



Commercial aircraft control using Deep reinforcement learning

AU332 project presentation

Group member:

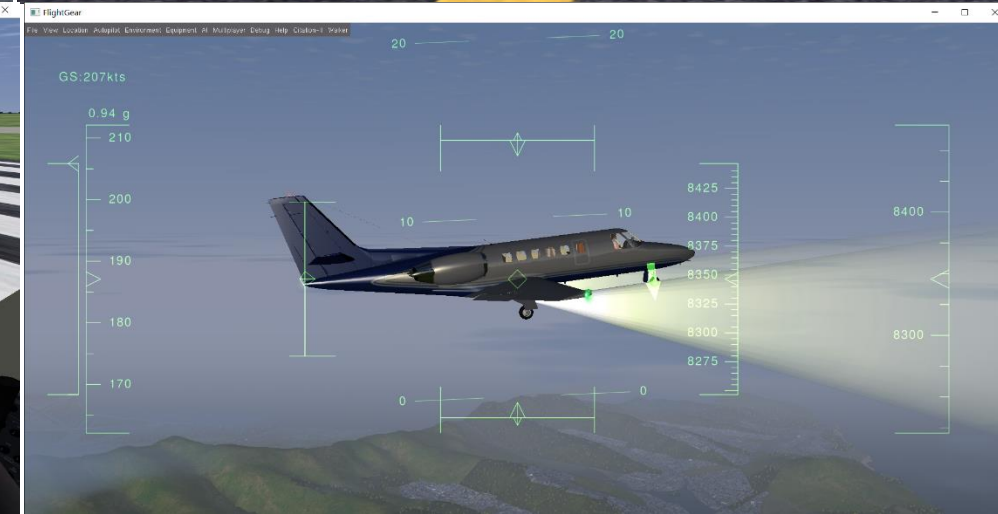
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Introduction to Flight Gear

01

Introduction to Flight Gear



How to get data?

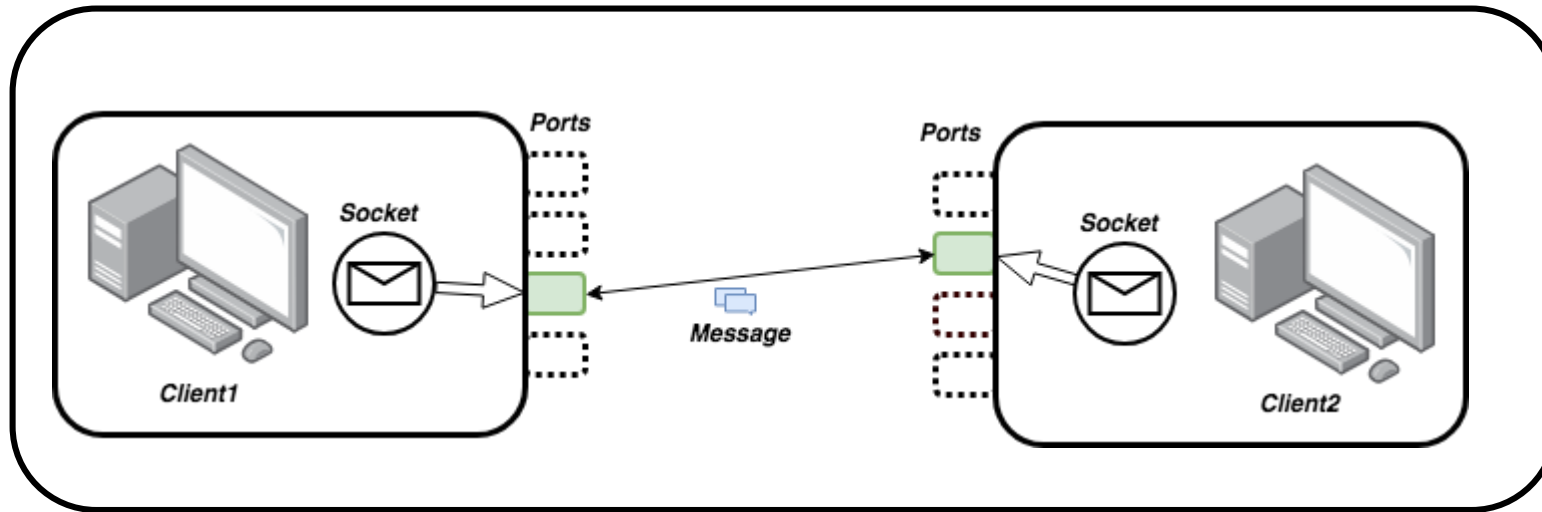
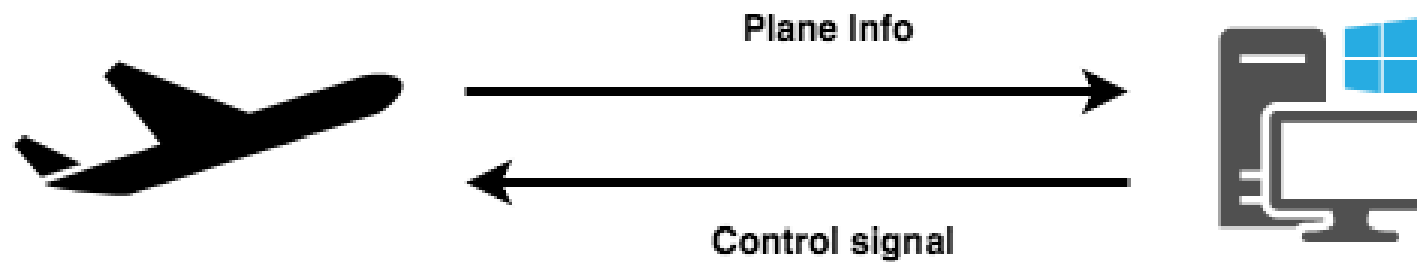


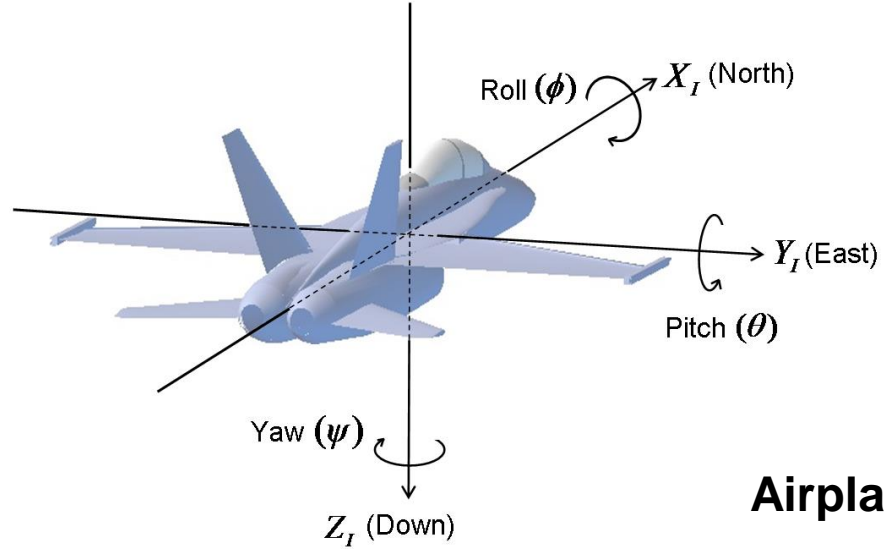
Fig: socket communication figure



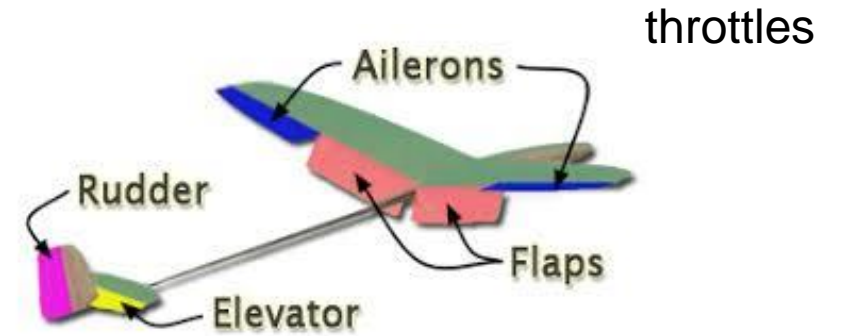


Problem formulation

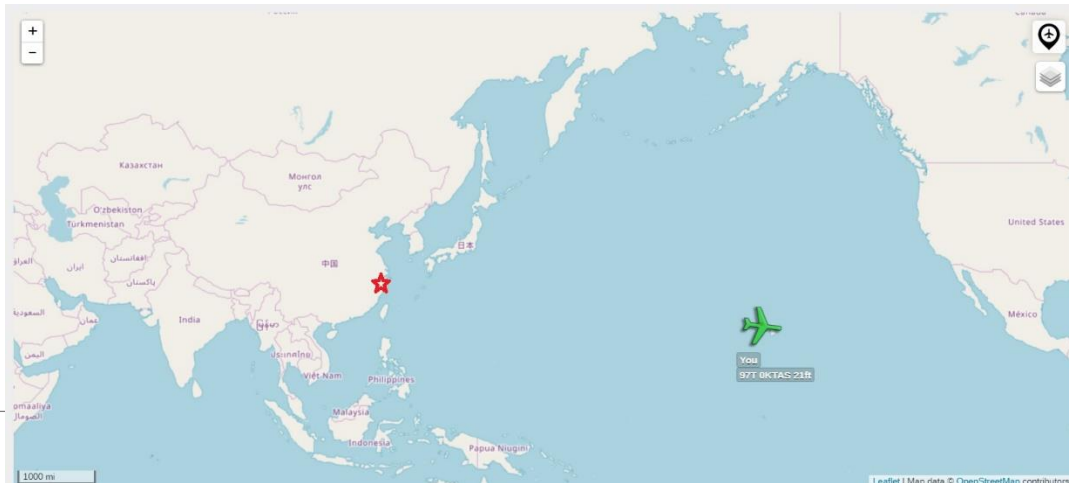
02



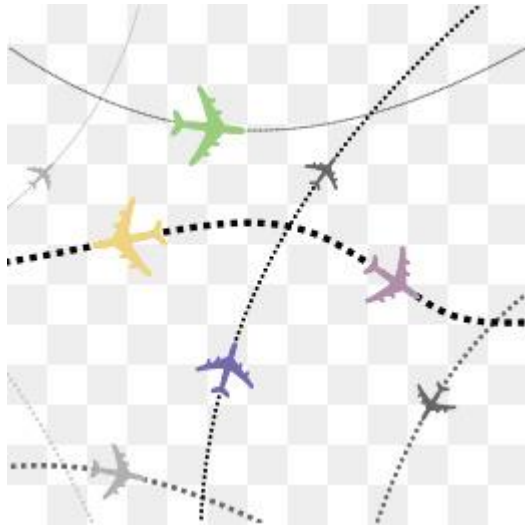
Airplane state



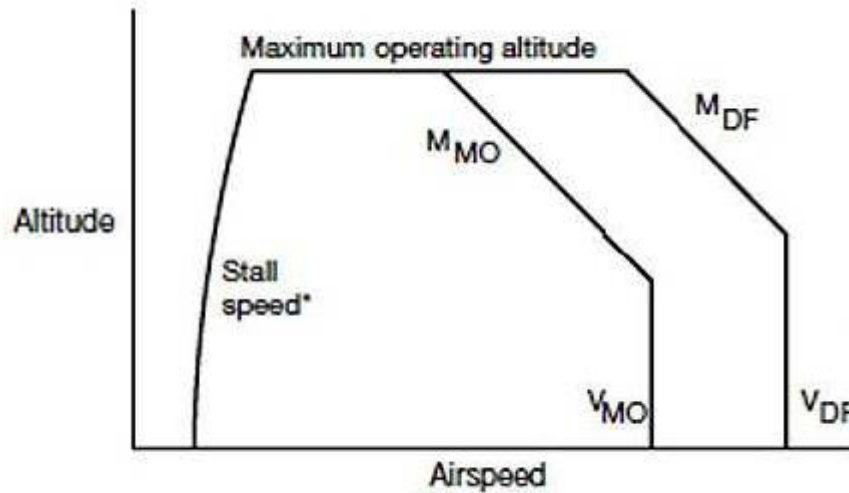
What do we need to control



Goal — flight route and safe flight



Altitude range
trajectory

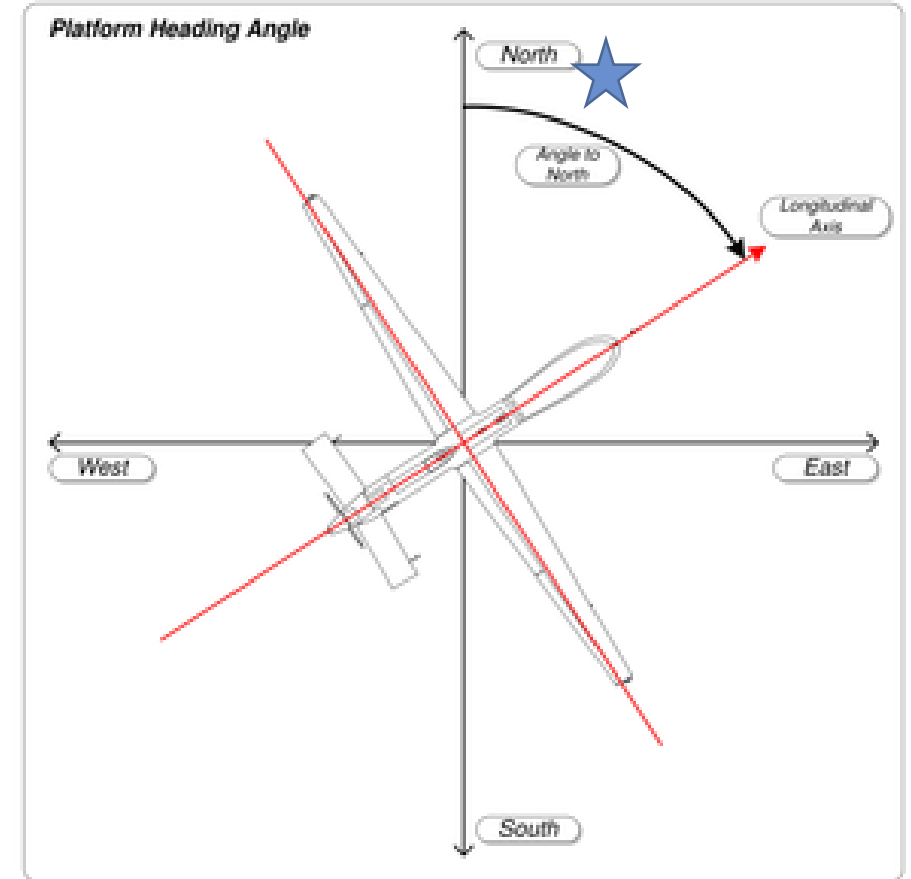


Flight envelop
altitude range
speed

How to represent a state given current information of plane and target, required range of altitude



Absolute position?



State (Altitude, dist_to_tar, head_offset, angles, vels, accelas_vels)

Reward

Different Stages:

Take-off

Flying stably

From dangerous states

.....



$$\begin{aligned} R_{alti} &= \omega_1 * |curr\ alti - alti\ range| \\ &\quad - \omega_2 * up_v_exceed \end{aligned}$$

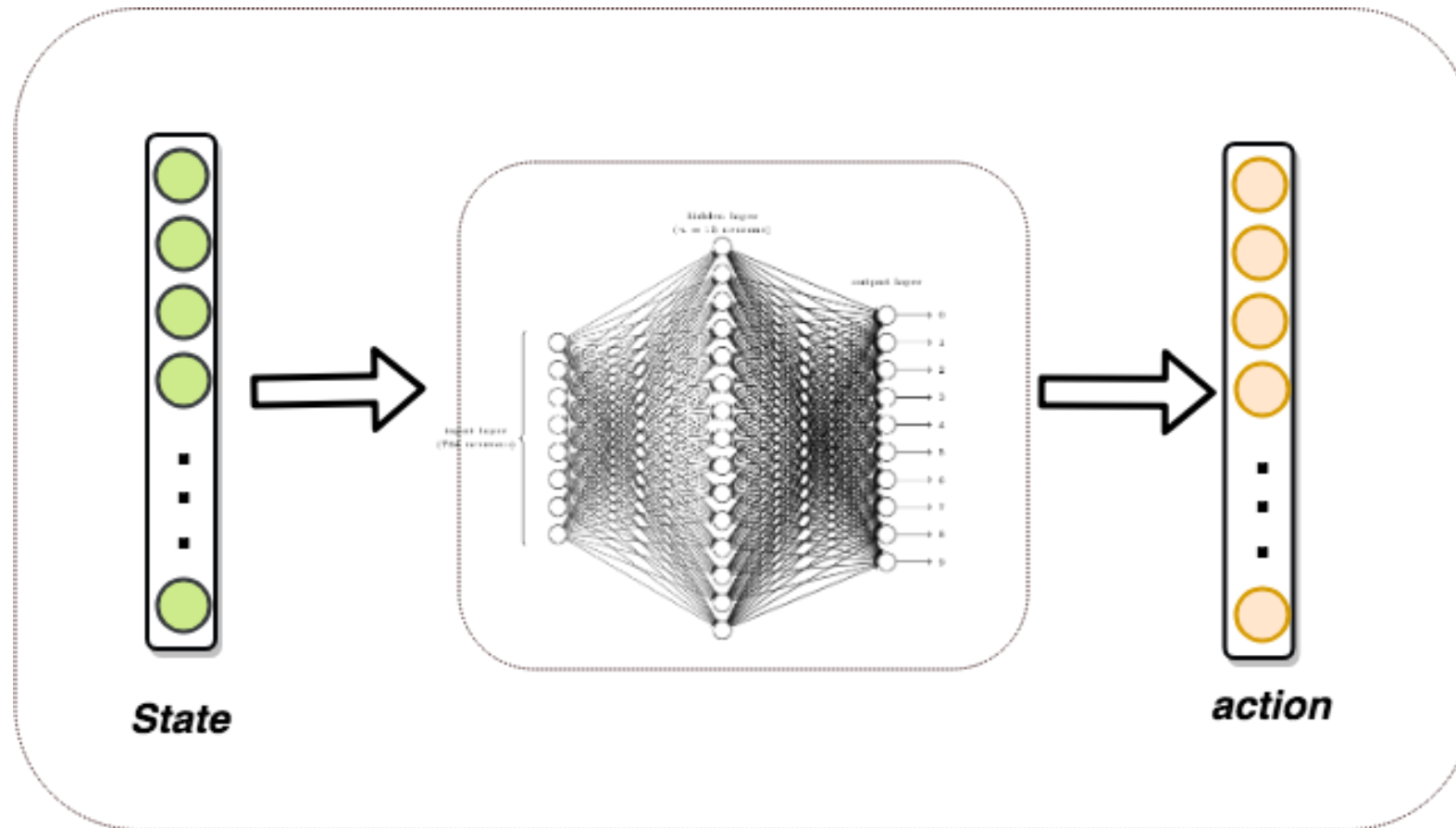
$$\begin{aligned} R_{dist} &= \omega_3 * dist \\ R_{heading} &= \omega_4 * |head_offset| \\ R_{stable} &= \omega_5 * |\Delta angle| + \omega_6 |\Delta vel| \end{aligned}$$

$$R_{danger} = -\omega_7 * e^{|exceed_speed|}$$

Combine them , will there be a problem ?

$$R = \dots + (if\ not\ in\ danger) * (R_{stable} + R_{dist} + R_{heading}) + \dots$$

State -> action





The model we tried

DQN & PPO2

03

DQN algorithm

Q learning

- Replace the Q-table with the neural network
- experience replay for repeated learning
- Q-target mechanism to disrupt correlation

DQN

Advantage of DQN:

- Suitable for high dimensional continuous state space situation
 - The state of the plane composite high dimensional continuous state space
- High data utilization for our project
 - The experience replay is used for repeated learning
 - Difficulty for data acquisition

DQN algorithm

Q learning

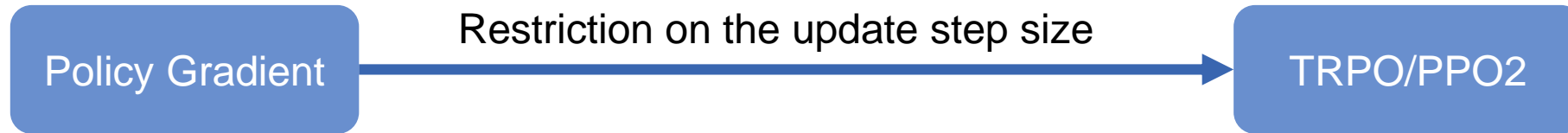
- Replace the Q-table with the neural network
- experience replay for repeated learning
- Q-target mechanism to disrupt correlation

DQN

Disadvantage of DQN:

- The action space must be low dimensional and discrete
 - The output action is discrete, i.e. we must discretize the action space
- Convergence is slow in our project
 - Discretization makes the action space too big, the convergence is too slow in our project.

PPO2(Proximal Policy Optimization) algorithm



Advantage of PPO2:

- Policy-based algorithm, suitable for high dimensional continuous state space & action space
 - The states and actions of the plane are continuous, and discretization is harmful to converge

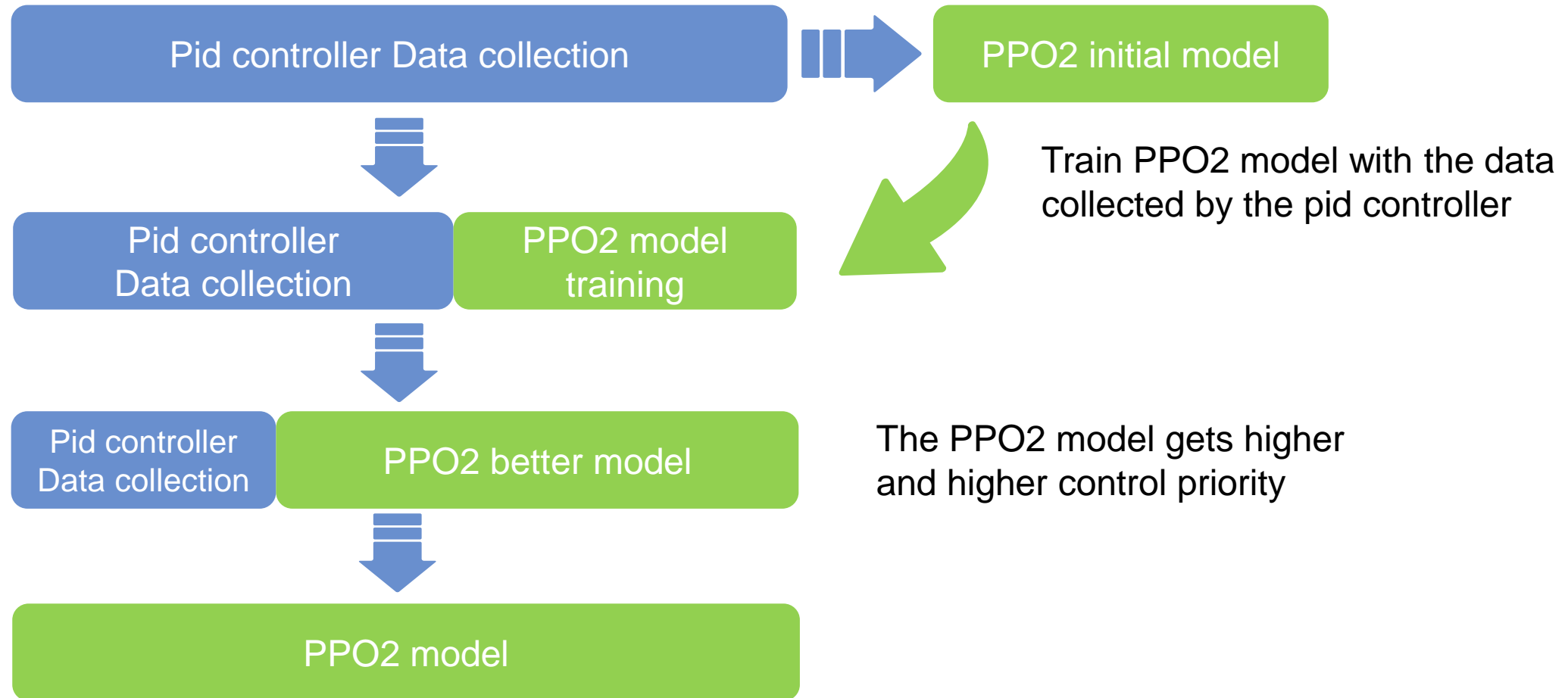


What we are doing

PPO2 + pid controller

04

What we are doing



What we are doing

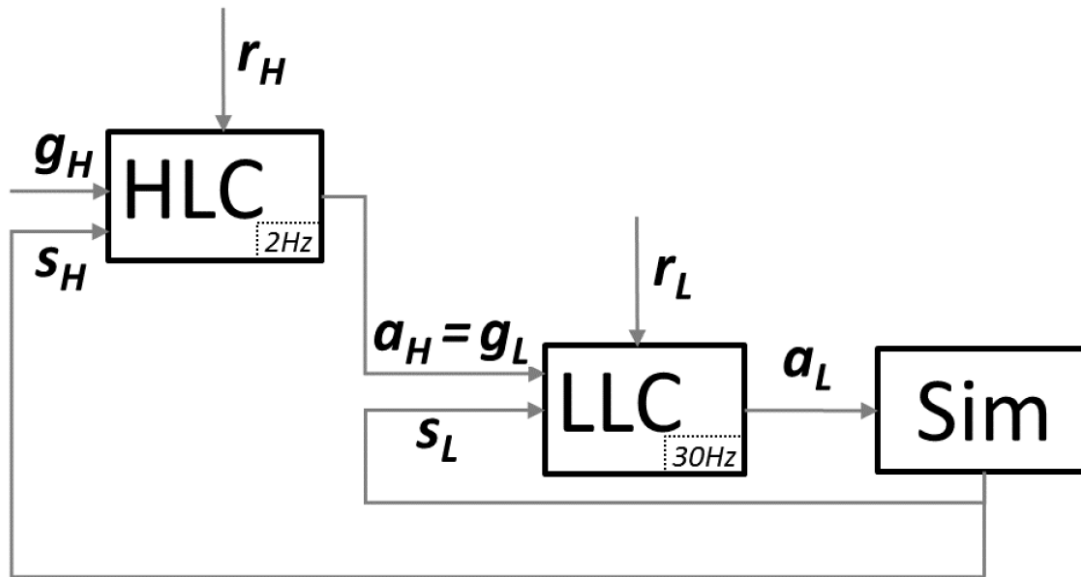


Fig: a two level controller architecture

- HLC: Flight path control
- LLC: Flight posture control



Challenge

Supporting text here.

When you copy & paste, choose "keep text only" option.

04

Data collection

Quality Diversity (perform randomly)

Website IRC Mailing lists Wiki Bug tracker Source Build server Aircraft Scenery Liveries

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Support All general support: help on flying, installation, hardware, getting online etc. There are lots of users and developers to help you out.	11476	80530	by wilbragg → Fri Dec 28, 2018 4:28 am

Imitation ?

S -> a -> s -> a ->... sampling frequency

Trajectory planning

Given a long journey, how to do local planning?

Not only algorithms

Redefine the state and reward

self restriction

Interaction with the software



Insight needs efforts

When training : Reset takes long time



Thank for your listening

2018/12/28
