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
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- 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!

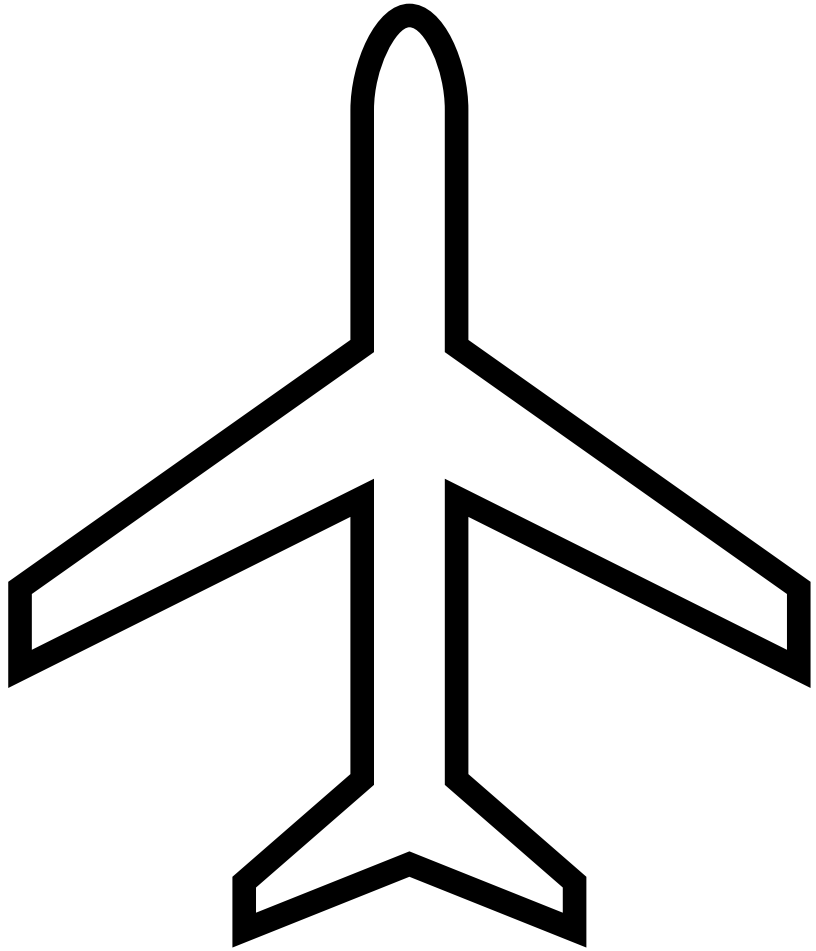
- Keep an open mind—enter the classroom dialogue with the expectation of learning something new. Look forward to learning about–and being challenged by–ideas, questions, and points of view that are different than your own.
- Arrive on time to the class and finish the class on time

Necessary Information

- Course Repository link: https://github.com/IPNL-POLYU/PolyU_AAE2004_Github_Project
- 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
5. Path Planning Code Guide

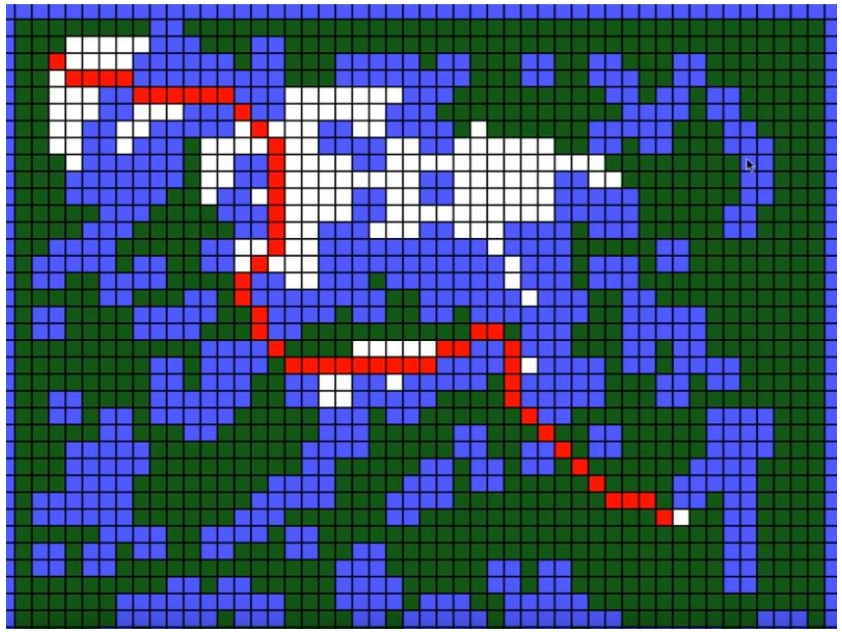


Introduction to Path Planning

What is Path Planning?

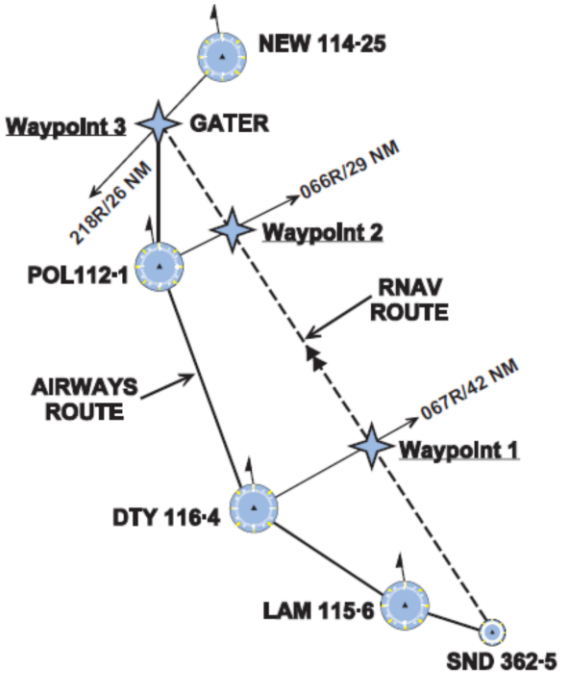
How to go from A to B considering factors!

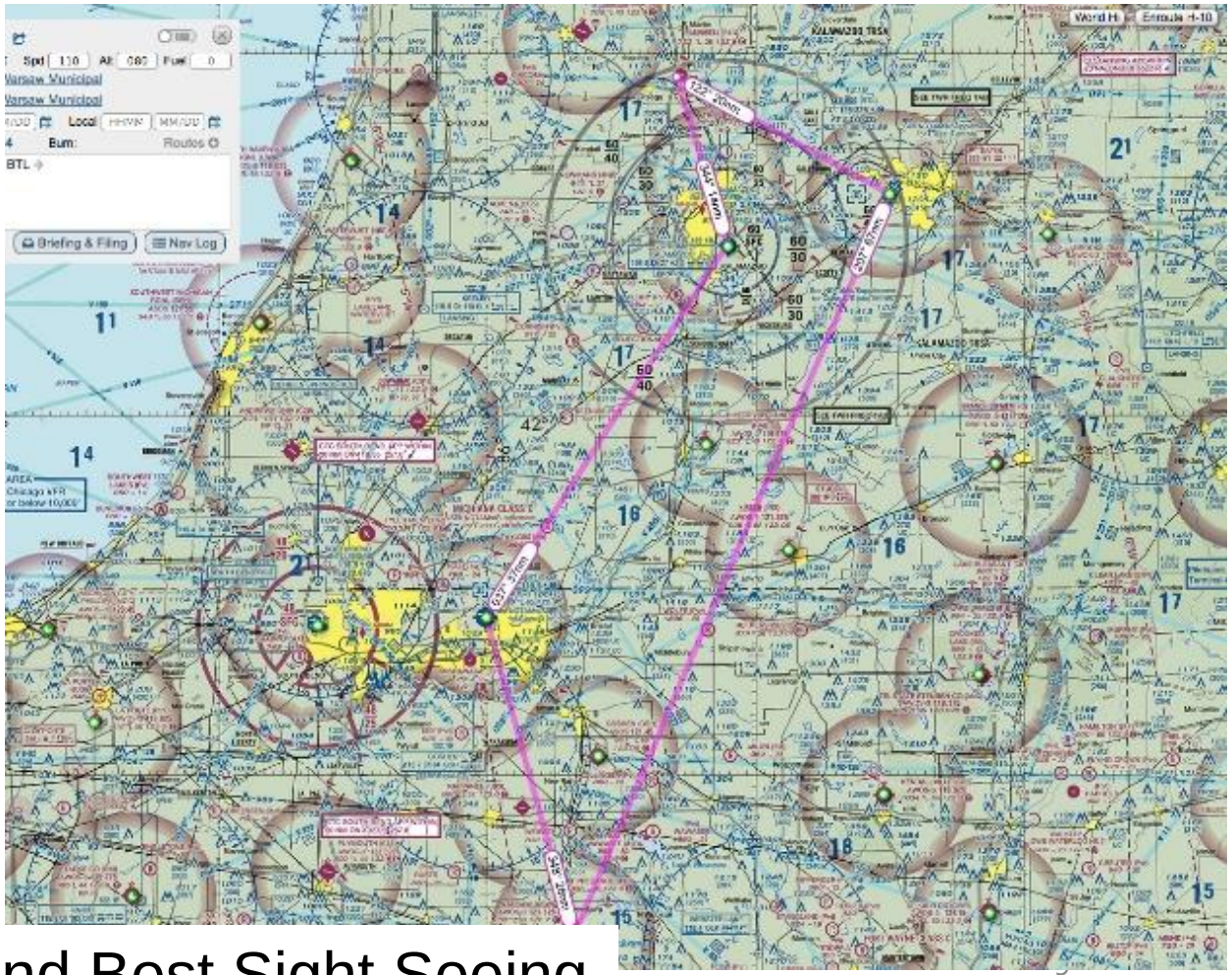
- **Path planning** (also known as the **navigation problem**) is computational problem to find a sequence of valid configurations that moves the object from the source to destination. The term is used in **aviation**, **robotics** and **computer games**.

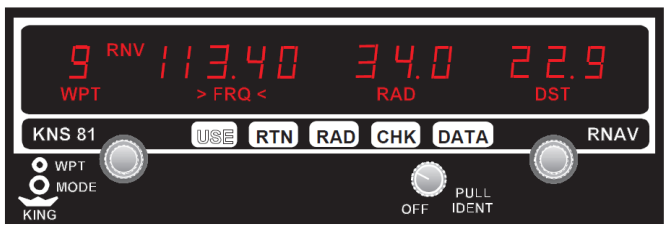


How is Path Planning important to Aviation Engineering?

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



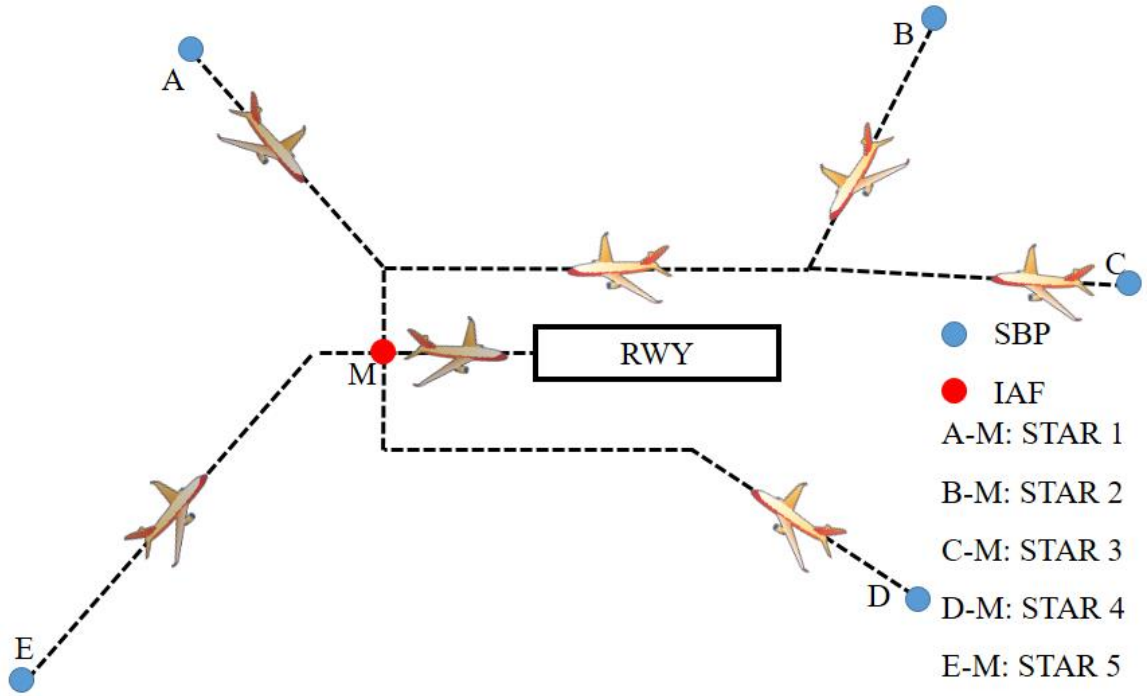


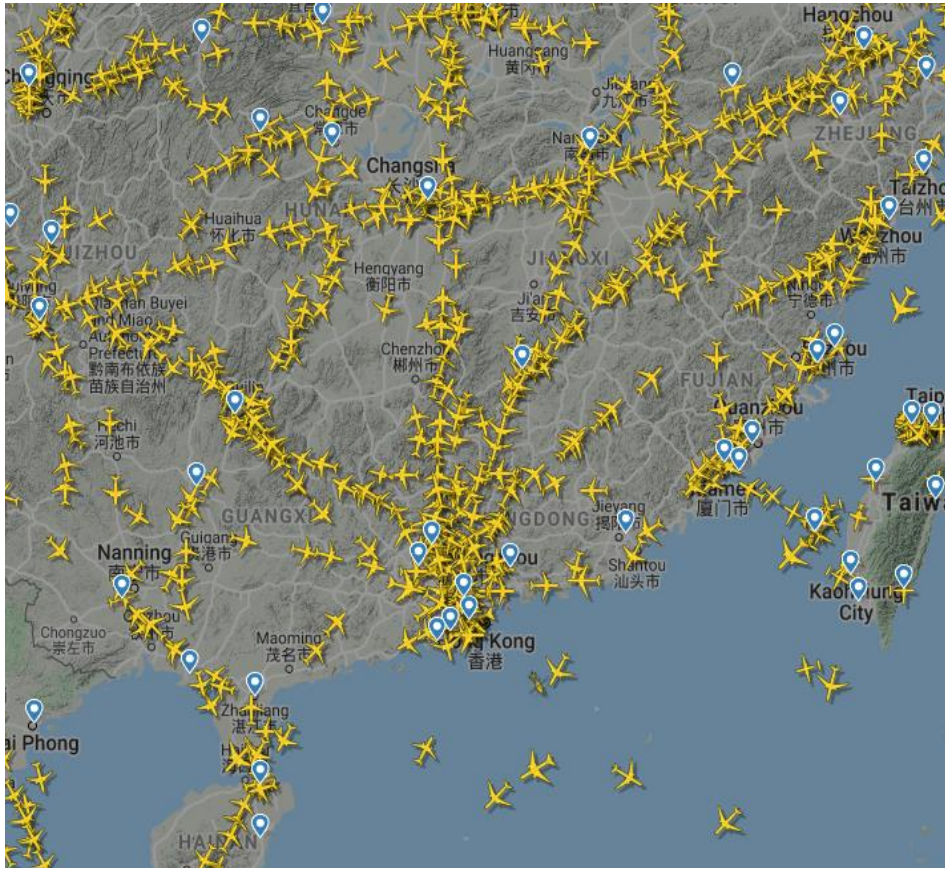


Objective: Safe and Best Sight Seeing

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





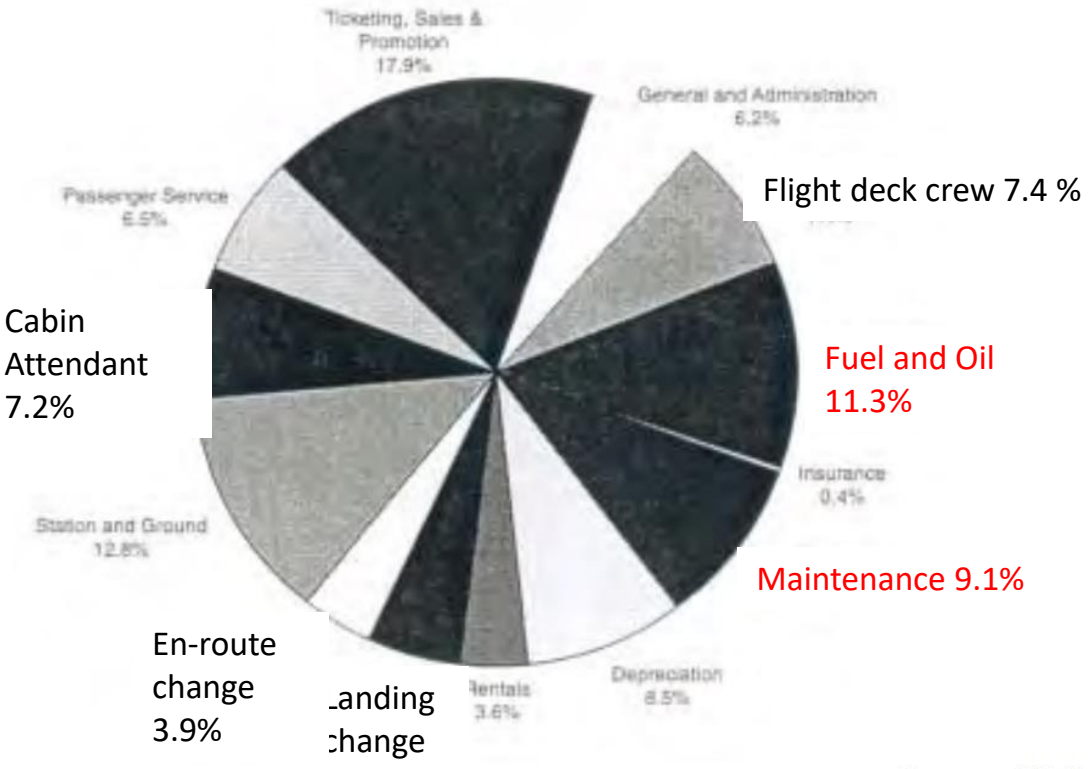
Objective: Safe and least delay

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

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 :

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

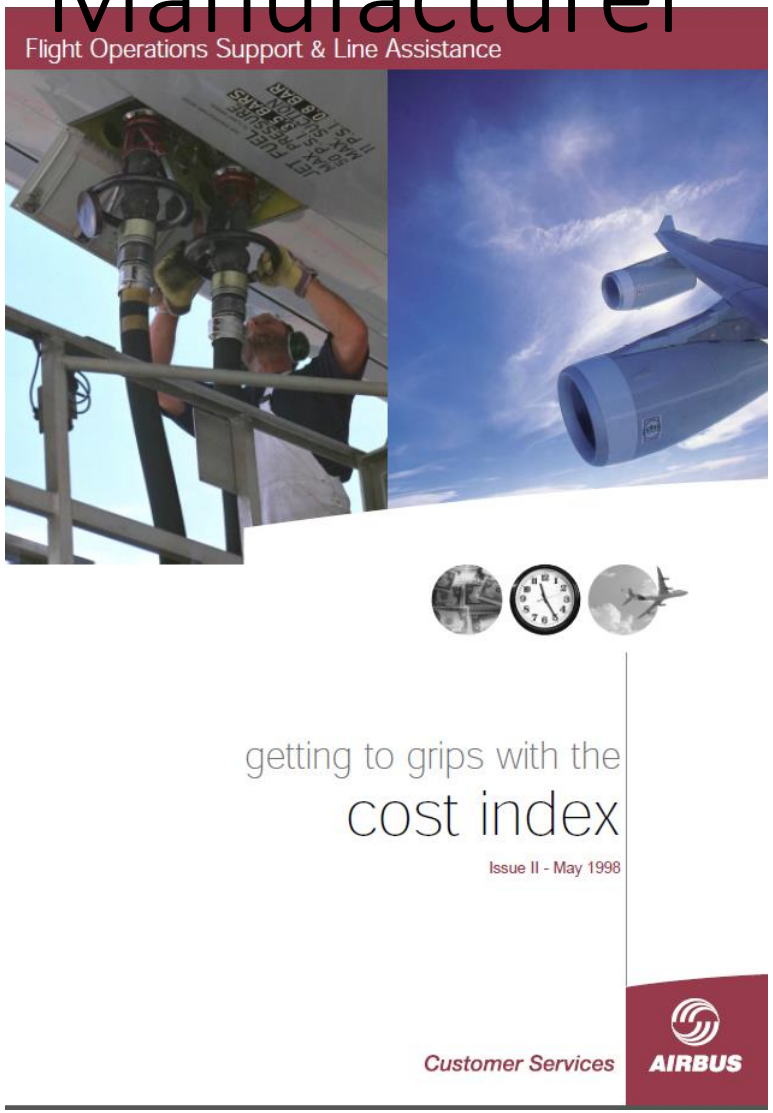
with C_F = cost of fuel per kg
C_T = time-related cost per minute of flight
C_c = fixed costs independent of time
ΔF = trip fuel
ΔT = trip time

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

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

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

Cost-Index Published by Aircraft Manufacturer



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.

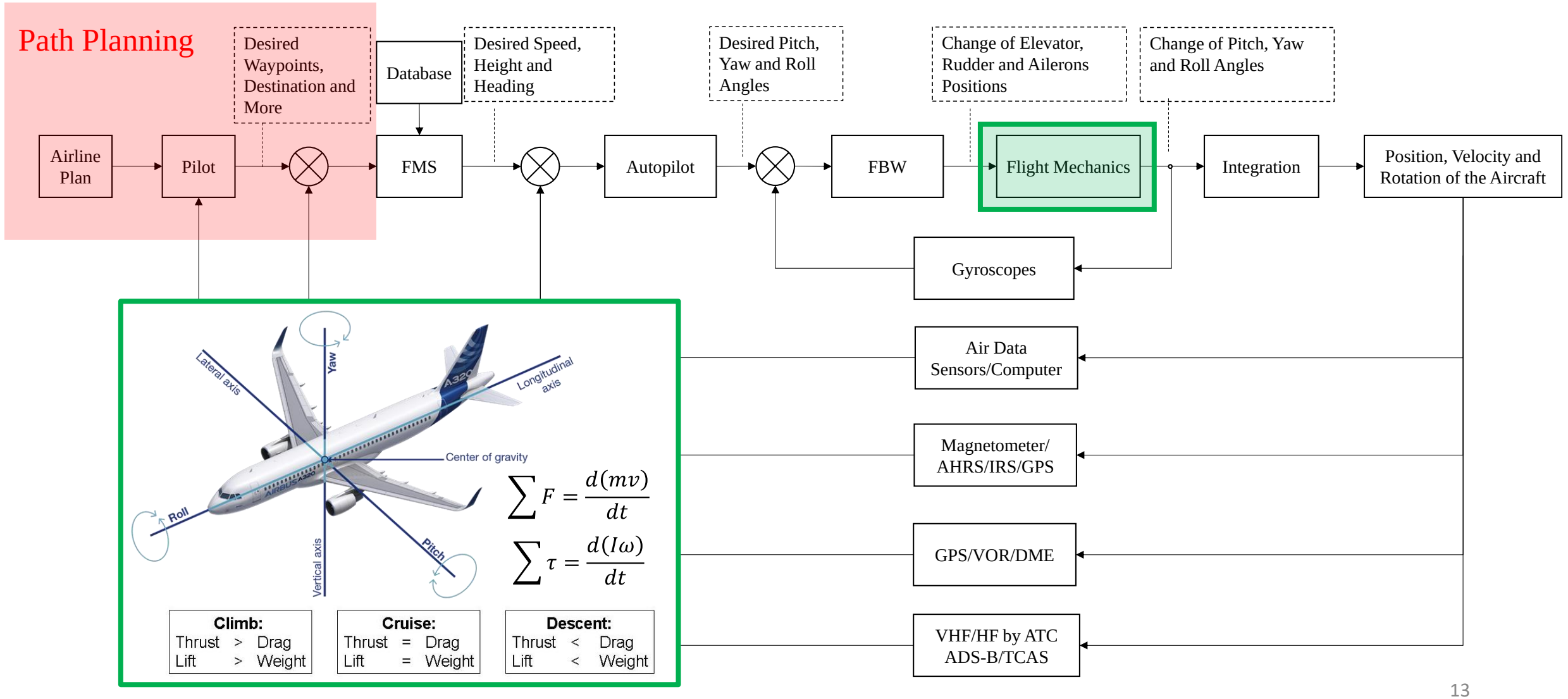
Table 1. A300/A310 cost index

(kg/min)
(Honeywell FMS)

FUEL COST (US$/USG) \ TIME COST (US$/min)	LOW < 15	MEDIUM 15 < to < 20	HIGH > 20
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

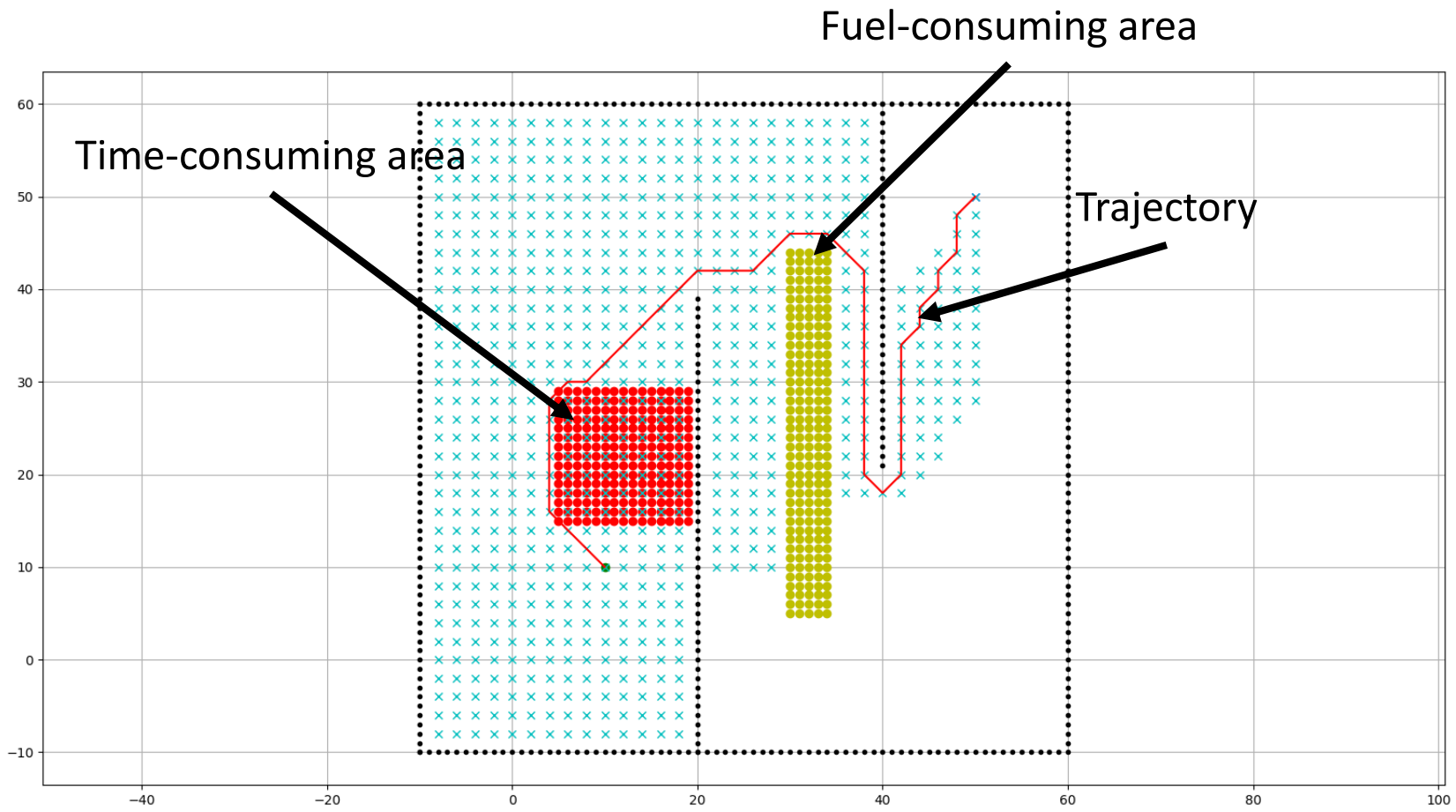
- The plan should be planned considering the physical limitation (dynamics) of the aircraft

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 Syste
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.***

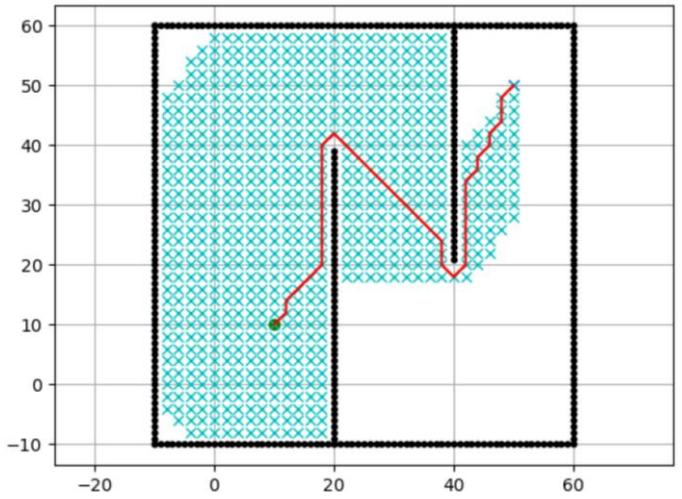
Expected Outcome.
Every Group have different scenarios



Model of Aircraft to select

Aircraft Model	C_F	ΔF	C_T	ΔT	C_c	ΔF_a	ΔT_a
PolyU-A380	1	1	2	5	10	0.2	0.2
PolyU-A381	1	1.5	3	5	10	0.3	0.4
PolyU-A382	1	2.0	4	5	10	0.4	0.5
PolyU-A383	1	2.5	5	5	10	0.5	0.1
AAE-Group 1	?	?	?	?	?	?	?
AAE-Group 2	?	?	?	?	?	?	?
AAE-Group 3	?	?	?	?	?	?	?
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

What you are expected to learn?



Academic level of algorithm designs

- Design of a path planning algorithm and aircraf 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

AtsushiSakai / PythonRobotics

In this project, students will be acted as

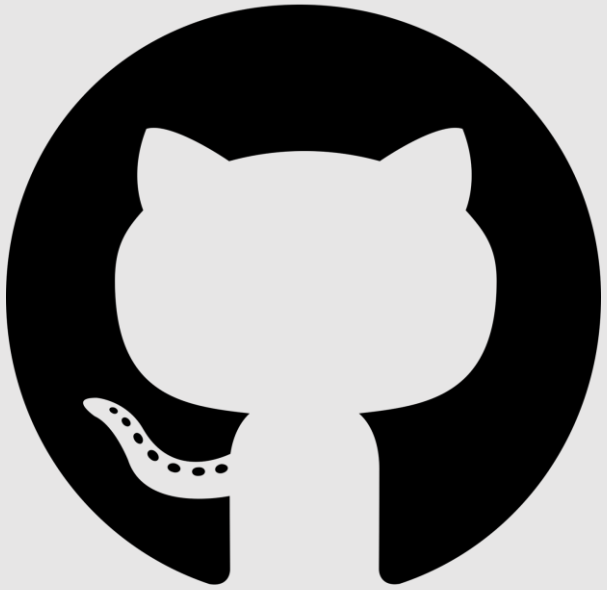
1. Group leader or members to collaborate on an online project,
2. R&D engineers to design and develop path-planning algorithm,
3. Project manager to present the designed code and prepare report.

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?

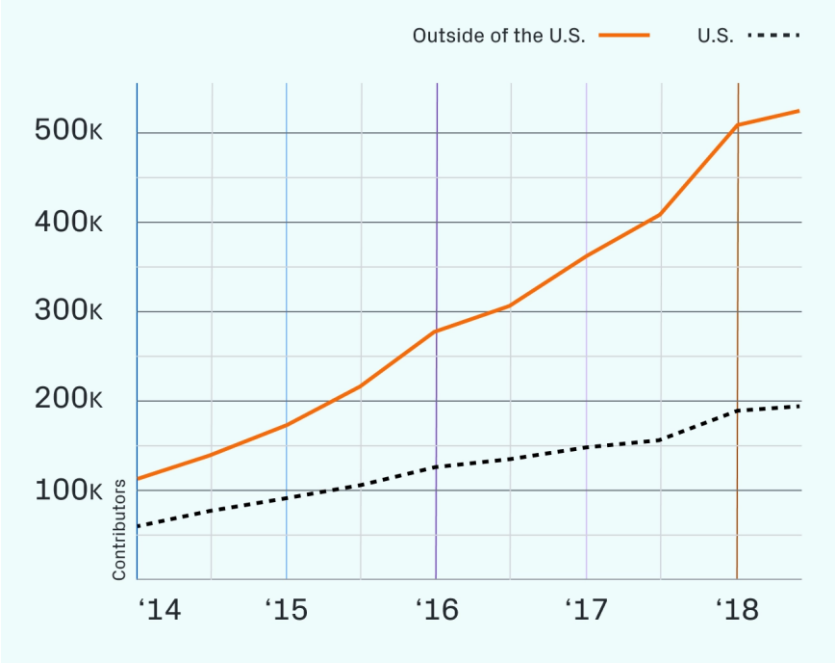


What is Github?

- 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

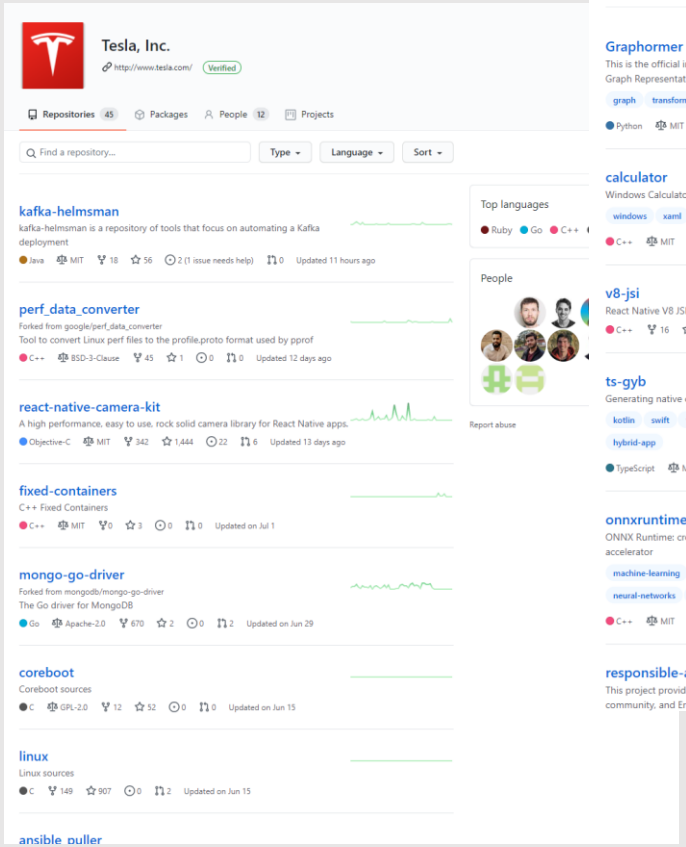
- Over 100 million live Projects
- New projects increasing over the years
- Showing the trend of using GitHub for Software development

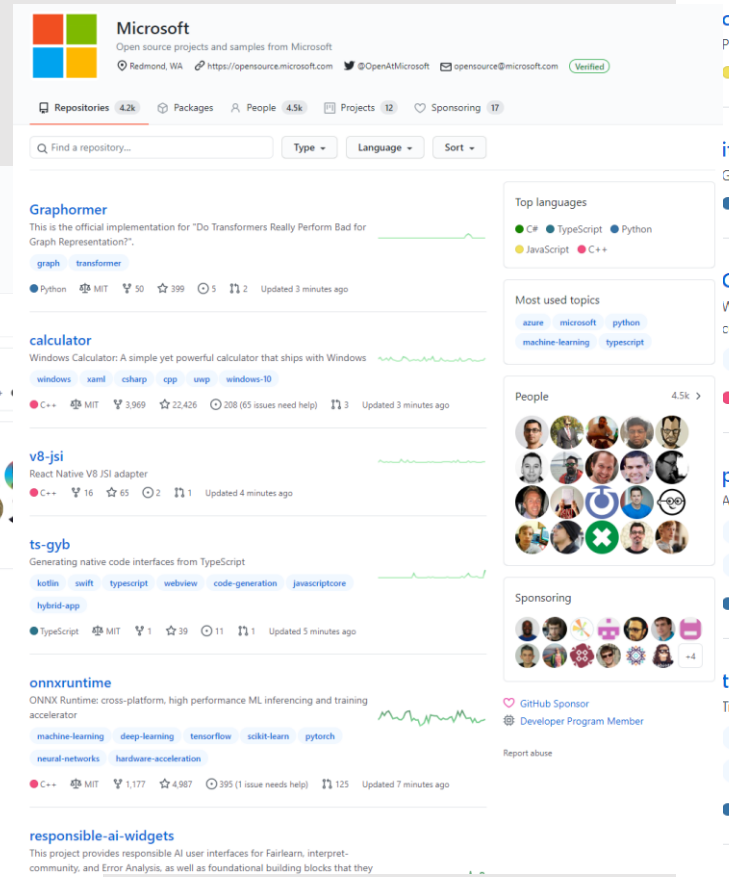


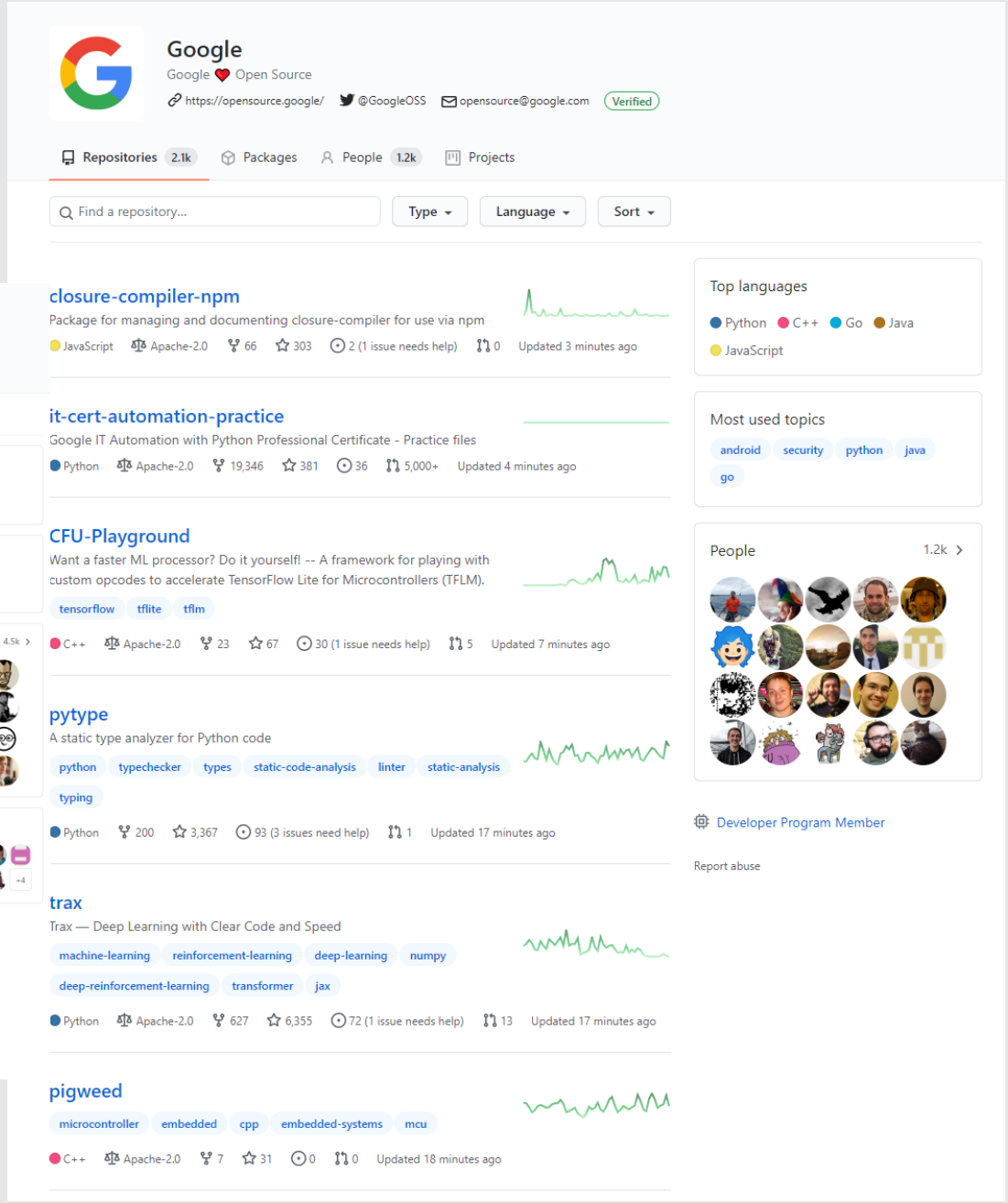
Variety of GitHub

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

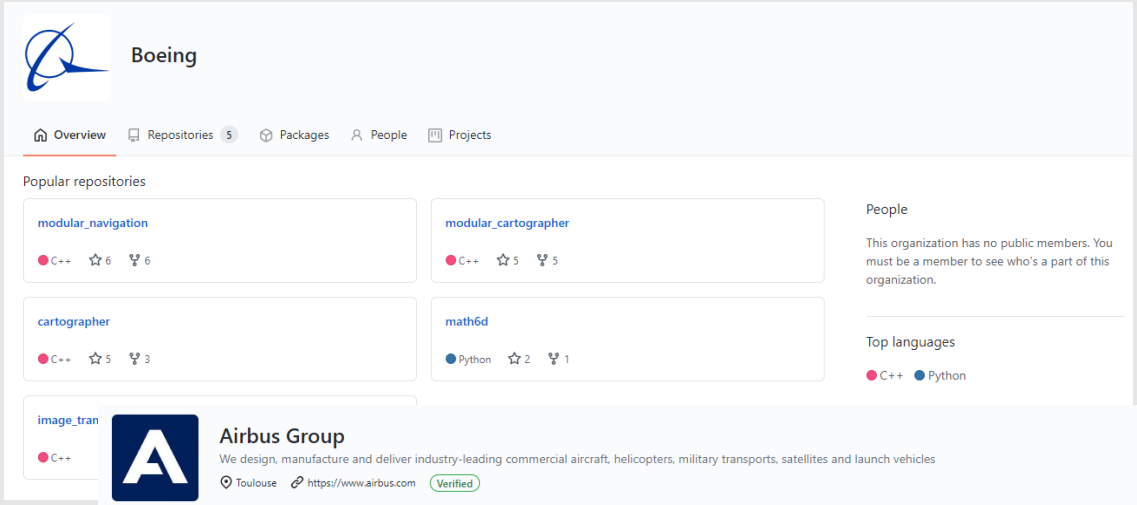
BIG GitHub Pages

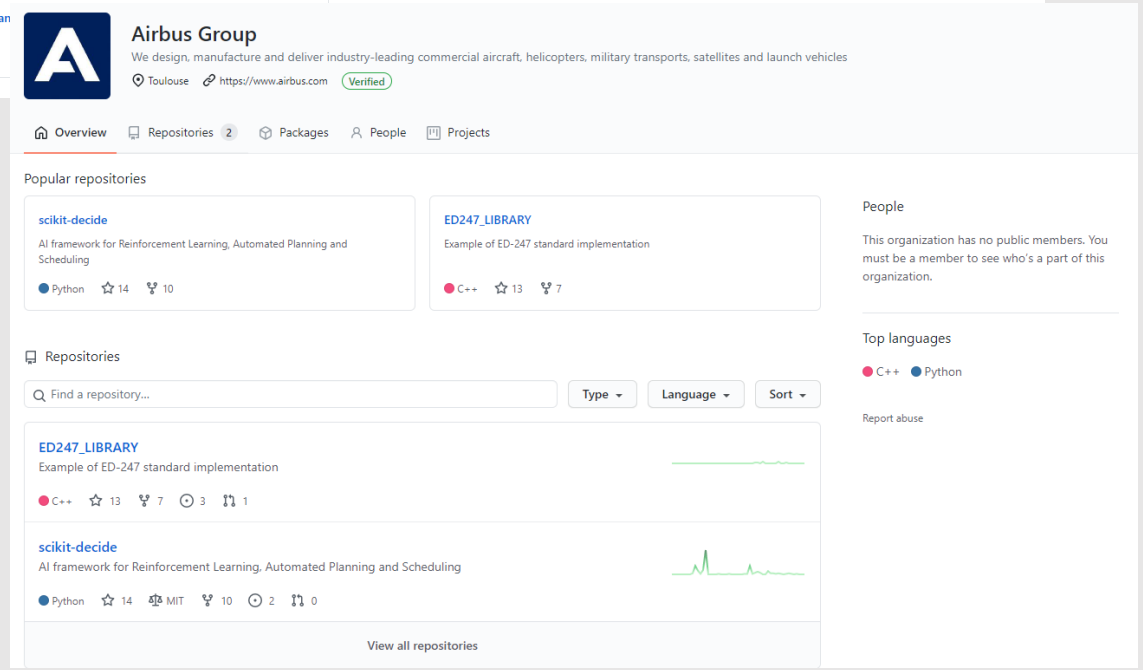


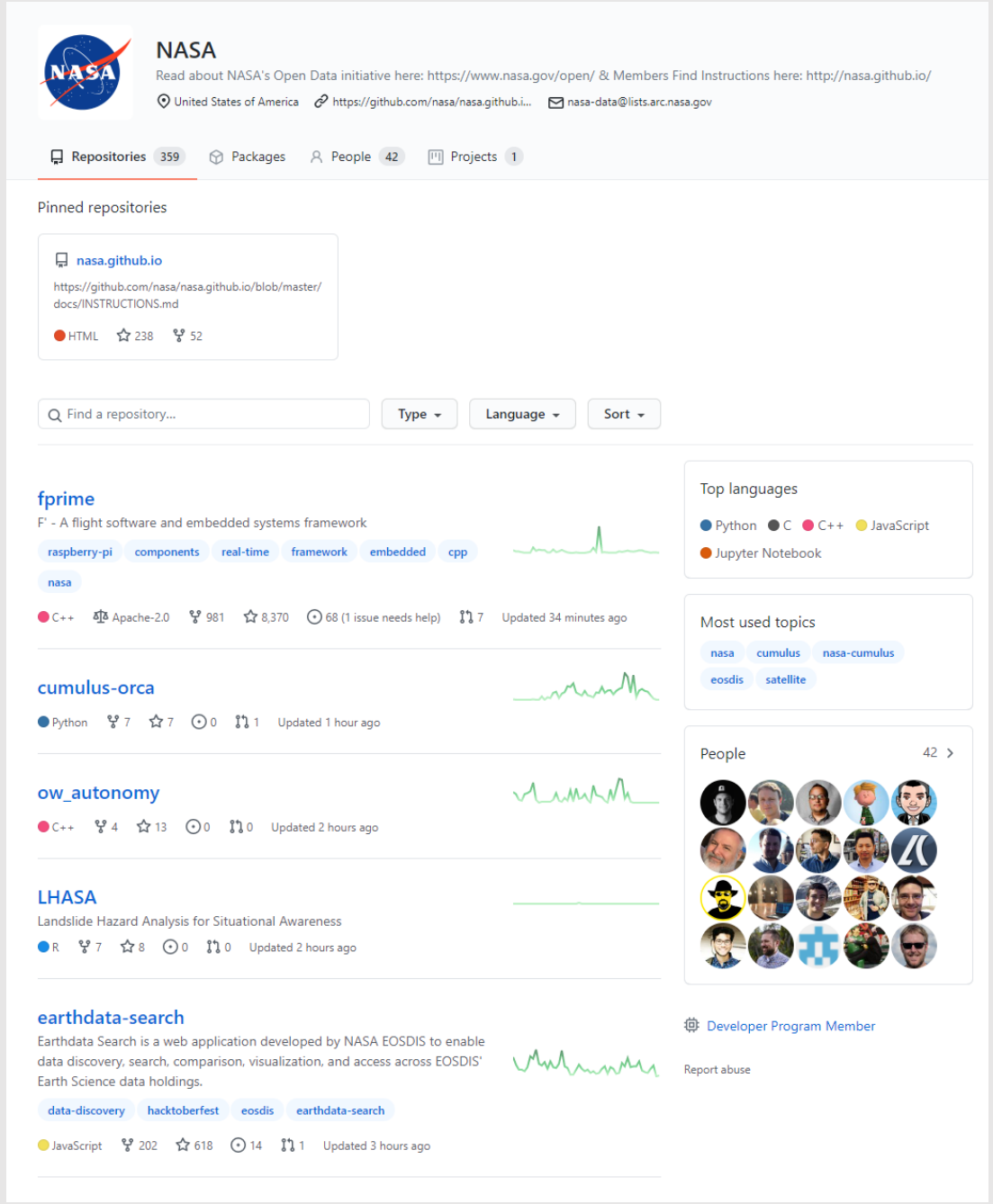




BIG GitHub Pages







What’s on GitHub?

How is it related to AAE?

Flight control softwares for UAV

Ardupilot, PX4 and more

ArduPilot / ardupilot

Star 6k

Code Issues Pull requests

Open Move test_onboard_logging_generation outside autotest.py

khancyr commented on May 27

Feature request

Is your feature request related to a problem? Please describe.
Move test_onboard_logging_generation outside autotest.py to all to validate logger documentation before running the full autotest suite. Ideally, on CI it should run on build_ci.sh with param_parse.py to allow to validate soon that the documentation is correct and not wait that all test pass to trigger a docu

Read more

AllVehicles BuildSystem CI good first issue

Open Fix Copter test which tests all frames in autotest

Open Plane: maximum altitude for FBWB and cruise mode 10

Find more good first issues →

PX4 / PX4-Autopilot

Star 4.7k

Code Issues Pull requests

PX4 Autopilot Software

uav drone ros px4 pixhawk uas dronecode autopilot mavlink autonomous drones dds hacktoberfest ugv mavros multicopter qgroundcontrol fixed-wing fast-rtps avoidance

Updated 19 minutes ago C++

mavlink / qgroundcontrol

Star 1.9k

Code Issues Pull requests

Cross-platform ground control station for drones (Android, iOS, Mac OS, Linux, Windows)

qt uav drone px4 pixhawk uas mavlink ardupilot

Updated 23 hours ago C++

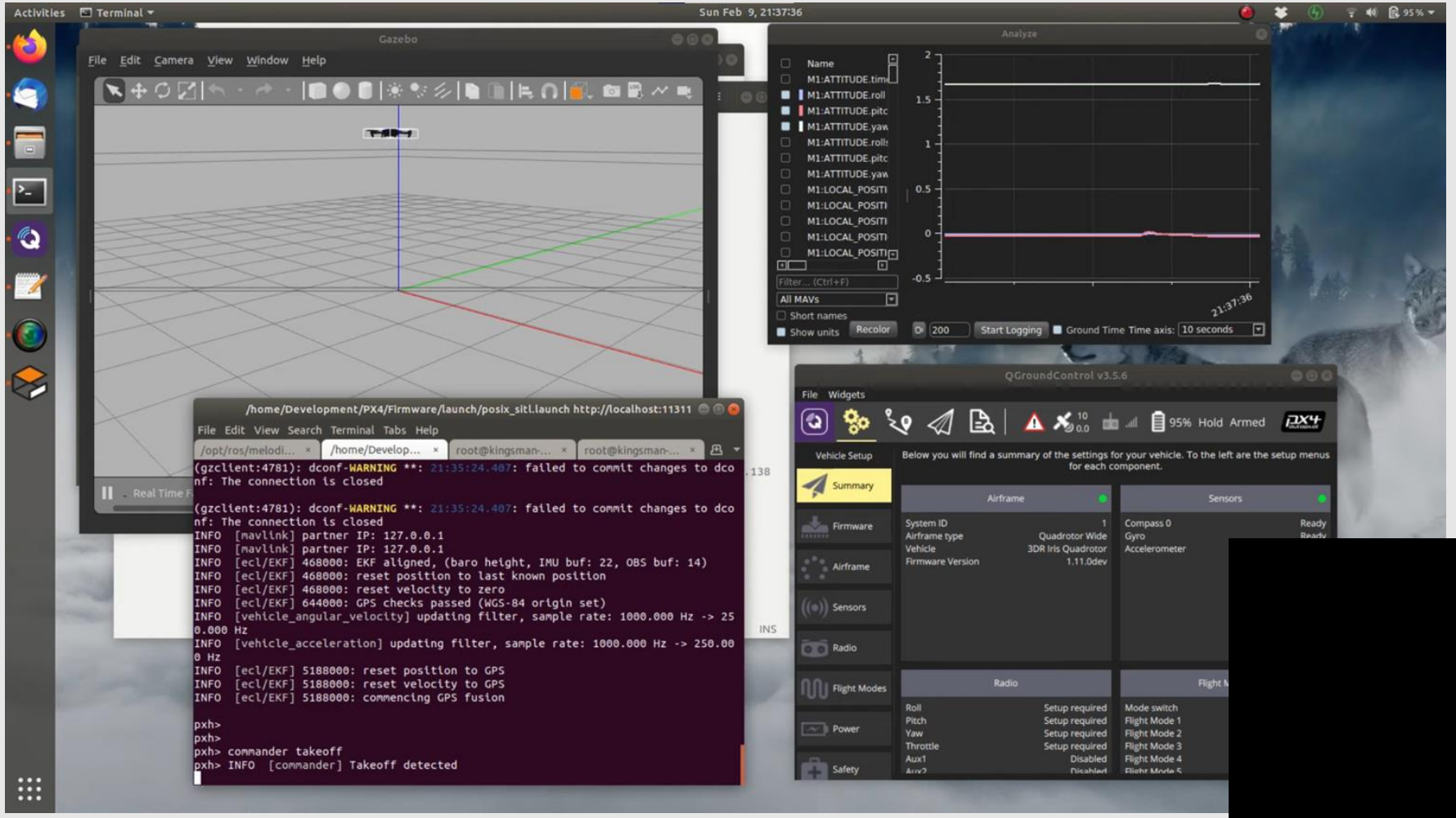
About These Softwares

Ardupilot:

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

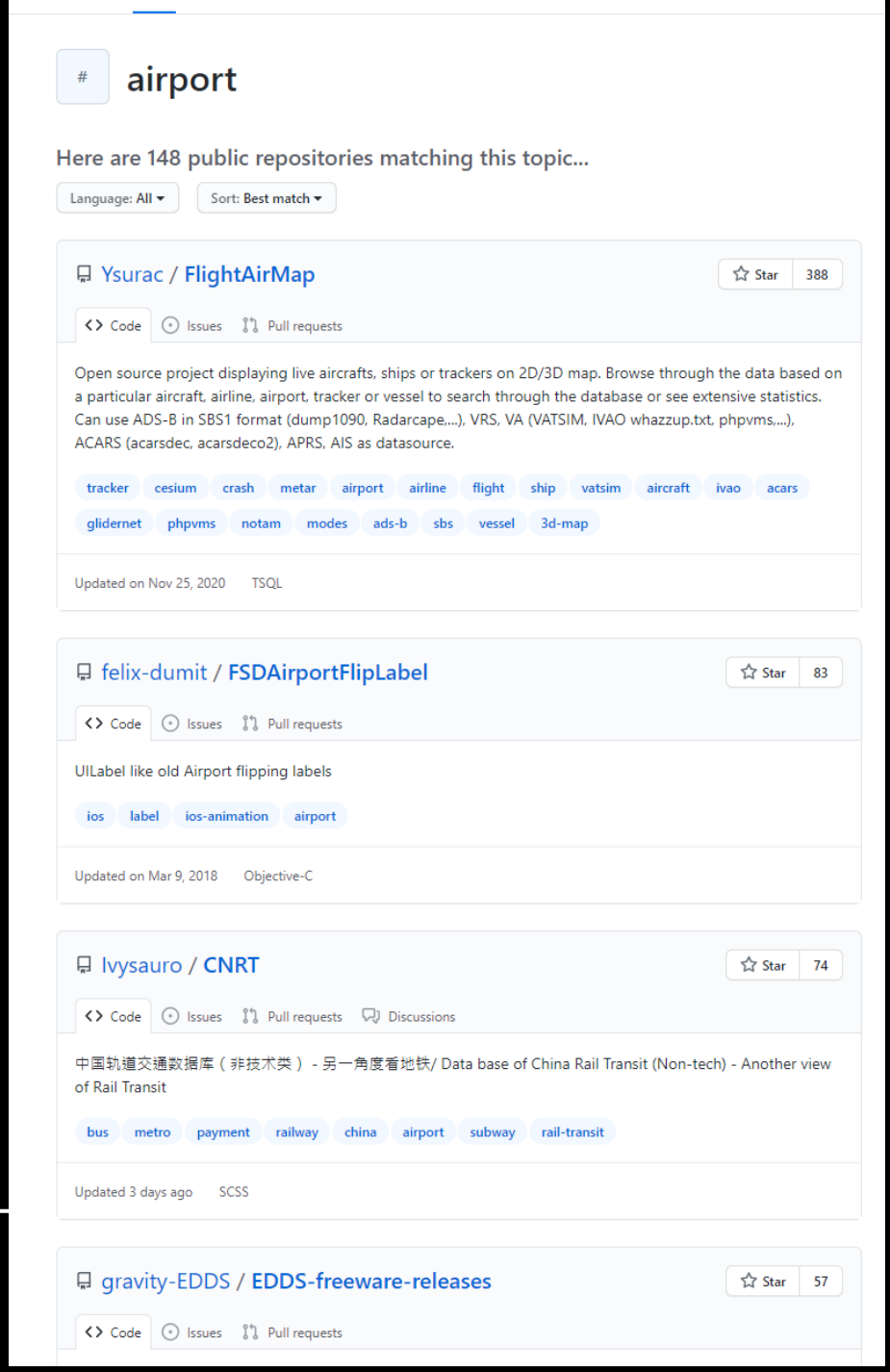
PX4:

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


Activities
Terminal
Sun Feb 9, 21:37:36
Gazebo
File Edit Camera View Window Help
Analyze
Name
M1:ATTITUDE.roll
M1:ATTITUDE.pitc
M1:ATTITUDE.yaw
Filter... (Ctrl+F)
All MAVs
Short names
Show units
Recolor
Start Logging
Ground Time
Time axis:
10 seconds
21:37:36
/home/Development/PX4/Firmware/launch/posix_sitl.launch http://localhost:11311
File Edit View Search Terminal Tabs Help
(gzclient:4781): dconf-WARNING **: 21:35:24.407: failed to commit changes to dconf: The connection is closed
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 -> 250.000 Hz
INFO [vehicle_acceleration] updating filter, sample rate: 1000.000 Hz -> 250.000 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
QGroundControl v3.5.6
File Widgets
95% Hold Armed
Vehicle Setup
Summary
Firmware
Airframe
Sensors
Radio
Flight Modes
Power
Safety
Below you will find a summary of the settings for your vehicle. To the left are the setup menus for each component.
Airframe
System ID 1
Airframe type Quadrotor Wide
Vehicle 3DR Iris Quadrotor
Firmware Version 1.11.0dev
Sensors
Compass 0 Ready
Gyro Ready
Accelerometer
Radio
Roll Setup required
Pitch Setup required
Yaw Setup required
Throttle Setup required
Aux1 Disabled
Mode switch
Flight Mode 1
Flight Mode 2
Flight Mode 3
Flight Mode 4

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, Radarcape,...), VRS, VA (VATSIM, IVAO whazzup.txt, phpvms,...), ACARS (acarsdec, acarsdeco2), APRS, AIS as datasource.

tracker cesium crash metar airport airline flight ship vatsim aircraft ivao 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

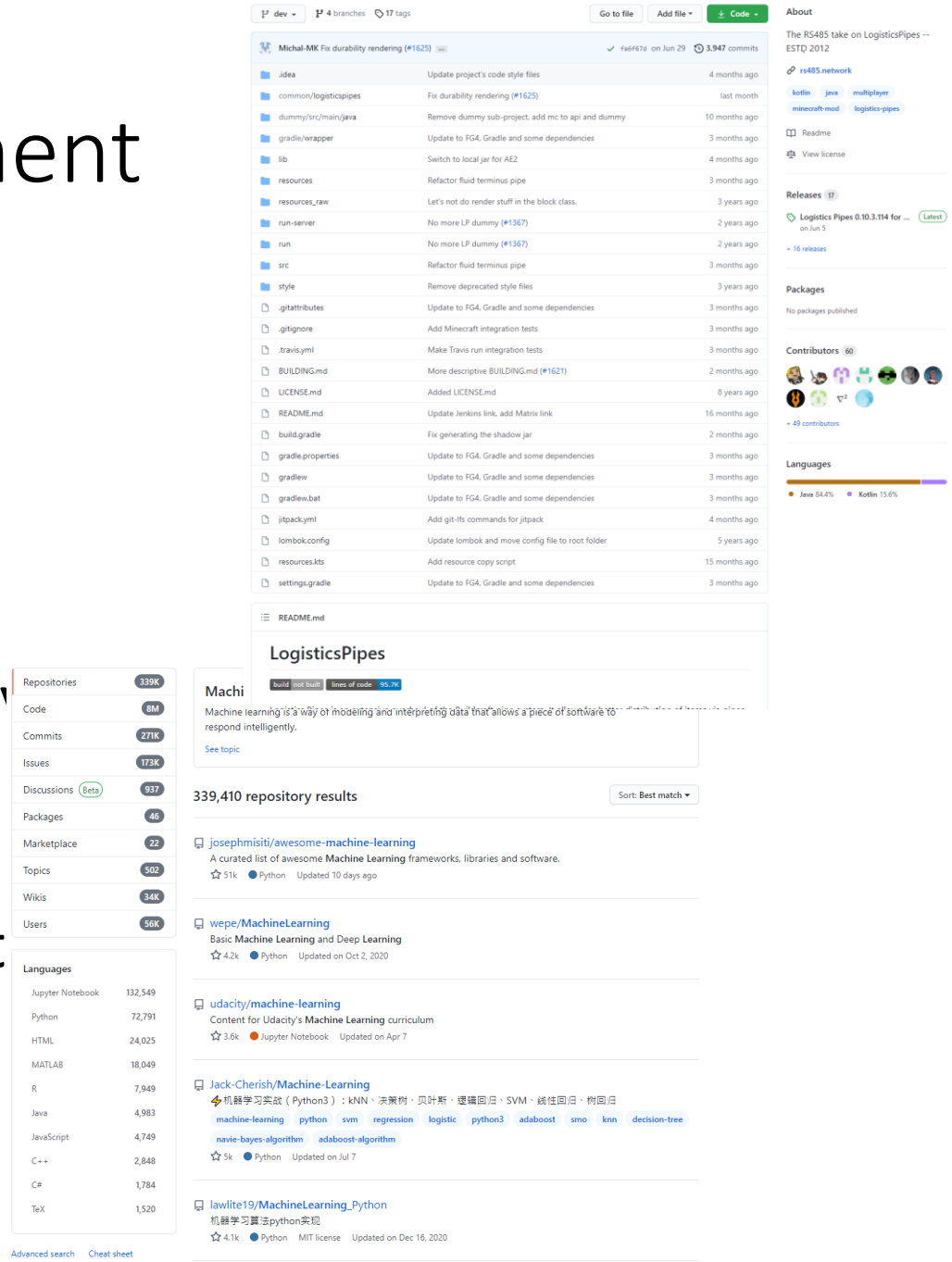
Code Issues Pull requests

Logistics and Facility Management

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

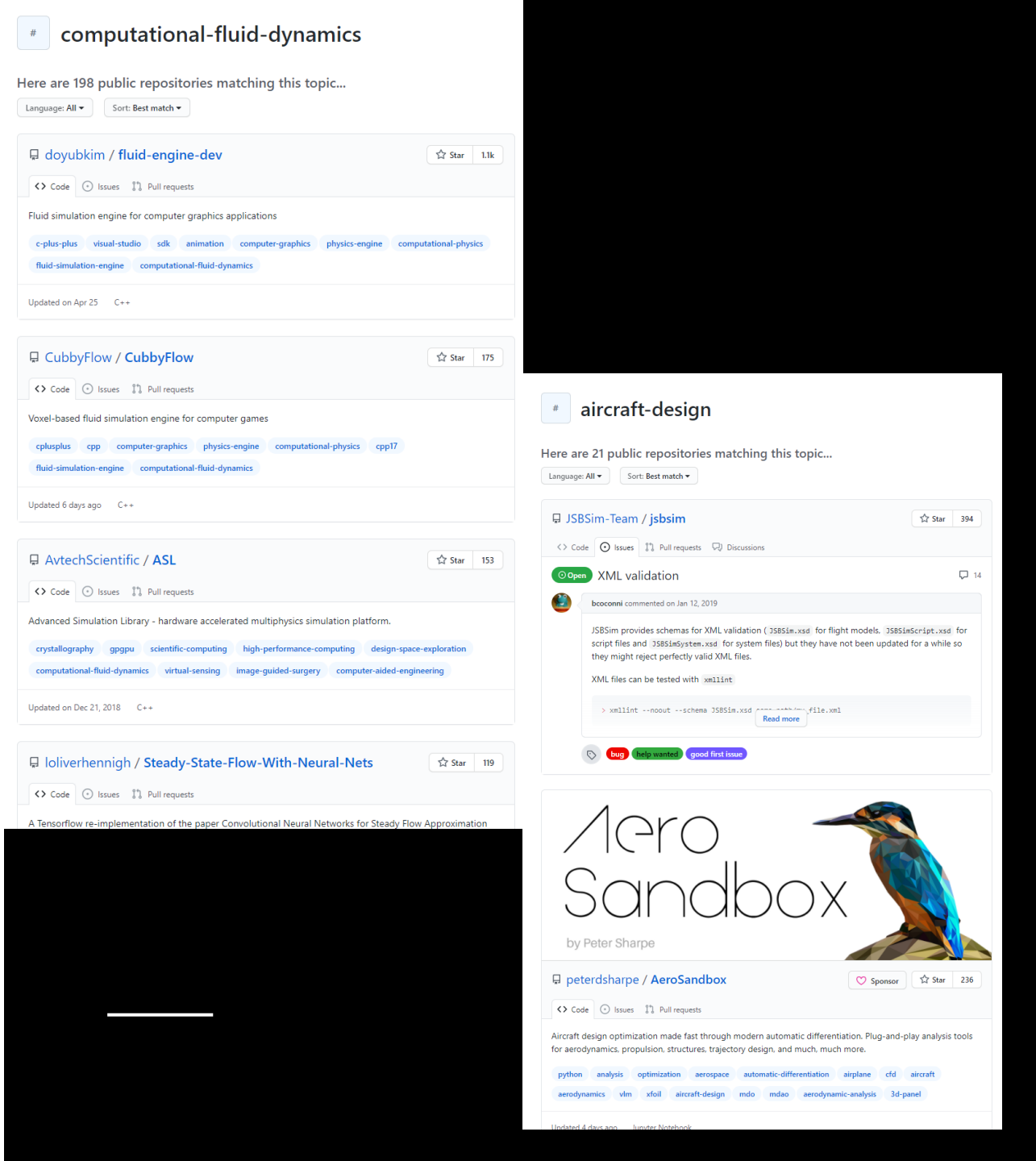
Machine learning for data anal

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



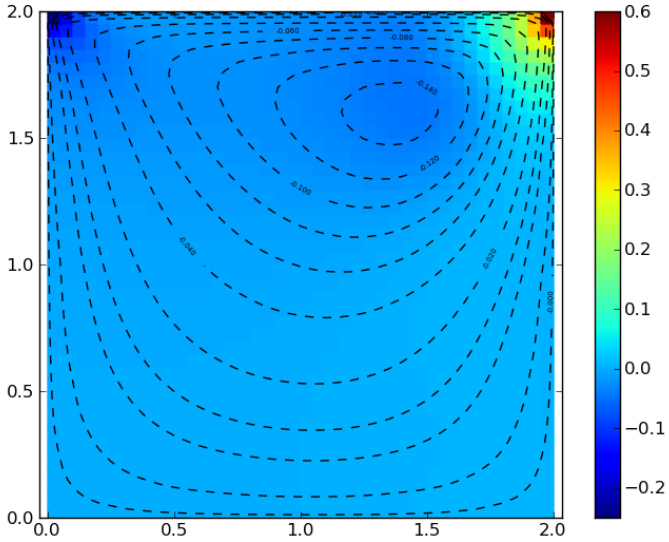
Aeronautical Engineering

Material, aircraft designs, CFD and more



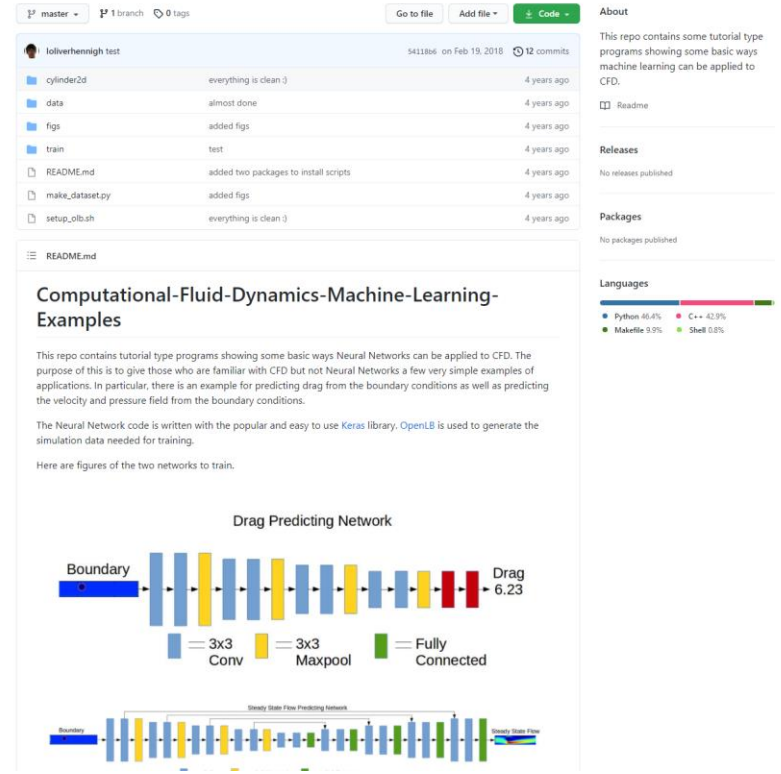
CFD Python

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



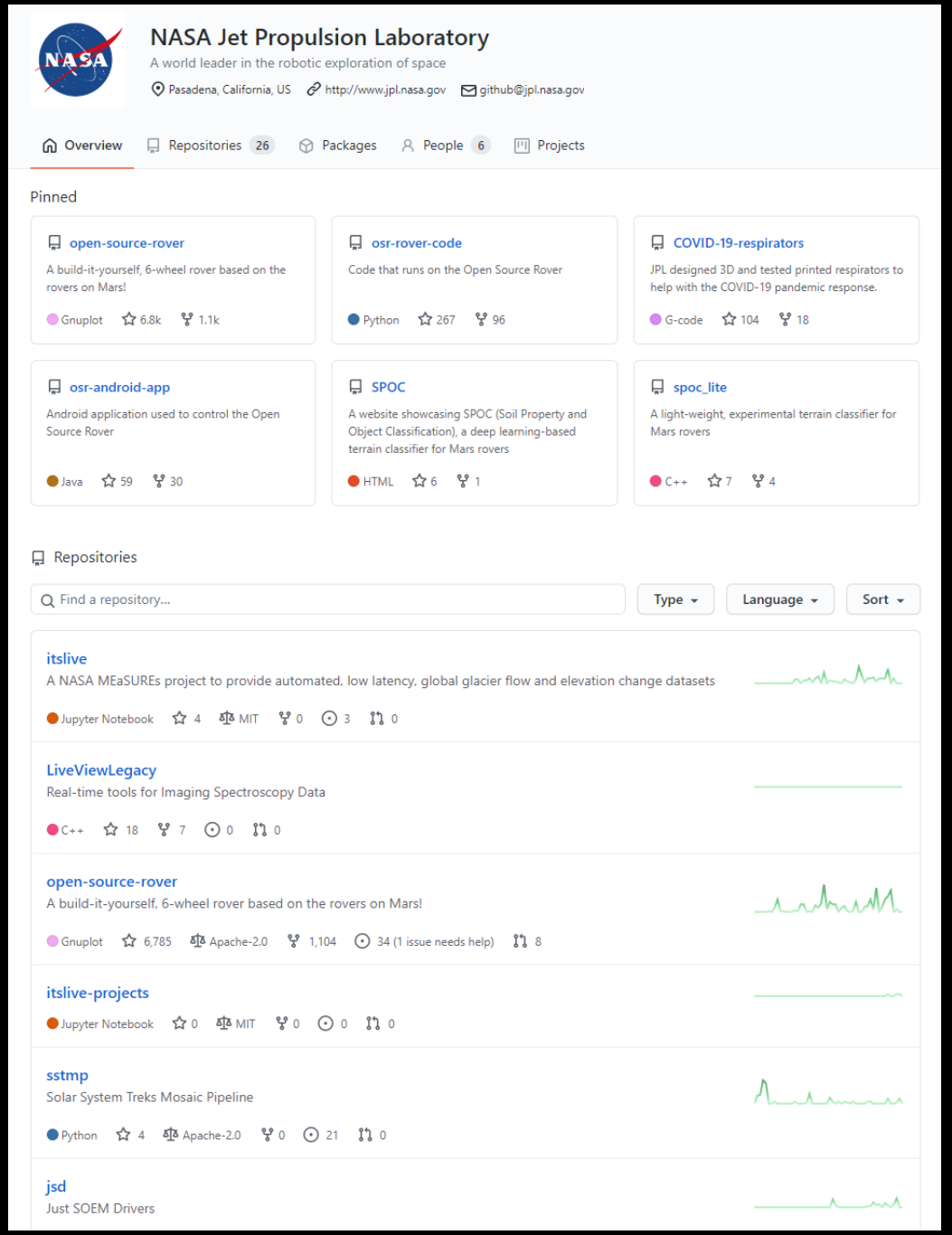
CFD and Machine Learning

- Making use of ML
- Showing how neural networks can be applied to CFD



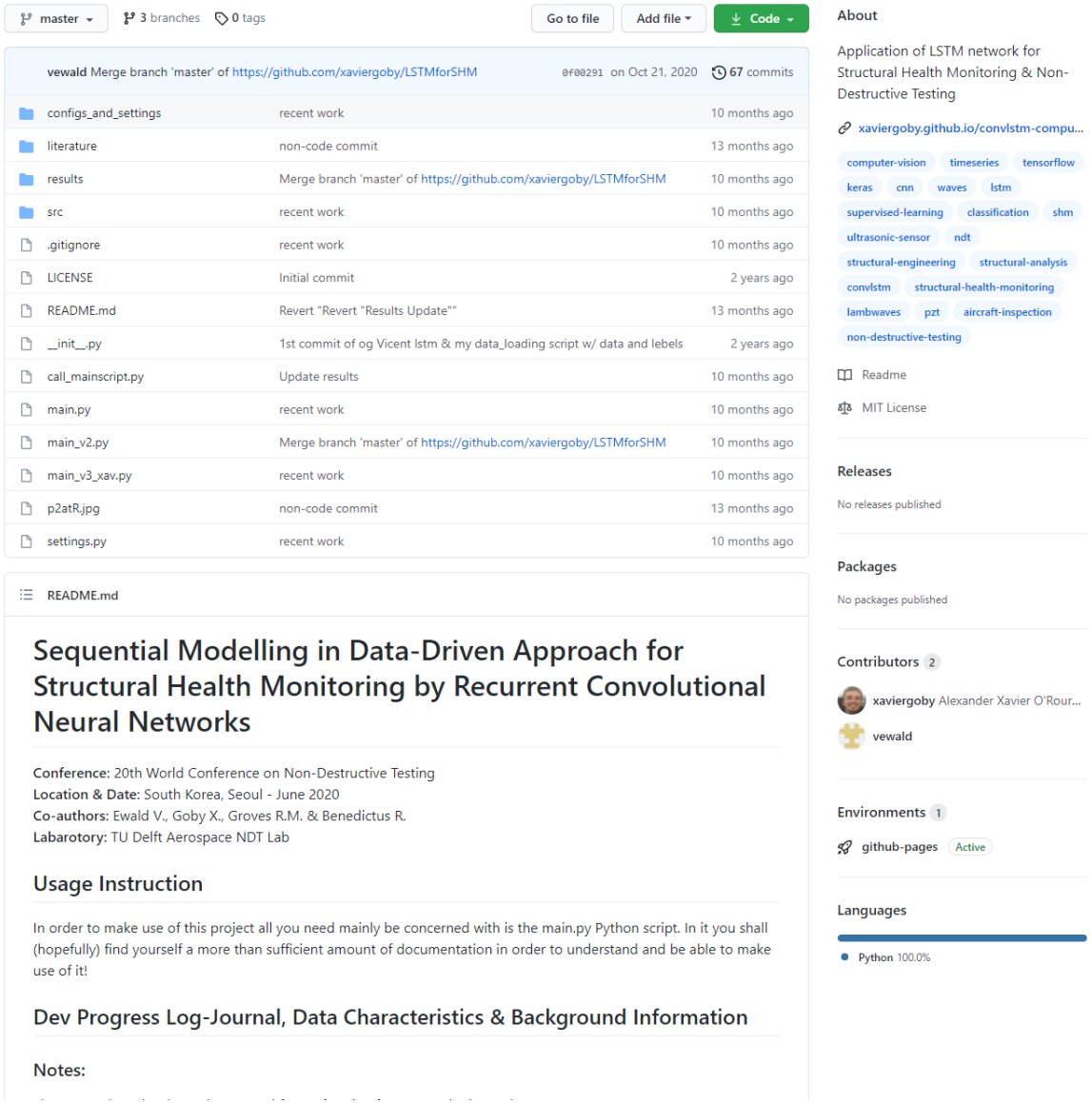
Aircraft Maintenance

Propulsion, NDT and more



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

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 "Revert "Results Update""	13 months ago
__init__.py	1st commit of og Vicent lstm & my data_loading script w/ data and lebels	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.md

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:

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

Readme

MIT License

Releases

No releases published

Packages

No packages published

Contributors 2

xaviergoby Alexander Xavier O'Rour...

vewald

Environments 1

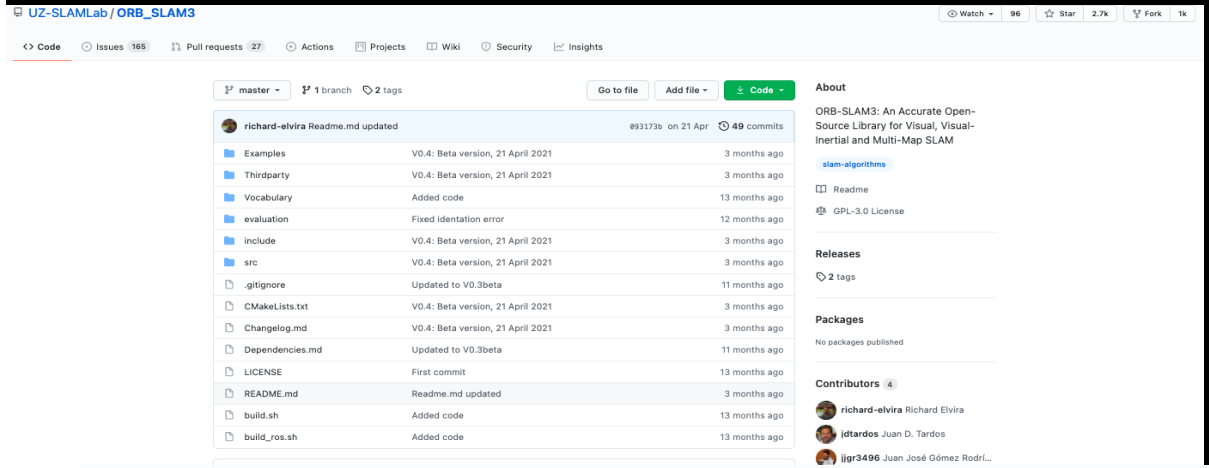
github-pages Active

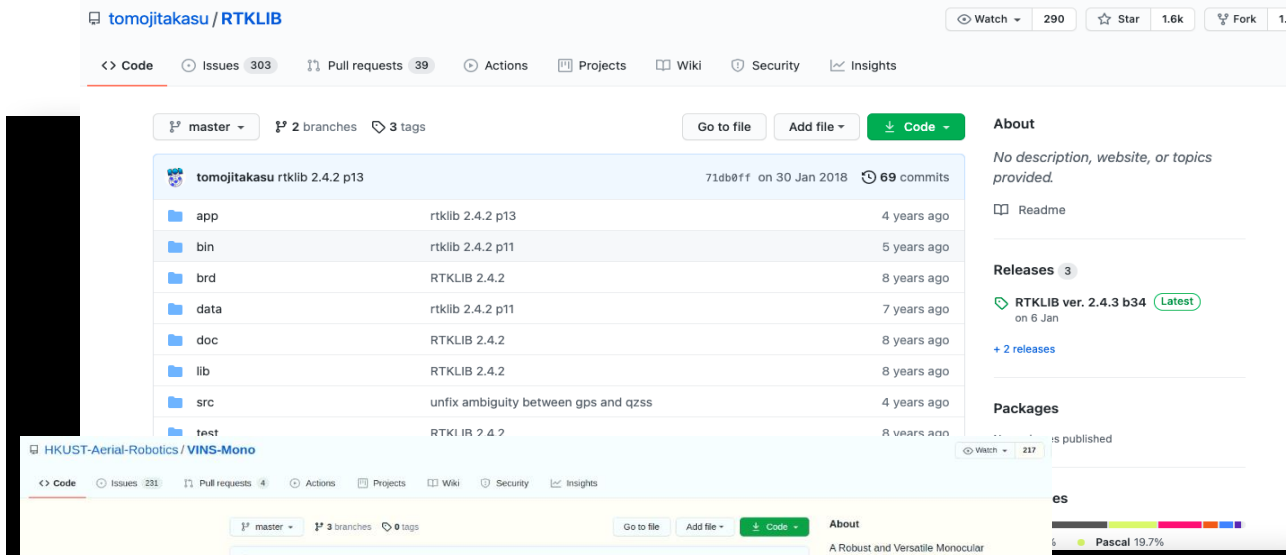
Languages

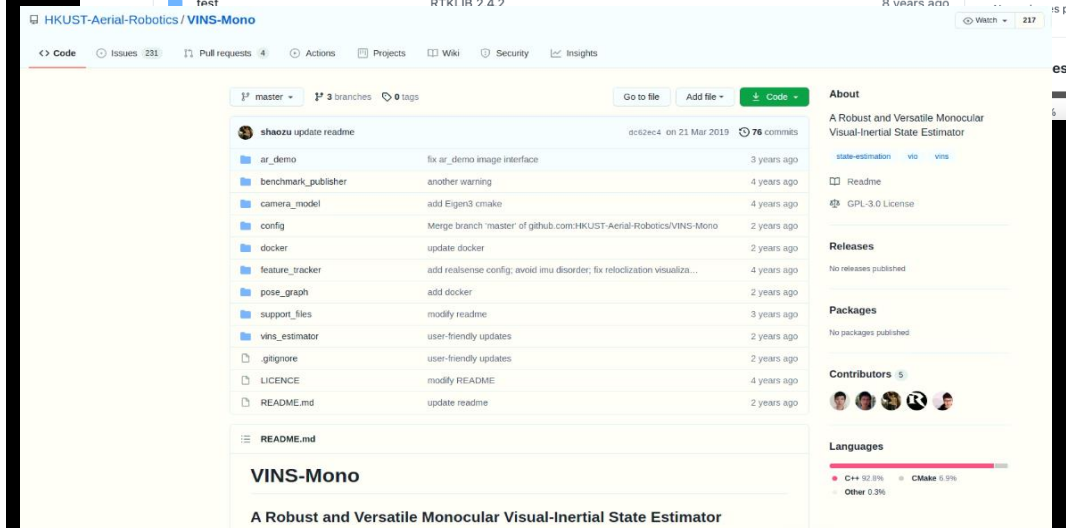
Python 100.0%

Navigation and Positioning

RTKLIB, VINS, ORB_SLAM3, ROS and more

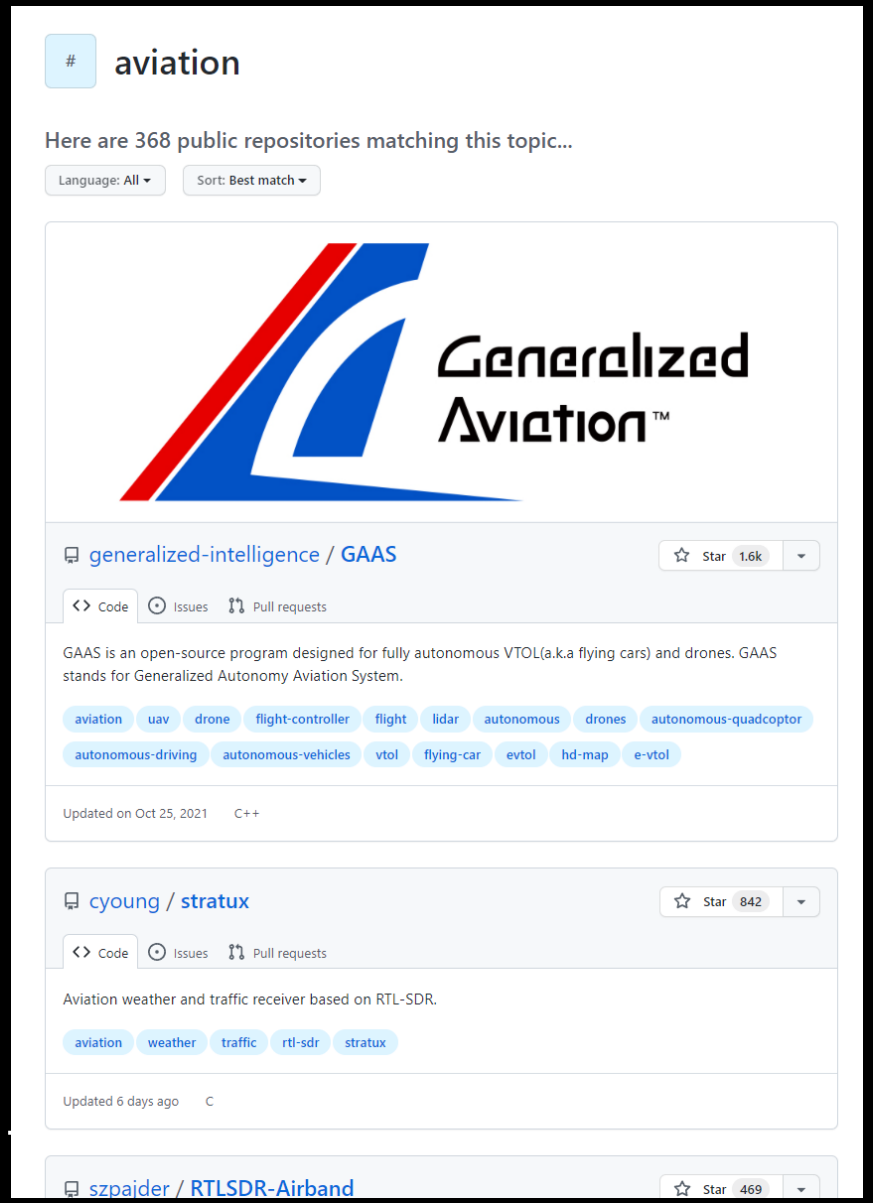






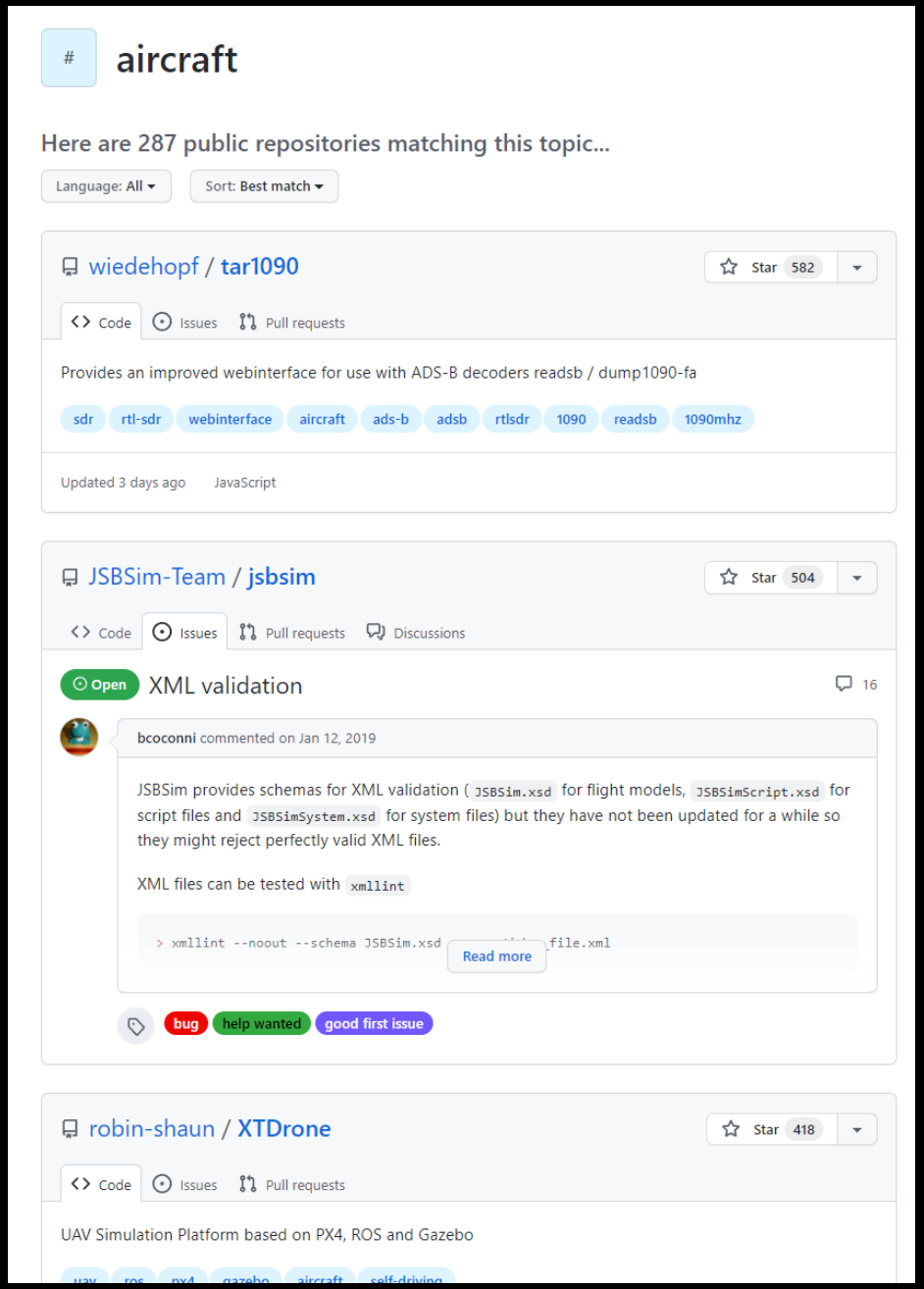
Aviation

Powered By GitHub



Variety of resources

All free on GitHub




Issue
Open
Moisture data sharing
What if farmers could share moisture data?I
Comment

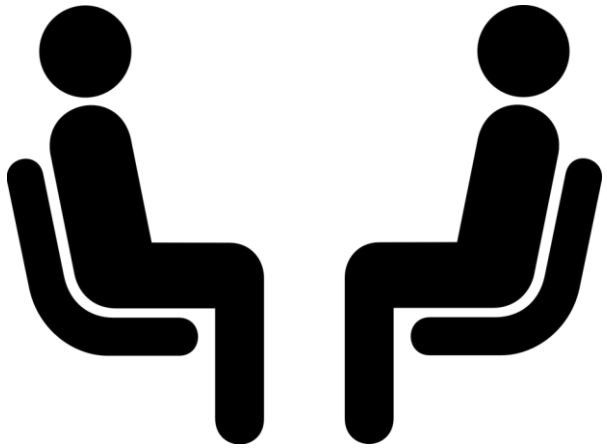
What Will You will Learn and Experience?

- 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

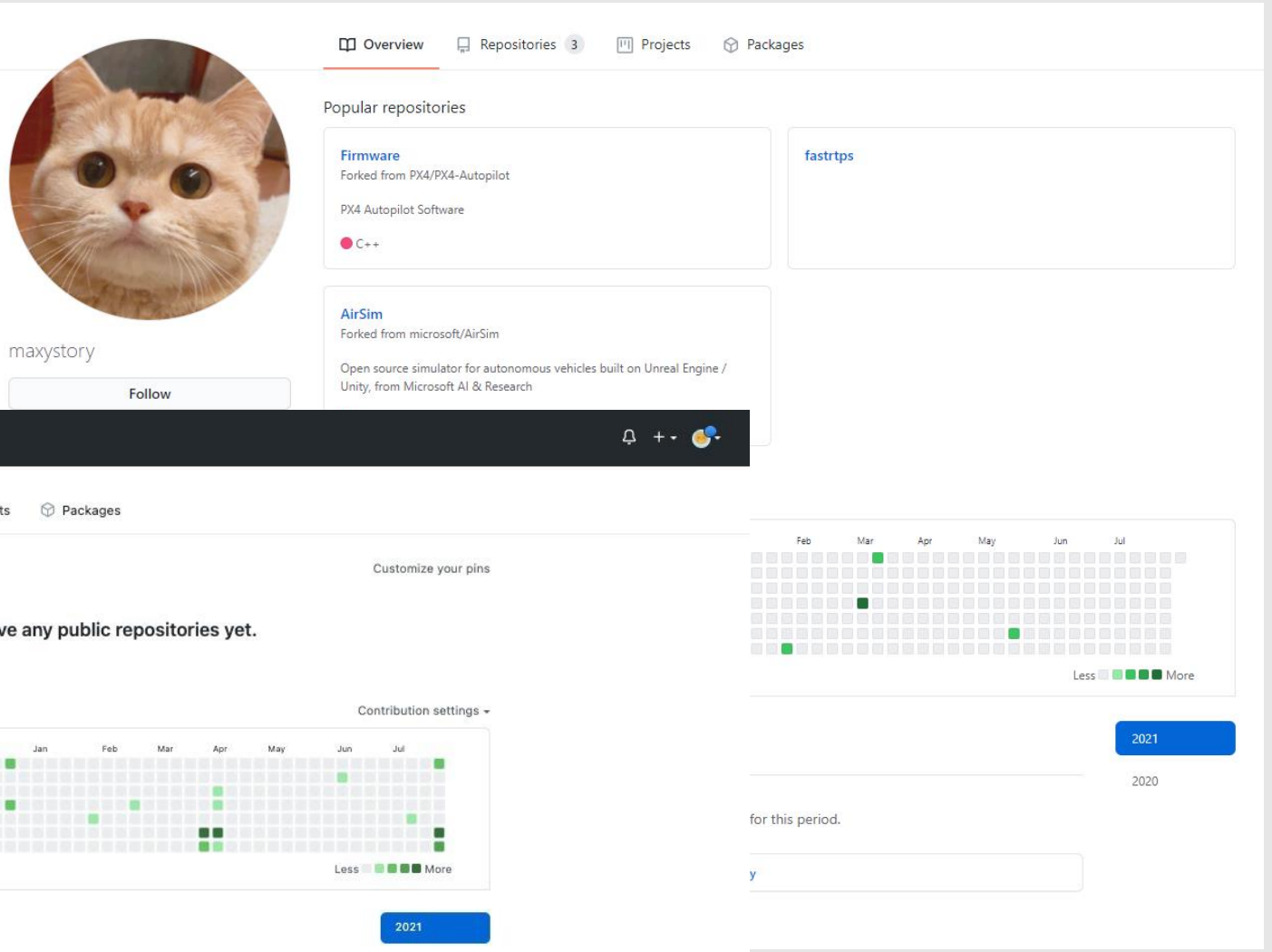
For Your Career

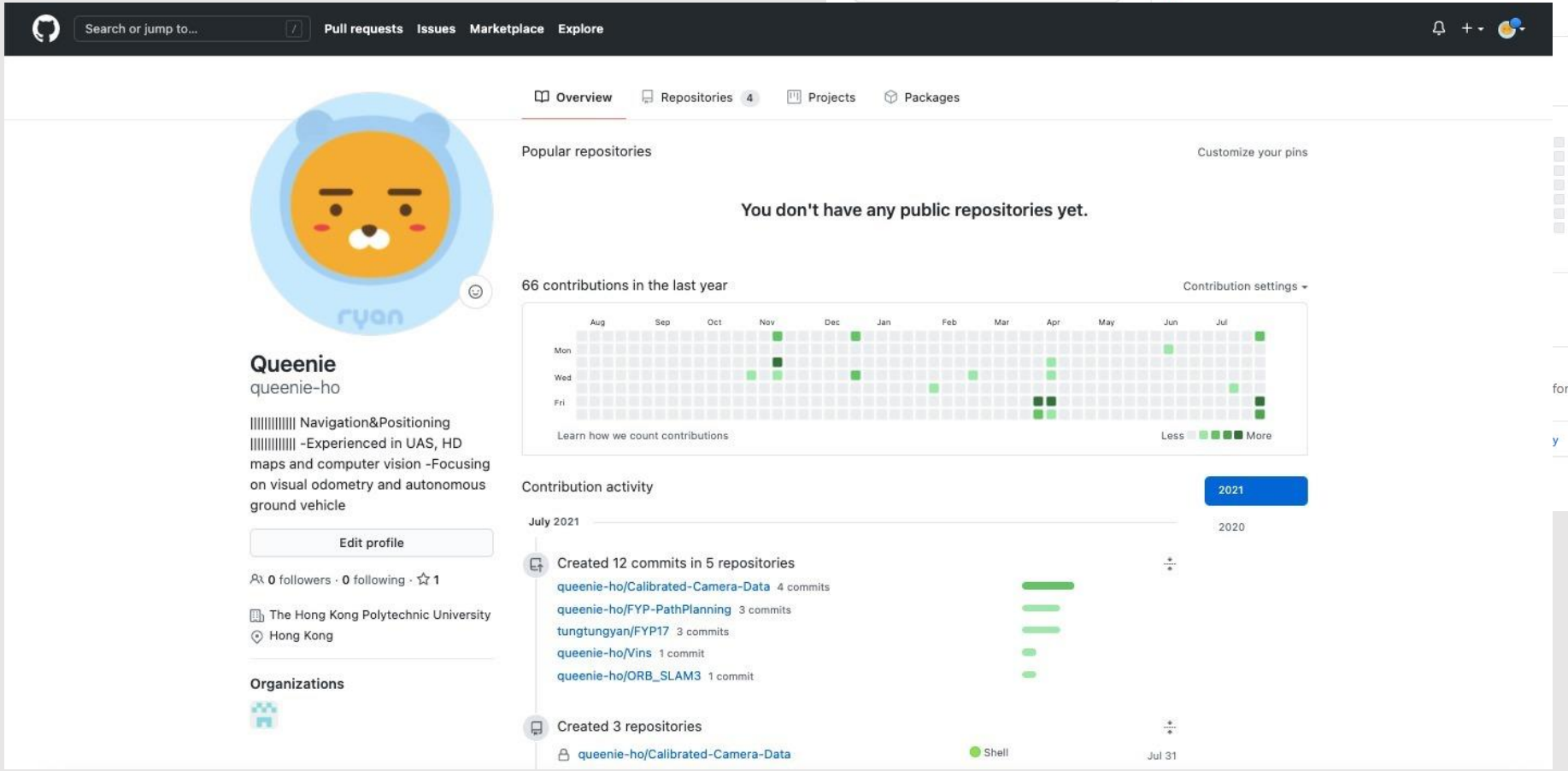
GitHub Facilitated Job Hunting

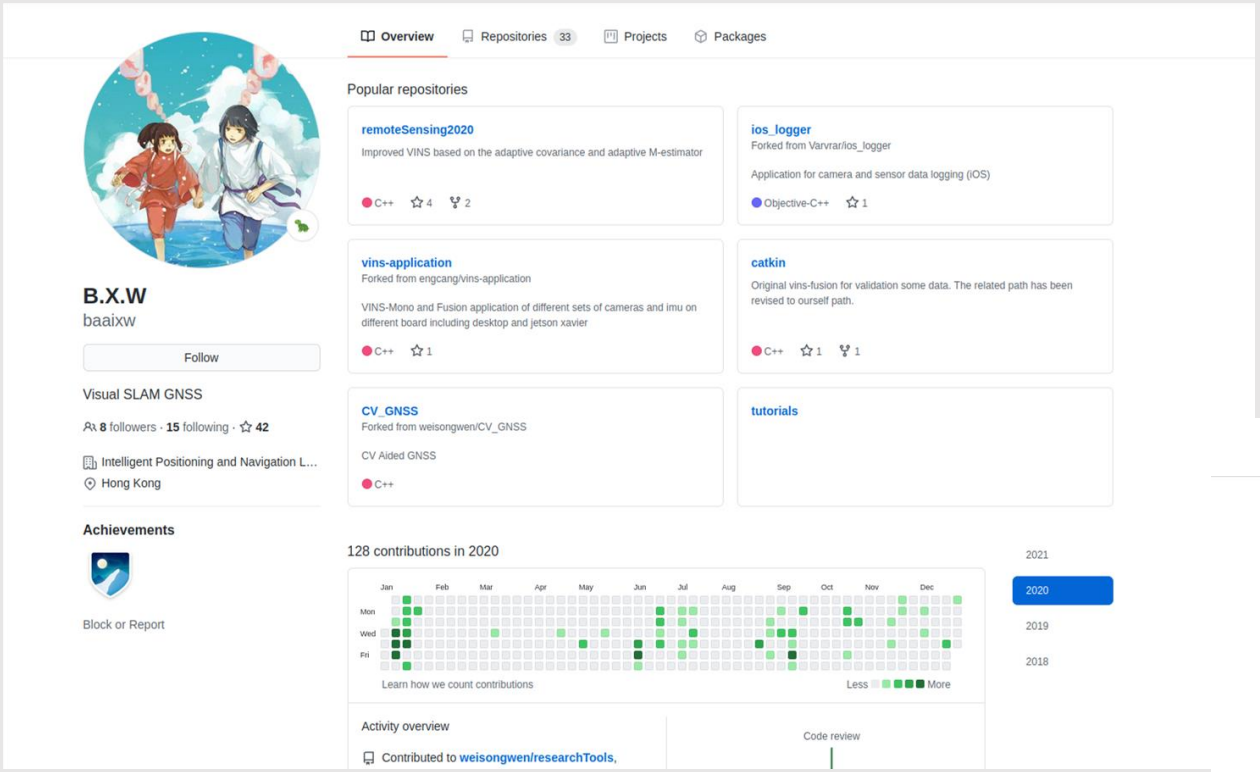
- A online digital profile for students
  - Indicating interests
  - Show past work
  - Roadmap of students' development career
- Let people know that you are looking for a job
- During job hunting
  - Better first impression
  - Better understanding
  - Appears more enthusiastic

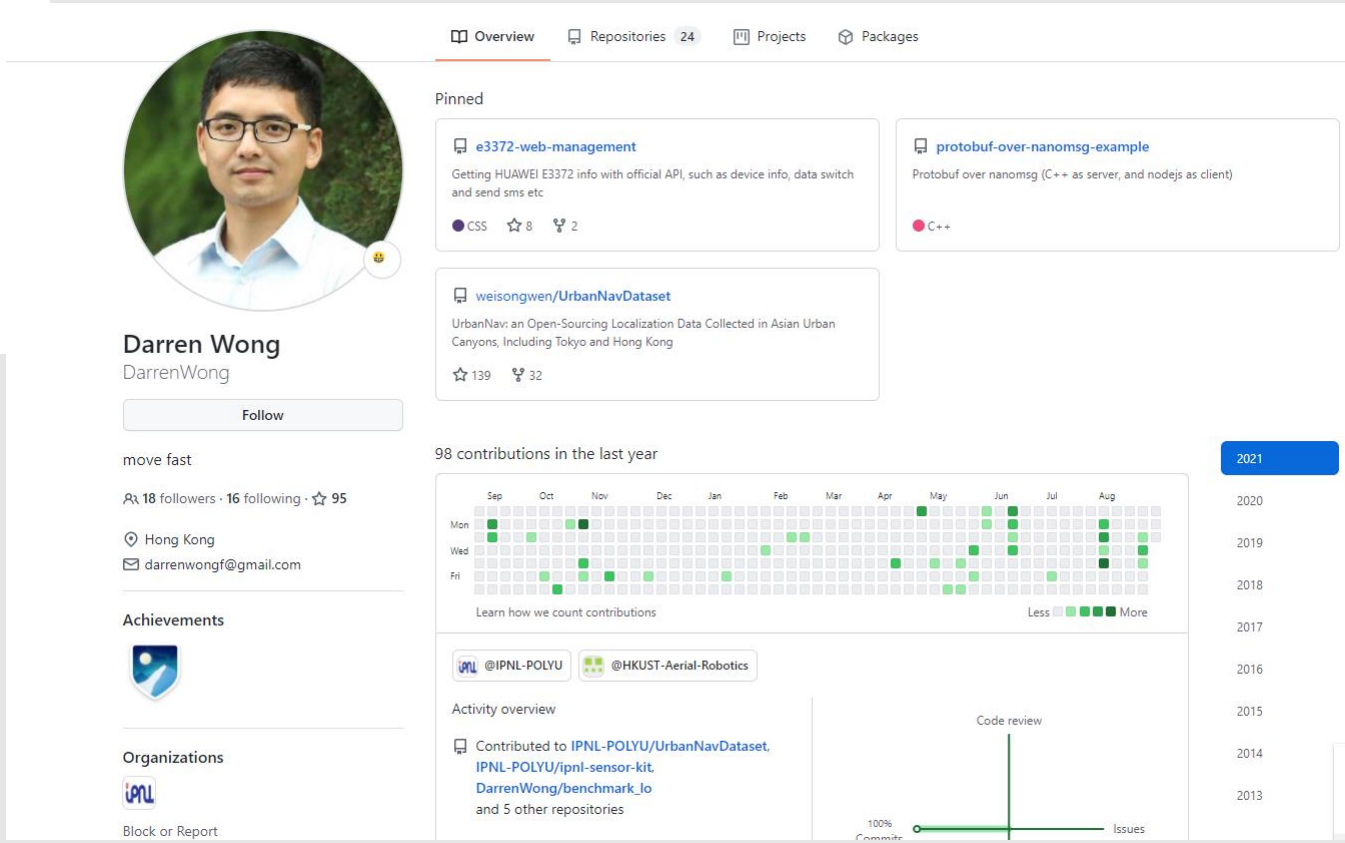


Develop Personal Profiles Starting from AAE UG

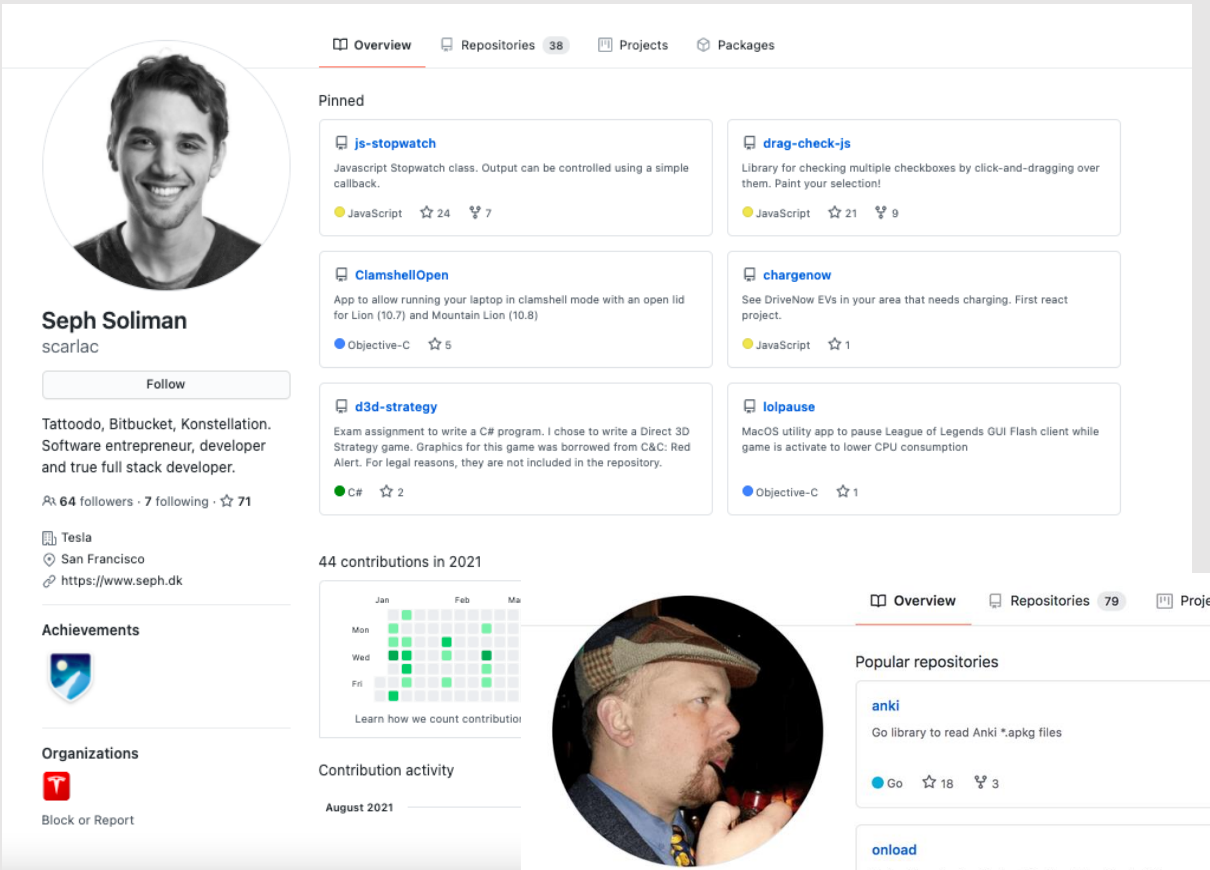


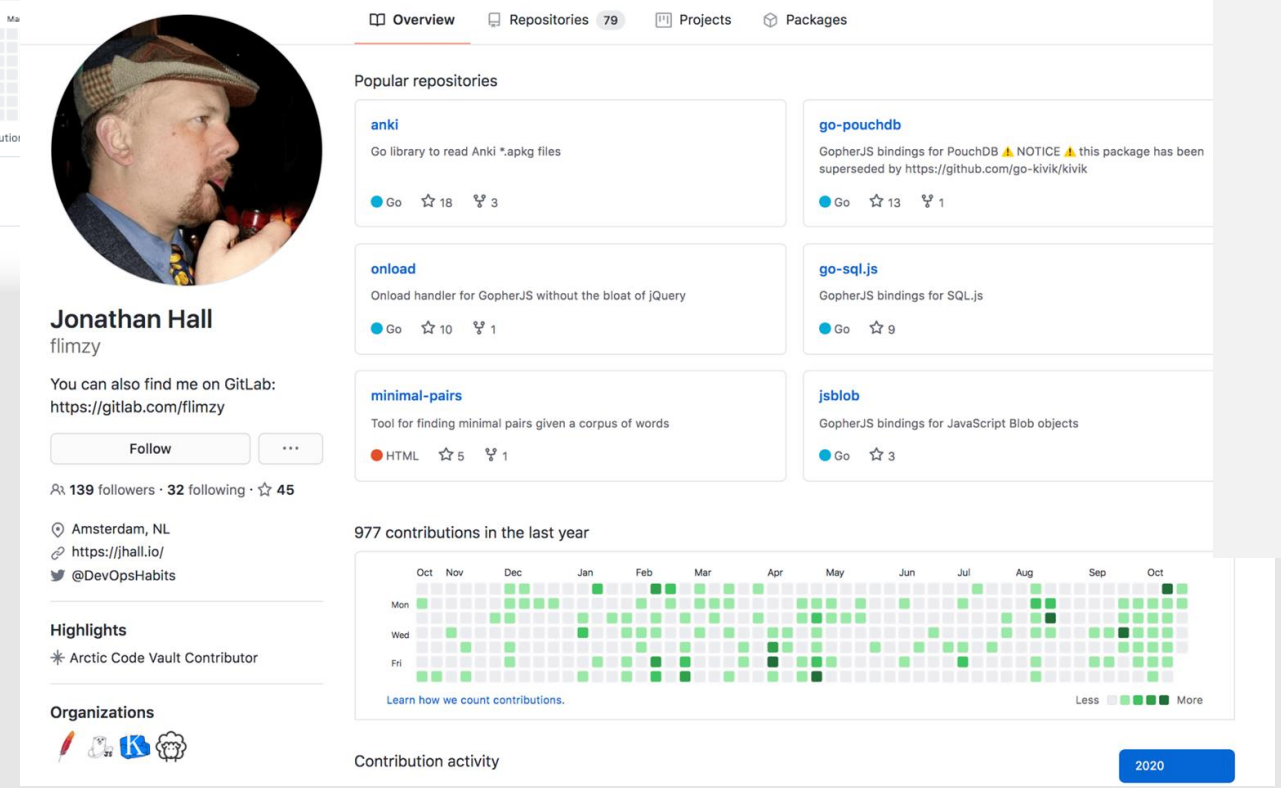


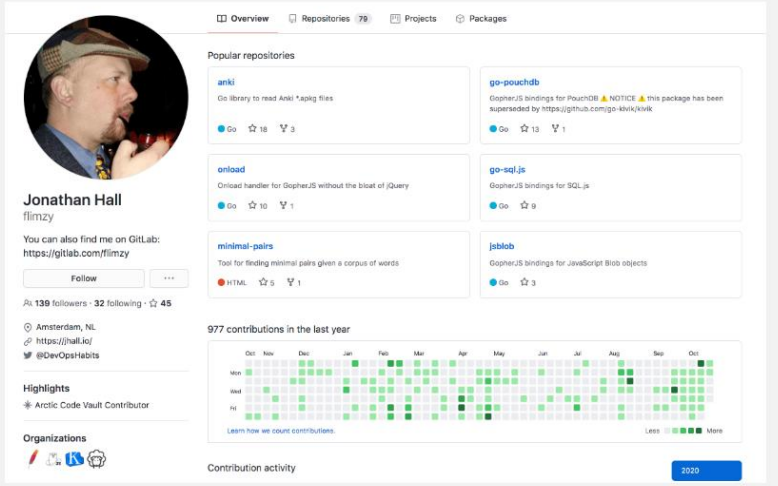




Up to Phd Studies







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

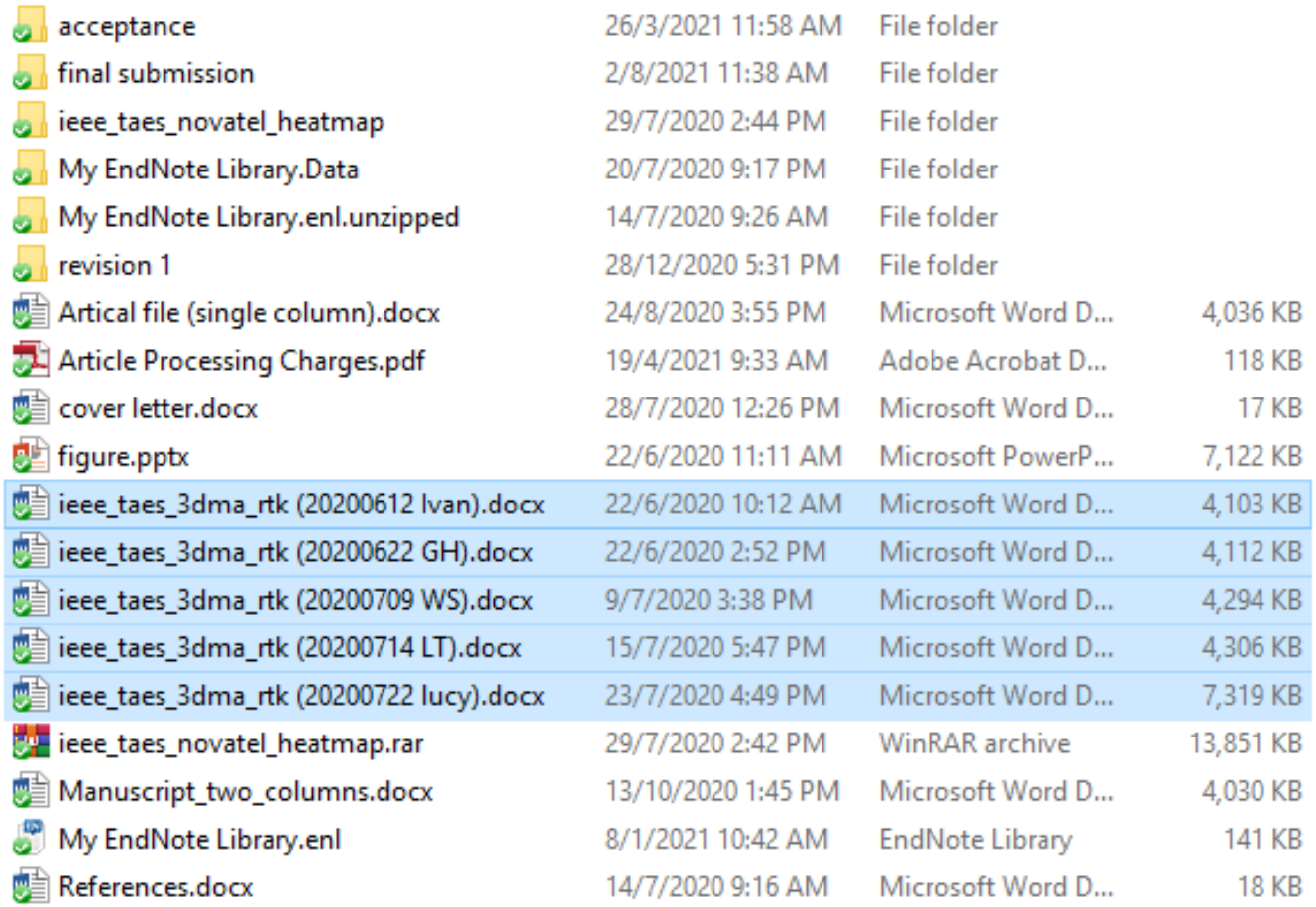
Whenever you run across a GitHub project that piques your interest, "star" it. Your starred projects appear on your public profile, and if nothing else, they provide recruiters and hiring managers an indication of what sorts of projects you find interesting.

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?

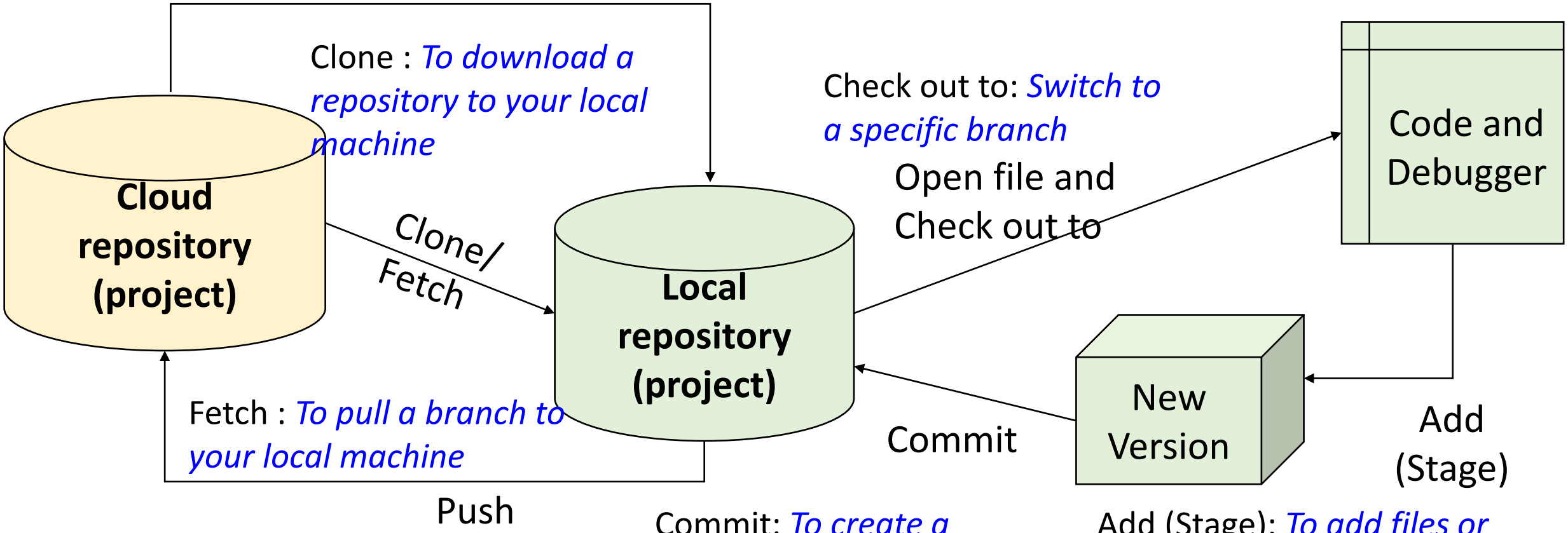
Github

Archive your coding online (in the cloud)

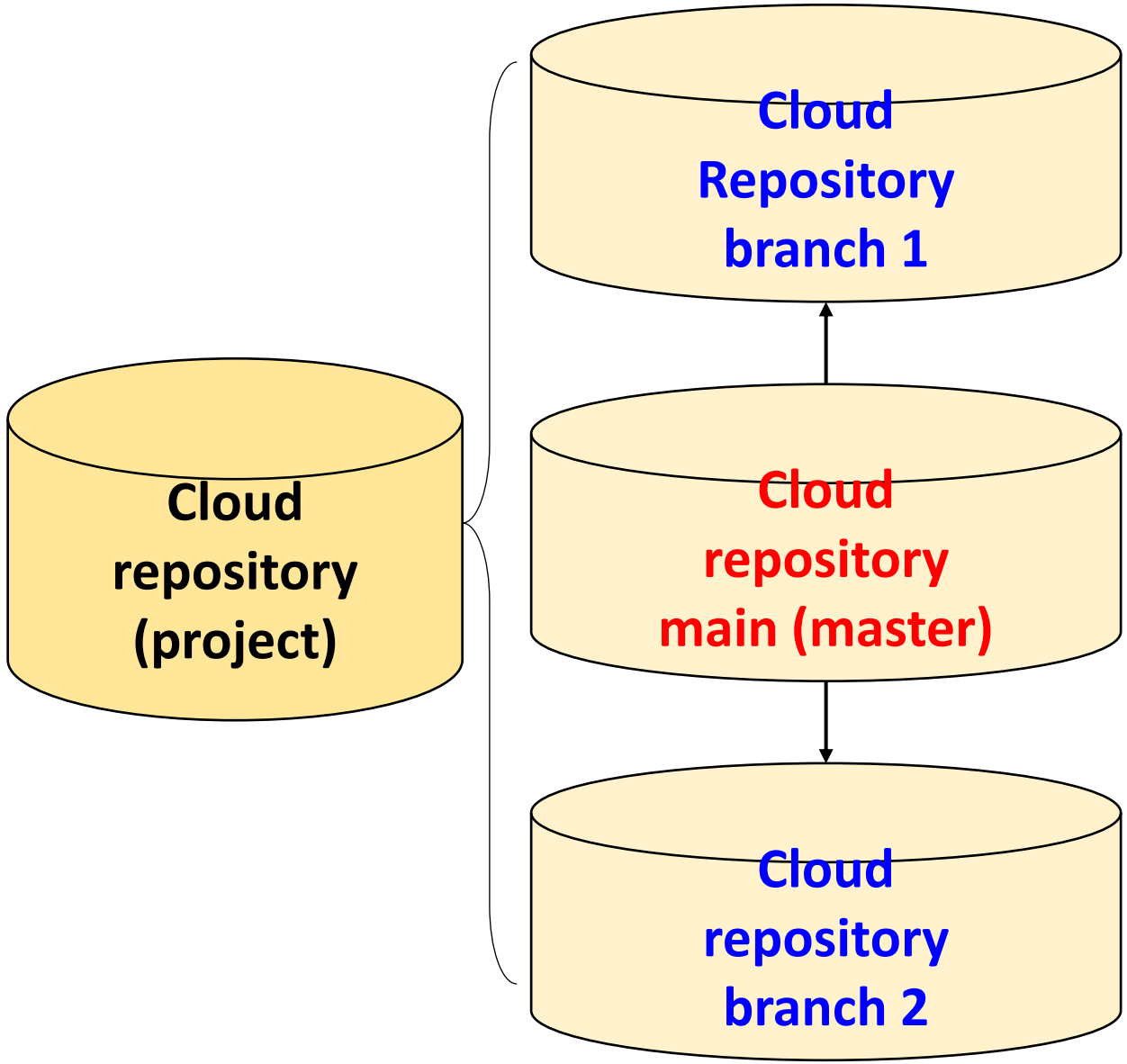
Pull

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

Video: VSC-Git Basic Operations

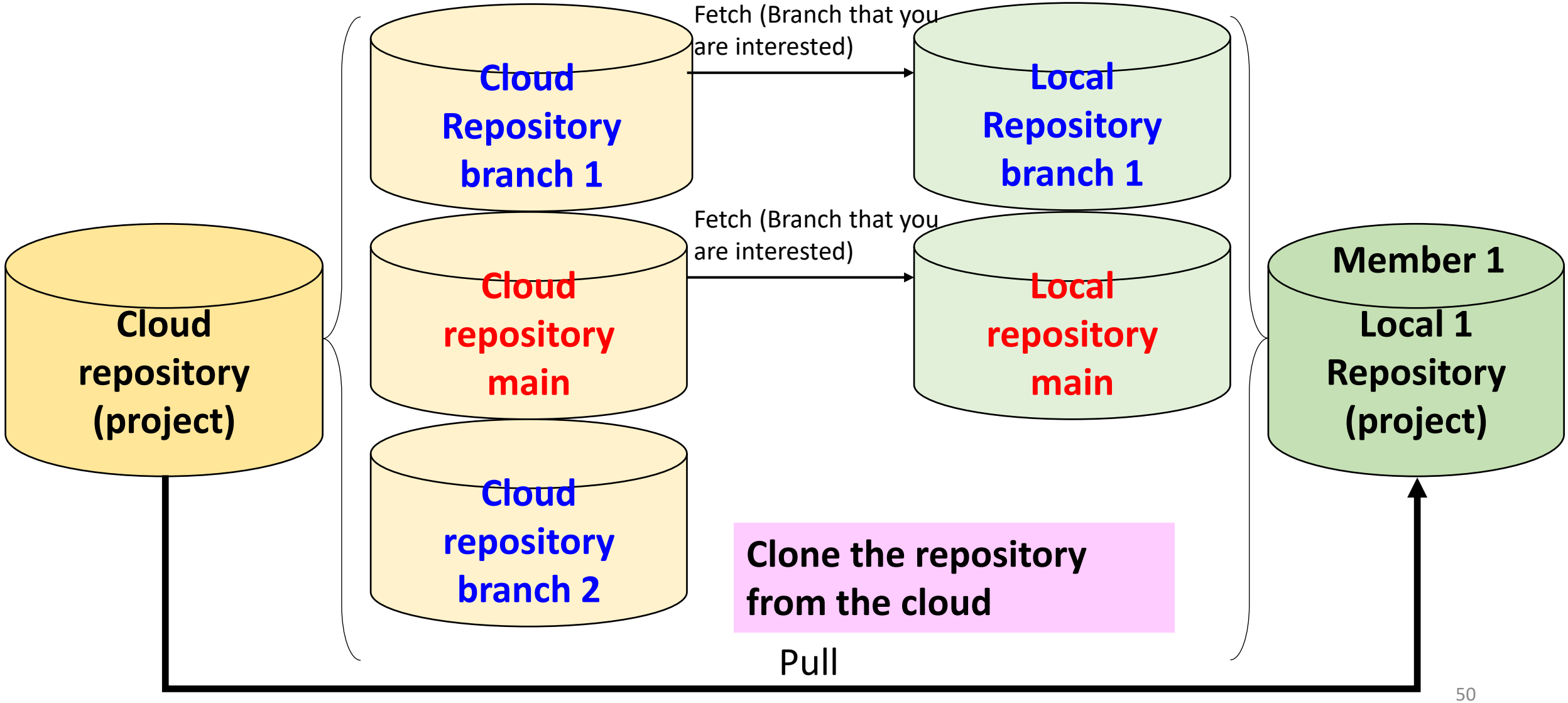


Collaborative coding online – Generate Branch (Member)

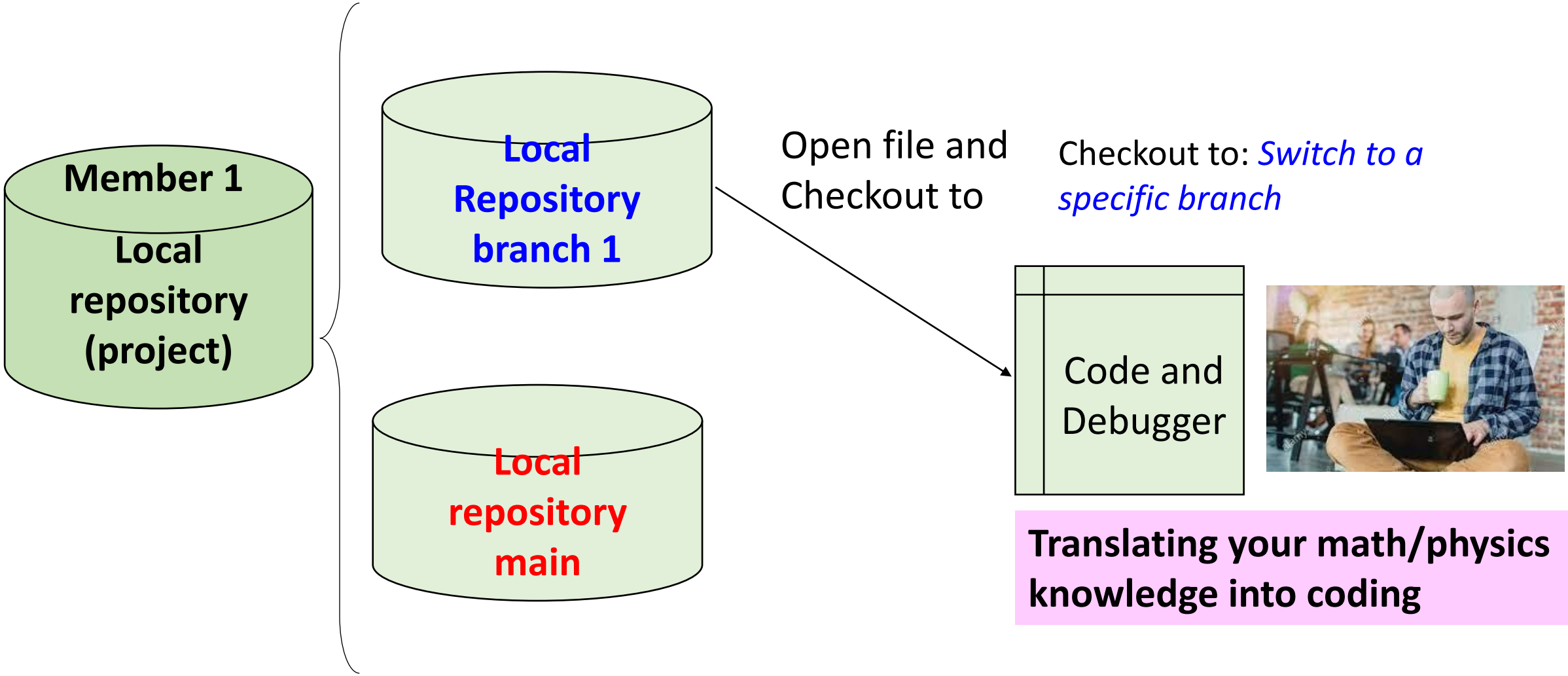


To generate a branch for different member that participant the project, creating a contained area of your repository to develop features, fix bugs and more.

Collaborative coding online – Fetch/Pull Branch from Cloud

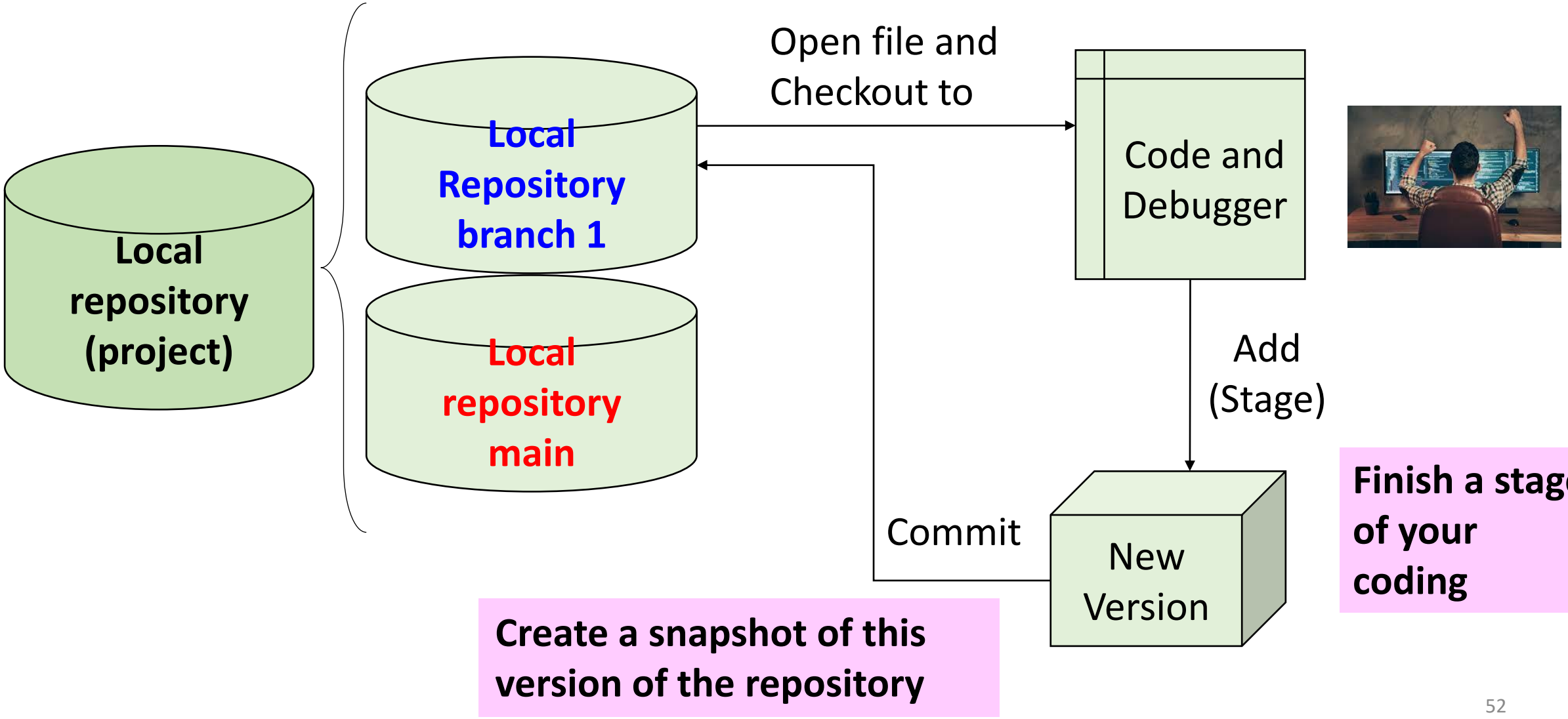


Collaborative coding online – Edit the code in the local computer



Translating your math/physics knowledge into coding

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!

Open file and Check out to

Push

Cloud Repository branch 1

Local Repository branch 1

Code and Debugger

Let the group leader knows my work

Merge by Pull Request

File 1 in the local

Add (Stage)

File 1 in the cloud

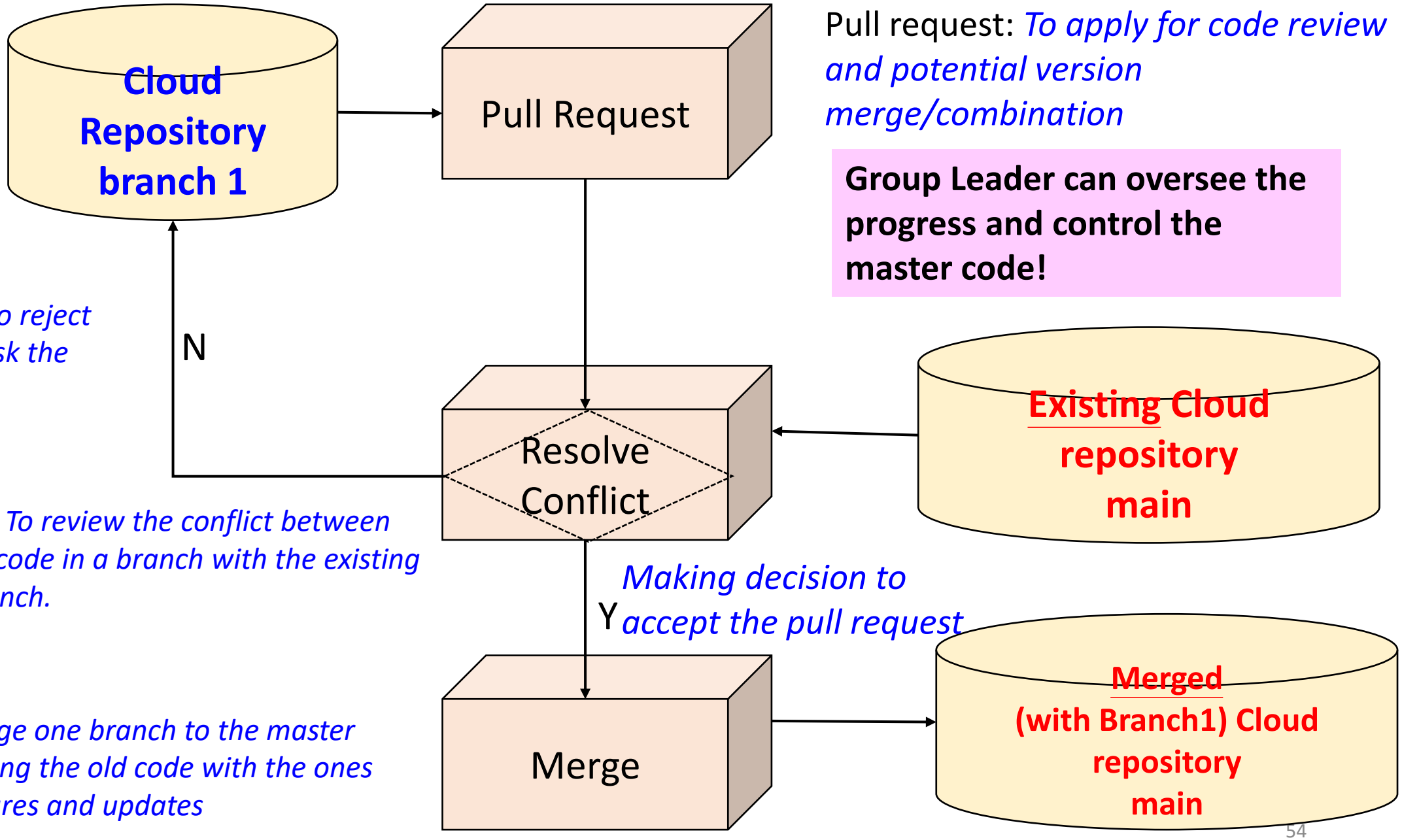
Cloud repository main

Commit

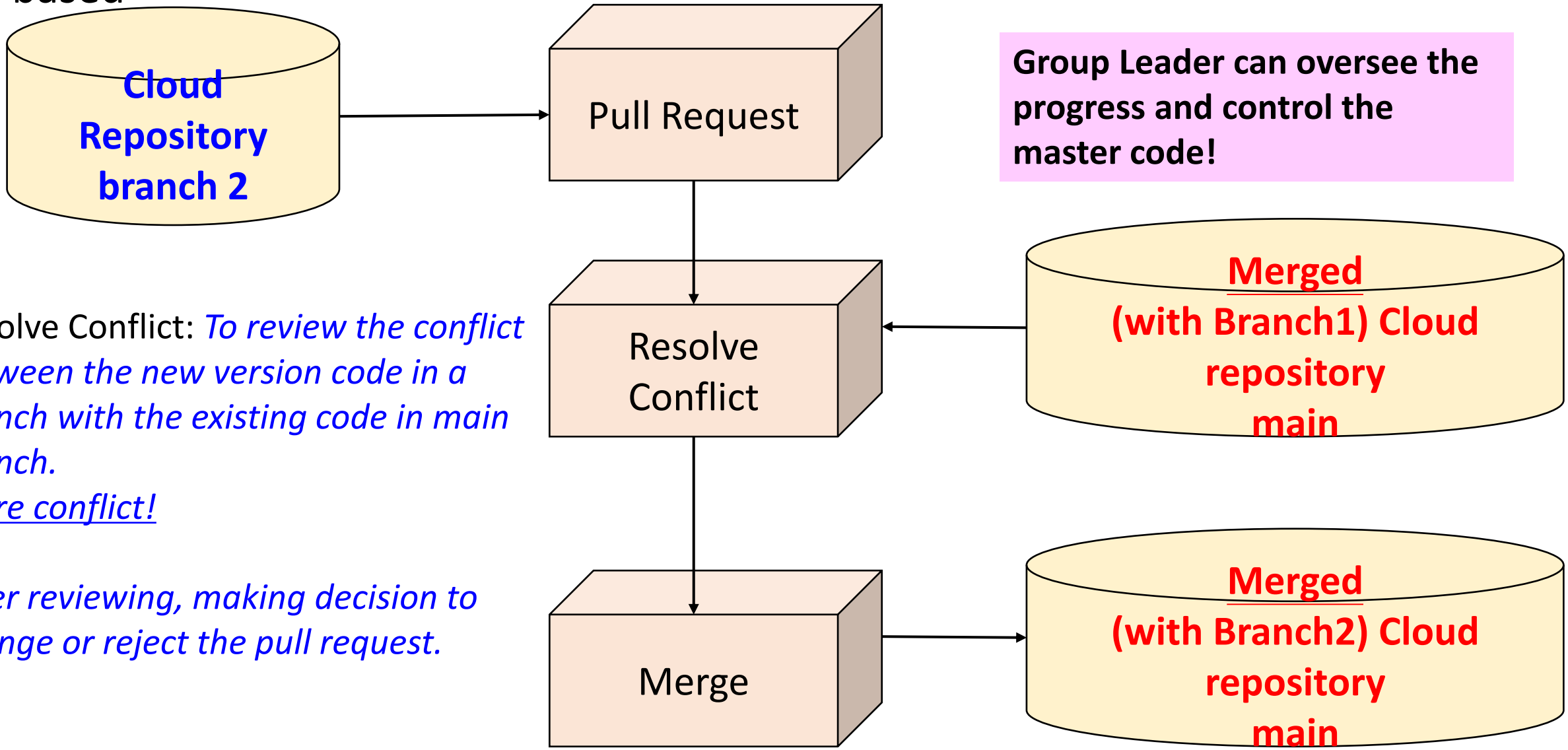
New Version

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

Web based


Cloud Repository branch 1
Pull Request
Pull request: To apply for code review and potential version merge/combination
Group Leader can oversee the progress and control the master code!
Making decision to reject the pull request ask the member to revise.
N
Resolve Conflict
Existing Cloud repository main
Resolve Conflict: To review the conflict between the new version code in a branch with the existing code in main branch.
Making decision to accept the pull request
Y
Merge
Merged (with Branch1) Cloud repository main
Merge: To merge one branch to the master branch, replacing the old code with the ones with new features and updates

Web based



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.

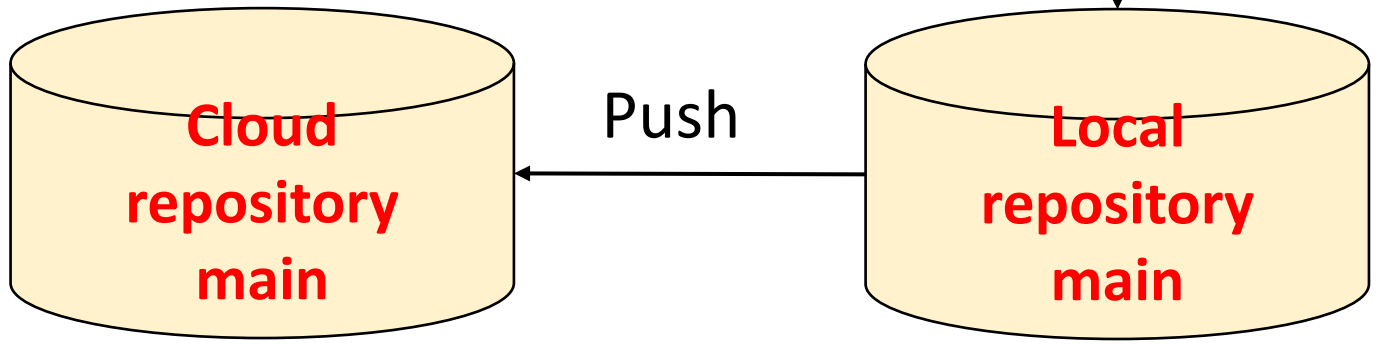
Concept of collaborative coding online

VS code based

Video: VSC Git Conflicts

File 1 in the local

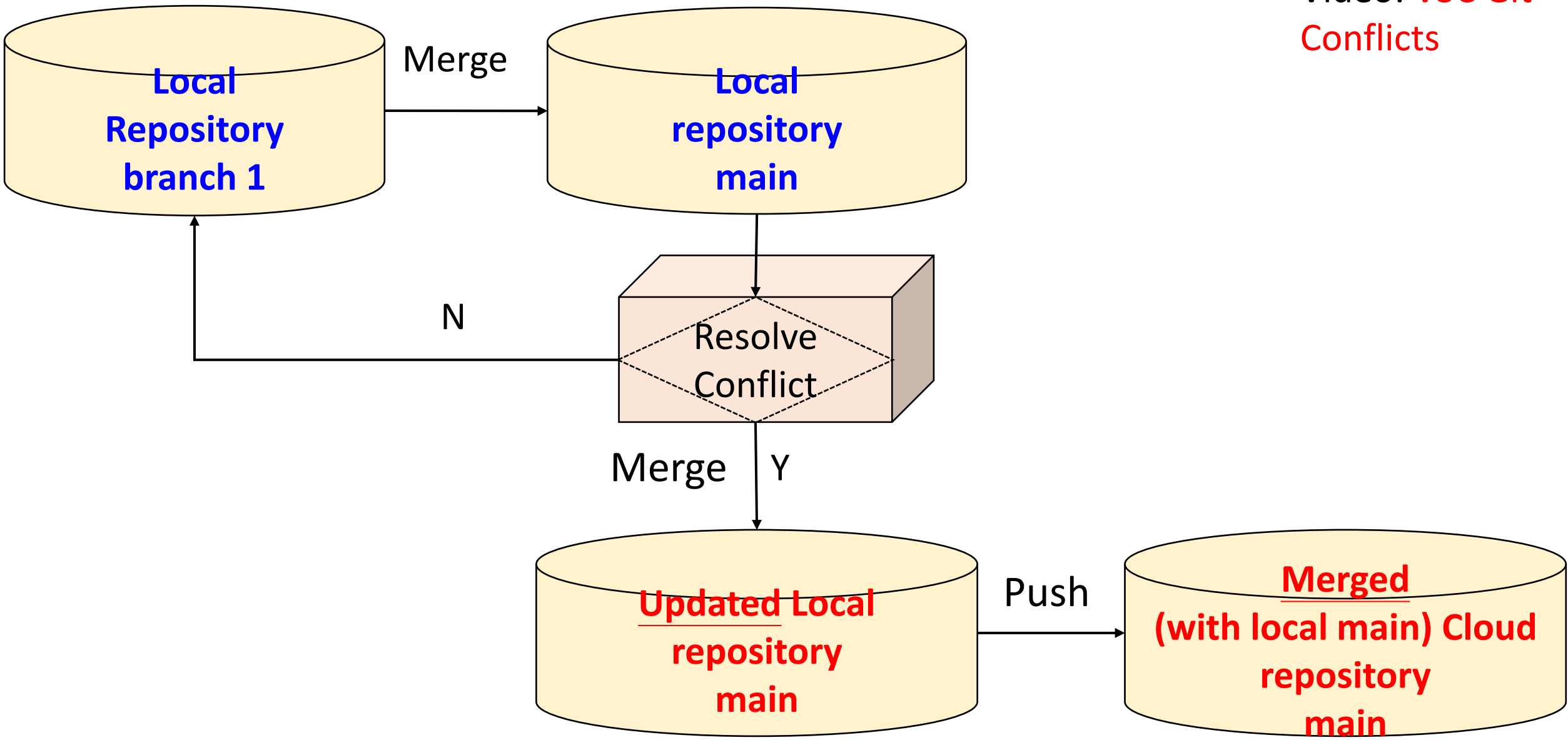
File 1 in the cloud



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



Software Installation and setup Guide

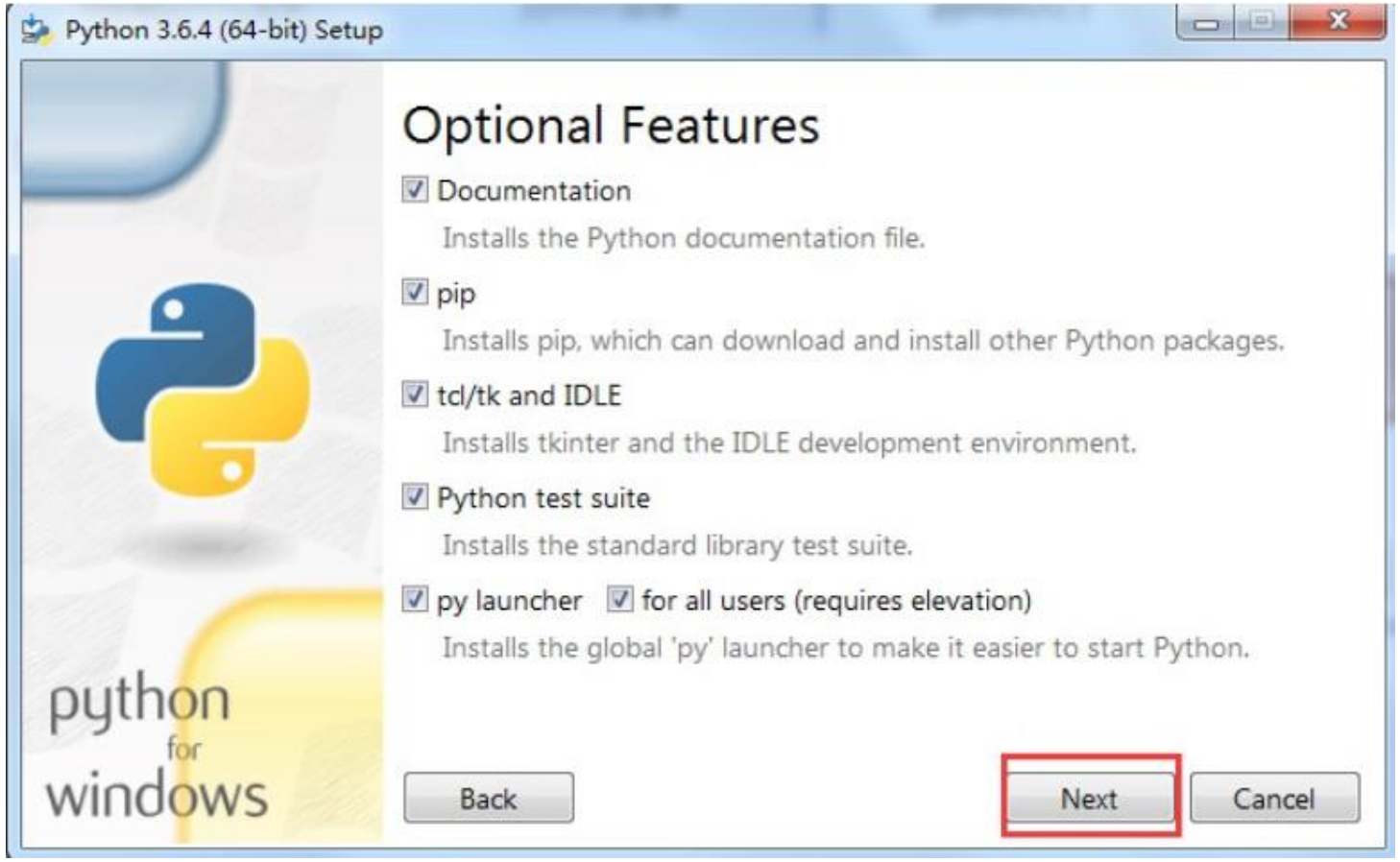
Install Python in Windows 10

Step 1: Download Python 3.6.4
https://www.python.org/ftp/python/3.6.4/python-3.6.4-amd64.exe

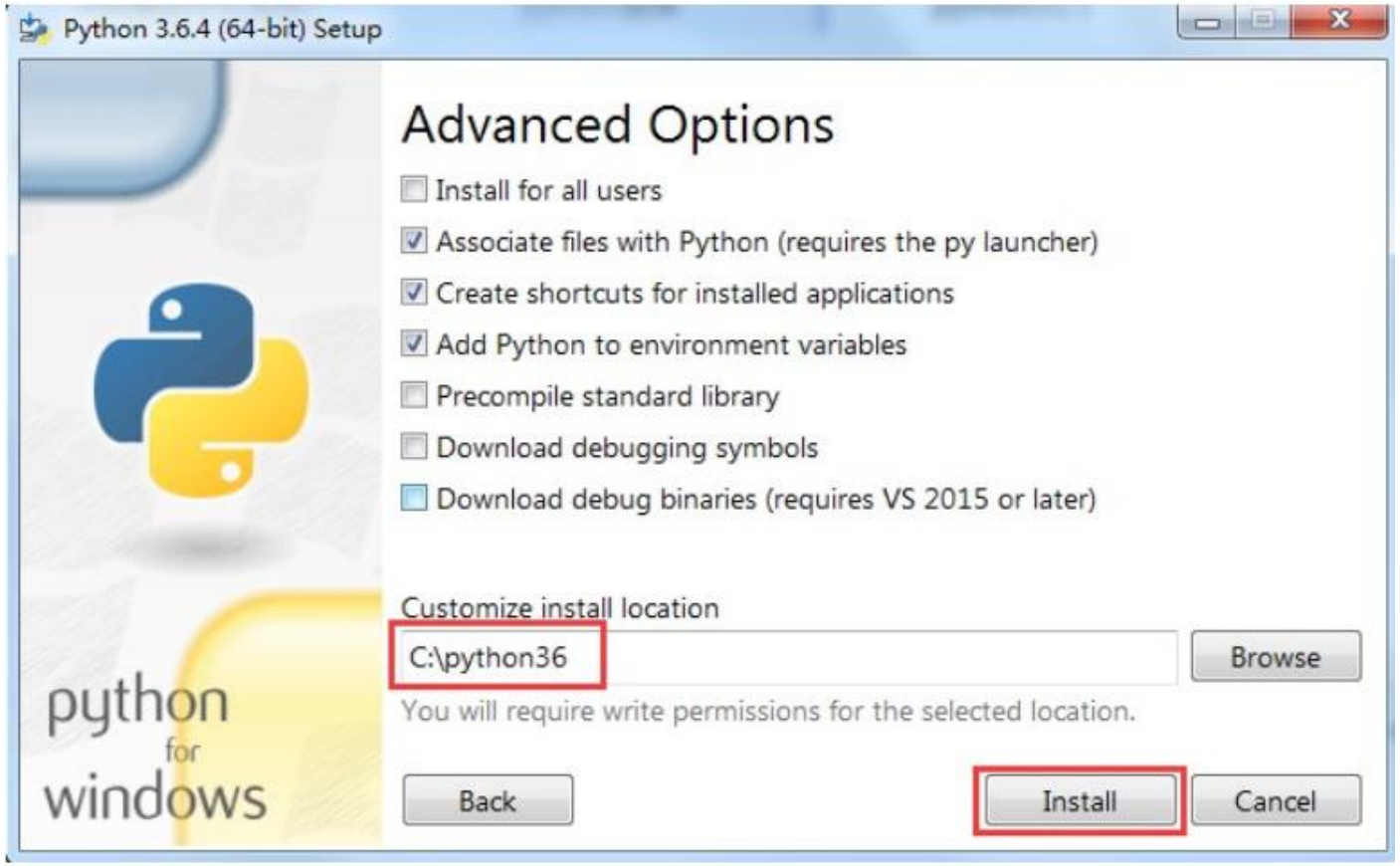
Step 2: Install Python 3.6.4 in Windows 10

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.

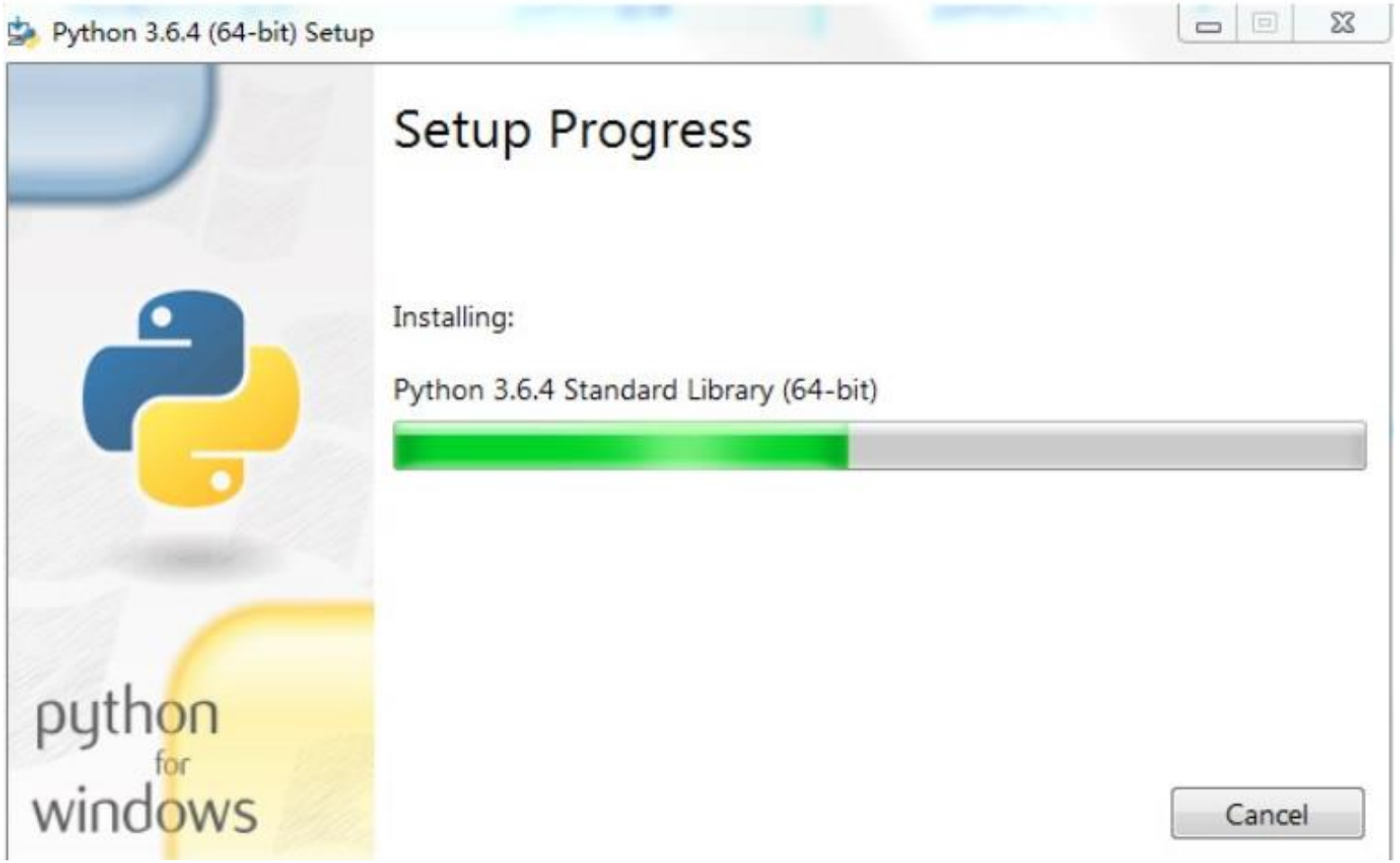
Install Python in Windows 10



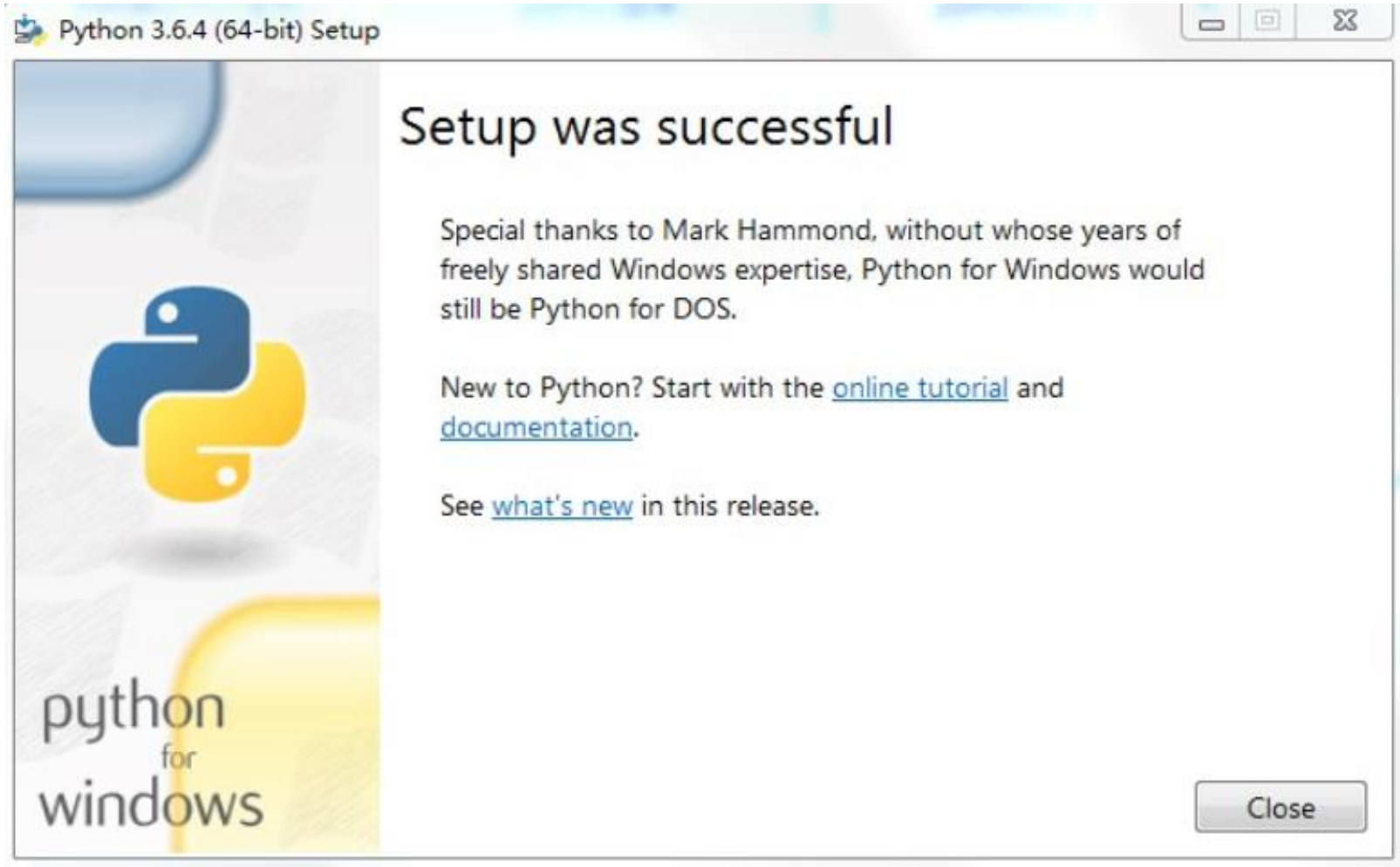
Install Python in Windows 10



Install Python in Windows 10



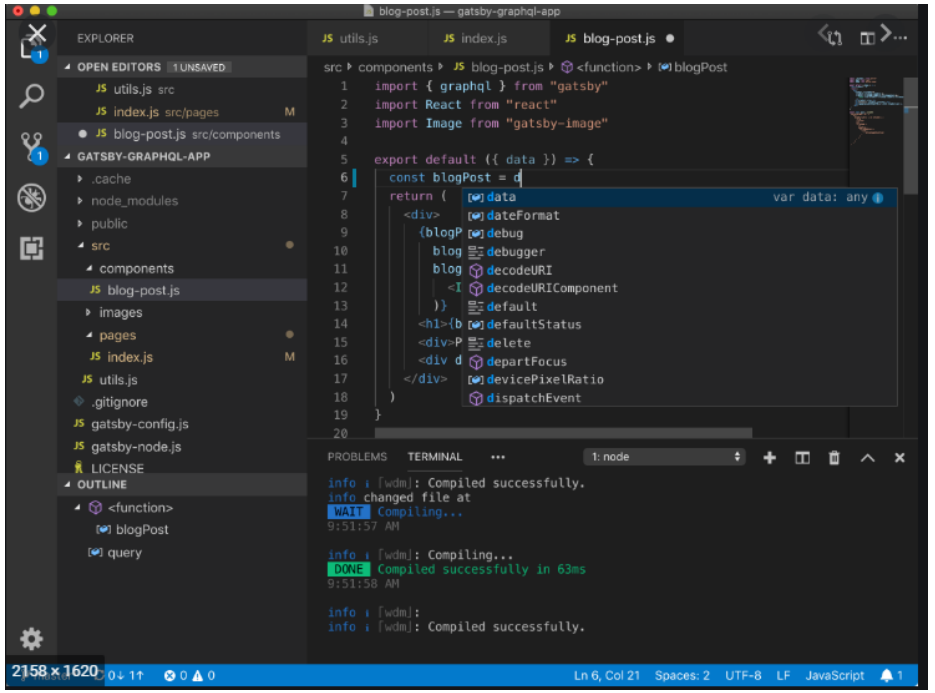
Install Python in Windows 10



Install VS code in Windows 10

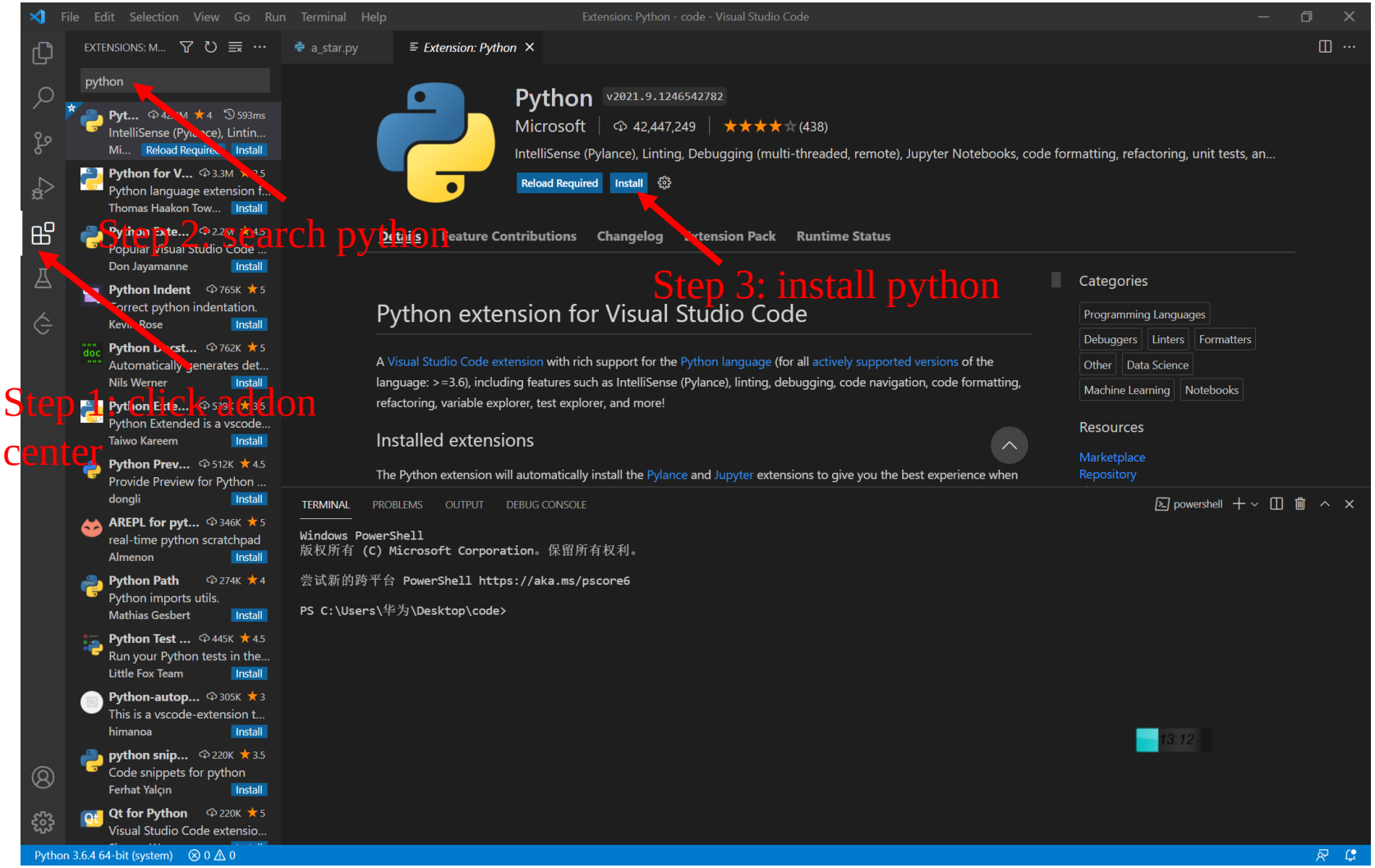
Step 1: Download the latest VS code
https://code.visualstudio.com/download

Step 2: Install latest VS code in Windows 10

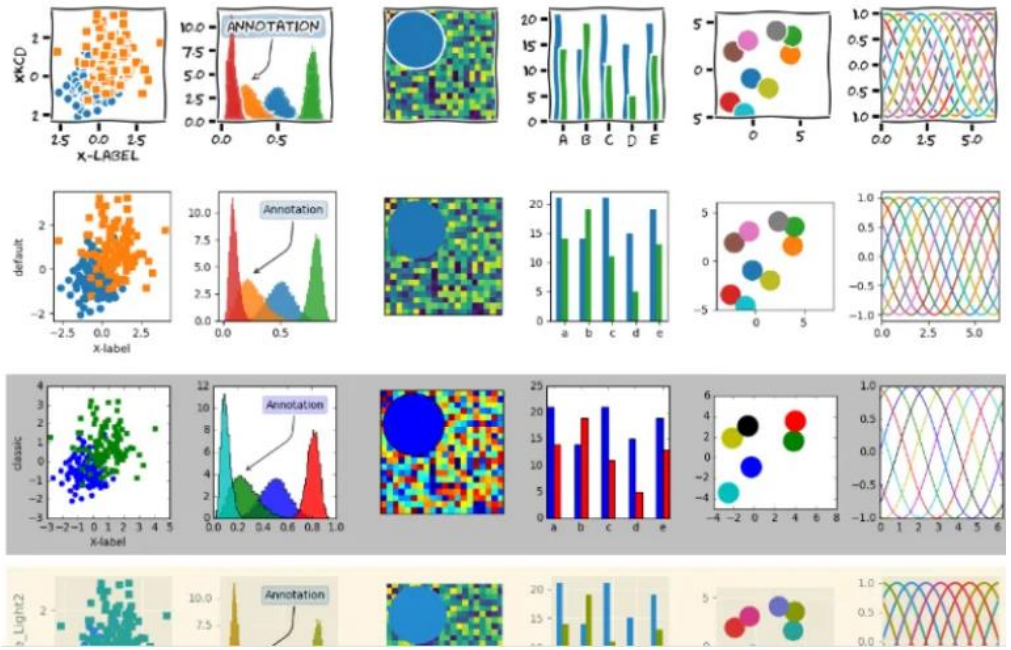


Visual Studio Code is a free source-code editor made by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

Install Python addon in VS code in Windows 10



Install matplotlib

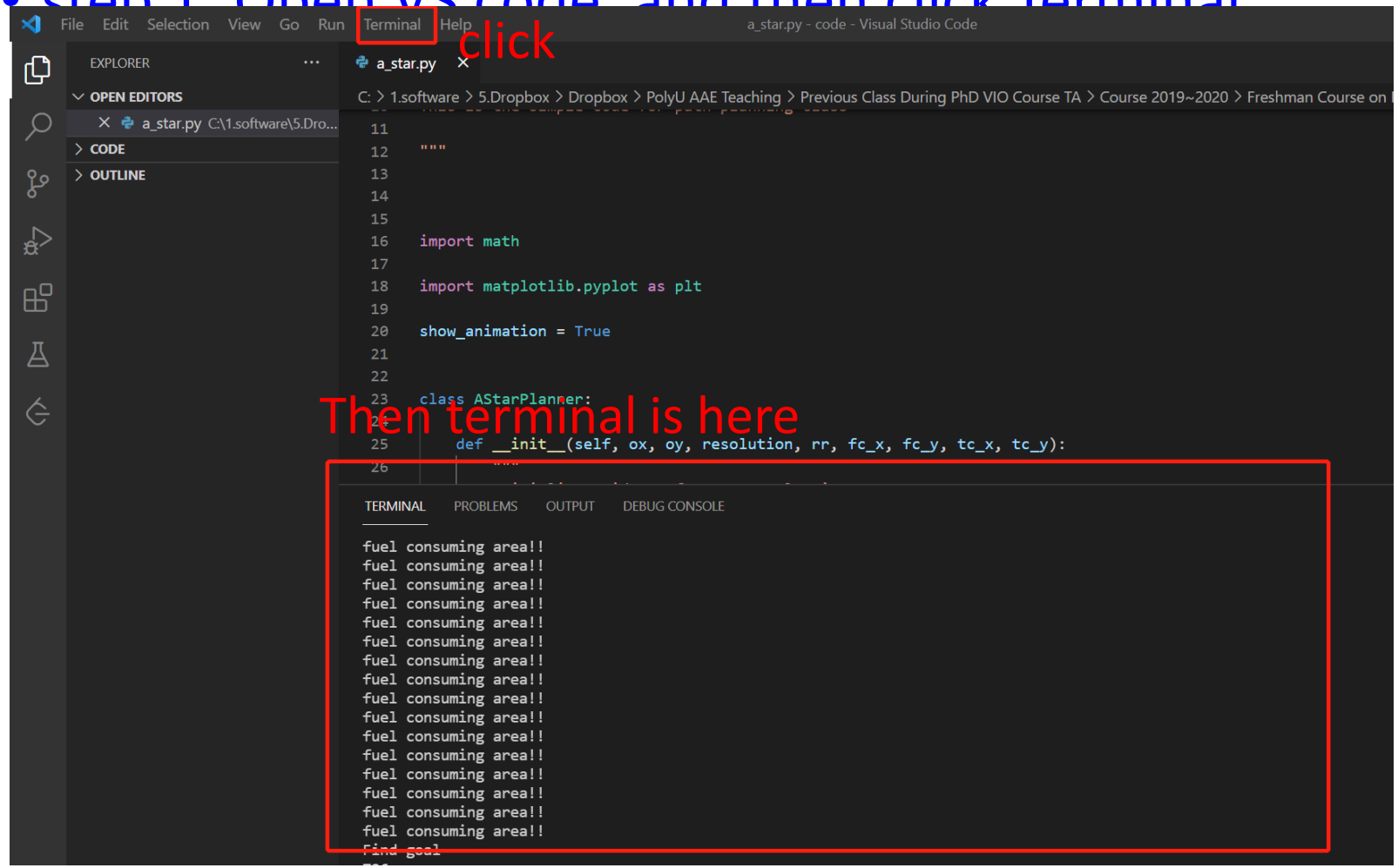


Source:
https://www.gnuband.org/2017/12/29/gallery-of-xkcd-and-other-python-matplotlib-styles/

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+.

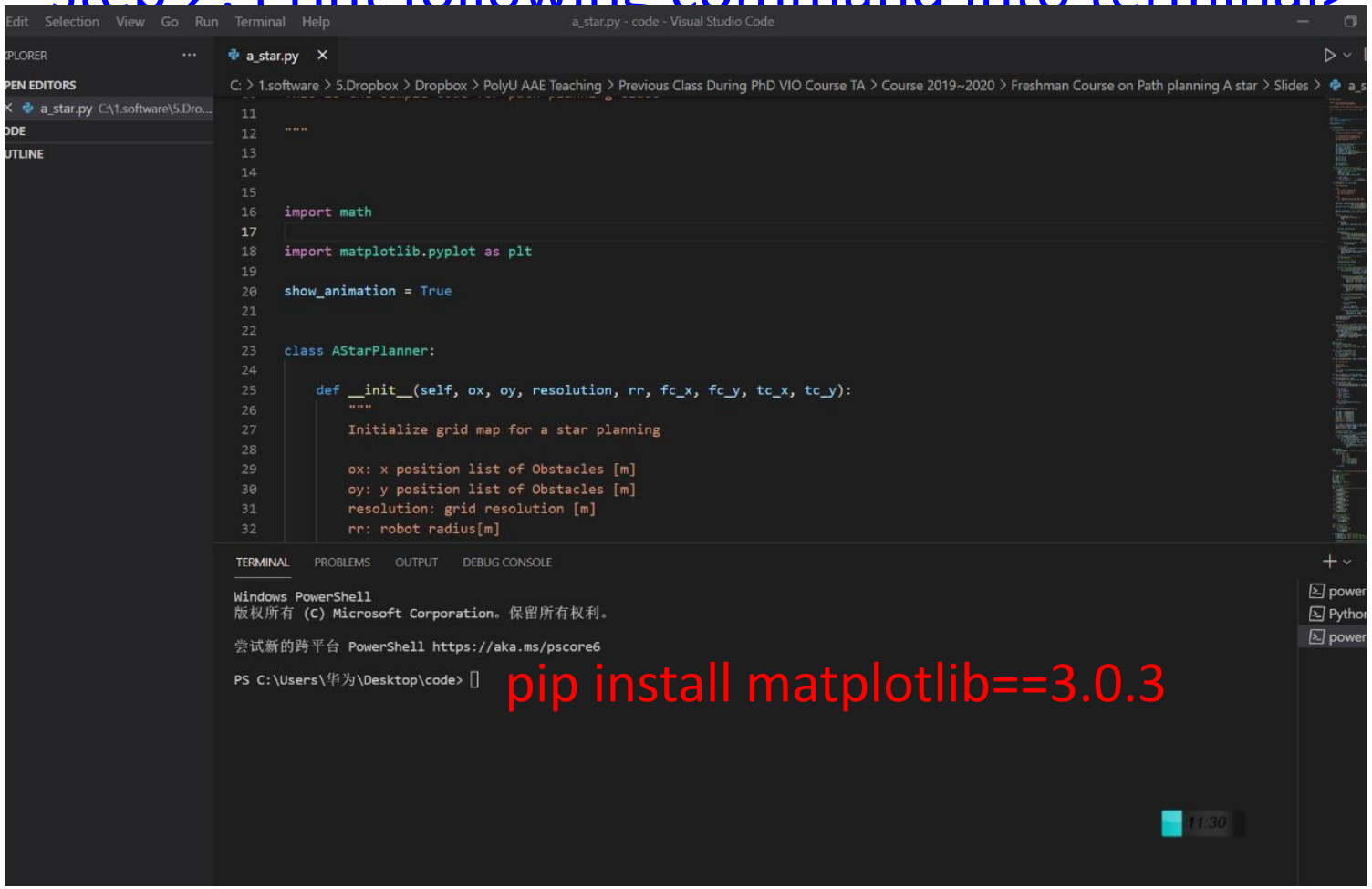
Install matplotlib

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



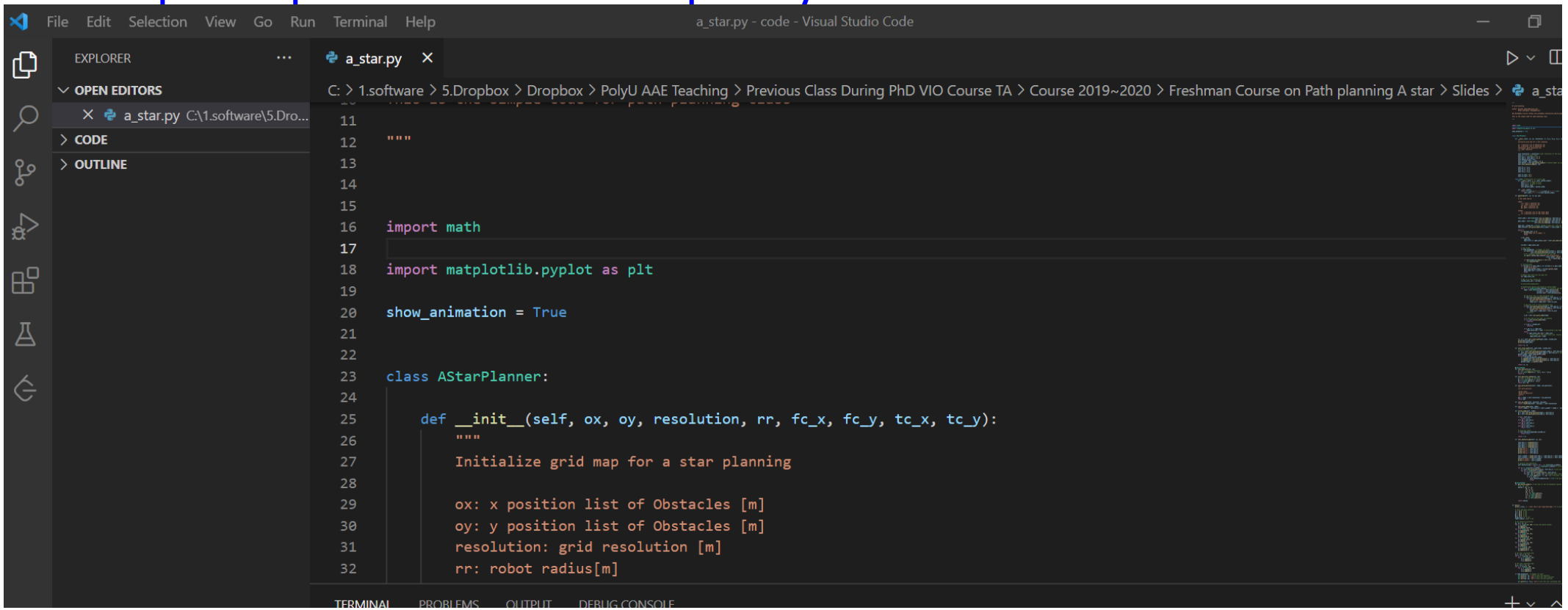
Install matplotlib

- step 2: Print following command into terminal>



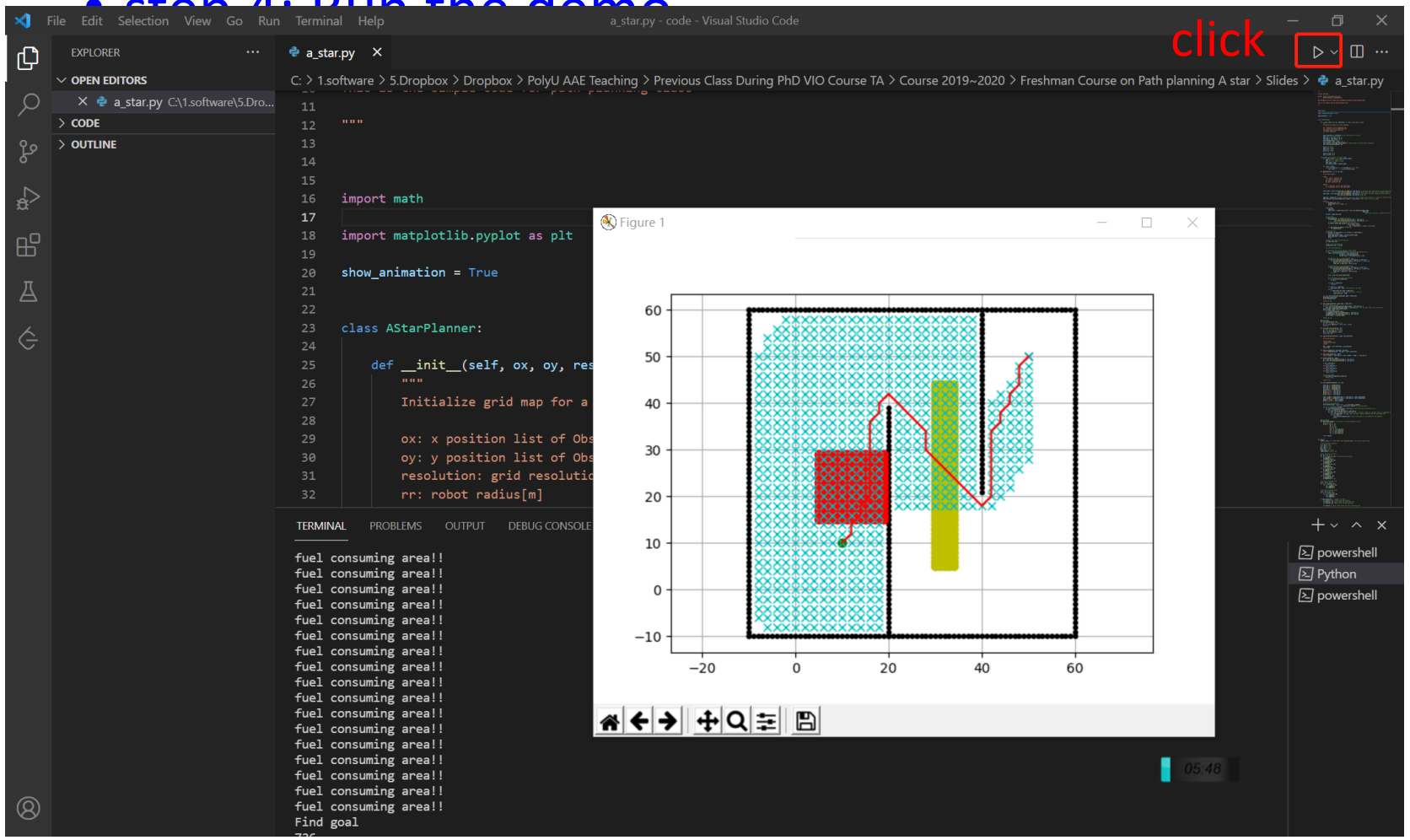
Test matplotlib

- step 3: Open the code sample by VS code



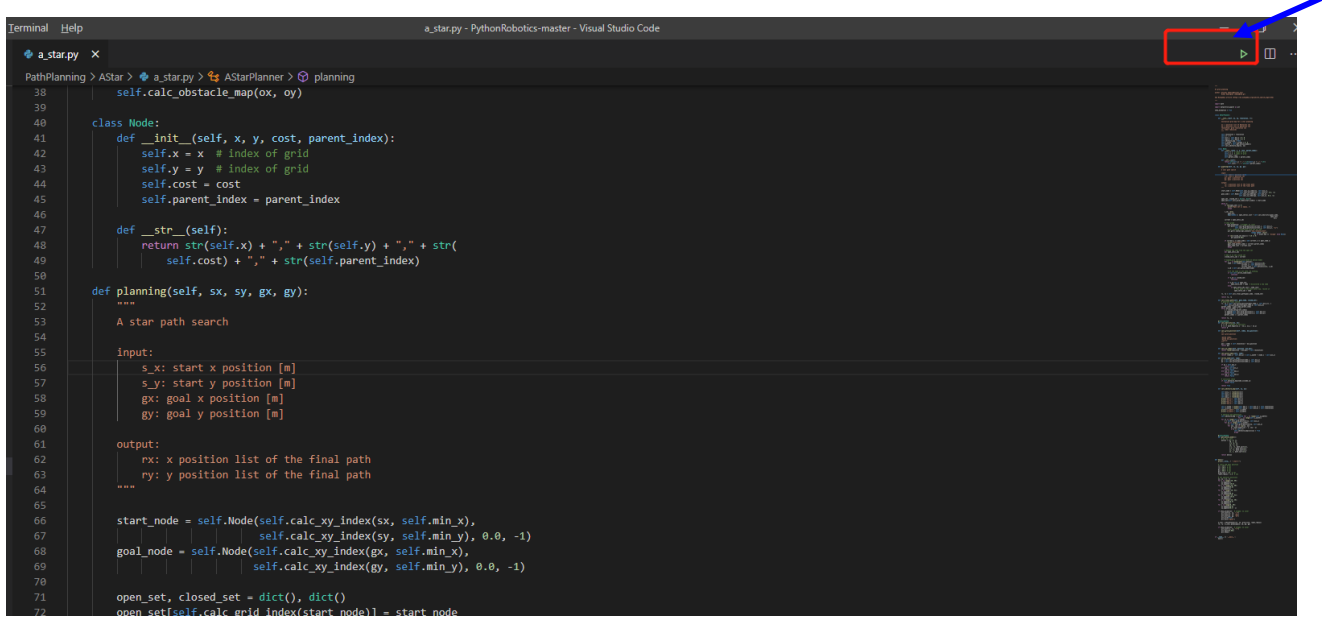
Test matplotlib

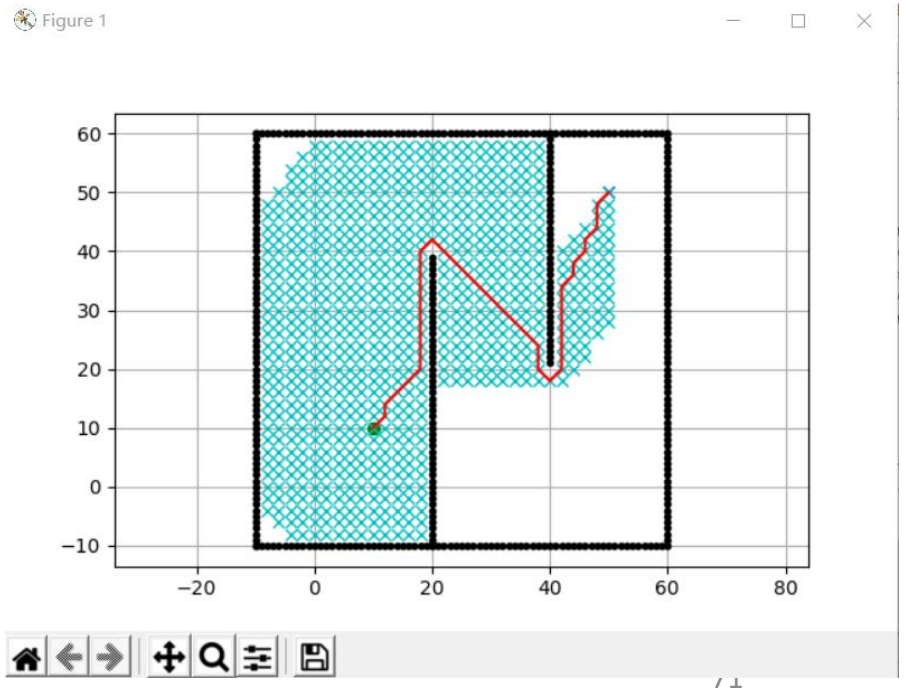
- step 4: Run the demo



Run A Star in VS code

Run the code

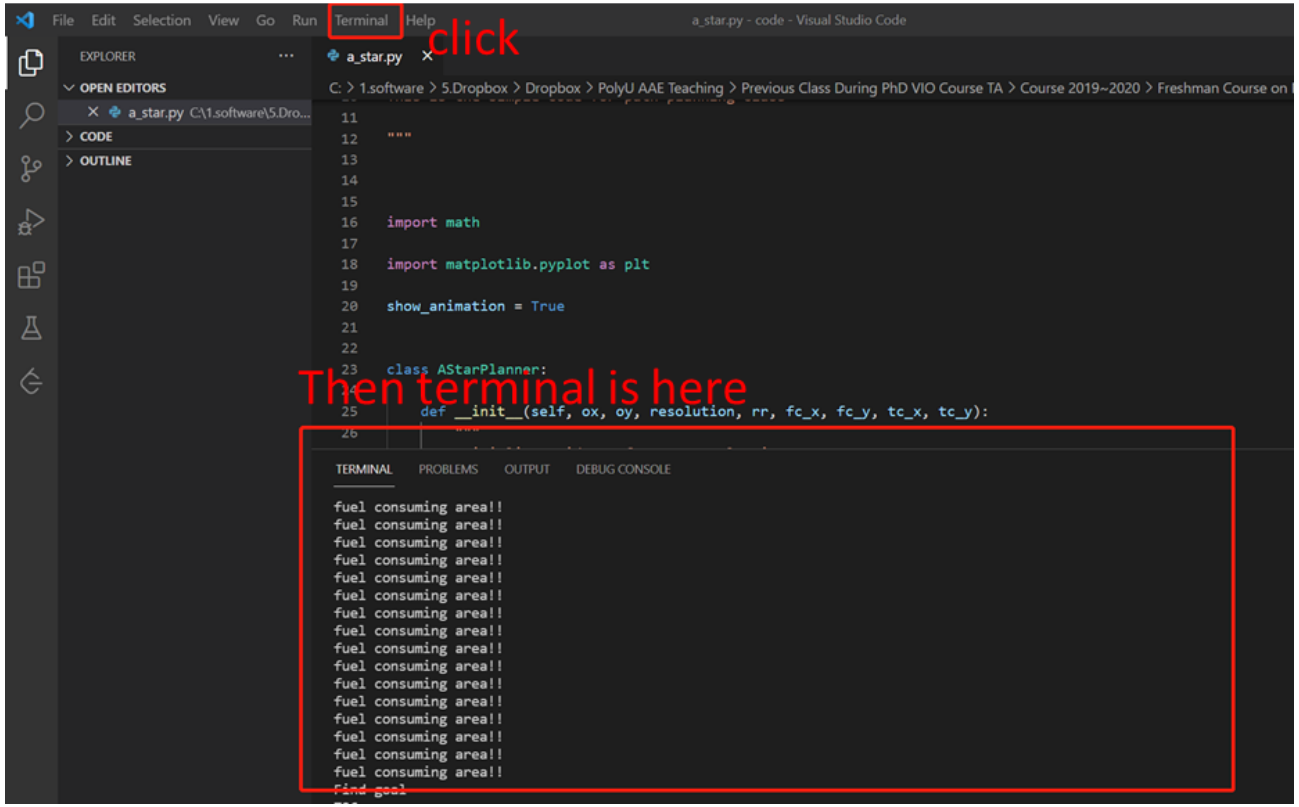




A* is a graph traversal and path search algorithm, which is often used in many fields of computer science due to its completeness, optimality, and optimal efficiency. One major practical drawback is its space complexity, as it stores all generated nodes in memory.

Troubleshot: 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*



Path Planning Code Guide

The Path Planning Code

- You can find the path planning code inside the course GitHub repository
- There are 2 set of codes:
  - A default one
  - A noted one
- The default one is a basic A* path planning code without any extra information and features
- The noted one provides an example of what your code should look like after modifications (Remember each group should complete a different set of obstacles and requirements)
- Repository link: https://github.com/IPNL-POLYU/PolyU_AAE2004_Github_Project

Where you can find the code

main | PolyU_AAE2004_Github_Project / Sample Codes / | Go to file | Add file | ...

This branch is up to date with qmohsu:main. | Contribute | Fetch upstream

qmohsu Merge branch 'main' into LT2 — de19c32 on Oct 15, 2021 — History

..		
Tutorial 1 Sample.py	Update Tutorial 1 Sample.py	5 months ago
a_star_noted.py	Add files via upload	5 months ago
a_star_original.py	Merge branch 'main' into LT2	4 months ago
animation.gif	update sample code	5 months ago
readme.md	Update readme.md	5 months ago

Noted Version Guide

- Line 50,51: Declaration of cost intensive area cost modifier
- Line 53: Declare cost per grid

```
34
35          self.resolution = resolution # get resolution of the grid
36          self.rr = rr # robot radis
37          self.min_x, self.min_y = 0, 0
38          self.max_x, self.max_y = 0, 0
39          self.obstacle_map = None
40          self.x_width, self.y_width = 0, 0
41          self.motion = self.get_motion_model() # motion model for grid search expansion
42          self.calc_obstacle_map(ox, oy)
43
44          self.fc_x = fc_x
45          self.fc_y = fc_y
46          self.tc_x = tc_x
47          self.tc_y = tc_y
48
49
50          self.Delta_C1 = 0.2 # cost intensive area 1 modifier
51          self.Delta_C2 = 0.4 # cost intensive area 2 modifier
52
53          self.costPerGrid = 1
54
```

Noted Version Guide

- Line 115: Showing the final calculation of total trip time
- Line 135-144: Adding additional cost during cost intensive area

```
103         if show_animation:  # pragma: no cover
104             plt.plot(self.calc_grid_position(current.x, self.min_x),
105                      self.calc_grid_position(current.y, self.min_y), "xc")
106             # for stopping simulation with the esc key.
107             plt.gcf().canvas.mpl_connect('key_release_event',
108                                          lambda event: [exit(
109                                              0) if event.key == 'escape' else None])
110             if len(closed_set.keys()) % 10 == 0:
111                 plt.pause(0.001)
112
113         # reaching goal
114         if current.x == goal_node.x and current.y == goal_node.y:
115             print("Total Trip time required -> ",current.cost )
116             goal_node.parent_index = current.parent_index
117             goal_node.cost = current.cost
118             break
119
120         # Remove the item from the open set
121         del open_set[c_id]
122
123         # Add it to the closed set
124         closed_set[c_id] = current
125
126         # print(len(closed_set))
127
128         # expand_grid search grid based on motion model
129         for i, _ in enumerate(self.motion): # tranverse the motion matrix
130             node = self.Node(current.x + self.motion[i][0],
131                              current.y + self.motion[i][1],
132                              current.cost + self.motion[i][2] * self.costPerGrid, c_id)
133
134             ## add more cost in cost intensive area 1
135             if self.calc_grid_position(node.x, self.min_x) in self.tc_x:
136                 if self.calc_grid_position(node.y, self.min_y) in self.tc_y:
137                     # print("cost intensive area!!")
138                     node.cost = node.cost + self.Delta_C1 * self.motion[i][2]
139
140             # add more cost in cost intensive area 2
141             if self.calc_grid_position(node.x, self.min_x) in self.fc_x:
142                 if self.calc_grid_position(node.y, self.min_y) in self.fc_y:
143                     # print("cost intensive area!!")
144                     node.cost = node.cost + self.Delta_C2 * self.motion[i][2]
145                 # print()
146
```

Noted Version Guide

- Line 263-270: Declaring motions for the aircraft
- Line 279-284: Declaring starting point and end point

```
260     @staticmethod
261     def get_motion_model(): # the cost of the surrounding 8 points
262         # dx, dy, cost
263         motion = [[1, 0, 1],
264                   [0, 1, 1],
265                   [-1, 0, 1],
266                   [0, -1, 1],
267                   [-1, -1, math.sqrt(2)],
268                   [-1, 1, math.sqrt(2)],
269                   [1, -1, math.sqrt(2)],
270                   [1, 1, math.sqrt(2)]]
271
272         return motion
273
274
275 def main():
276     print(__file__ + " start the A star algorithm demo !!") # print simple notes
277
278     # start and goal position
279     sx = 0.0  # [m]
280     sy = 0.0  # [m]
281     gx = 50.0  # [m]
282     gy = 0.0  # [m]
283     grid_size = 1  # [m]
284     robot_radius = 1.0  # [m]
```

Noted Version Guide

- Line 309-329: Adding obstacles
- Line 337-348, Adding cost intensive areas (Hint: Refer to this part for your task 2!)

```
308     # set obstacle positions for group 9
309     ox, oy = [], []
310     for i in range(-10, 60): # draw the button border
311         ox.append(i)
312         oy.append(-10.0)
313     for i in range(-10, 60): # draw the right border
314         ox.append(60.0)
315         oy.append(i)
316     for i in range(-10, 60): # draw the top border
317         ox.append(i)
318         oy.append(60.0)
319     for i in range(-10, 60): # draw the left border
320         ox.append(-10.0)
321         oy.append(i)
322
323     for i in range(-10, 30): # draw the free border
324         ox.append(20.0)
325         oy.append(i)
326
327     for i in range(0, 20):
328         ox.append(i)
329         oy.append(-1 * i + 10)
330
331     # for i in range(40, 45): # draw the button border
332     #     ox.append(i)
333     #     oy.append(30.0)
334
335
336     # set cost intesive area 1
337     fc_x, fc_y = [], []
338     for i in range(30, 40):
339         for j in range(0, 40):
340             fc_x.append(i)
341             fc_y.append(j)
342
343     # set cost intesive area 1
344     tc_x, tc_y = [], []
345     for i in range(10, 20):
346         for j in range(20, 50):
347             tc_x.append(i)
348             tc_y.append(j)
```

Noted Version Guide

- If you wish to do the calculation using the program, you should add the calculation function under line 117, inside the reaching goal condition
- It would be even better if the program could distinguish viable and non-viable aircraft types!
- Use the noted version as your sample to modify your own code!

Program Calculation for Task 1

- When you add in a cost calculation function, the output should look something like this, it should be able to:

1. Calculate each aircraft types' operating costs
2. Mention which type might not be viable for certain scenarios

```
min_x: -10
min_y: -10
max_x: 60
max_y: 60
x_width: 70
y_width: 70
Total travelling time ->  93.35575746753788
A321 not viable!
Total cost of operating A330 in this scenario:  27360.167918740684
Total cost of operating A350 in this scenario:  30752.648960130347
```