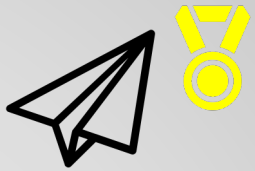
Aircraft Design Project
Urban Air Mobility (UAM)

Week 3
01/11 – 05/11

Instituto Superior Técnico
Universidade de Lisboa

Rotorcraft sizing
Mission profile





You have now selected the best design, so let's move on to the first MTOW estimation!

- Propose a mission profile using the different segments taught in class;
- Be descriptive about altitudes, range, speeds, total mission time, starting and ending points (e.g. Victoria - Vancouver) and energy sources.
- Propose multiple missions in case you feel undecided, or if you would like to work on multiple missions simultaneously!

Rotorcraft sizing
Mission profile

Example:

1. Vertical Climb
R/C, h = ?
Energy = Batteries

2. Climb
R/C, Climb angle, h = ?
Energy = Fuel

3. Cruise
V, R = ?
Energy = Fuel

4. Vertical Descent
R/D, h = ?
Energy = Batteries

5. Passenger drop

6. Vertical Climb
R/C, h = ?
Energy = Batteries

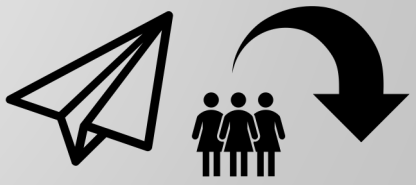
7. Cruise
V, R = ?
Energy = Fuel

8. Vertical Descent
R/D, h = ?
Energy = Batteries

Victoria, BC

Nanaimo, BC

Vancouver, BC



Rotorcraft sizing
MTOW estimation

$$W_{T0} = \frac{W_{Payload}}{1 - (MF_{Struct} + MF_{Subs} + MF_{Prop} + MF_{Energy})}$$

You're now asked to provide input to the project.json file based on:

- Historical trends;
- Trends from your market research;
- Known payloads.

Values were randomly assigned to some of the variables!
Therefore, make corrections whenever needed according to your project specifications!

Be consistent with the system of units you're using!

Every assumption made must be well-justified!

Rotorcraft sizing
MTOW estimation

This is how the json file is structured:

```
"concept": { # AHP
},
"mission": { # contains information of your mission profile
    "segments": [
        {# information of segment 1
        },
        {# information of segment 2
        },
        ...
        {# information of segment n
        },
    ]
},
"vehicle": { # contains information of the vehicle components
    "components": [
        {# information of component 1
        },
        {# information of component 2
        },
        ...
        {# information of component n
        },
    ]
},
"energy": { # contains information of your powerplant(s)
    "networks": [
        {# information of network 1
        },
        {# information of network 2
        },
        ...
        {# information of network n
        },
    ]
}
```

```
{
    "name": "Fuselage",
    "type": "fuselage",
    "interf_factor": 1.0,
    "diameter": 1.0,
    "length": 4.0,
    "mass": 800
},
```

```
{
    "name": "Main Wing",
    "type": "wing.main",
    "interf_factor": 1.0,
    "aspect_ratio": 7.0,
    "mean_chord": 3.0,
    "oswald_efficiency": 0.85,
    "airfoil": {
        "type": "naca0012",
        "tc_max": 0.15,
        "xc_max": 0.3,
        "lift_slope_coefficient": 6.2,
        "cl_max": 2.0
    },
    "sweep_le": 10.0,
    "sweep_c4": 15.0,
    "sweep_tc_max": 20.0,
    "mass": 200
},
```

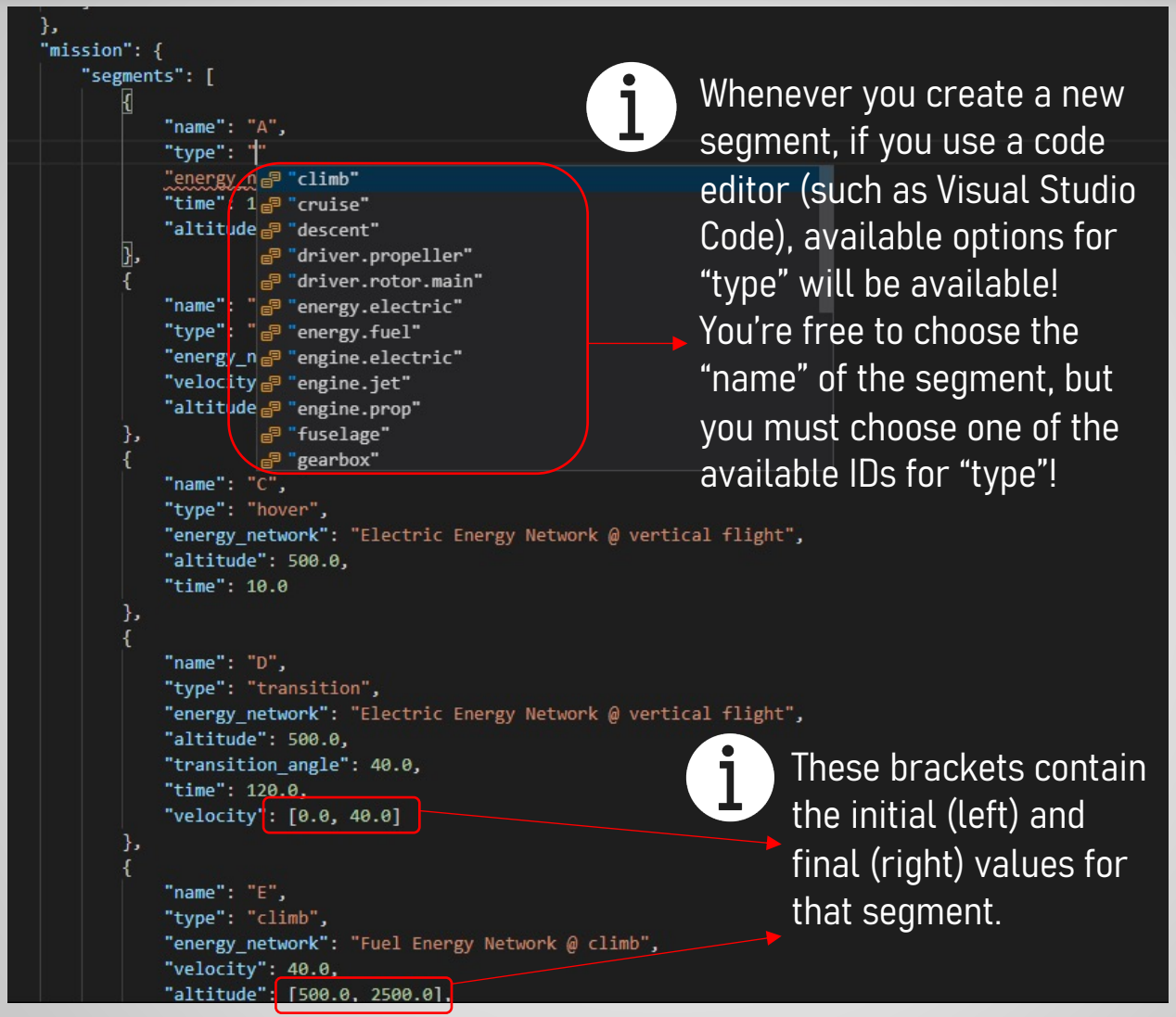
```
{
    "name": "Horizontal Tail",
    "type": "wing.htail",
    "interf_factor": 1.0,
    "aspect_ratio": 5.0,
    "mean_chord": 0.5,
    "oswald_efficiency": 0.85,
    "airfoil": {
        "type": "naca0012",
        "tc_max": 0.15,
        "xc_max": 0.3,
        "lift_slope_coefficient": 6.2,
        "cl_max": 2.0
    },
    "sweep_le": 10.0,
    "sweep_c4": 15.0,
    "sweep_tc_max": 20.0,
    "mass": 50
},
```

```
{
    "name": "Vertical Tail",
    "type": "wing.vtail",
    "interf_factor": 1.0,
    "aspect_ratio": 5.0,
    "mean_chord": 1.0,
    "oswald_efficiency": 0.85,
    "airfoil": {
        "type": "naca0012",
        "tc_max": 0.15,
        "xc_max": 0.3,
        "lift_slope_coefficient": 6.2,
        "cl_max": 2.0
    },
    "sweep_le": 10.0,
    "sweep_c4": 15.0,
    "sweep_tc_max": 20.0,
    "mass": 50
},
```

```
{
    "name": "Turboshaft",
    "type": "engine.prop",
    "efficiency": 0.8,
    "mass": 100,
    "max_power": 210000
},
```

- You will be modifying the last three sections
- You will find estimates for all variables except for the following:

Rotorcraft sizing
MTOW estimation



Whenever you create a new segment, if you use a code editor (such as Visual Studio Code), available options for “type” will be available! You’re free to choose the “name” of the segment, but you must choose one of the available IDs for “type”!

These brackets contain the initial (left) and final (right) values for that segment.

Rotorcraft sizing
MTOW estimation

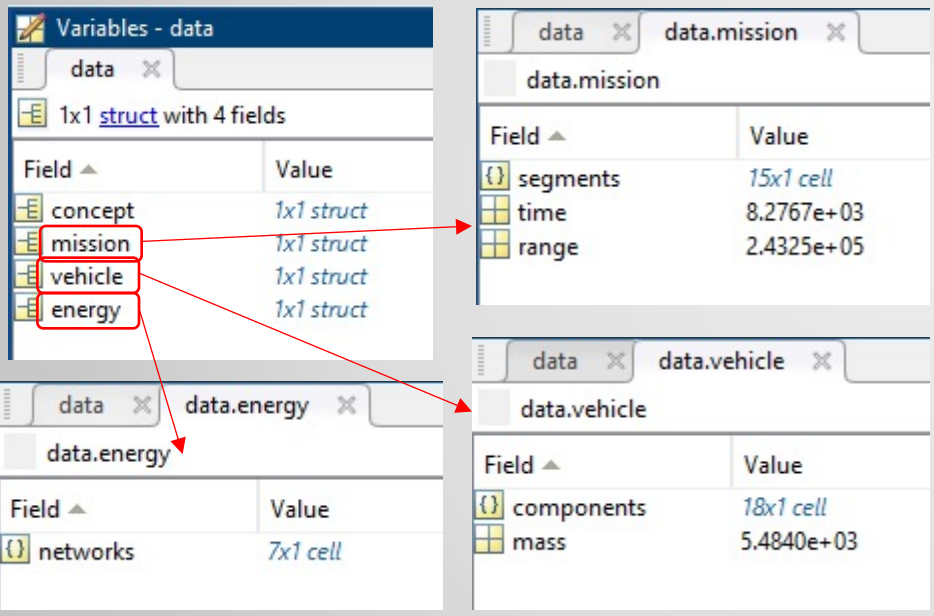
You will be running the functions:

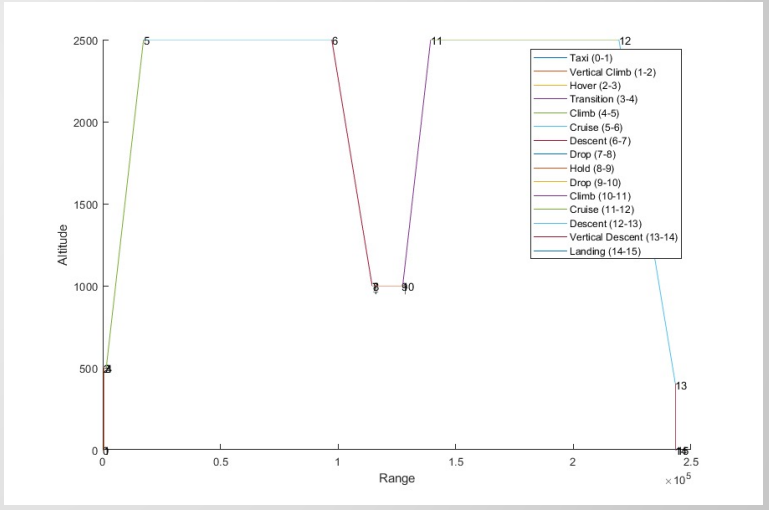
```
% Add missing mission segment and vehicle component parameters
data.mission = build_mission(data.mission);
data.vehicle = build_vehicle(data.mission, data.vehicle);

%% Plot mission profile
plot_mission(data.mission);

%% Mission analyses
[data.mission, data.vehicle] = mass_analysis(data.mission, data.vehicle, data.energy);
```

And the following output will be available in your workspace:





Rotorcraft sizing
Objectives/deliverables

This week's objectives are:

Define mission profile(s)

- Mission segments
- Segment parameters

Aircraft sizing

- Find estimates for variables in "mission", "vehicle" and "energy" sections of JSON file
- Compute MTOW

For next week's meeting:

Prepare Powerpoint presentation

Max: 5-10 min