

# AAE2004 Introduction to Aviation Systems

## AAE

### Design of Path Planning Algorithm for Aircraft Operation

#### Final Week: Discussion and Outlook

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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

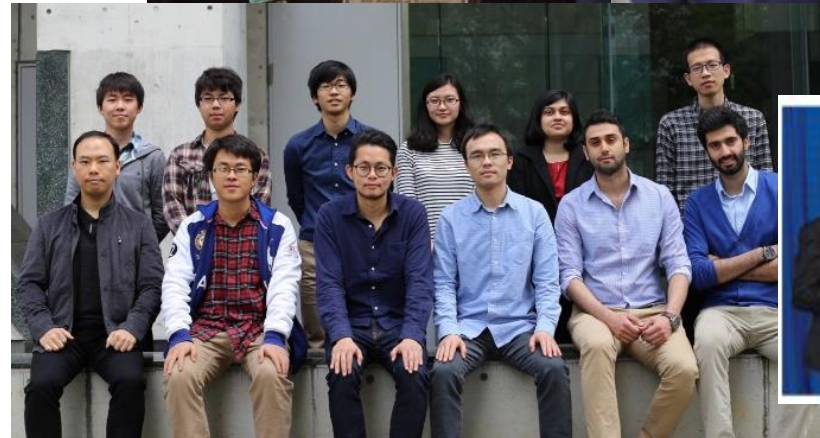
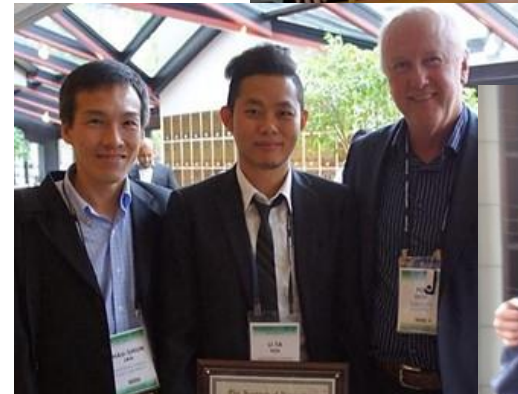
2013.07 – Visiting Researcher  
in Tokyo Marine University, Japan

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](mailto:hiu-yi.ho@connect.polyu.hk) )
  - Group 6-10: Nikkie Leung ([yan-tung.leung@connect.polyu.hk](mailto:yan-tung.leung@connect.polyu.hk))



# Why coding/programming is important for Aviation Engineering (specially after COVID-19)?

**What are challenges to make this happen?**

Infrastructure inspection

- Parcel Delivery

Infrastructure inspection

- building and bridge defects, etc.

Search and Rescue (SAR)

- disaster prevention and rescue,

Smart transportation

- traffic monitoring management
- air quality monitoring

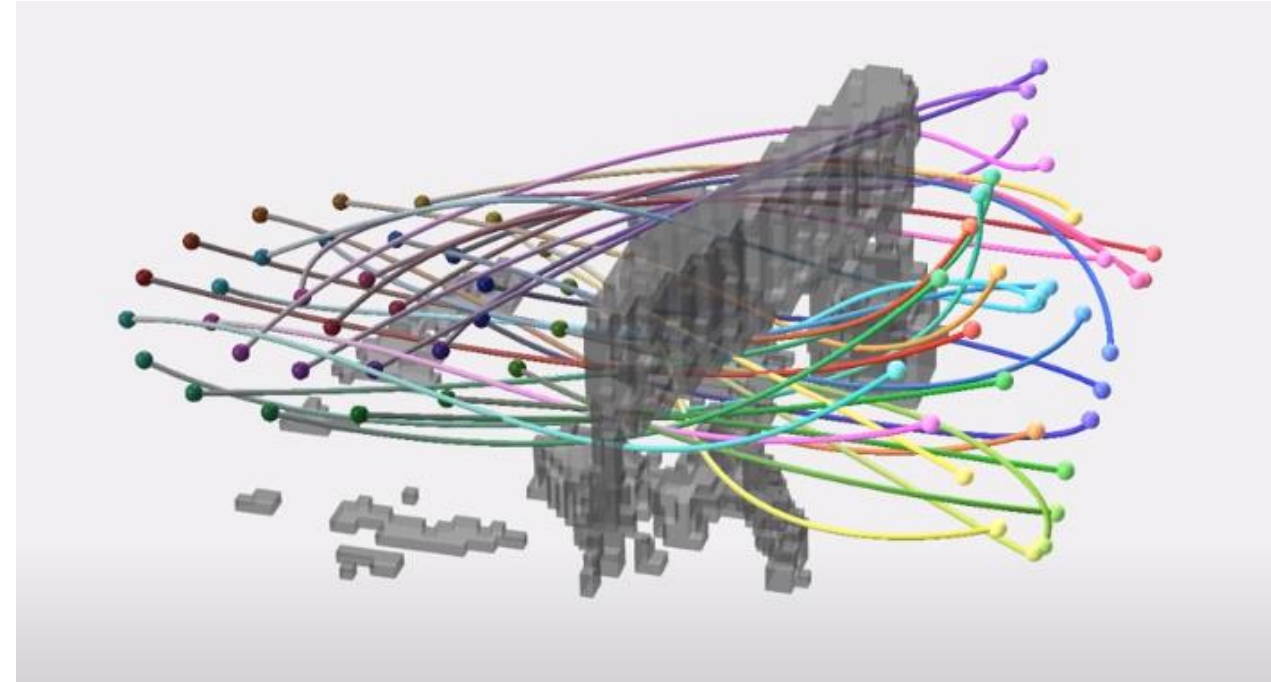
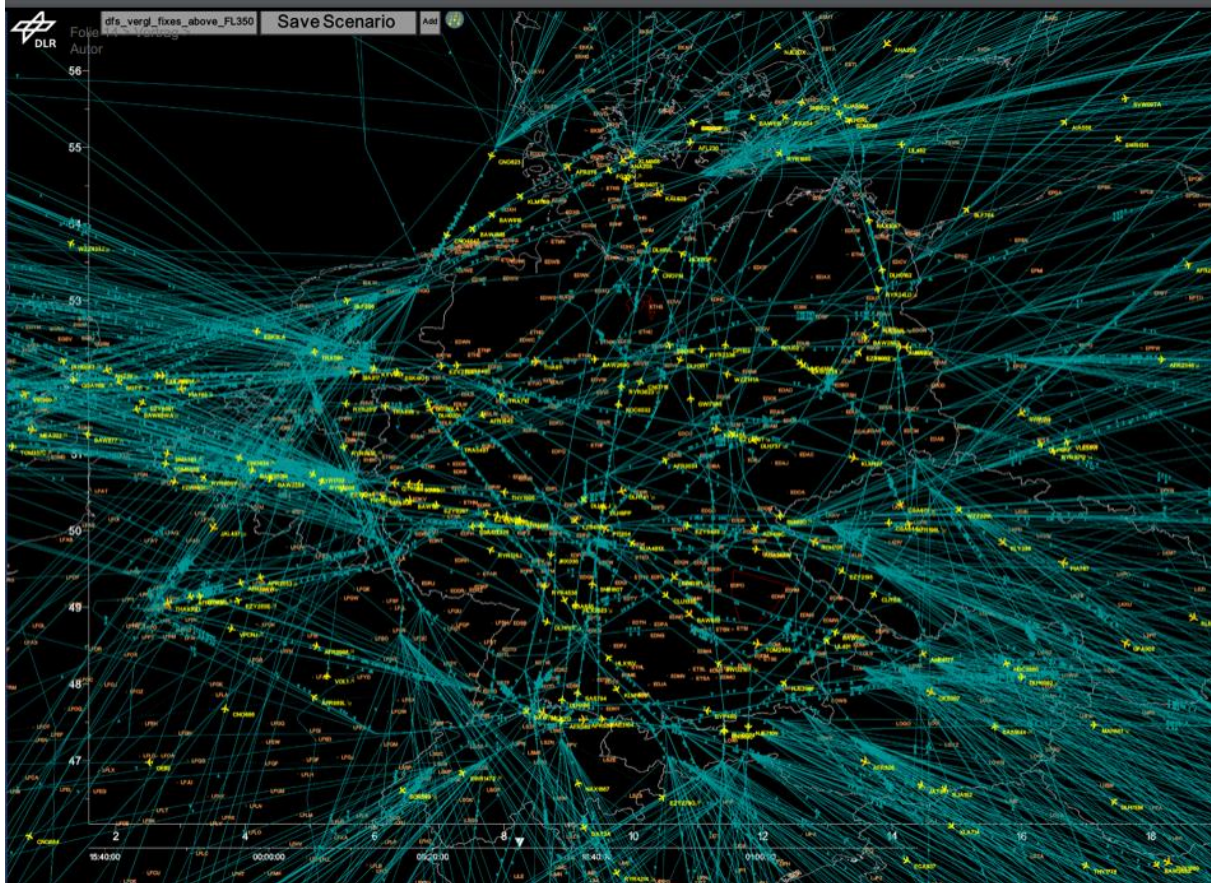


# Crowded Airspace in Cities





# Challenges - Collaborative Path Planning

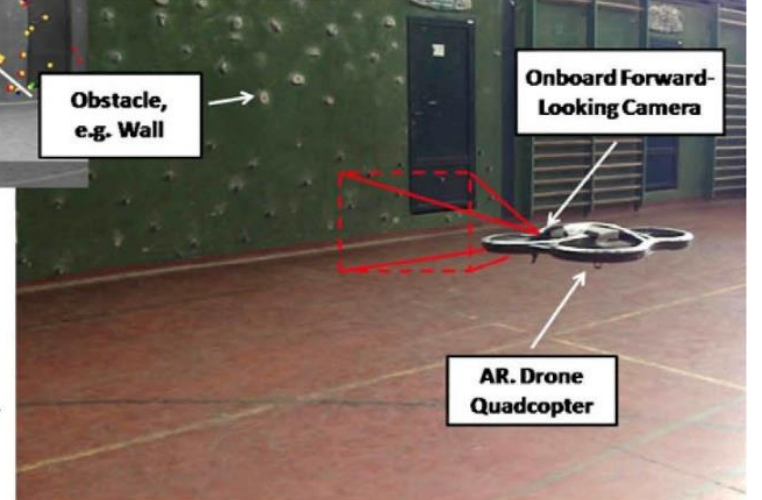
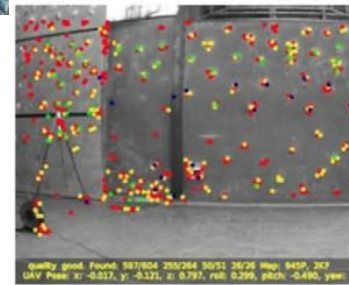


<https://www.youtube.com/watch?v=7Kla9FlmbRc>

Keywords: Path planning, traffic control, SWARM collabation, IoT, Connect vehicles, and Smart Cities



# Challenges – Collision Avoidance

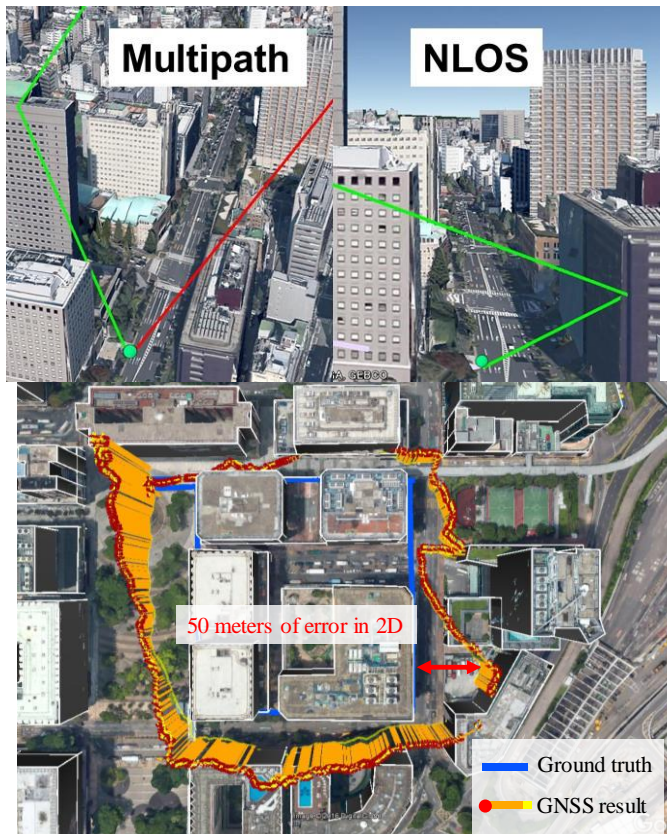


Keywords: Perception by AI (deep learning), image processing, estimation and optimization



# Challenges – Navigation in Challenged Environments

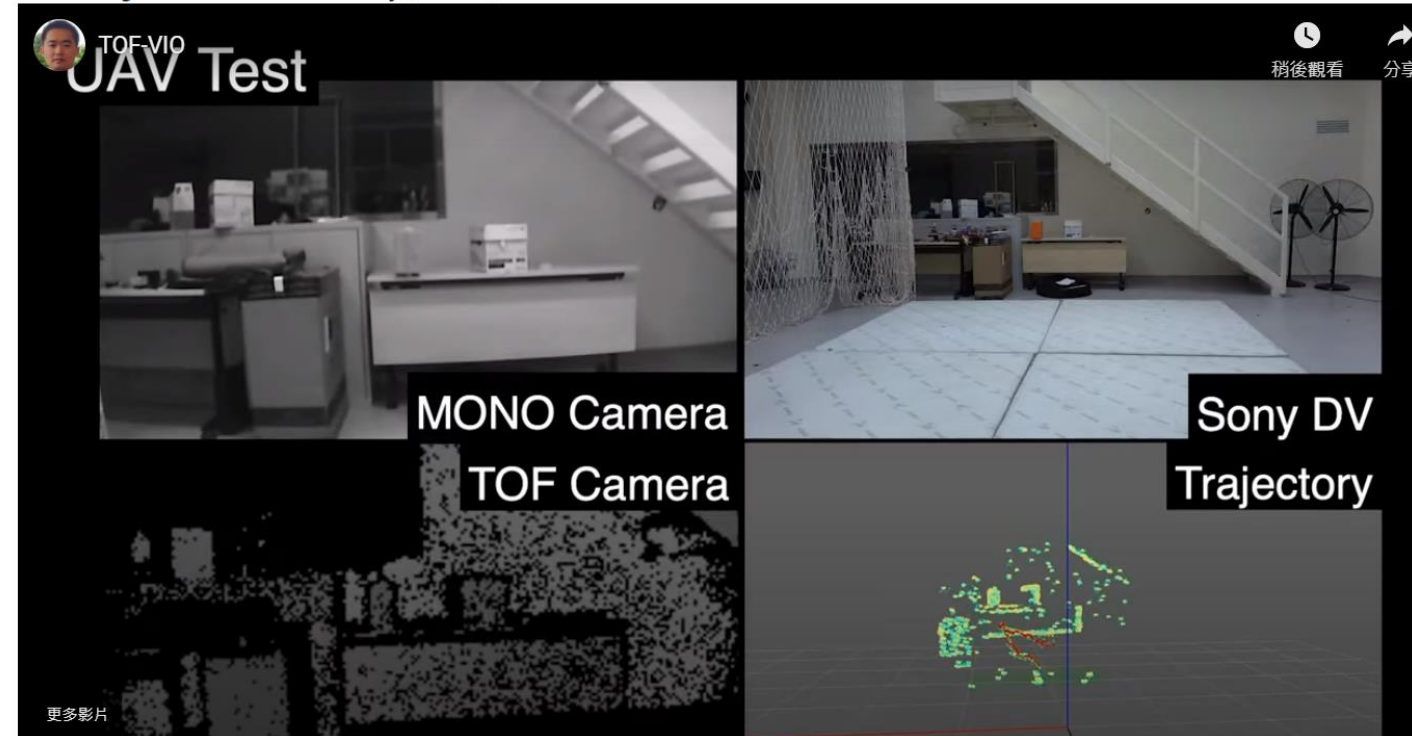
## Challenge in GNSS Positioning



## Visual Navigation

<https://www.polyu.edu.hk/researchgrp/cywen/index.php/en/mav-uav/perception-slam.html>

Time of Flight Visual Inertial Odometry (ToF-VIO)



Keywords: GNSS, inertial navigation system, visual positioning, simultaneous localization and mapping (SLAM), sensor fusion, filtering.

# Integrity and Safety



Keywords:

Airworthiness, Reliability, Compliance (regulation-wise)

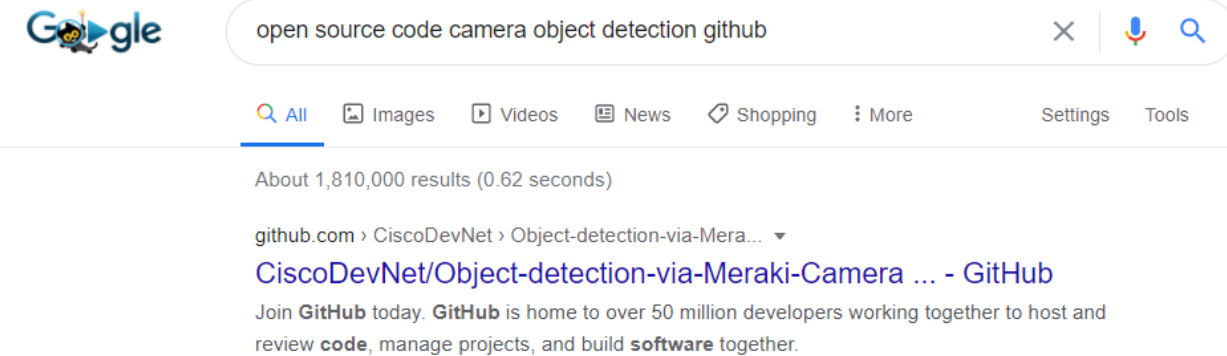
Statistics and modelling (mathematics-wise)



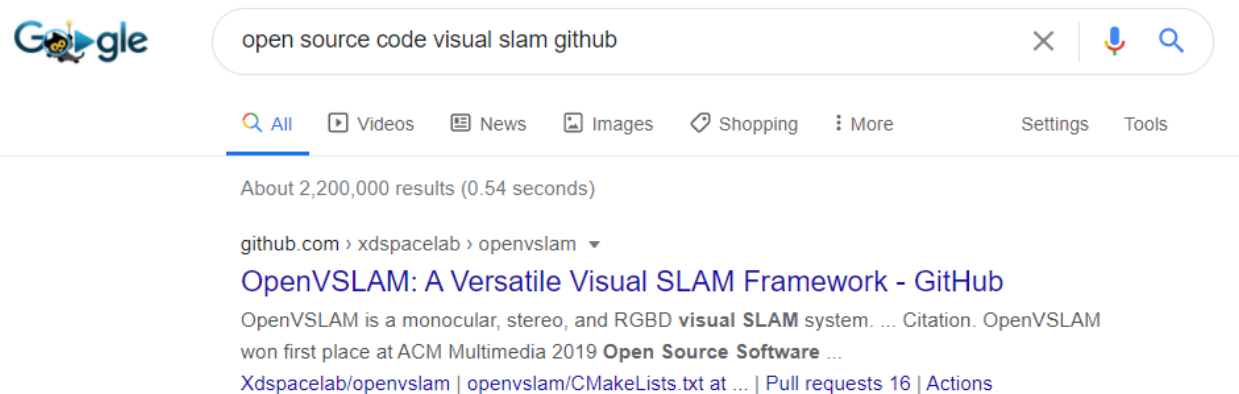
# Most of the sample open-source codes can be found in GitHub



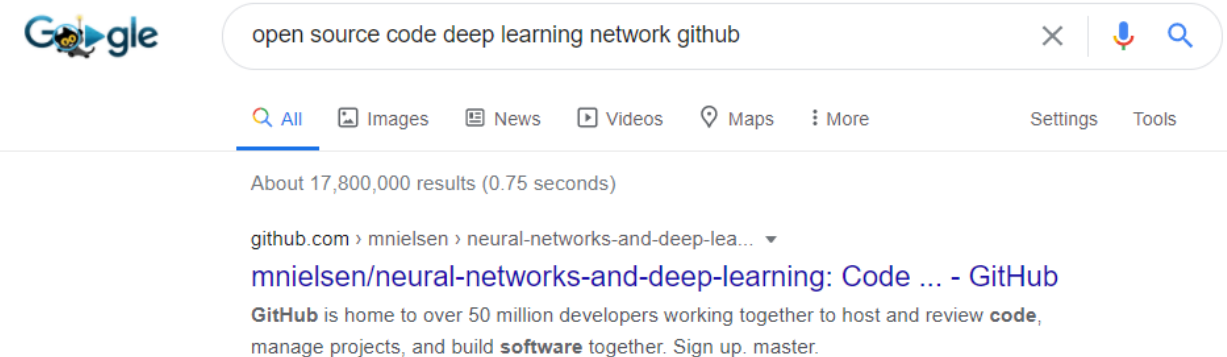
Google search results for "open source code path planning python github". The search bar shows the query and a microphone icon. Below the search bar, there are tabs for "All", "Images", "Videos", "News", "Shopping", and "More". The results show "About 860,000 results (0.64 seconds)". The top result is from github.com, titled "AtsushiSakai/PythonRobotics: Python sample codes ... - GitHub". The description states: "This is a **Python code** collection of robotics algorithms, especially for autonomous navigation. Features: Easy to read for understanding each **algorithm's** basic idea. [README.md](#) | [Issues 4](#) | [AtsushiSakai/PythonRobotics](#) | [Pull requests](#). You've visited this page 3 times. Last visit: 10/26/20".



Google search results for "open source code camera object detection github". The search bar shows the query and a microphone icon. Below the search bar, there are tabs for "All", "Images", "Videos", "News", "Shopping", and "More". The results show "About 1,810,000 results (0.62 seconds)". The top result is from github.com, titled "CiscoDevNet/Object-detection-via-Meraki-Camera ... - GitHub". The description states: "Join **GitHub** today. **GitHub** is home to over 50 million developers working together to host and review **code**, manage projects, and build **software** together."



Google search results for "open source code visual slam github". The search bar shows the query and a microphone icon. Below the search bar, there are tabs for "All", "Videos", "News", "Images", "Shopping", and "More". The results show "About 2,200,000 results (0.54 seconds)". The top result is from github.com, titled "OpenVSLAM: A Versatile Visual SLAM Framework - GitHub". The description states: "OpenVSLAM is a monocular, stereo, and RGBD **visual SLAM** system. ... Citation. OpenVSLAM won first place at ACM Multimedia 2019 **Open Source Software** ... [Xdspacelab/openvslam](#) | [openvslam/CMakeLists.txt at ...](#) | [Pull requests 16](#) | [Actions](#)".



Google search results for "open source code deep learning network github". The search bar shows the query and a microphone icon. Below the search bar, there are tabs for "All", "Images", "News", "Videos", "Maps", and "More". The results show "About 17,800,000 results (0.75 seconds)". The top result is from github.com, titled "mnielsen/neural-networks-and-deep-learning: Code ... - GitHub". The description states: "**GitHub** is home to over 50 million developers working together to host and review **code**, manage projects, and build **software** together. Sign up. master."

# To do list in your 4 years...

1. To initiate one hand-on project (by coding or manufacturing) related to your passion.
  - Manufacturing an UAV, Enabling autonomous function of an UAV, etc
2. To find news and articles (by hashtag or club in social networks) that related to your interests.
  - Accumulating your domain knowledge and expand your network with someone who have similar passion to you.
3. To find the issues/problems (in your network, village, city, nation, area and the world) you cared and try to find solutions to these challenges.

# (Video) AI and Data Science in Aviation

- <https://www.youtube.com/watch?v=D8NIYPtPgWA>
- [1:18 - Revenue Management](#)
- [3:36 - In-flight sales and food supply](#)
- [5:03 - Fuel consumption optimization](#)
- [6:36 - Boarding and checking bags with facial recognition](#)
- [8:33 - Preparing a plane for the next flight](#)



# Dialogues and Discussions

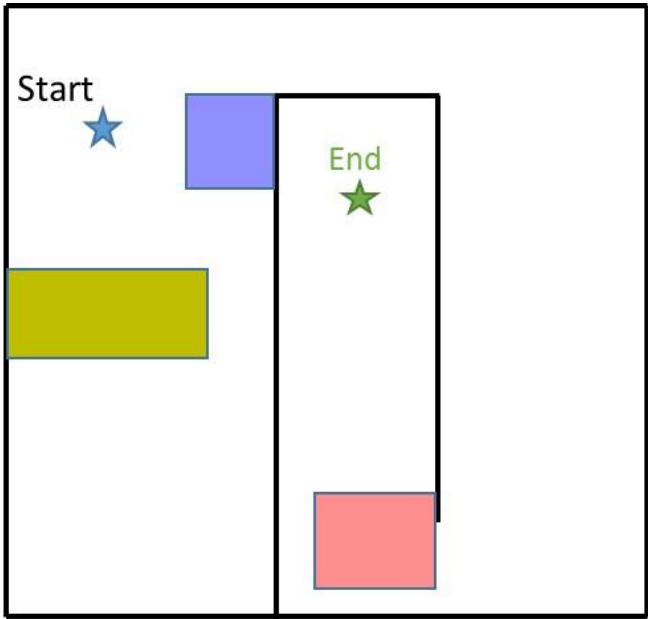
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Dare to ask and communication is the first step of your  
success

In this project, we do...

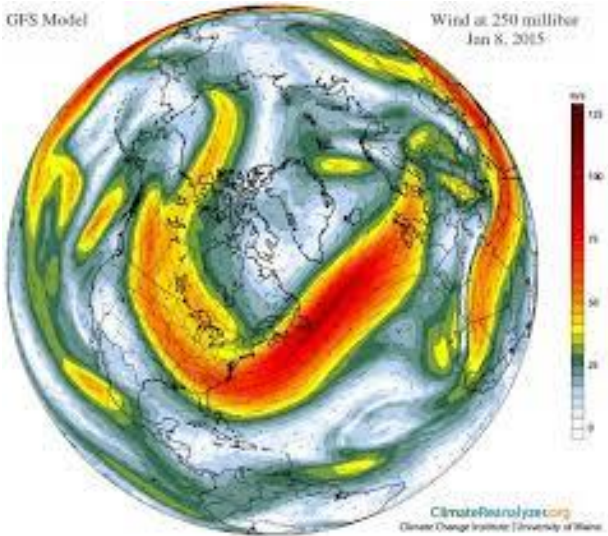
Aircraft Model	$C_F$	$\Delta F$	$C_T$	$\Delta T$	$C_c$	$\Delta F_a$	$\Delta T_a$	$C_P$	$\Delta P$
PolyU-A380	1	1	2	5	10	0.2	0.2	-2	2

$$C = C_F \cdot \Delta F + C_T \cdot \Delta T + C_c + C_P \cdot \Delta P$$

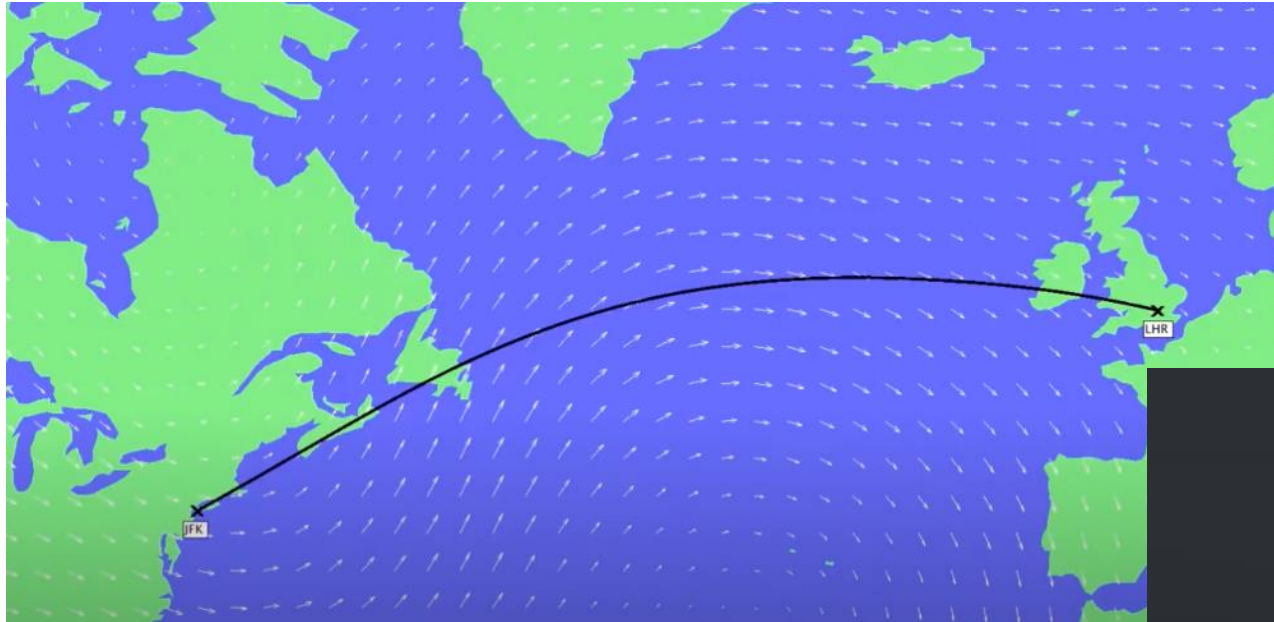


But in the real life,

Aircraft Model	$C_F$	$\Delta F$	$C_T$	$\Delta T$	$C_c$	$\Delta F_a$	$\Delta T_a$	$C_P$	$\Delta P$	...
Your designed aircraft	?	?	?	?	?	?	?	?	?	?



# What does $C_p$ mean? Jet Stream Winds



<https://www.youtube.com/watch?v=tMN1f4dvpHI>



# Final To do list in this project

1. Finish as much tasks (using Python) as you can
2. Write a report to introduce your project and reflect what you have learned
3. Make a video presentation to share and communication your ideas and projects
4. Submit the peer evaluation form individually