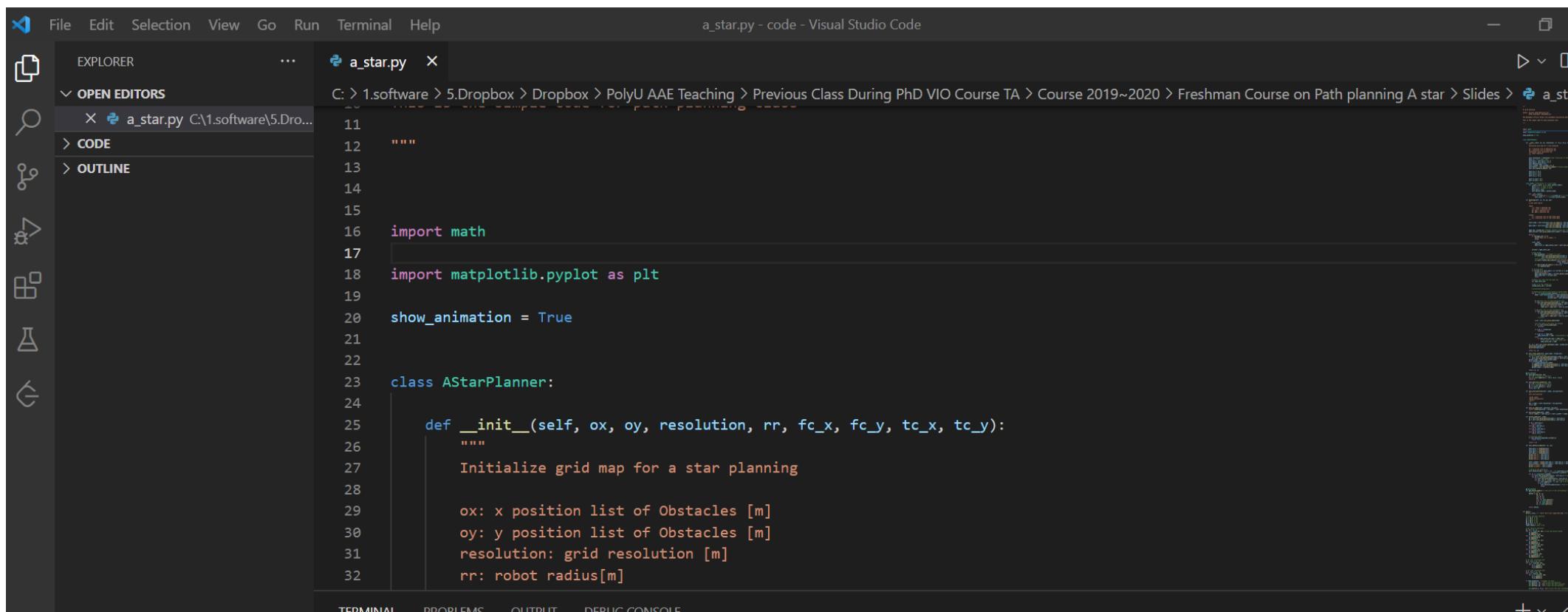


Install matplotlib

- step 2: Print following command into terminal>

Test matplotlib

- step 3: Open the code sample by VS code



The screenshot shows the Visual Studio Code interface with the following details:

- File Bar:** File, Edit, Selection, View, Go, Run, Terminal, Help.
- Title Bar:** a_star.py - code - Visual Studio Code.
- Left Sidebar (Icon Bar):** Explorer, Open Editors, Code, Outline.
- Open Editors:** a_star.py (active tab).
- Code Editor:** The file content is as follows:

```
11
12
13
14
15
16 import math
17
18 import matplotlib.pyplot as plt
19
20 show_animation = True
21
22
23 class AStarPlanner:
24
25     def __init__(self, ox, oy, resolution, rr, fc_x, fc_y, tc_x, tc_y):
26         """
27             Initialize grid map for a star planning
28
29             ox: x position list of Obstacles [m]
30             oy: y position list of Obstacles [m]
31             resolution: grid resolution [m]
32             rr: robot radius[m]
33         
```

The code editor shows lines 11 through 32 of the Python script. The script imports math and matplotlib.pyplot, defines a class AStarPlanner, and includes a constructor __init__ with parameters ox, oy, resolution, rr, fc_x, fc_y, tc_x, and tc_y. The constructor includes a docstring and initializes a grid map for A* planning.

Test matplotlib

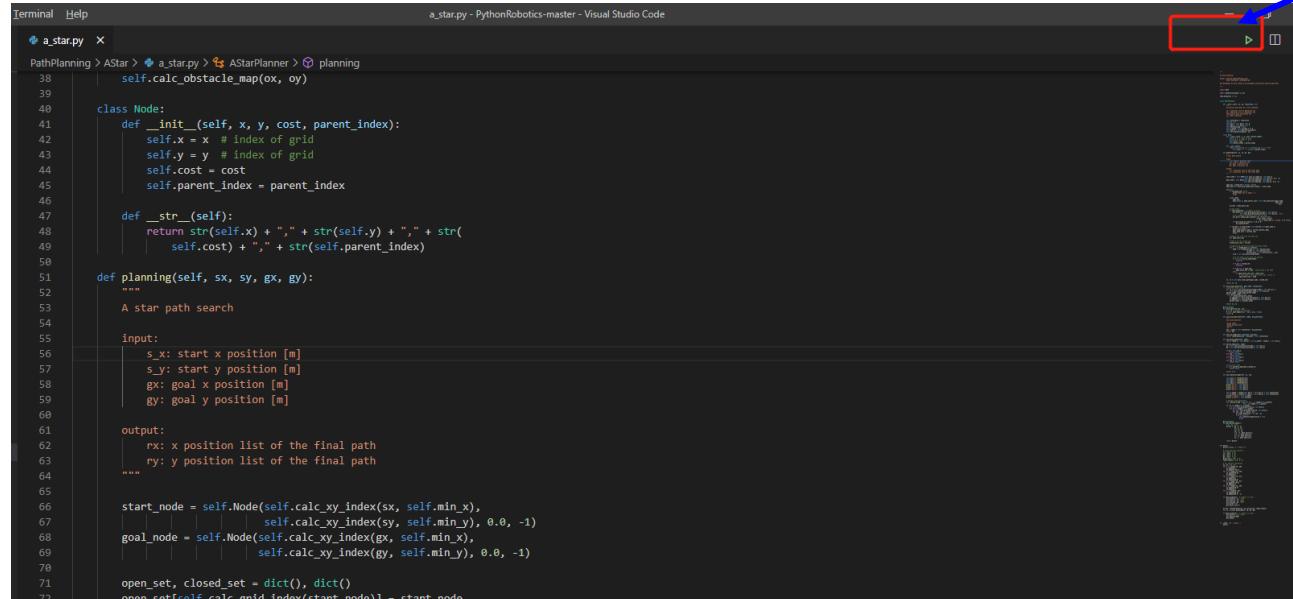
- step 4: Run the demo

The screenshot shows a Visual Studio Code interface with the following components:

- File Explorer:** Shows the file `a_star.py` is open.
- Code Editor:** Displays the Python code for the A* algorithm. The code includes imports for `math` and `matplotlib.pyplot`, and defines a class `AStarPlanner` with an `__init__` method. The code also includes a terminal output section with repeated "fuel consuming area!!" messages and a "Find goal" message.
- Terminal:** Shows the terminal output from running the script.
- Output:** Shows the output pane with three entries: "powershell", "Python", and "powershell".
- Figure View:** A subplot titled "Figure 1" showing a 2D grid-based map. The grid ranges from -10 to 60 on both axes. The map features several obstacles: a red rectangular wall from (15, 20) to (25, 30), a vertical green rectangle from (35, 10) to (35, 40), and a vertical blue rectangle from (45, 20) to (45, 50). A red line represents the path calculated by the A* algorithm, starting from a green circle at approximately (15, 10) and ending at a green circle at approximately (45, 50).

Run A Star in VS code

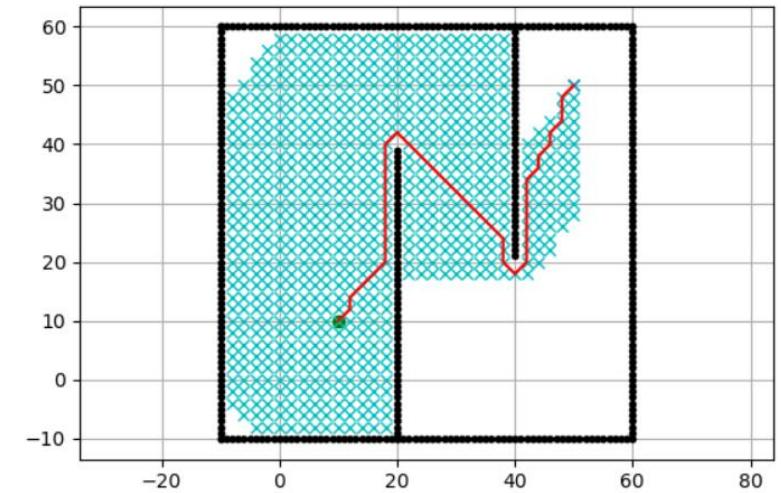
Run the code



```
Terminal Help
a_star.py - PythonRobotics-master - Visual Studio Code
PathPlanning > AStar > a_star.py > AStarPlanner > planning
38     self.calc_obstacle_map(ox, oy)
39
40 class Node:
41     def __init__(self, x, y, cost, parent_index):
42         self.x = x # index of grid
43         self.y = y # index of grid
44         self.cost = cost
45         self.parent_index = parent_index
46
47     def __str__(self):
48         return str(self.x) + "," + str(self.y) + "," + str(
49             self.cost) + "," + str(self.parent_index)
50
51 def planning(self, sx, sy, gx, gy):
52     """
53     A star path search
54
55     input:
56         sx: start x position [m]
57         sy: start y position [m]
58         gx: goal x position [m]
59         gy: goal y position [m]
56
57     output:
58         rx: x position list of the final path
59         ry: y position list of the final path
56
57     """
58
59     start_node = self.Node(self.calc_xy_index(sx, self.min_x),
60                           self.calc_xy_index(sy, self.min_y), 0.0, -1)
61     goal_node = self.Node(self.calc_xy_index(gx, self.min_x),
62                           self.calc_xy_index(gy, self.min_y), 0.0, -1)
63
64     open_set, closed_set = dict(), dict()
65     open_set[self.calc_grid_index(start_node)] = start_node
66
67     while True:
68         cur_node = None
69         for node in open_set:
70             if cur_node == None or open_set[node].f < open_set[cur_node].f:
71                 cur_node = node
72
73         if cur_node == None:
74             print("A* failed to find a path")
75             break
76
77         if cur_node.x == gx and cur_node.y == gy:
78             print("A* found a path")
79             rx, ry = self.reconstruct_path(cur_node)
80             break
81
82         for i, j in self.get_neighboor_index(cur_node.x, cur_node.y):
83             if i == None or j == None:
84                 continue
85
86             n = self.Node(self.calc_xy_index(i, self.min_x),
87                           self.calc_xy_index(j, self.min_y), cur_node.cost + self.sr,
88                           cur_node.index)
89
90             if i == gx and j == gy:
91                 print("A* found a path")
92                 rx, ry = self.reconstruct_path(n)
93                 break
94
95             if n not in closed_set:
96                 if (i, j) in closed_set:
97                     closed_set.pop((i, j))
98
99                 open_set[n.index] = n
100
101             else:
102                 if closed_set[(i, j)].f > n.f:
103                     closed_set.pop((i, j))
104
105                     open_set[n.index] = n
106
107             if n not in open_set:
108                 open_set[n.index] = n
109
110         closed_set[(cur_node.x, cur_node.y)] = cur_node
111
112         self.show_grid(ox, oy, cur_node)
113
114     return rx, ry
115
116
117 def reconstruct_path(self, cur_node):
118     rx, ry = [], []
119
120     while cur_node.parent_index != -1:
121         rx.append(cur_node.x)
122         ry.append(cur_node.y)
123
124         cur_node = self.nodes[cur_node.parent_index]
125
126     rx.append(self.start_x)
127     ry.append(self.start_y)
128
129     return rx, ry
130
131
132 def show_grid(self, ox, oy, cur_node):
133     if len(ox) == 0 and len(oy) == 0:
134         return
135
136     min_x, min_y, max_x, max_y = self.get_min_max(ox, oy)
137
138     dx, dy = self.calc_xy_distanse(self.min_x, self.min_y)
139
140     grid = [[0 for _ in range(max_x - min_x + 1)]
141             for _ in range(max_y - min_y + 1)]
142
143     for i, j in self.get_neighboor_index(cur_node.x, cur_node.y):
144         if i == None or j == None:
145             continue
146
147         if (i, j) in self.obstacles:
148             grid[j - min_y][i - min_x] = 1
149
150         if (i, j) == (cur_node.x, cur_node.y):
151             grid[j - min_y][i - min_x] = 2
152
153         if (i, j) == (self.start_x, self.start_y):
154             grid[j - min_y][i - min_x] = 3
155
156         if (i, j) == (self.goal_x, self.goal_y):
157             grid[j - min_y][i - min_x] = 4
158
159     plt.imshow(grid, cmap='gray')
160
161     plt.plot([self.start_x, self.goal_x], [self.start_y, self.goal_y], color='red')
162
163     plt.plot([cur_node.x], [cur_node.y], color='green')
164
165     plt.grid(True)
166
167     plt.show()
```

A* is a graph traversal and path search algorithm, which is often used in many fields of computer science due to its completeness, optimality, and optimal efficiency. One major practical drawback is its space complexity, as it stores all generated nodes in memory.

Figure 1



Troubleshoot: Connect Github page via command in VS Code

- Input the command below to the terminal (change the blue to your info)
 - *git config --global user.name weisongwen*
 - *git config --global user.email wenwsrobo@gmail.com*

The screenshot shows the Visual Studio Code interface with the following details:

- Terminal Tab:** The "Terminal" tab is highlighted in red.
- Code Editor:** An editor window titled "a_star.py" is open, showing Python code for an A* pathfinding algorithm.
- Terminal Output:** The terminal window at the bottom displays repeated text "fuel consuming area!!" followed by "Find goal".
- Text Overlay:** The text "Then terminal is here" is overlaid in red on the terminal output area.
- Red Box:** A large red box highlights the terminal output area, specifically the part where the text "fuel consuming area!!" is printed multiple times.

Mac Version

Python Installation

Tutorial Video:

https://www.youtube.com/watch?v=p-joFbfB57c&ab_channel=POLYUIPNL

A screenshot of a search results page from a search engine. The top navigation bar includes 'All', 'Videos', 'Images', 'News', 'Shopping', 'More', and 'Tools'. Below the search bar, it says 'About 92,100,000 results (0.60 seconds)'. The first result is titled 'How to Install Python on a Mac' and contains a numbered list of steps: 1. Navigate to the Python download site with your browser. ... 2. Click the appropriate link for your version of OS X: ... 3. Double-click python. ... 4. Click Continue three times. ... 5. Select the Volume (hard drive or other media) that you want to use for installing Python and click Continue. ... 6. Click Install. There is also a 'More items...' link. Below this, there is a snippet from a dummies.com article with the title 'How to Install Python on a Mac - dummies'. At the bottom of the snippet, there is a link to 'Python Releases for macOS' which is circled in orange.

All Videos Images News Shopping More Tools

About 92,100,000 results (0.60 seconds)

How to Install Python on a Mac

1. Navigate to the Python download site with your browser. ...
2. Click the appropriate link for your version of OS X: ...
3. Double-click python. ...
4. Click Continue three times. ...
5. Select the Volume (hard drive or other media) that you want to use for installing Python and click Continue. ...
6. Click Install.

[More items...](#)

<https://www.dummies.com> › programming › how-to-inst... ::

How to Install Python on a Mac - dummies

>About featured snippets · Feedback

<https://www.python.org> › downloads › macos ::

Python Releases for macOS

No files for this release. Python 3.8.9 - April 2, 2021. Download macOS 64-bit Intel installer ·

[Python 3.9.2 - Feb 2021](#) ·

You visited this page on 9/22/21.

Click it

Python Installation

The screenshot shows the Python.org website with a dark blue header. The top navigation bar includes links for Python, PSF, Docs, PyPI, and Jobs. Below the header is a main menu with links for About, Downloads, Documentation, Community, Success Stories, News, and Events. A search bar and a 'Donate' button are also present. The page title is 'Python >>> Downloads >>> macOS'. The main content area is titled 'Python Releases for macOS' and lists two items under 'Stable Releases': 'Latest Python 3 Release - Python 3.9.7' and 'Latest Python 2 Release - Python 2.7.18'. An orange circle highlights the first item. Below this, there are sections for 'Stable Releases' and 'Pre-releases', each containing a single item with a download link.

Python >>> Downloads >>> macOS

Python Releases for macOS

- [Latest Python 3 Release - Python 3.9.7](#)
- [Latest Python 2 Release - Python 2.7.18](#)

Stable Releases

- [Python 3.7.12 - Sept. 4, 2021](#)
 - No files for this release.
- [Python 3.6.15 - Sept. 4, 2021](#)
 - No files for this release.
- [Python 3.9.7 - Aug. 30, 2021](#)

Pre-releases

- [Python 3.10.0rc2 - Sept. 7, 2021](#)
 - Download [macOS 64-bit universal2 installer](#)
- [Python 3.10.0rc1 - Aug. 2, 2021](#)
 - Download [macOS 64-bit universal2 installer](#)
- [Python 3.10.0b4 - July 10, 2021](#)
 - **Click it**

Python Installation

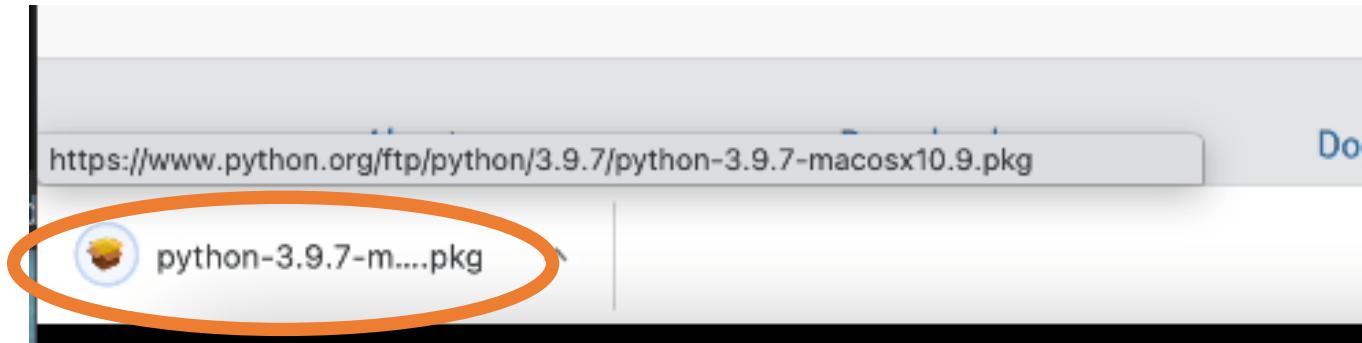
[Full Changelog](#)

Files

Version	Operating System	Description	MD5 Sum	File Size	GPG
Gzipped source tarball	Source release		5f463f30b1fdcb545f156583630318b3	25755357	SIG
xz compressed source tarball	Source release		fddb060b483bc01850a3f412eea1d954	19123232	SIG
macOS 64-bit Intel installer	macOS	for macOS 10.9 and later	ce8c2f885f26b09536857610644260d4	30038206	SIG
macOS 64-bit universal2 installer	macOS	for macOS 10.9 and later, including macOS 11 Big Sur on Apple Silicon (experimental)	825067610b16b03ec814630df1b65193	38144099	SIG
Windows embeddable package (32-bit)	Windows		6d12e3e0f942830de8466a83d30a45fb	7652688	SIG
Windows embeddable package (64-bit)	Windows		67e19ff32b3ef62a40bccd50e33b0f53	8473919	SIG
Windows help file	Windows		b92a78506ccf258d5ad0d98c341fc5d1	9263789	SIG
Windows installer (32-bit)	Windows		0d949bdfdbd0c8c66107a980a95efd85	27811736	SIG
Windows installer (64-bit)	Windows	Recommended	cc3eabc1f9d6c703d1d2a4e7c041bc1d	28895456	SIG

Click it

Python Installation



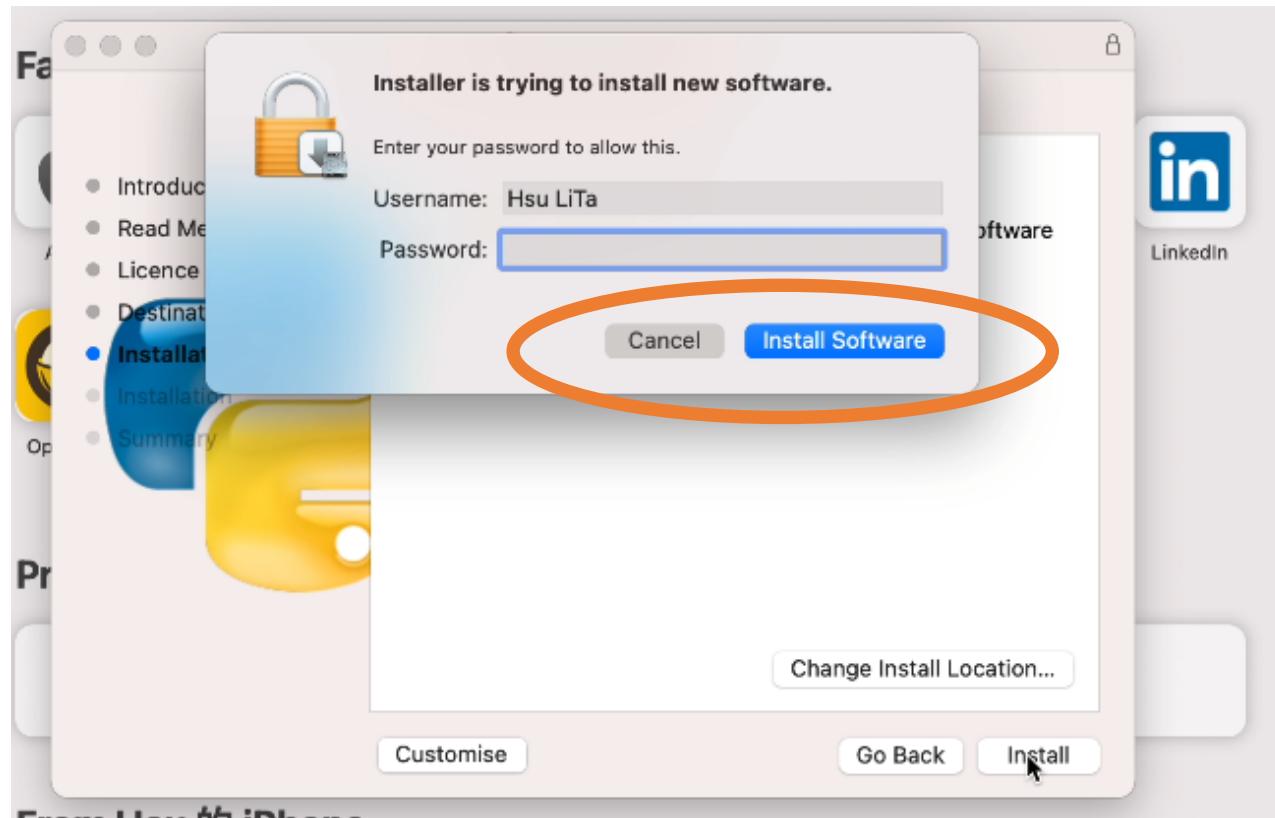
Click it

Python Installation



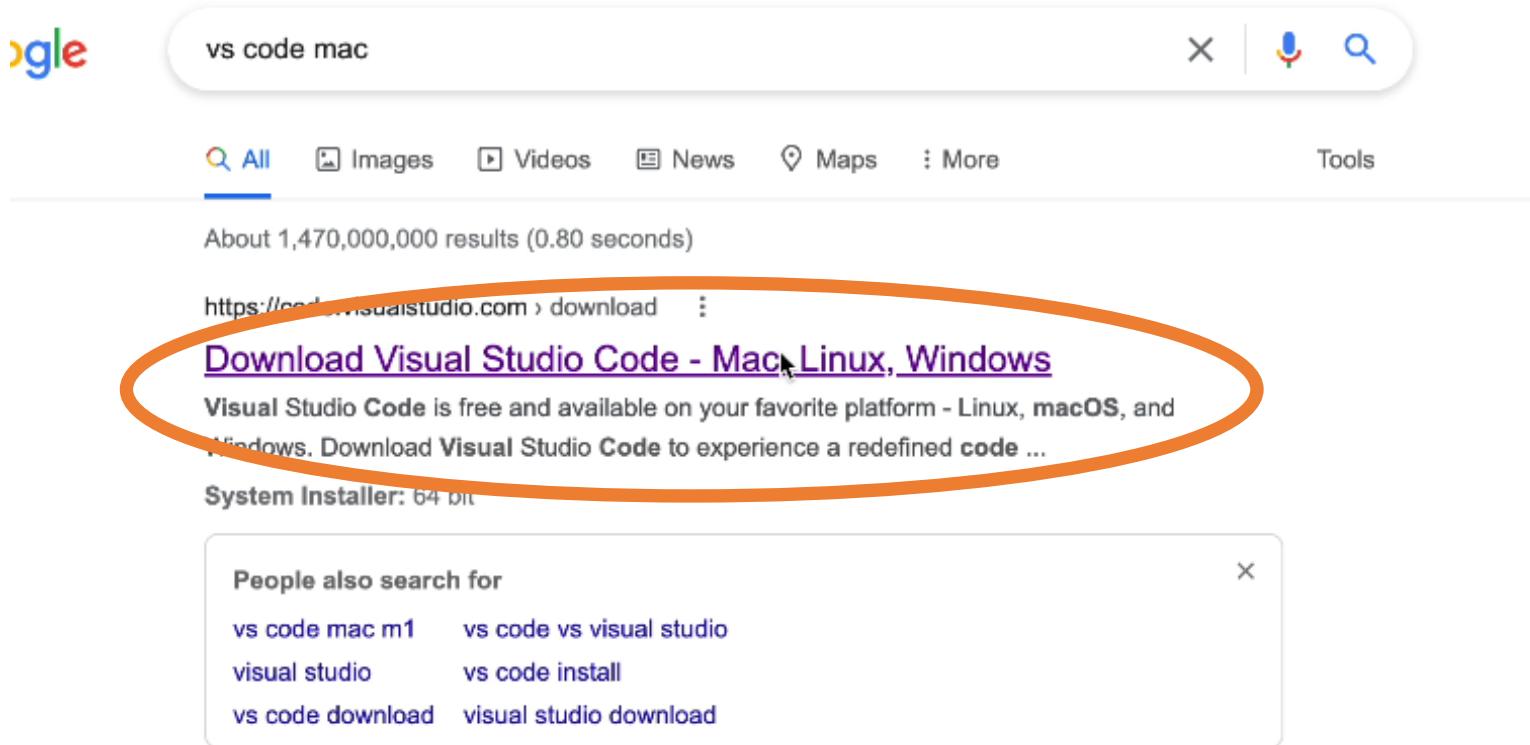
Click it

Python Installation



Click it

Visual Studio Code Installation



Click it

Visual Studio Code Installation

Download Visual Studio Code

Free and built on open source. Integrated Git, debugging and extensions.



↓ Windows

Windows 7, 8, 10

User Installer
System Installer
.zip



↓ .deb

Debian, Ubuntu



↓ .rpm

Red Hat, Fedora, SUSE

.deb
.rpm
.tar.gz

Snap Store



↓ Mac

macOS 10.11+

.zip
Universal
Intel Chip
Apple Silicon



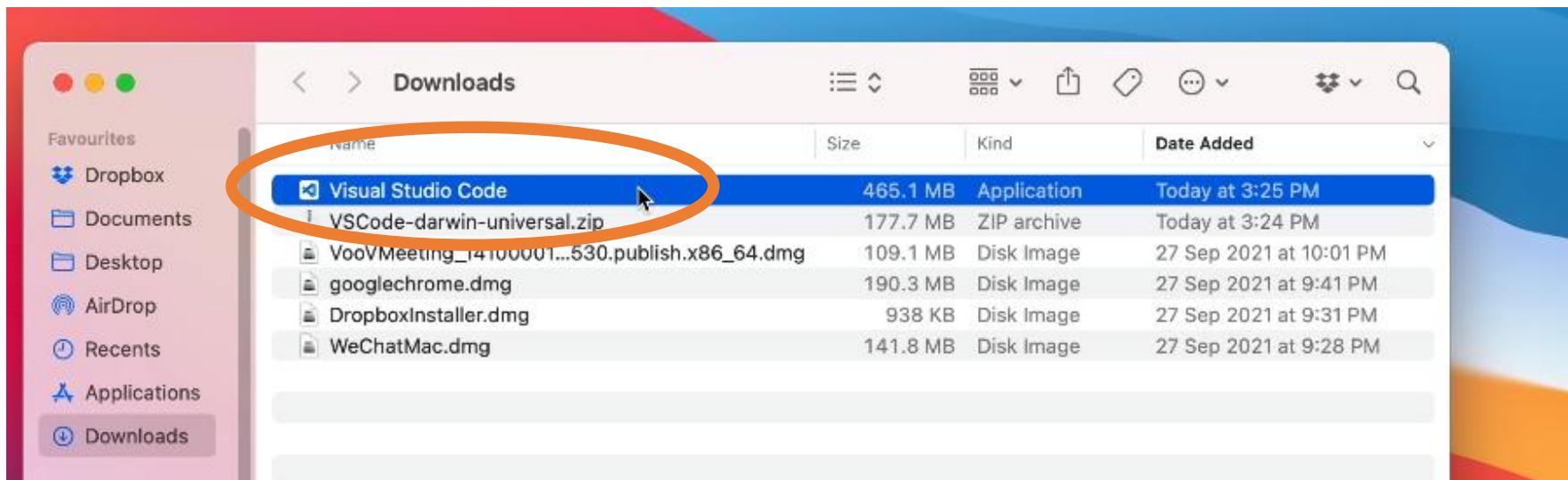
Click it

Visual Studio Code Installation



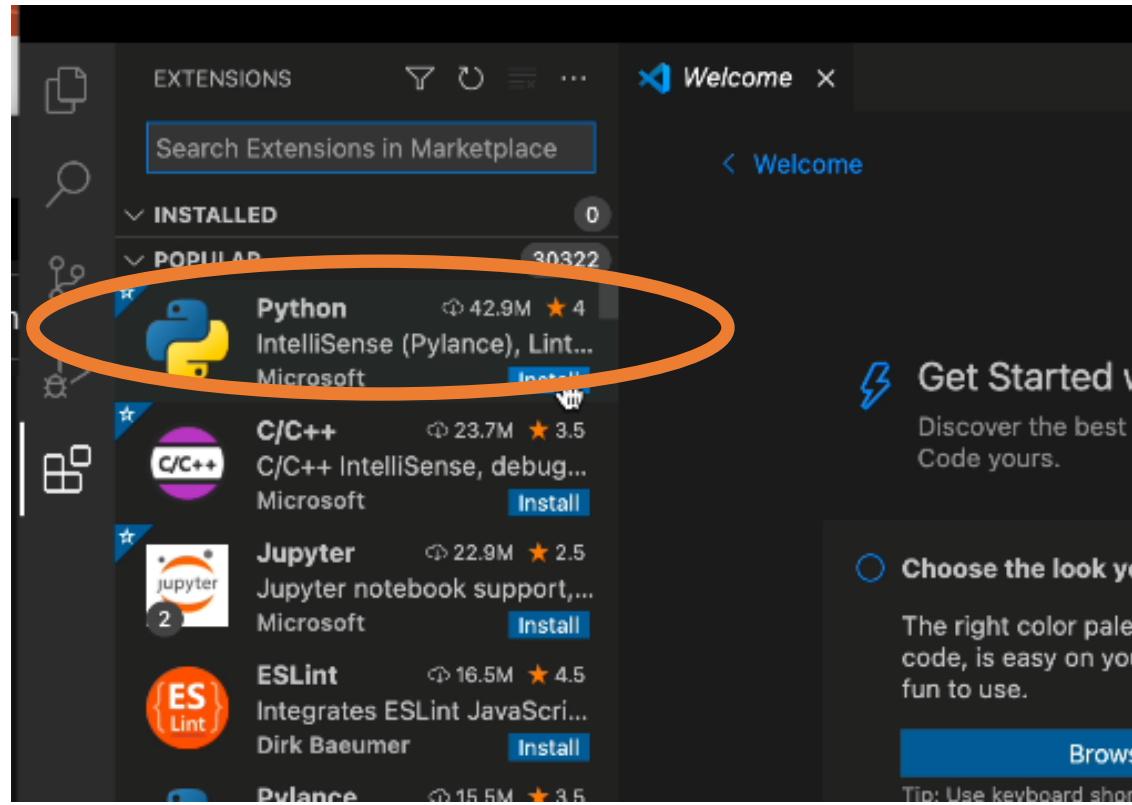
Click it

Visual Studio Code Installation



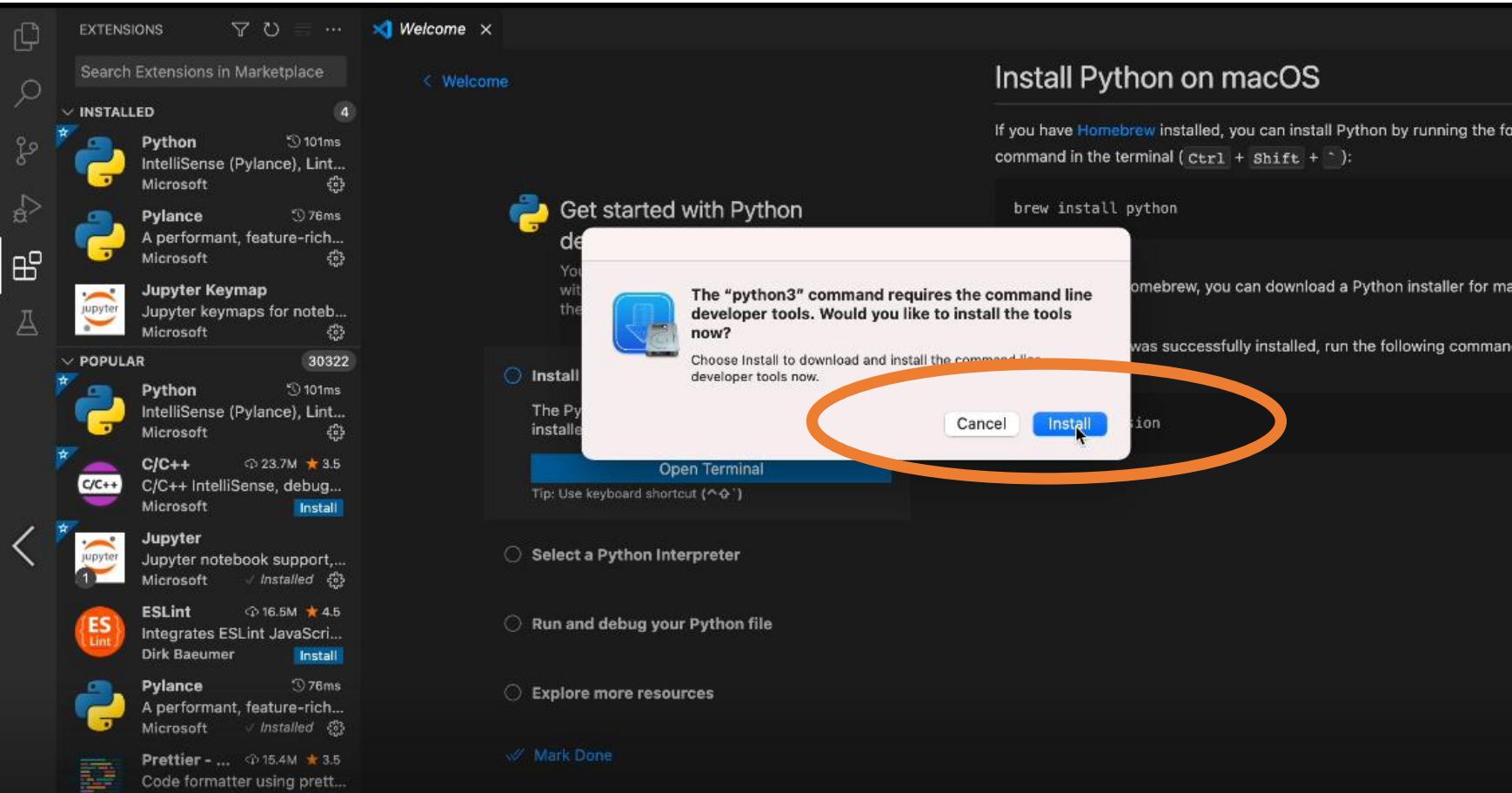
Click it

Visual Studio Code Installation



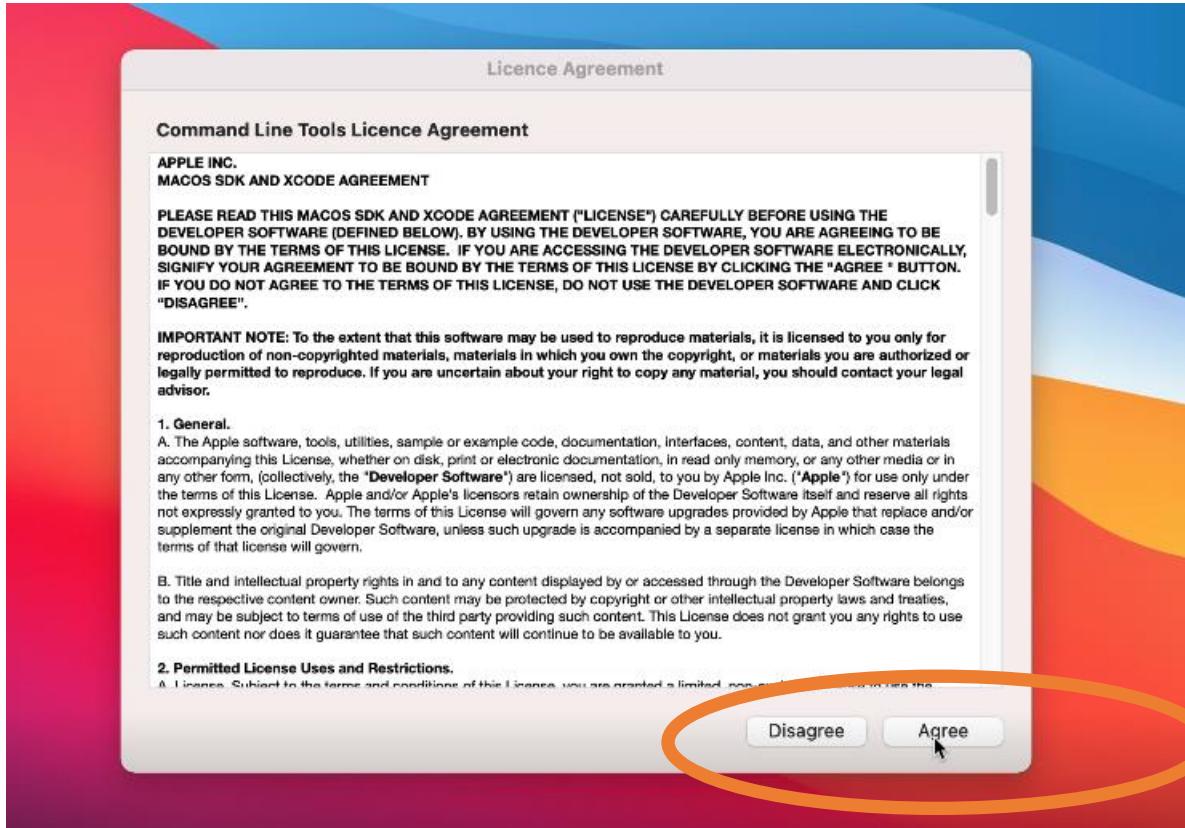
Click it

Visual Studio Code Installation



Click it

Visual Studio Code Installation



Click it

Git Installation

A screenshot of a Google search results page. The search query "git install mac" is entered in the search bar. Below the search bar, there are filters for "All", "Videos", "Images", "Shopping", "News", and "More". The "All" filter is selected. To the right of these filters is a "Tools" button. Below the filters, it says "About 40,800,000 results (0.74 seconds)". The first result is from the "git-scm.com" website, titled "1.5 Getting Started - Installing Git". The text below the title says: "There are several ways to install Git on a Mac. The easiest is probably to install the Xcode Command Line Tools. On Mavericks (10.9) or above you can do this ...". A link "https://git-scm.com > book > Getting-Started-Installing-..." is shown. Below this, another link "https://git-scm.com > download > macOS" is followed by the text "Download for macOS - Git". This link is circled in orange. Below the orange circle, the text continues: "There are several options for installing Git on macOS. Note that any non-source ... Install homebrew if you don't already have it, then: \$ brew install git ...".

Click it

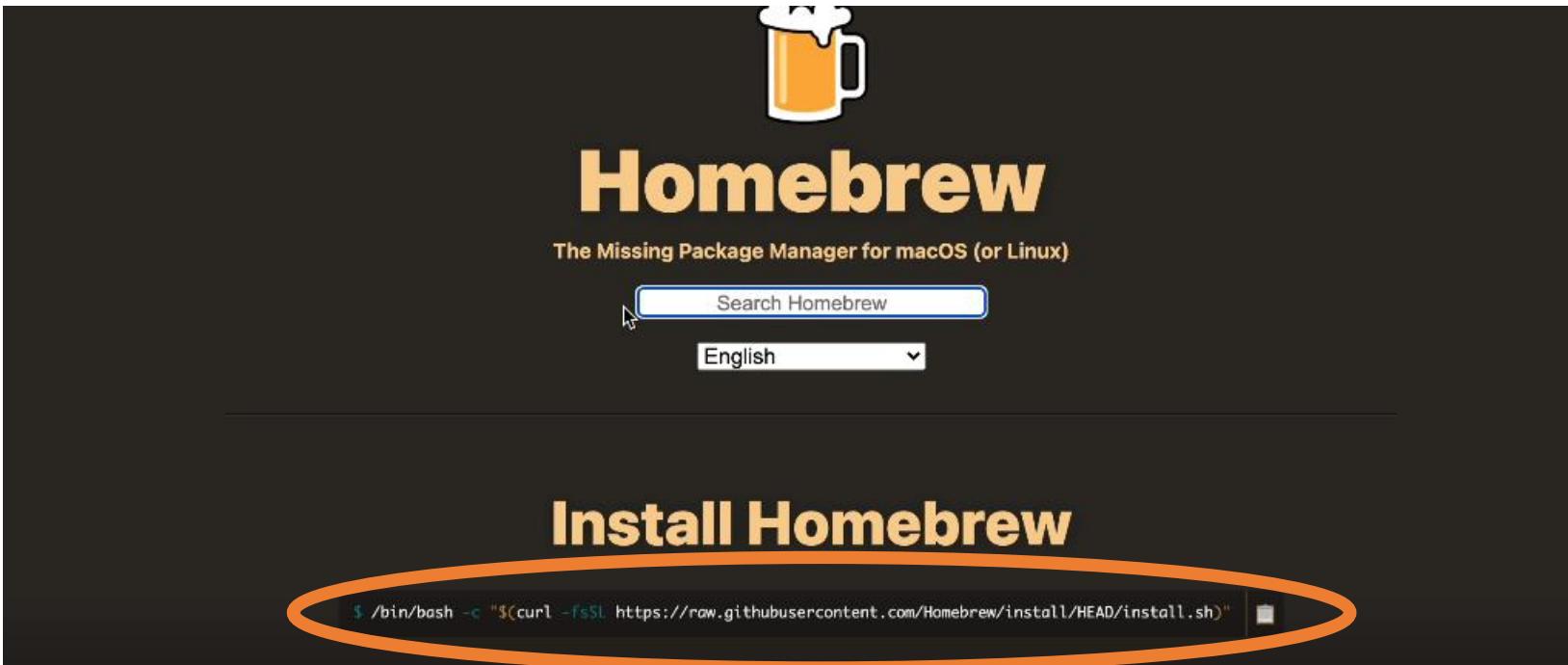
Git Installation

The screenshot shows the official Git website (git-scm.com/) with the following content:

- Header:** git --local-branching-on-the-cheap
- Search bar:** Search entire site...
- Navigation menu:** About, Documentation, Downloads, Community.
- Downloads menu:** GUI Clients, Logos.
- Community box:** The entire [Pro Git book](#) written by Scott Chacon and Ben Straub is available to read online for free. Dead tree versions are available on [Amazon.com](#).
- Main Content:** Download for macOS
- Text:** There are several options for installing Git on macOS. Note that any non-source distributions are provided by third parties, and may not be up to date with the latest source release.
- Section:** Homebrew
- Text:** Install homebrew if you don't already have it, then:
`$ brew install git`
- Section:** Xcode
- Text:** Apple ships a binary package of Git with Xcode.
- Section:** Binary installer
- Text:** Tim Harper provides an [installer](#) for Git. The latest version is [2.33.0](#), which was released about ago, on [2021-08-30](#).
- Section:** Building from Source
- Text:** If you prefer to build from source, you can find tarballs [on kernel.org](#). The latest version is [2.33](#).

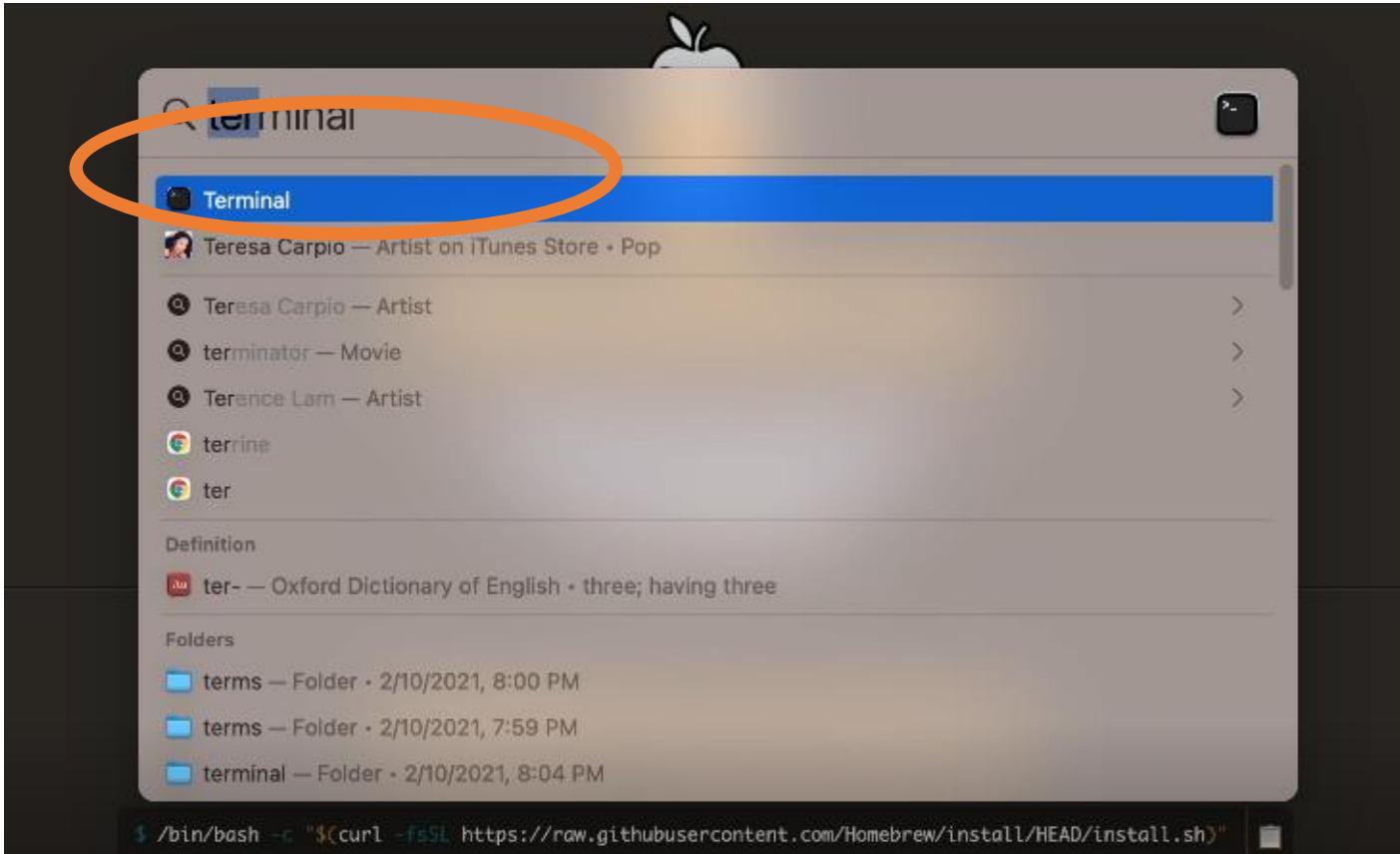
Click it

Git Installation



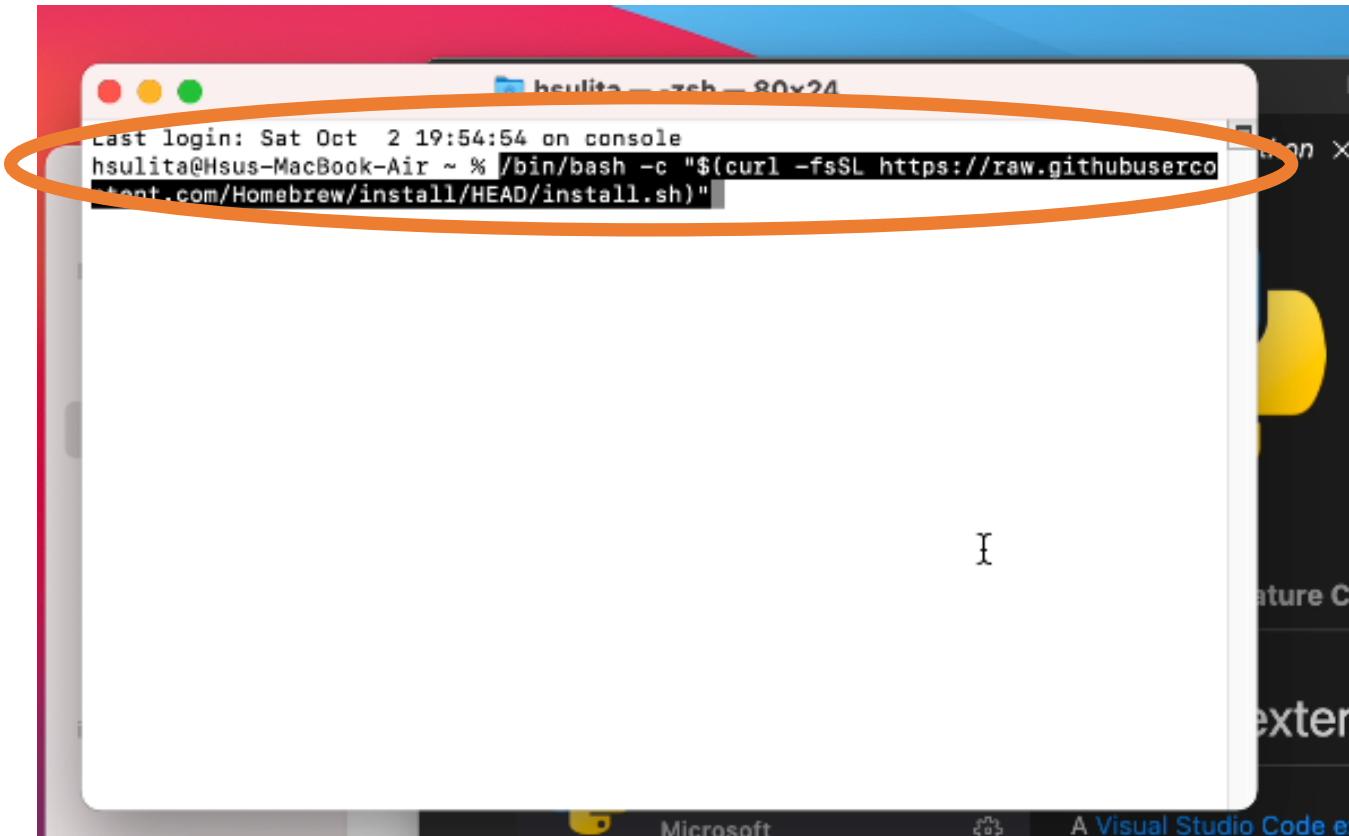
Copy this command

Git Installation



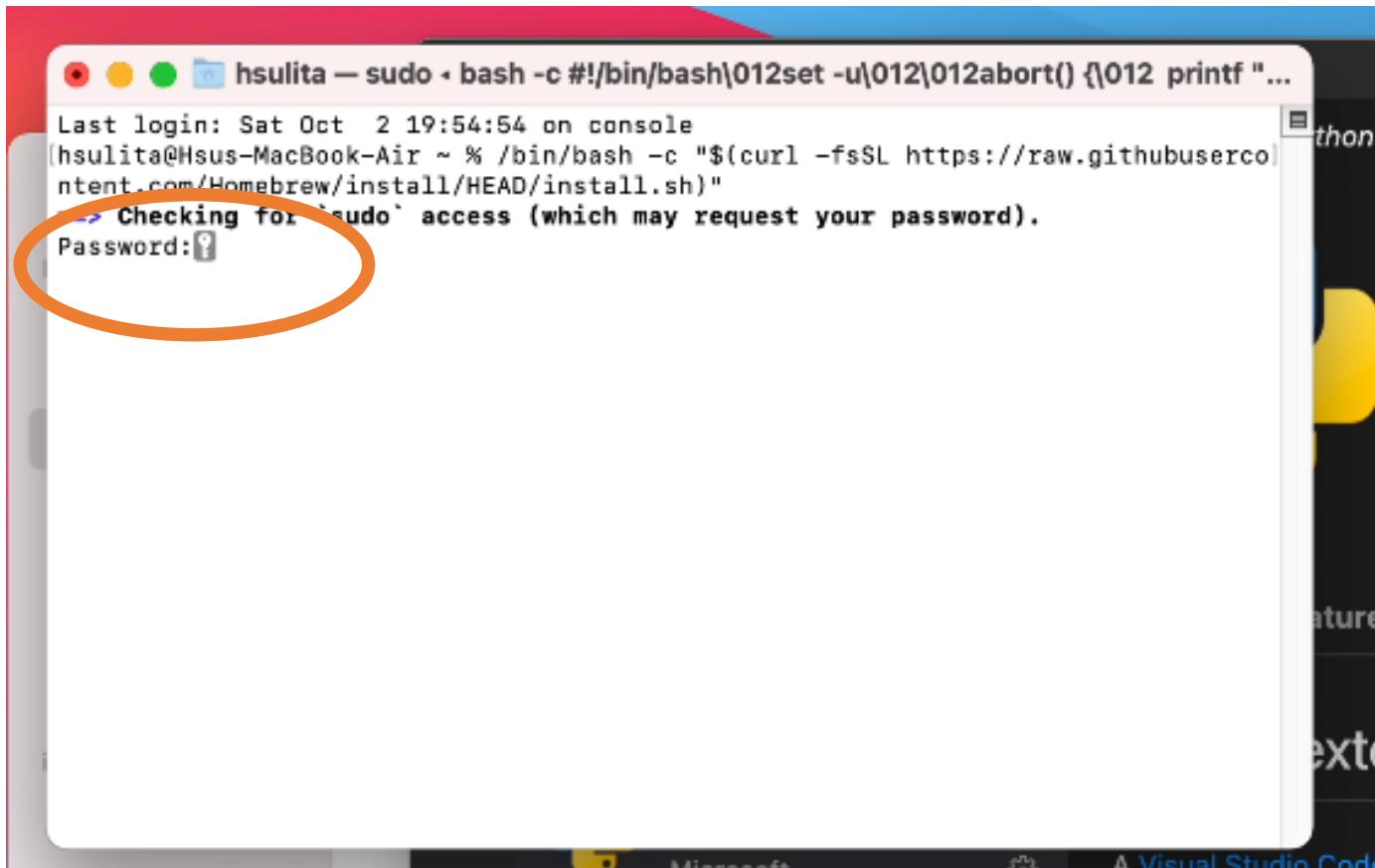
Click it

Git Installation



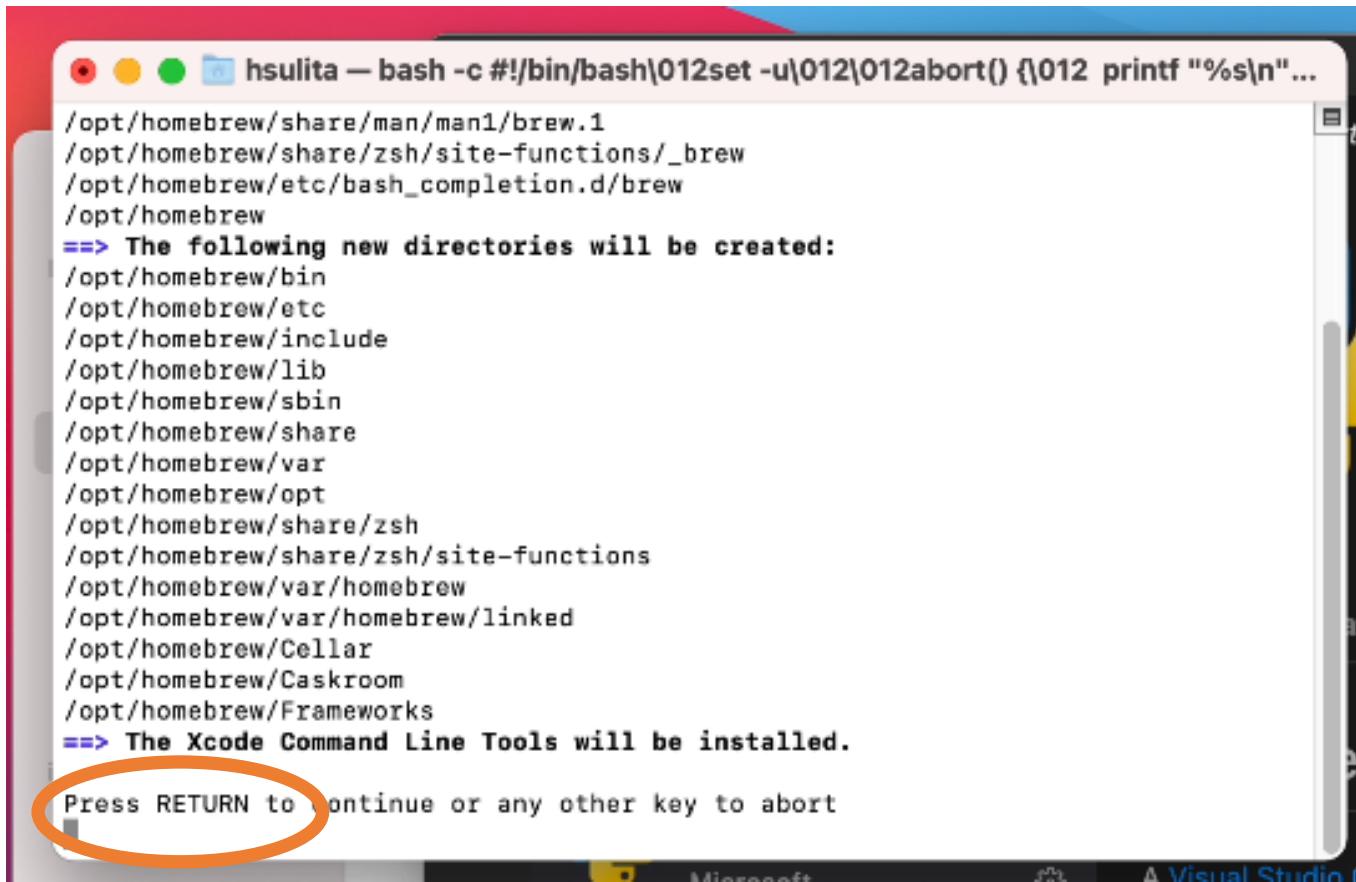
Paste the command

Git Installation



Enter your password

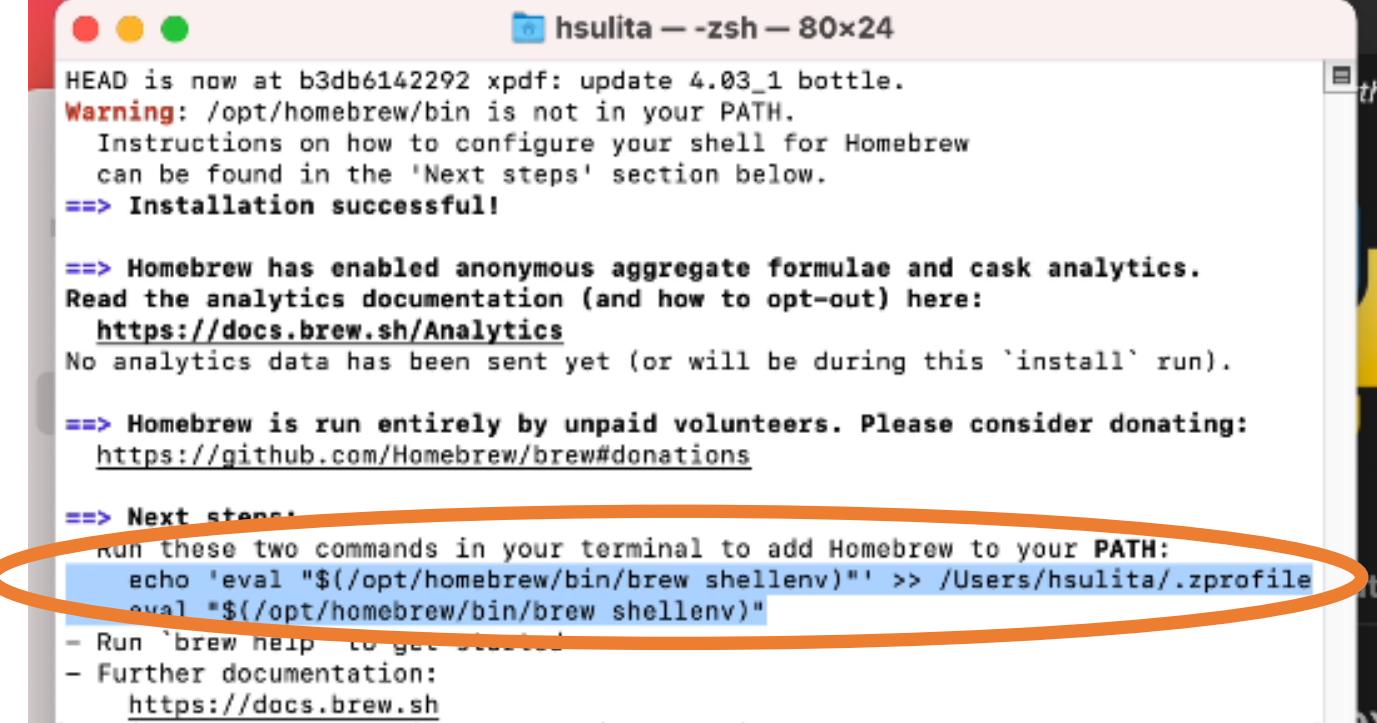
Git Installation



```
hsulita — bash -c #!/bin/bash\n12set -u\n12|012abort() {\n012 printf "%s\\n"...\n\n/opt/homebrew/share/man/man1/brew.1\n/opt/homebrew/share/zsh/site-functions/_brew\n/opt/homebrew/etc/bash_completion.d/brew\n/opt/homebrew\n==> The following new directories will be created:\n/opt/homebrew/bin\n/opt/homebrew/etc\n/opt/homebrew/include\n/opt/homebrew/lib\n/opt/homebrew/sbin\n/opt/homebrew/share\n/opt/homebrew/var\n/opt/homebrew/opt\n/opt/homebrew/share/zsh\n/opt/homebrew/share/zsh/site-functions\n/opt/homebrew/var/homebrew\n/opt/homebrew/var/homebrew/linked\n/opt/homebrew/Cellar\n/opt/homebrew/Caskroom\n/opt/homebrew/Frameworks\n==> The Xcode Command Line Tools will be installed.\n\nPress RETURN to continue or any other key to abort
```

Press RETURN

Git Installation



```
HEAD is now at b3db6142292 xpdf: update 4.03_1 bottle.
Warning: /opt/homebrew/bin is not in your PATH.
  Instructions on how to configure your shell for Homebrew
  can be found in the 'Next steps' section below.
--> Installation successful!

--> Homebrew has enabled anonymous aggregate formulae and cask analytics.
Read the analytics documentation (and how to opt-out) here:
  https://docs.brew.sh/Analytics
No analytics data has been sent yet (or will be during this 'install' run).

--> Homebrew is run entirely by unpaid volunteers. Please consider donating:
  https://github.com/Homebrew/brew#donations

--> Next steps:
Run these two commands in your terminal to add Homebrew to your PATH:
  echo 'eval "$( /opt/homebrew/bin/brew shellenv )"' >> /Users/hsulita/.zprofile
  eval "$(/opt/homebrew/bin/brew shellenv)"
- Run 'brew help' to get started
- Further documentation:
  https://docs.brew.sh
```

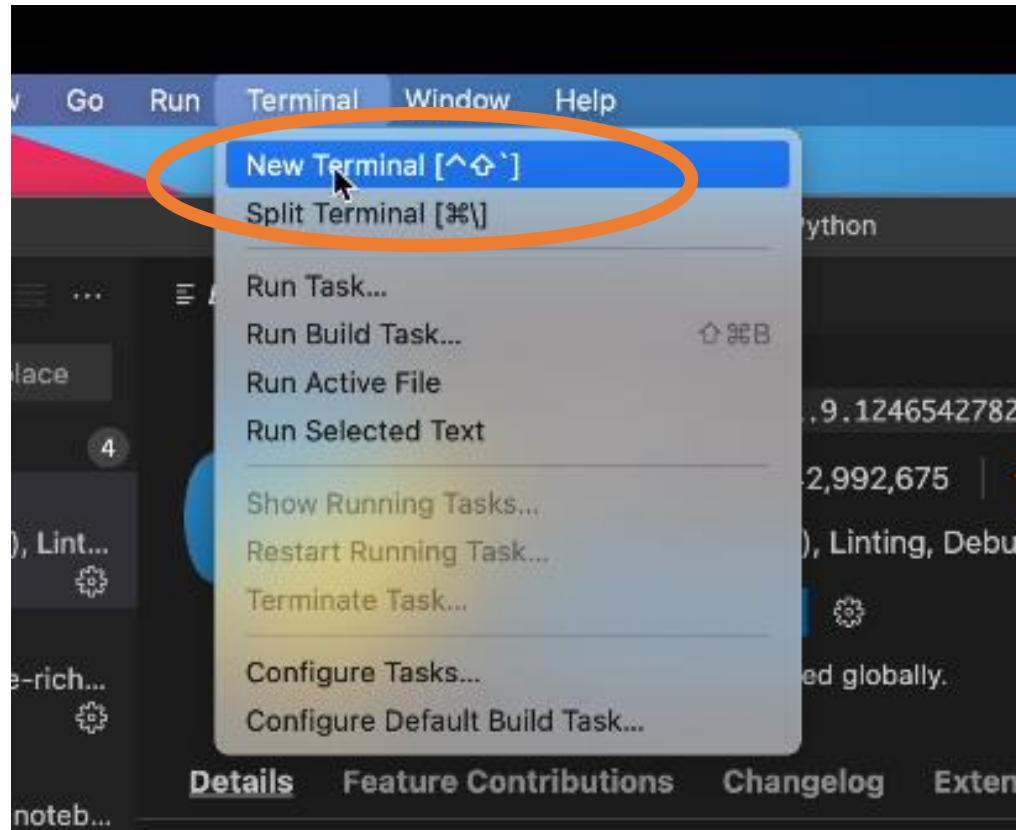
Copy this command

Git Installation

```
| hsulita@Hsus-MacBook-Air ~ %      echo 'eval "$( /opt/homebrew/bin/brew shellenv )"' |  
|   >> /Users/hsulita/.zprofile  
| [ eval "$(/opt/homebrew/bin/brew shellenv)"  
| [hsulita@Hsus-MacBook-Air ~ % brew install git
```

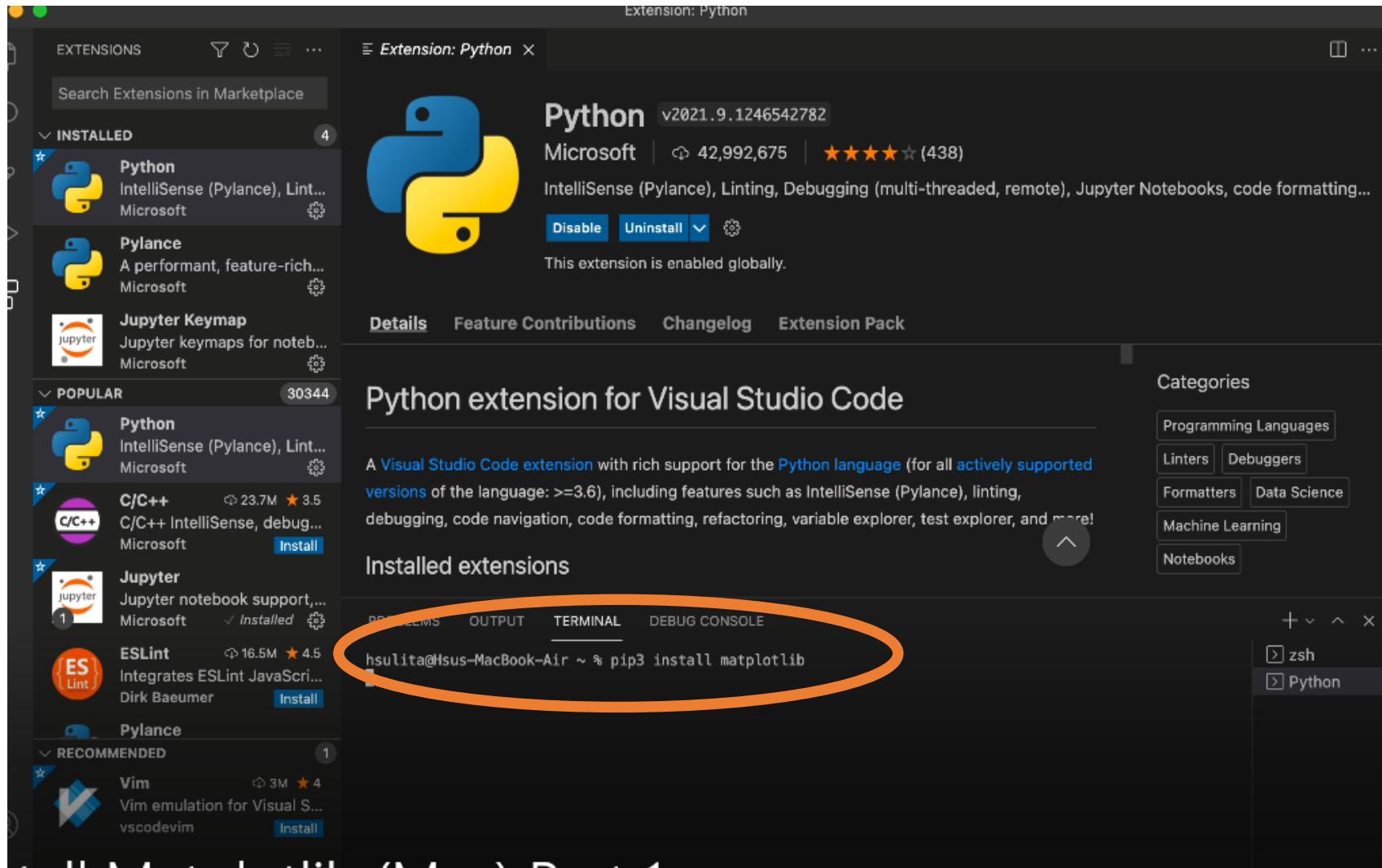
Type the command

Matplotlib Installation



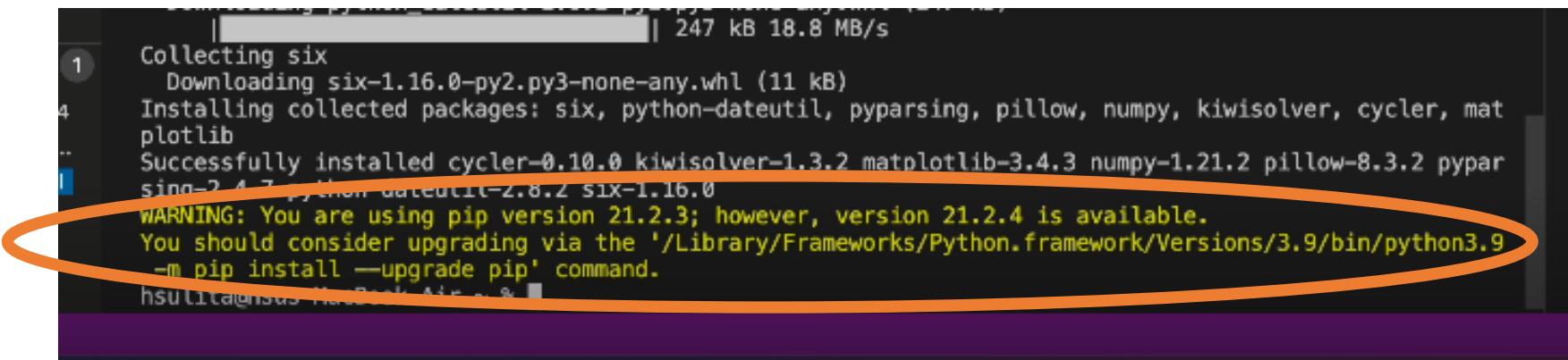
Click it

Matplotlib Installation



Type the command

Matplotlib Installation



```
|██████████| 247 kB 18.8 MB/s
1 Collecting six
  Downloading six-1.16.0-py2.py3-none-any.whl (11 kB)
4 Installing collected packages: six, python-dateutil, pyparsing, pillow, numpy, kiwisolver, cycler, mat
plotlib
--> Successfully installed cycler-0.10.0 kiwisolver-1.3.2 matplotlib-3.4.3 numpy-1.21.2 pillow-8.3.2 pypar
sing-2.4.7 python-dateutil-2.8.2 six-1.16.0
WARNING: You are using pip version 21.2.3; however, version 21.2.4 is available.
You should consider upgrading via the '/Library/Frameworks/Python.framework/Versions/3.9/bin/python3.9
-m pip install --upgrade pip' command.
hsultimo@hsultimo-MacBook-Air ~ %
```

You may encounter this problem

Matplotlib Installation

```
WARNING: You are using pip version 21.2.3; however, version 21.2.4 is available.  
You should consider upgrading via the  
/Library/Frameworks/Python.framework/Versions/3.9/bin  
/python3.9 -m pip install --upgrade pip command.  
bsulita@Hsus-MacBook-Air: ~ %
```

Copy this command

Matplotlib Installation

```
Successfully installed cycler-0.10.0 kiwisolver-1.3.2 matplotlib-3.4.3 numpy-1.21.2 pillow-8  
.3.2 pyparsing-2.4.7 python-dateutil-2.8.2 six-1.16.0  
WARNING: You are using pip version 21.2.3; however, version 21.2.4 is available.  
You should consider upgrading via the '/Library/Frameworks/Python.framework/Versions/3.9/bin  
/python3.9 -m pip install --upgrade pip' command.  
hsulita@Hsus-MacBook-Air ~ % pip install --upgrade pip  
zsh: command not found: pip  
hsulita@Hsus-MacBook-Air ~ % pip3 install --upgrade pip3  
ERROR: Could not find a version that satisfies the requirement pip3 (from versions: none)  
ERROR: No matching distribution found for pip3  
WARNING: You are using pip version 21.2.3; however, version 21.2.4 is available.  
You should consider upgrading via the '/Library/Frameworks/Python.framework/Versions/3.9/bin  
/python3.9 -m pip install --upgrade pip' command.  
hsulita@Hsus-MacBook-Air ~ % /Library/Frameworks/Python.framework/Versions/3.9/bin/python3.9  
-m pip install --upgrade pip
```

Paste the command

Matplotlib Installation

```
PROBLEMS    OUTPUT    TERMINAL    DEBUG CONSOLE

hsulita@Hsus-MacBook-Air ~ % /Library/Frameworks/Python.framework/Versions/3.9/bin/python3.9
-m pip install --upgrade pip
Requirement already satisfied: pip in /Library/Frameworks/Python.framework/Versions/3.9/lib/
python3.9/site-packages (21.2.3)
Collecting pip
  Downloading pip-21.2.4-py3-none-any.whl (1.6 MB)
    |████████| 1.6 MB 5.6 MB/s
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 21.2.3
    Uninstalling pip-21.2.3:
      Successfully uninstalled pip-21.2.3
Successfully installed pip-21.2.4
hsulita@Hsus-MacBook-Air ~ % pip3 install matplotlib
```

Type the command