

# ENG1003 Freshman Seminar for Engineering AAE

## Design of Path Planning Algorithm for Aircraft Operation

### Week 4: Additional Cost Area

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# Flight planning considering trip cost

The fundamental rationale of the cost index concept is to achieve minimum **trip cost** by means of a trade-off between **operating costs per hour** and **incremental fuel burn**.

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

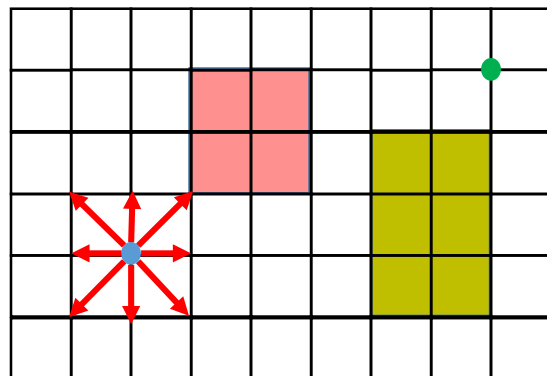
With

- $C_F$ =cost of fuel per kg
- $C_T$ =time related cost per minute of flight
- $C_c$ =fixed cost independent of time
- $C_T$ =time related cost per minute of flight
- $\Delta F$ =trip fuel (e.g. 3000kg/h)
- $\Delta T$ =trip Time (e.g. 8 hours from Hong Kong to Paris)

Can we consider this cost to our path planning to imitate the path planning for flights?



# Flight planning considering trip cost



● Start node

● Goal node



Fuel-consuming area: the volume of fuel consumption is twice larger than other area due to unstable airflow. (additional cost  $\Delta F_a$ )



Time-consuming area: the flying speed is limited due to the air traffic control. (additional cost  $\Delta T_a$ )

Cost can be calculated using the following formula:

$$f(x, y) = g(x, y) + h(x, y)$$

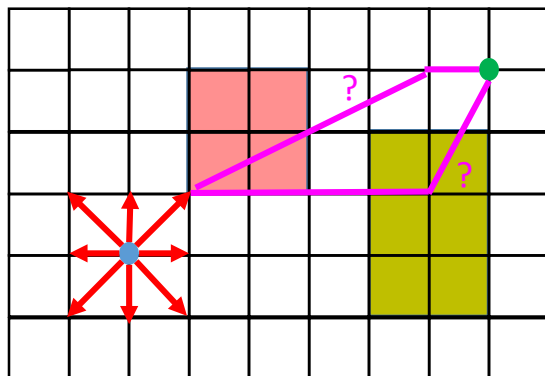
One white grid with cost as follows for  $g(x, y)$  &  $h(x, y)$ :

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

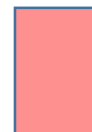
One colored grid with cost as follows for  $g(x, y)$  &  $h(x, y)$ :

$$C = C_F \cdot (\Delta F + \Delta F_a(x, y)) + C_T \cdot (\Delta T + \Delta T_a(x, y)) + C_c$$

# How we choose the routes ?



Fuel-consuming area: the volume of fuel consumption is twice larger than other area due to unstable airflow. (additional cost  $\Delta F_a$ )



Time-consuming area: the flying speed is limited due to the air traffic control. (additional cost  $\Delta T_a$ )

Cost can be calculated using the following formula:

$$f(x, y) = g(x, y) + h(x, y)$$

One white grid with cost as follows for  $g(x, y)$  &  $h(x, y)$ :

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

One colored grid with cost as follows for  $g(x, y)$  &  $h(x, y)$ :

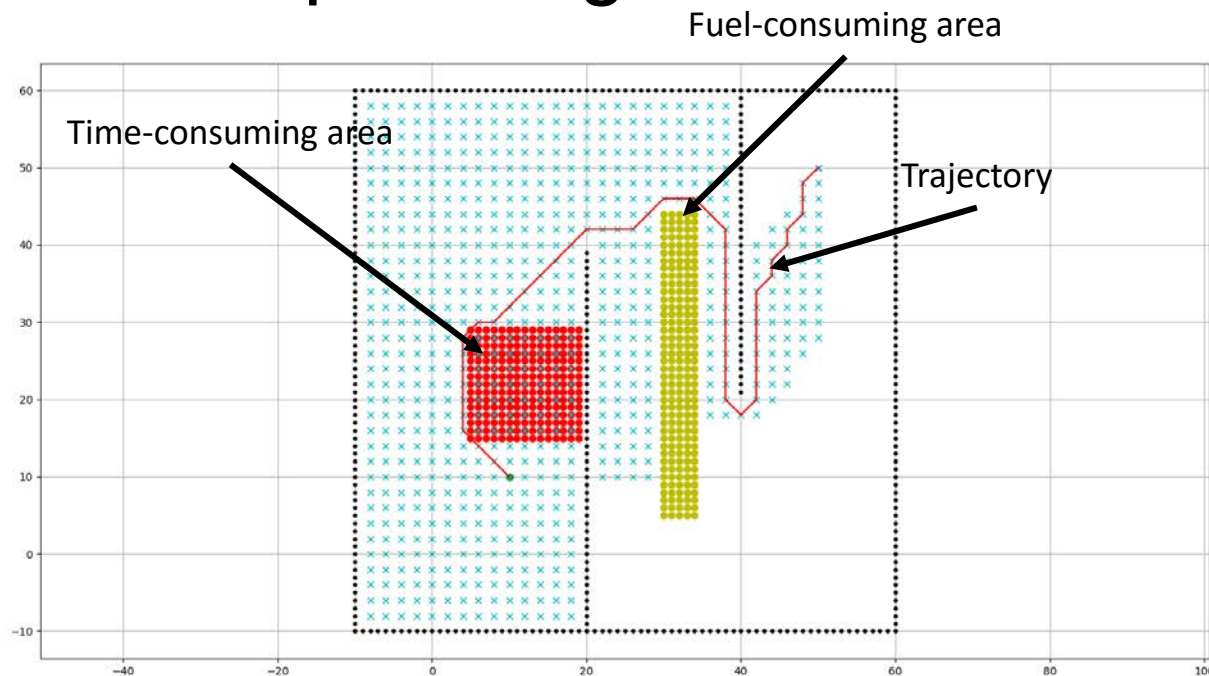
$$C = C_F \cdot (\Delta F + \Delta F_a(x, y)) + C_T \cdot (\Delta T + \Delta T_a(x, y)) + C_c$$

● Start node

● Goal node

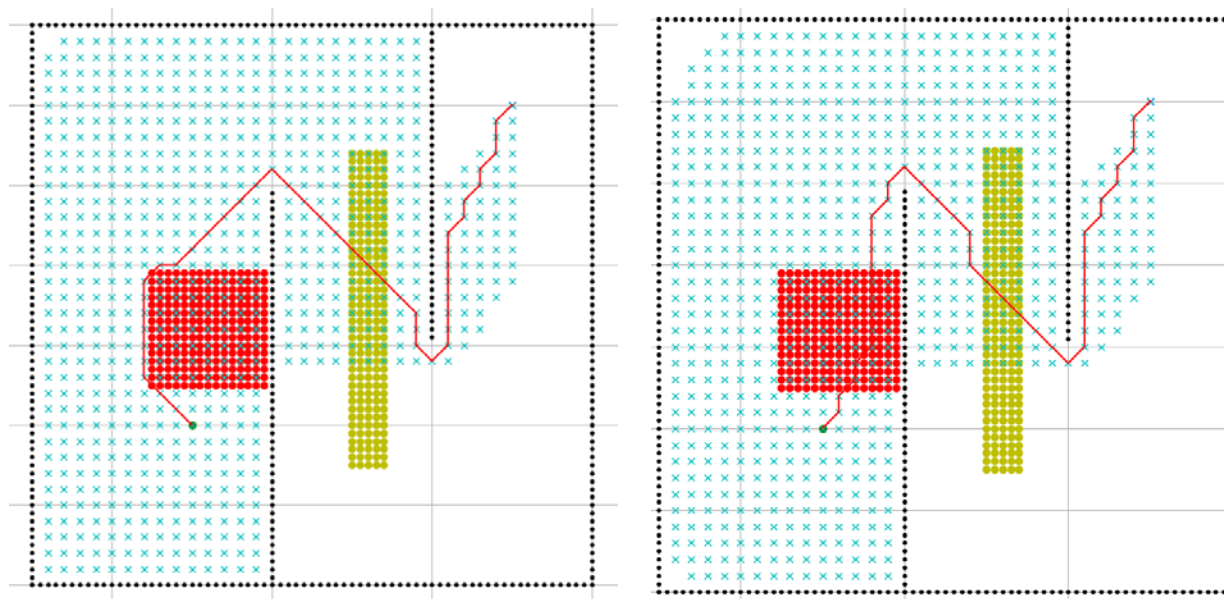
It depends on the  
 $\Delta F_a$  and  $\Delta T_a$

# Example route planning



Avoiding the Fuel-consuming and time-consuming area if their cost is too high?

# Example route planning



Go through the fuel-consuming and time-consuming area if their additional cost is quite small?

# Design your route

Aircraft Model	$C_F$	$\Delta F$	$C_T$	$\Delta T$	$C_c$	$\Delta F_a$	$\Delta T_a$
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

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

With

- $C_F$ =cost of fuel per kg
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