

AAE1001 - Introduction to Artificial Intelligence and Data Analytics in Aerospace and Aviation Engineering

Week 7-13: Group Project - Design of Path Planning Algorithm for Aircraft Operation

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Ground Rules

For students

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

For us!

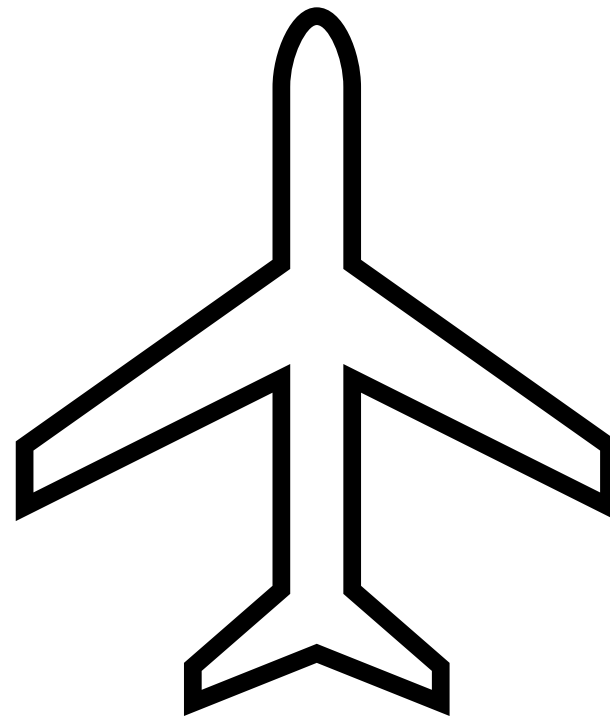
- Keep an open mind—enter the classroom dialogue with the expectation of learning something new. Look forward to learning about—and being challenged by—ideas, questions, and points of view that are different than your own.
- Arrive on time to the class and finish the class on time

For teaching staffs

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

Week 7 Content

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

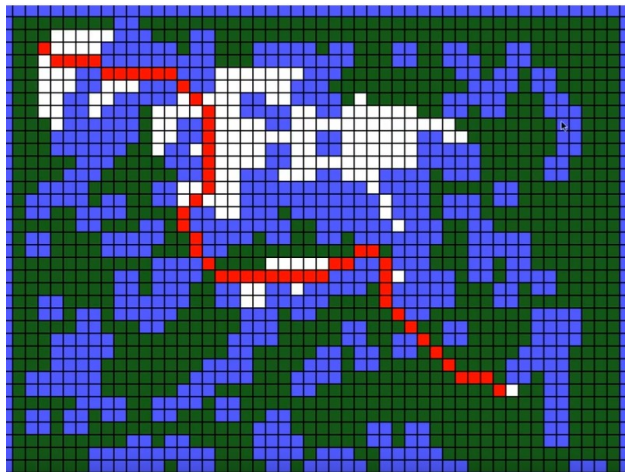


Introduction to Path Planning

What is Path Planning?

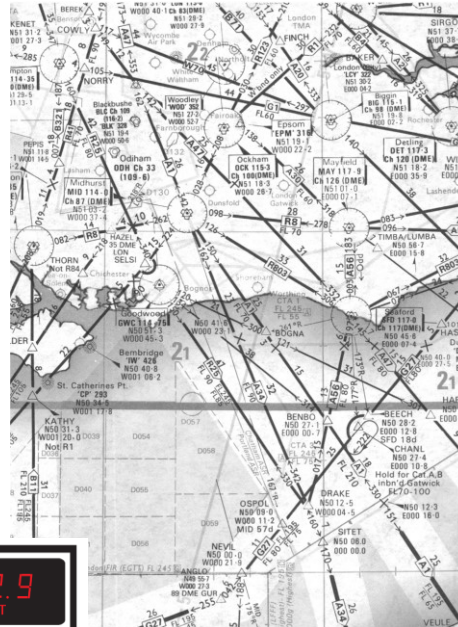
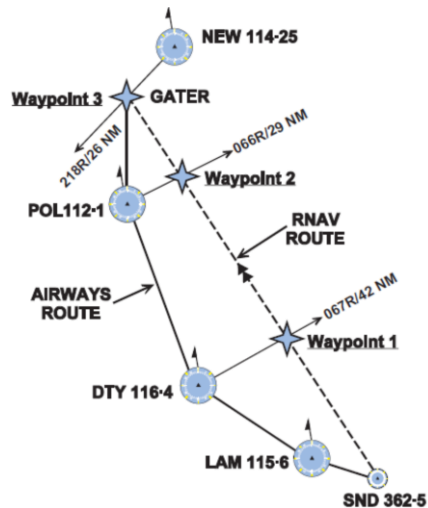
How to go from A to B considering factors!

- **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?

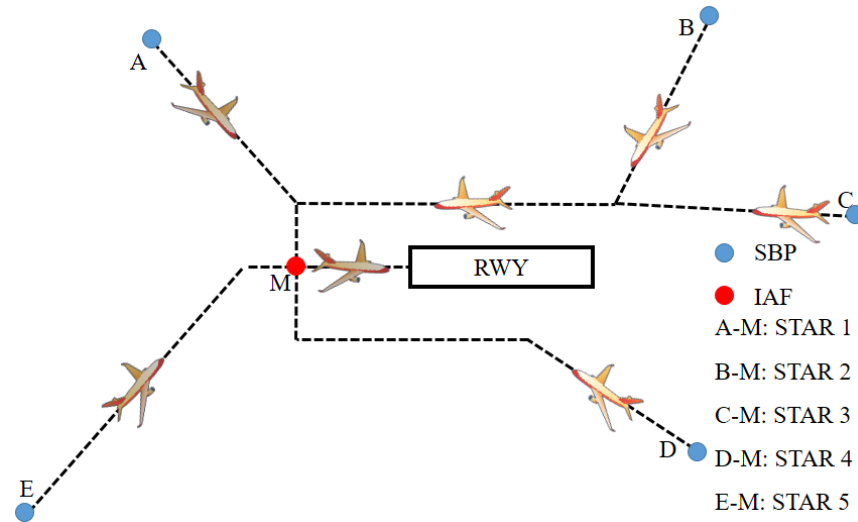
- Private pilots do the path plan before the flight to make sure the navigation aid is available



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

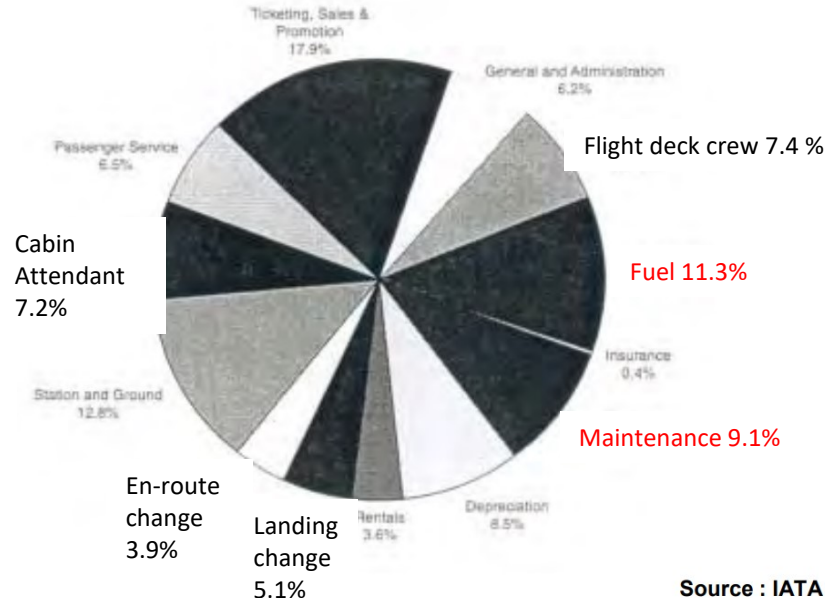


How is Path Planning important to Aviation Engineering?

- 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 :

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

Cost-Index Published by Aircraft Manufacturer

Flight Operations Support & Line Assistance



getting to grips with the
cost index

Issue II - May 1998

Customer Services



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

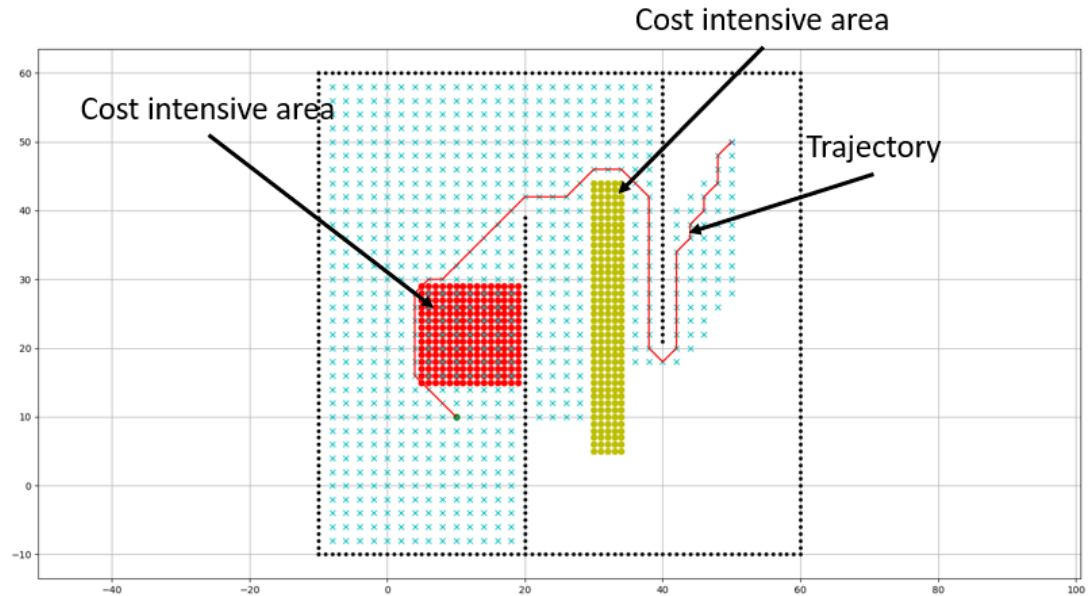
Path Planning

- 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

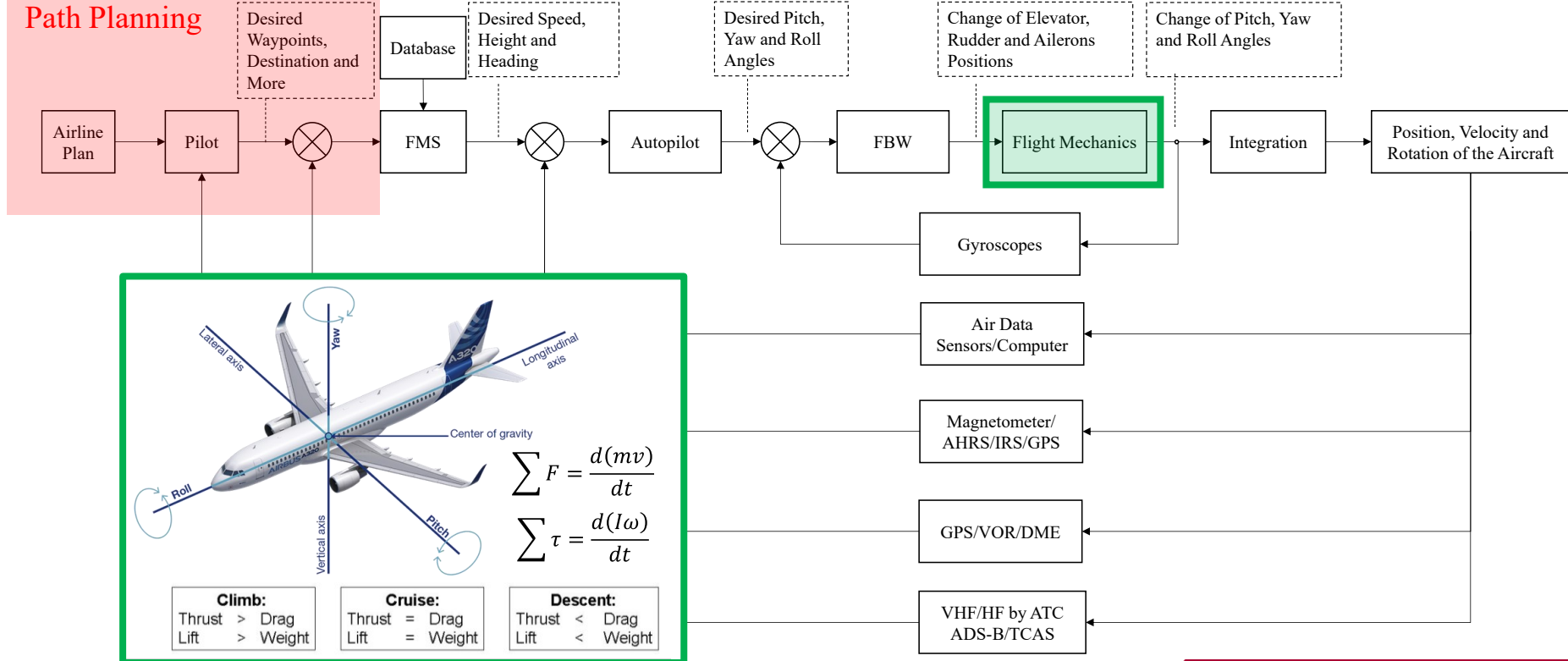
We are airline. We wish to
find a route with
minimized cost.

What tasks we do?



Aircraft Operation in Flight Control System

Path Planning



How is the Path Planning Project related to the AE programme study?

- Mathematics & Physics
- Computer Science
- Aeronautical and Aviation
- The path should be planned considering the **practical limitation (aviation system)** of the aircraft

Year 1 (30 + 4 training credits)			
Semester 1 (15 + 2 training credits)		Semester 2 (15 + 2 training credits)	
AAE1001	Introduction to Artificial Intelligence and Data Analytics in Aerospace and Aviation Engineering (GUR-AIDA) (2 credits)	AAE2003	Introduction to Aircraft Systems
AAE1002	Innovation and Entrepreneurship in Green Aviation and Space Economy (GUR-IE) (1 credit)	AMA1120	Basic Mathematics II
AAE2004	Introduction to Aviation System and Air Transport Regulation	AP10006	Physics II
AMA1110	Basic Mathematics I	APSS1L01	Tomorrow's Leaders
AP10005	Physics I	CAR I ^	
LCR I	English Language Subject		
Healthy Lifestyle (non-credit bearing) ^			
AAE2101 / IC2105 Engineering Communication and Fundamentals (4 training credits); or AAE2102 / IC2133 Aircraft Manufacturing and Maintenance Fundamentals (4 training credits)			
Year 2 (33 + 3 training credits)			
Semester 1 (15 + 3 training credits)		Semester 2 (18 credits)	
AAE3103 / IC381	Appreciation of Aircraft Manufacturing Processes (3 training credits)	AAE2005	Electrics and Electronic for Aeronautical Engineering
AMA2111	Mathematics I	AMA2112	Mathematics II
ENG2001	Fundamentals of Materials Science and Engineering	CAR II ^	
ENG2002	Computer Programming	ENG2003	Information Technology
LCR II	English Language Subject	LCR III	Chinese Language Subject
ME23001	Engineering Mechanics	Service Learning ^	
Year 3 (30 + 3 training credits)			
Semester 1 (15 + 1.5 training credits)		Semester 2 (15 + 1.5 training credits)	
AAE3002	Aircraft Structures and Materials	AAE3001	Fundamentals of Aerodynamics
AAE3004	Dynamical Systems and Control	AAE3003	Aircraft Propulsion Systems
AAE3008	Fundamental Thermal-fluid Science	AAE4006	Flight Mechanics and Control Systems
CAR III ^		ENG3004	Society and the Engineer
Elective Subject (1)		Elective Subject (2)	
AAE3104 / IC388 Aircraft Manufacturing and Maintenance Practice (3 training credits)			

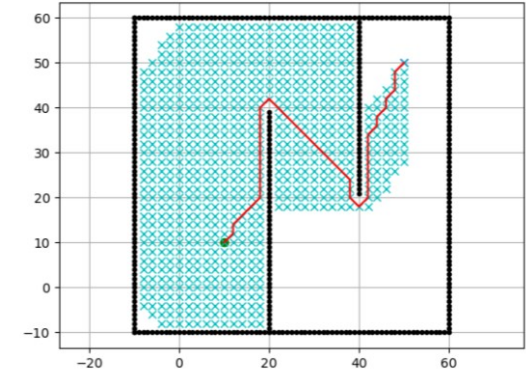
What you are expected to learn?

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



Assessments

- (25%) Demonstration and Presentation
- (25%) Report & reflective essay – one report per group, with individual reflective essay
- (10%) Performance/participation in in-class activities (Confidential peer evaluation)

In this project, students will be acted as


- Technical Lead/Members (MUST be the one who is interested at coding)
 - Develop the math behind the compulsory tasks.
 - Write the codes (Compulsory Tasks 1, 2 and 3)
 - Write the codes (Additional Tasks)
- Project Lead/Members (manage the project report and video presentation [slide])
 - Study the “numbers” related to aviation context.
 - Prepare report using GitHub Readme format.
 - Prepare PowerPoint slide and record the presentation video.





Deadline to submit the work




- Codes uploads to GitHub project created yourself
- Project report written in GitHub readme format.
- Peer review assessment
- Face-to-face presentation (15 minutes).
 - Everyone has to present.
 - Must have a slide
- Report Deadline 23:50pm on 1 Dec (Sun).

Project GitHub Homepage


https://github.com/IPNL-POLYU/PolyU_AAE1001_Github_Project










 PolyU_AAE1001_Github_Project Public

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