Interdisciplinary Division of
Aeronautical and Aviation Engineering
航空工程跨領域學部

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

AAE2004 Introduction to Aviation Systems
AAE
Design of Path Planning Algorithm for Aircraft Operation

Third 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

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 3 Content

1. Project Additional Tasks (Optional)

2. GitHub Readme tutorial
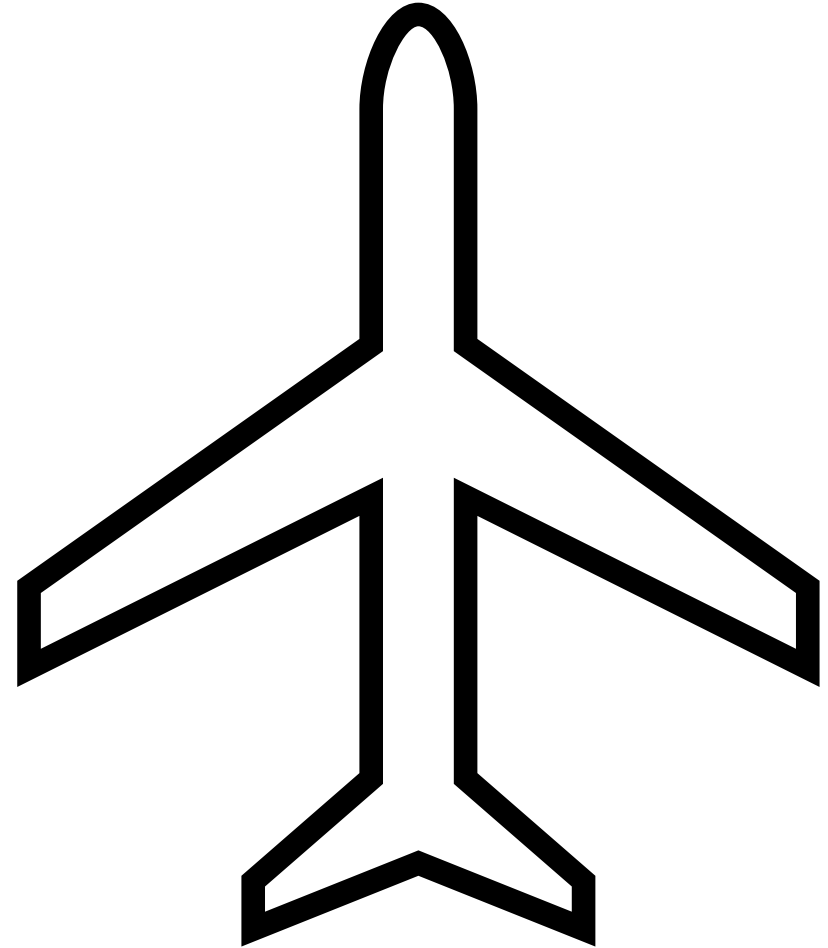
Project Additional Tasks (Optional)

Additional Tasks

- Start working on the following Tasks after you finish the previous ones (Create separate .py files so these tasks don't affect each other)

- Additional Tasks:
    - Adding Checkpoints
    - Changing Environment
   - Compare Different Algorithms

Adding a Checkpoint (Waypoint)

• Assume the Aircraft is a supply craft that must reach 2 drop-off points to drop supplies before heading back to base

1. Add 2 checkpoints:

   • One per each heavy consumption area

2. Reach all checkpoints before arriving at the destination

Adding a Checkpoint

- Requirements:
  1. This is an add-on for the code you are currently working on
  2. Checkpoints should be generated inside the heavy consumption areas
  3. Print the checkpoints, planning and the final path correctly **with different appearance**
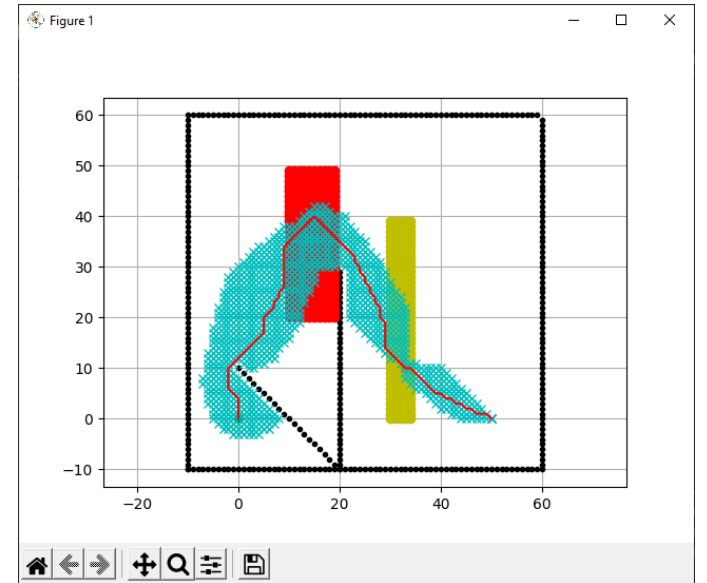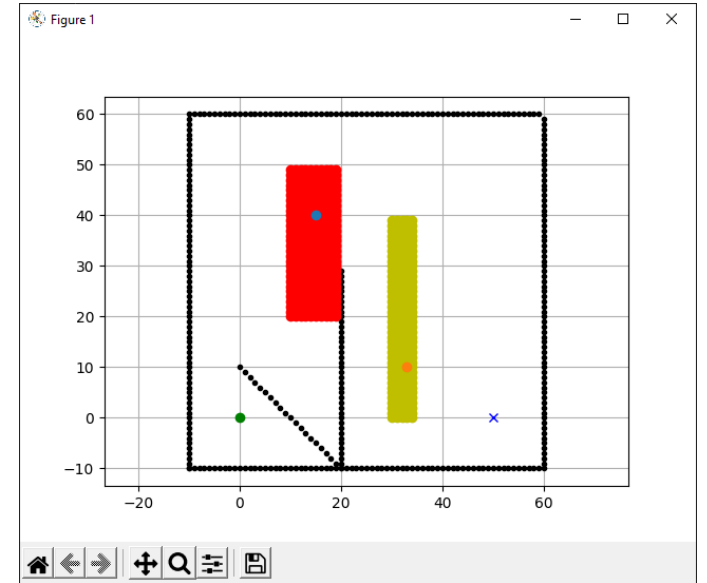
Changing Environment

- *****Continue this task using the previous task's code**
- We have been working on the same set of obstacles
- However, Path Planning should be able to work with different obstacle sets
- A **new scenario** per execution

Changing Environment
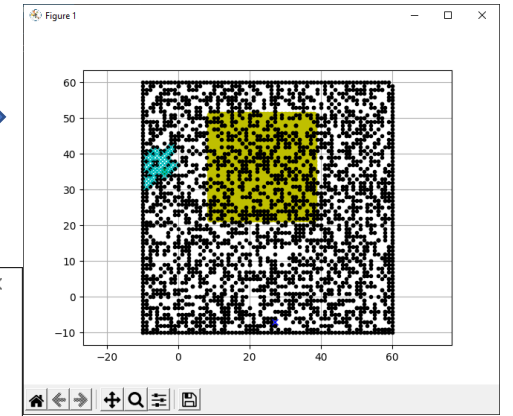

Density too high
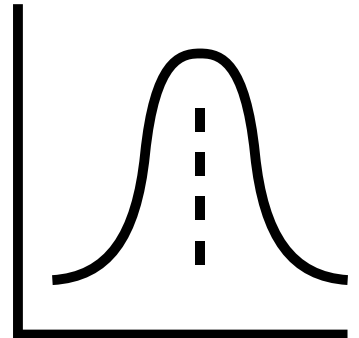
- Modify the code so that:
  1. Only the fuel-consuming area remains and generate it randomly **with a fixed area (30x30)**
  2. Diagonal movement is **disabled**, change parameter(s) so that the object could travel **within one grid size**
  3. Obstacles are generated randomly with **reasonable density**
  4. Destination and starting points are generated randomly with **at least a 50-unit distance in-between**
  5. Diagonal movements are **disabled**
  6. Plotting of the fuel-consuming area would not cover the obstacles, and obstacles **should not generate** at/near the start and end point
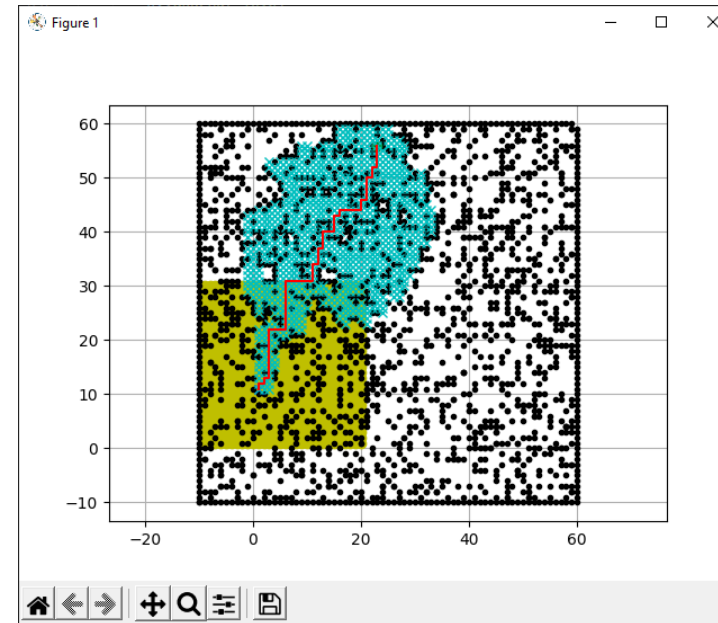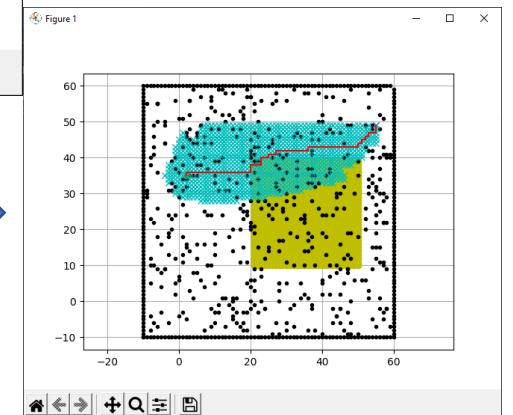

Reasonable

Density too low

Comparing Algorithms

- AStar is only one of the many Pathplanning Algorithms
- Different Algorithms
  - Different theories
  - Different performance
 - Difference limitations and strengths

AStar	fix unittest animation bugs (#429)	10 months ago
BSplinePath	mypy fix test	2 years ago
BatchInformedRRTStar	fix scanning error (#339)	15 months ago
BezierPath	Replaced sqrt(x**2+y**2) with hypot in PathPlanning/BezierPath/bezier...	2 years ago
BidirectionalAStar	fix scanning error (#339)	15 months ago
BidirectionalBreadthFirstSearch	fix scanning error (#339)	15 months ago
BreadthFirstSearch	Update breadth_first_search.py (#374)	13 months ago
BugPlanning	fix docstring error	12 months ago
ClosedLoopRRTStar	Fix No module error in GridBasedSweepCPP and ClosedLoopRRTStart (#516)	3 months ago
CubicSpline	improve test coverage (#352)	14 months ago
DStar	change DStar animation	4 months ago
DStarLite	Add D* Lite. (#511)	3 months ago
DepthFirstSearch	Update breadth_first_search.py (#374)	13 months ago
Dijkstra	Update breadth_first_search.py (#374)	13 months ago
DubinsPath	fix dubins path length bug and clean up codes. (#527)	2 months ago
DynamicWindowApproach	dwa pr (#390)	12 months ago
Eta3SplinePath	use pytest for test runner (#452)	8 months ago
Eta3SplineTrajectory	use pytest for test runner (#452)	8 months ago
FlowField	fix unittest animation bugs (#429)	10 months ago
FrenetOptimalTrajectory	mypy fix test	2 years ago
GreedyBestFirstSearch	Update greedy_best_first_search - calc_final_path method (#477)	7 months ago
GridBasedSweepCPP	Fix No module error in GridBasedSweepCPP and ClosedLoopRRTStart (#516)	3 months ago
HybridAStar	Test code clean up (#456)	8 months ago
InformedRRTStar	Using scipy.spatial.rotation matrix (#335)	15 months ago
LQRPlanner	add comment for stopping the simulation	2 years ago
LQRRRTStar	add comment for stopping the simulation	2 years ago
ModelPredictiveTrajectoryGenerator	Merge pull request #222 from zhkmxx9302013/master	2 years ago
PotentialFieldPlanning	Potential field - potential range and ocillations (#345)	14 months ago
ProbabilisticRoadMap	use scipy kd-tree directly (#337)	15 months ago
QuinticPolynomialsPlanner	Using scipy.spatial.rotation matrix (#335)	15 months ago
RRT	Sobol sampler implemented (#413)	8 months ago
RRTDubins	fix dubins path length bug and clean up codes. (#527)	2 months ago
RRTStar	Bug RRT* fix, issues #382 and #383 (#401)	11 months ago
RRTStarDubins	fix dubins path length bug and clean up codes. (#527)	2 months ago
RRTStarReedsShepp	add comment for stopping the simulation	2 years ago
ReedsSheppPath	Fix reeds shepp path issue (#529)	2 months ago
SpiralSpanningTreeCPP	fix deprecation warning for latest numpy (#480)	7 months ago
StateLatticePlanner	fix state_lattice_planner.py coordinate conversion (#495)	5 months ago
VisibilityRoadMap	fixed CI	2 years ago
VoronoiRoadMap	fix dijkstra hypot check bug (#522)	2 months ago
WavefrontCPP	fix deprecation warning for latest numpy (#480)	7 months ago

Comparing Algorithms

1. Choose 2 more algorithms from the AStar GitHub repository

2. Modify the code so all 3 algorithms are working with the **same obstacle set**

3. Try and compare the algorithms and produce a conclusion
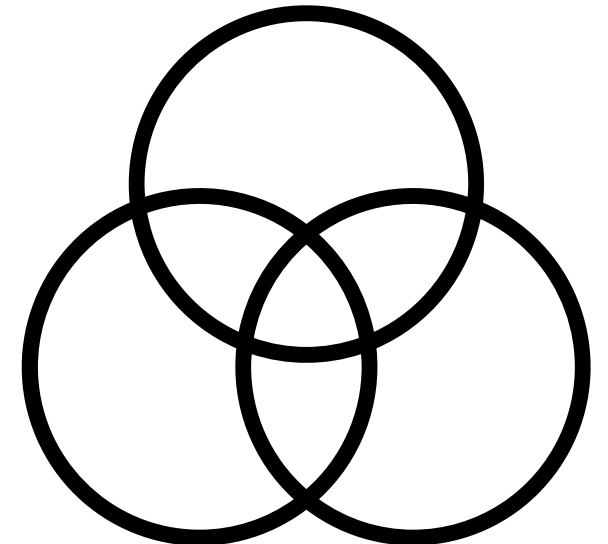
Readme in GitHub Repository
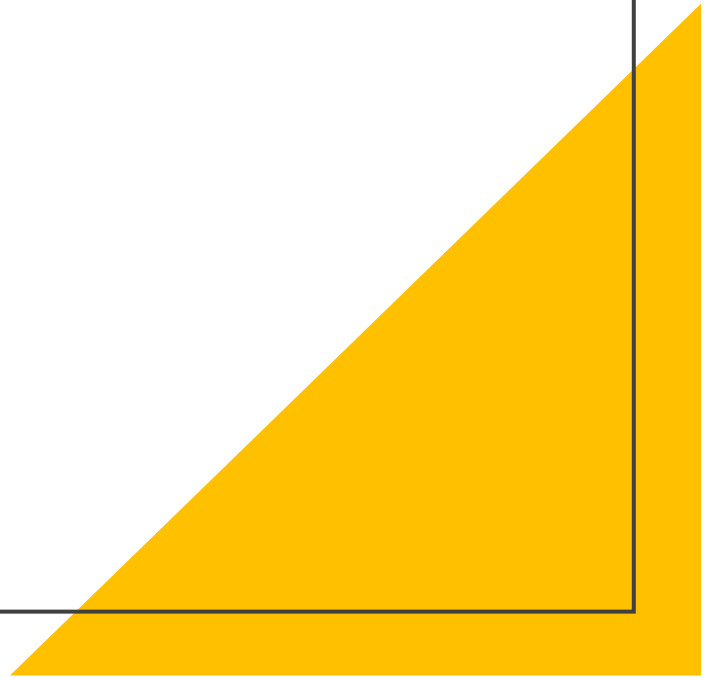
What is a README.md?

- A file for your repository front page
- Contains:
  - Information about your repository
  - Directory
  - Contribution
  - And more...

Preview vs Source code of the README.md file

Preview side:

Table of Contents

Background of Path Planning to Aviation Engineering

"Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum."

Records (y-axis): 8k, 7k, 6k, 5k, 4k, 3k, 2k, 1k, 0
Age Group (x-axis): <18, 18-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80+

"At vero eos et accusamus et iusto odio dignissimos ducimus qui blanditiis praesentium voluptatum deleniti atque corrupti quos dolores et quas molestias excepturi sint occaecati cupiditate non provident, similique sunt in culpa qui officia deserunt mollitia animi, id est laborum et dolorum fuga. Et harum quidem rerum facilis est et expedita distinctio. Nam libero tempore, cum soluta nobis est eligendi optio cumque nihil impedit quo minus id quod maxime placeat facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum hic tenetur a sapiente delectus, ut aut reiciendis voluptatibus maiores alias consequatur aut perferendis doloribus asperiores repellat."

Preview

Source side:

```
1   <!-- TABLE OF CONTENTS -->
2   <details open="open">
3     <summary><h2 style="display: inline-block">Table of Contents</h2></summary>
4       <li><a href="#Background-of-Path-Planning-to-Aviation-Engineering">Background of Path Planning to Aviation Engineering</a></li>
5       <li><a href="#Theory-of-Path-Planning-Algorithm">Theory of Path Planning Algorithm</a></li>
6       <li><a href="#Introduction-of-the-Engineering-Tools ">Introduction of the Engineering Tools </a></li>
7     </ol>
8   </details>
9
10
11
12  <!-- ABOUT THE PROJECT -->
13  # Background of Path Planning to Aviation Engineering
14
15  "Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum."
16
17  ![This is an image](https://www.researchgate.net/profile/Jan-Bieser/publication/333867743/figure/fig2/AS:771428257374208@1560934237674/Bar-chart-showing-the-number-of-observations-value-attribute-for-each-age-group-key.png)
18
19  "At vero eos et accusamus et iusto odio dignissimos ducimus qui blanditiis praesentium voluptatum deleniti atque corrupti quos dolores et quas molestias excepturi sint occaecati cupiditate non provident, similique sunt in culpa qui officia deserunt mollitia animi, id est laborum et dolorum fuga. Et harum quidem rerum facilis est et expedita distinctio. Nam libero tempore, cum soluta nobis est eligendi optio cumque nihil impedit quo minus id quod maxime placeat facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum hic tenetur a sapiente delectus, ut aut reiciendis voluptatibus maiores alias consequatur aut perferendis doloribus asperiores repellat."
20
21  "On the other hand, we denounce with righteous indignation and dislike men who are so beguiled and demoralized by the charms of pleasure of the moment, so blinded by desire, that they cannot foresee the pain and trouble that are bound to ensue; and equal blame belongs to those who fail in their duty through weakness of will, which is the same as saying through shrinking from toil and pain. These cases are perfectly simple and easy to distinguish. In a free hour, when our power of choice is untrammelled and when nothing prevents our being able to do what we like best, every pleasure is to be welcomed and every pain avoided. But in certain circumstances and owing to the claims of duty or the obligations of business it will frequently occur that pleasures have to be repudiated and annoyances accepted. The wise man therefore always holds in these matters to this principle of selection: he rejects pleasures to secure other greater pleasures, or else he endures pains to avoid worse pains."
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```
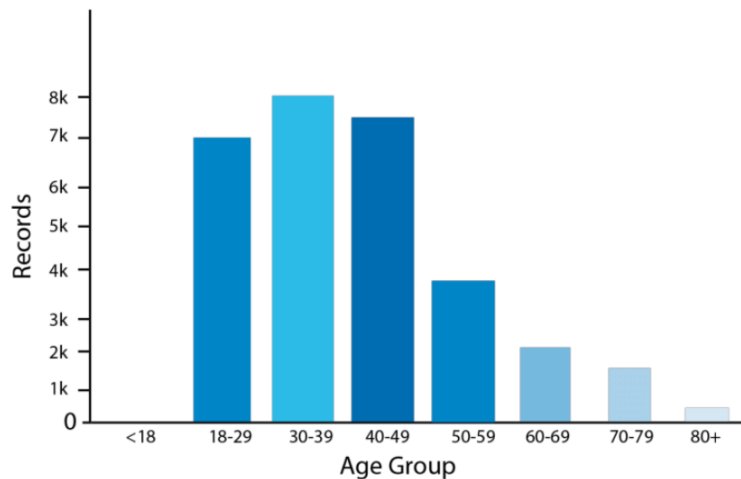
Source Code

How to create a README.md

- You can create a README before or after your create your repository

Basic Features

1. Basic text, titles and subtitles
2. Table of contents
3. Inserting figures / photos

Basic text, titles and subtitles

- To create <u>normal texts</u>, simply type them in to the source code
- To create a <u>main title</u>, add a '#' at the beginning
  - *# This is the Main Title*
  - *##### More # makes smaller titles*

Background of Path Planning to Aviation Engineering

Smaller Title

Even smaller title

```
# Background of Path Planning to Aviation Engineering
### Smaller Title
##### Even smaller title
```

Table of Contents

- You need to have titles before creating a table of Contents
- Format of a table of contents
- Everything like fonts, text sizes and more can be altered!

```html
<!-- TABLE OF CONTENTS -->
<details open="open">
  <summary><h2 style="display: inline-block">Table of Contents</h2></summary>
    <li><a href="#Background-of-Path-Planning-to-Aviation-Engineering">Background of Path Planning to Aviation Engineering</a></li>
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    <li><a href="#Introduction-of-the-Engineering-Tools ">Introduction of the Engineering Tools </a></li>
  </ol>
</details>
```

Text to be shown

Titles to be directed to

Inserting Figures / photos

- You need to provide a link of the photo for this to work
- For screenshots you make, you can upload them to your repository and do the same thing by copying the image address!
- Example:

`![This is an image](https://www.researchgate.net/profile/Jan-Bieser/publication/333867743/figure/fig2/AS:771428257374208@1560934237674/Bar-chart-showing-the-number-of-observations-value-attribute-for-each-age-group-key.png)`

Message shown when picture cannot load

You can get the link for a photo by right clicking on it and select 'Copy link address'

Open image in new tab
Save image as...
Copy image
Copy image address
Create QR Code for this image
Search Google for image

Inspect

Full Example

Table of Contents

- Background of Path Planning to Aviation Engineering
- Theory of Path Planning Algorithm
- Introduction of the Engineering Tools

Background of Path Planning to Aviation Engineering

"Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum."

"At vero eos et accusamus et iusto odio dignissimos ducimus qui blanditiis praesentium voluptatum deleniti atque corrupti quos dolores et quas molestias excepturi sint occaecati cupiditate non provident, similique sunt in culpa qui officia deserunt mollitia animi, id est laborum et dolorum fuga. Et harum quidem rerum facilis est et expedita distinctio. Nam libero tempore, cum soluta nobis est eligendi optio cumque nihil impedit quo minus id quod maxime placeat facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum hic tenetur a sapiente delectus, ut aut reiciendis voluptatibus maiores alias consequatur aut perferendis doloribus asperiores repellat."

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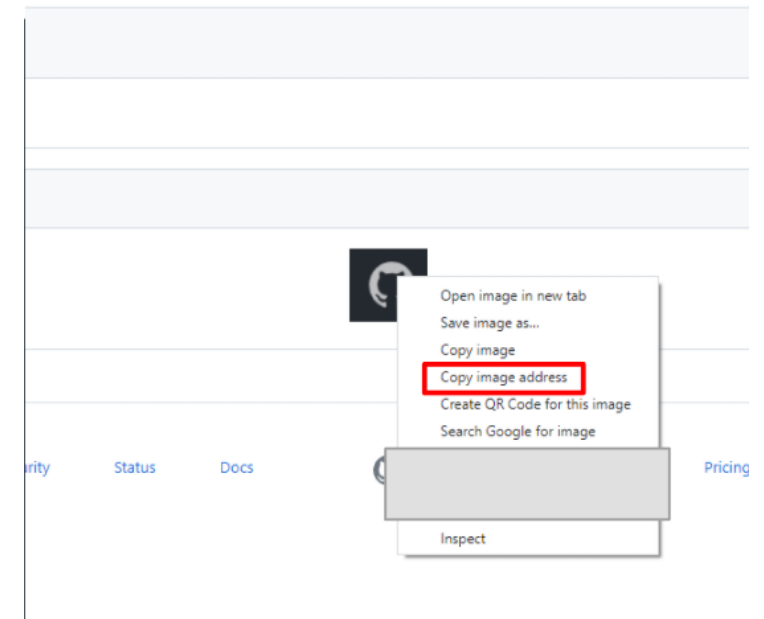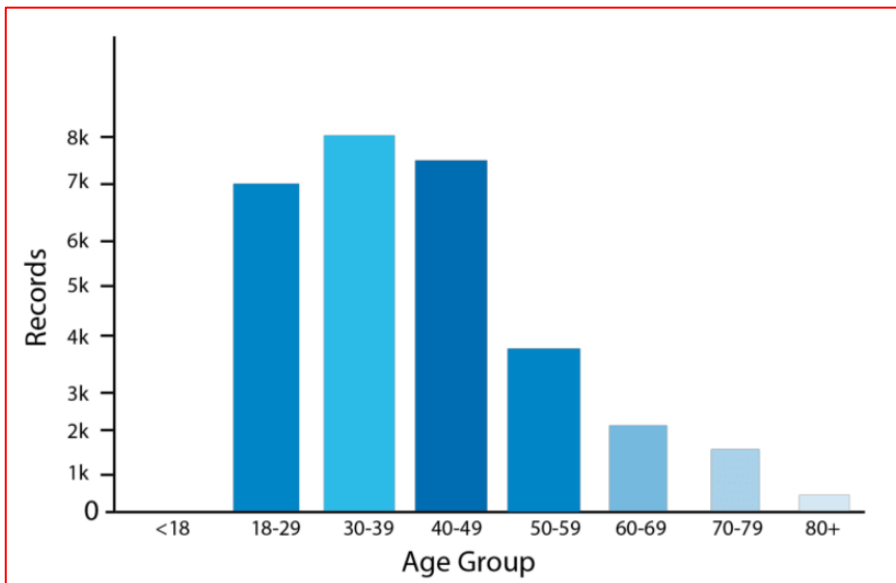
- Just like writing an HTML page
- Different formatting syntax creates corresponding visual formatting for the README page

Your README.md Report

- You are <u>required</u> to include the basic features mentioned in this PPT
  - Table of content, image, titling
- For bonus marks:
  - Search for more features on the web and include them appropriately to your README file!
  - What to add?
    - A gif showing your path planning plot
    - Other potential materials you find useful
- Useful links:
  - [GitHub official tutorial](#)