# ECE 4960

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# Fast Robots

## Lab 10 (Flipped classroom)

# Lecture overview

- Please team up…
- Mid-semester feedback
  - Suggestions for improvements
- Lab 10 (Flipped classroom)
  - How many people have the simulator installed on their laptops?

## Course Midway Feedback

- 16 students (8 ugrad/8 M.Eng.)
  - Pretty positive (thank you!!)
  - Clarify how the material extends to industry
  - Expand on how the weekly lab is supposed to be done
  - More small group discussions
  - Support Windows 11….
  - 6/16 felt lectures are progressing too fast
  - 10/16 preferred more open-ended labs
  - Workload less sporadic
  - **Shorter assignments**

# Ideas for improvement?

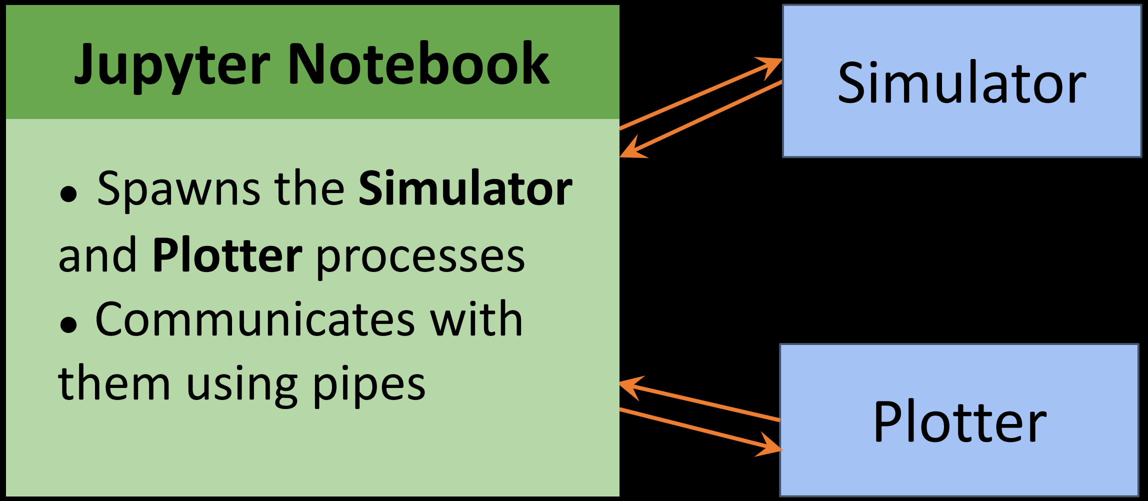
- What would you cut/edit?...
- Our ideas…
  - Lab 1-2 Artemis and Bluetooth
    - Add arrays/debugging scripts
  - Lab 3-4 - Sensors and car characterization
    - 7 new soldering stations
    - Split lab 3 into two weeks, and skip lab 4
    - Just one sensor?
    - Avoid some soldering
  - Lab 5 – Open loop
  - Lab 6 - PID
  - Lab 7 – Kalman Filters
    - Could give you the code and just have you tune the KF
  - Lab 8 – Stunts
  - Lab 9 - Mapping

*Also prelims…*

- Please consider teaming up…
  - Strengths / weaknesses
  - Time commitment
  - Weekly availability

# Lab 10 – Simulation Software

- Multiple processes
  - Simulator
    - Robot
      - Motion
      - Ground truth
    - YAML (map and other parameters)
  - Plotter
  - Controller
    - Get odometry pose, get and plot sensor data, move the robot, etc.




- *Why do we bother with the simulator?*
  - Helpful for debugging the Bayes Filter
  - Helpful for evaluating implication of accuracy
  - Can be used to also debug the real robot

# Lab 10 - Simulation

## Commander

Functions to interact with the simulator and the plotter

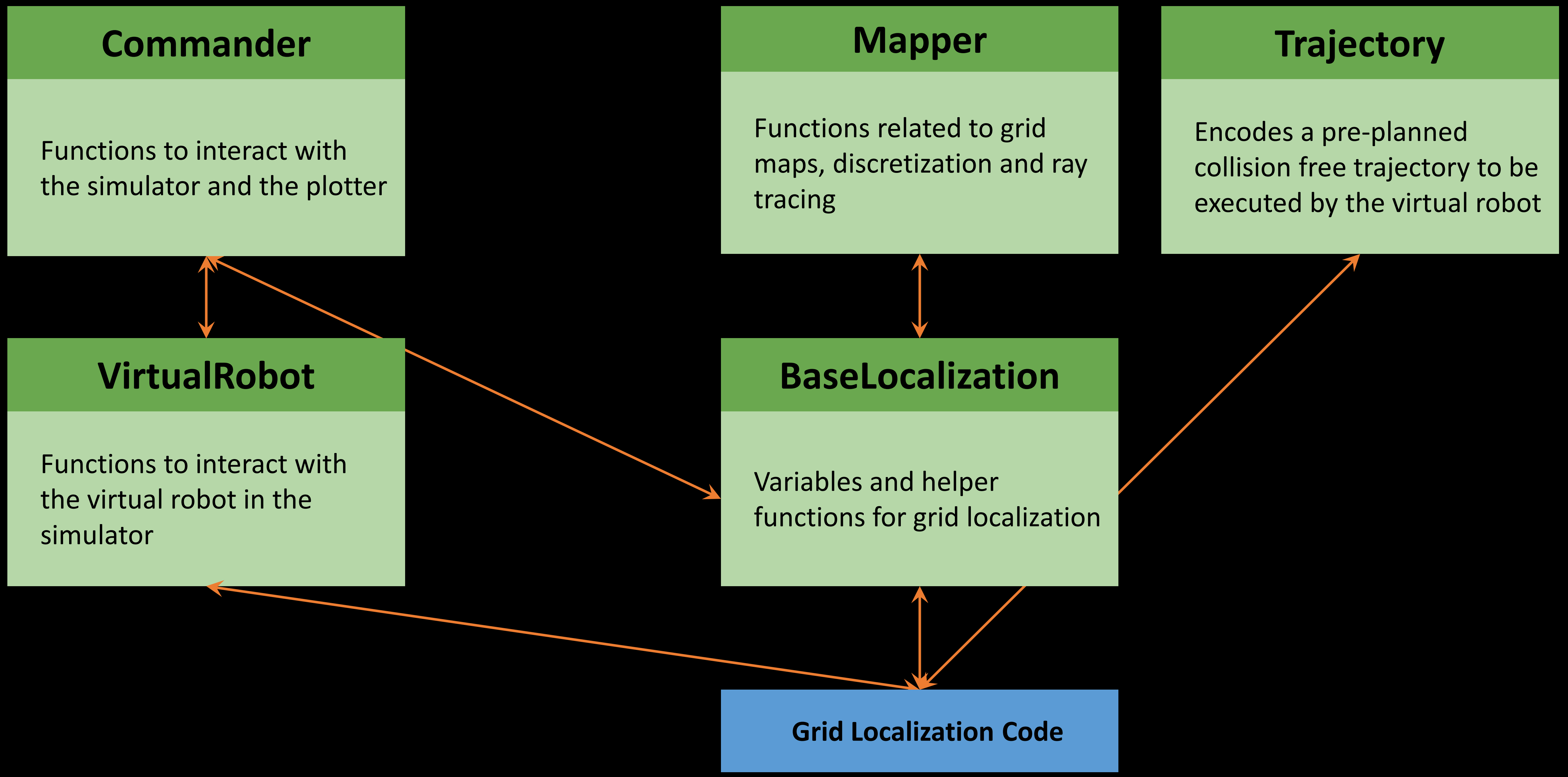
## VirtualRobot

Functions to interact with the virtual robot in the simulator

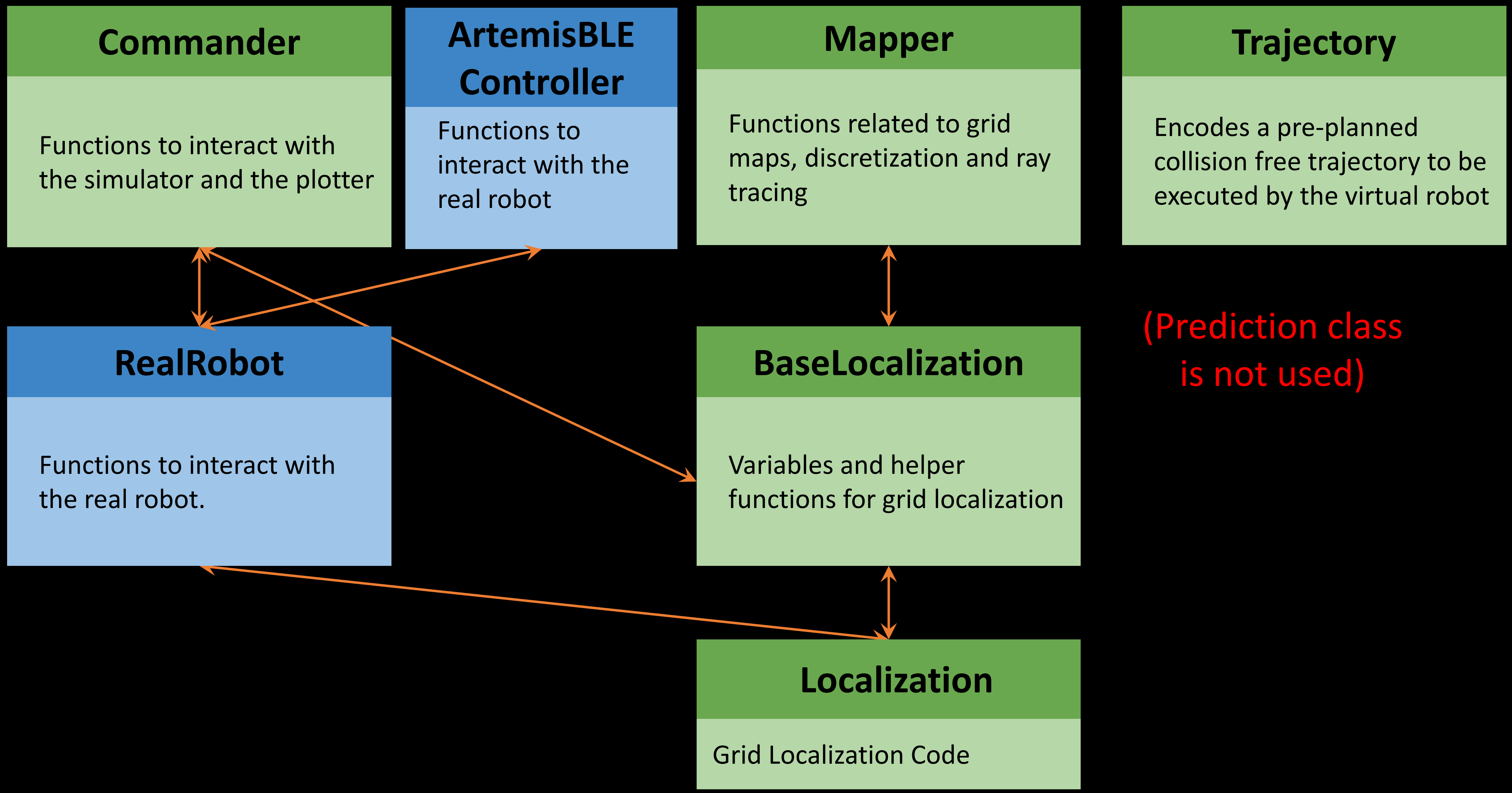
## Mapper

Functions related to grid maps, discretization and ray tracing

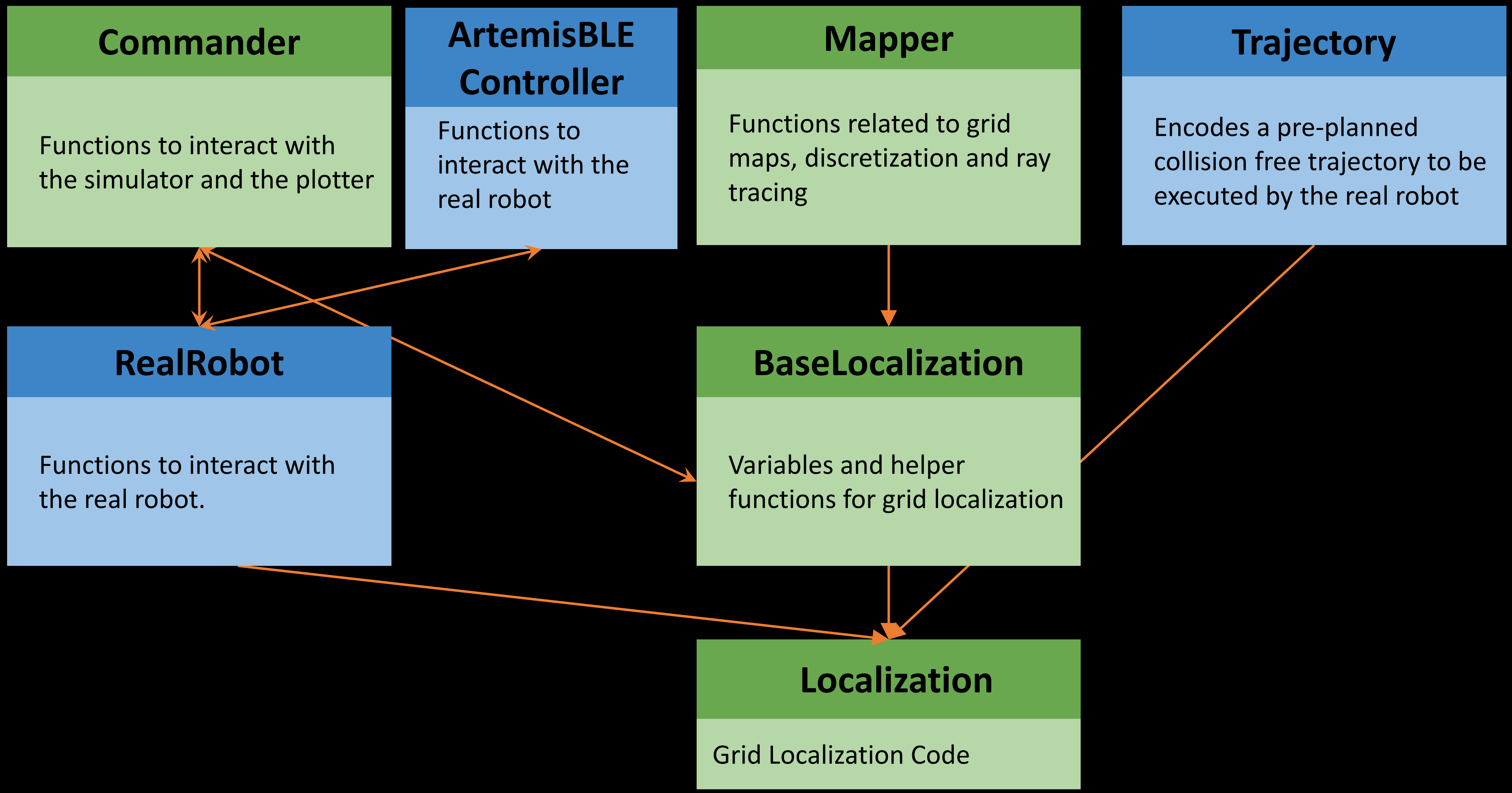
# Lab 11 - Localization on the virtual robot



# Lab 12 - Pure localization on the virtual robot



# Lab 13 - Localization and planning on the virtual robot



# Lab 10 – Workflow

- Prelab
  - Upgrade to Python 3.10 (if you haven't already)
    - …Reinstall the packages from Lab 2
  - Install dependencies
  - Install Box2D
  - Simulation base code

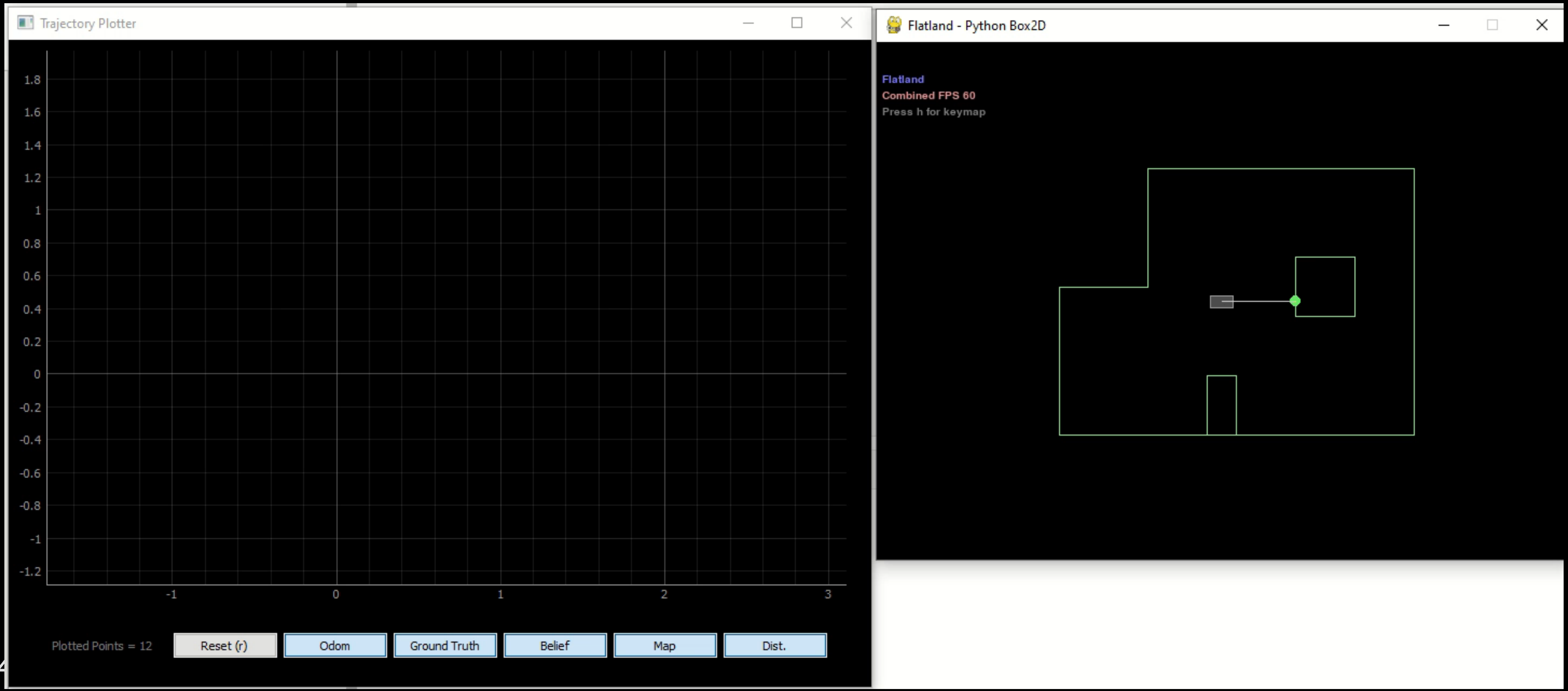
# Lab 10 – Workflow

- **Task 1: Control and plotting**
  - Keyboard control of robot
    - H brings up a key-map in the plotter
  - Programmatically control your robot and visualize the trajectory in the plotter

# Lab 10 – Workflow

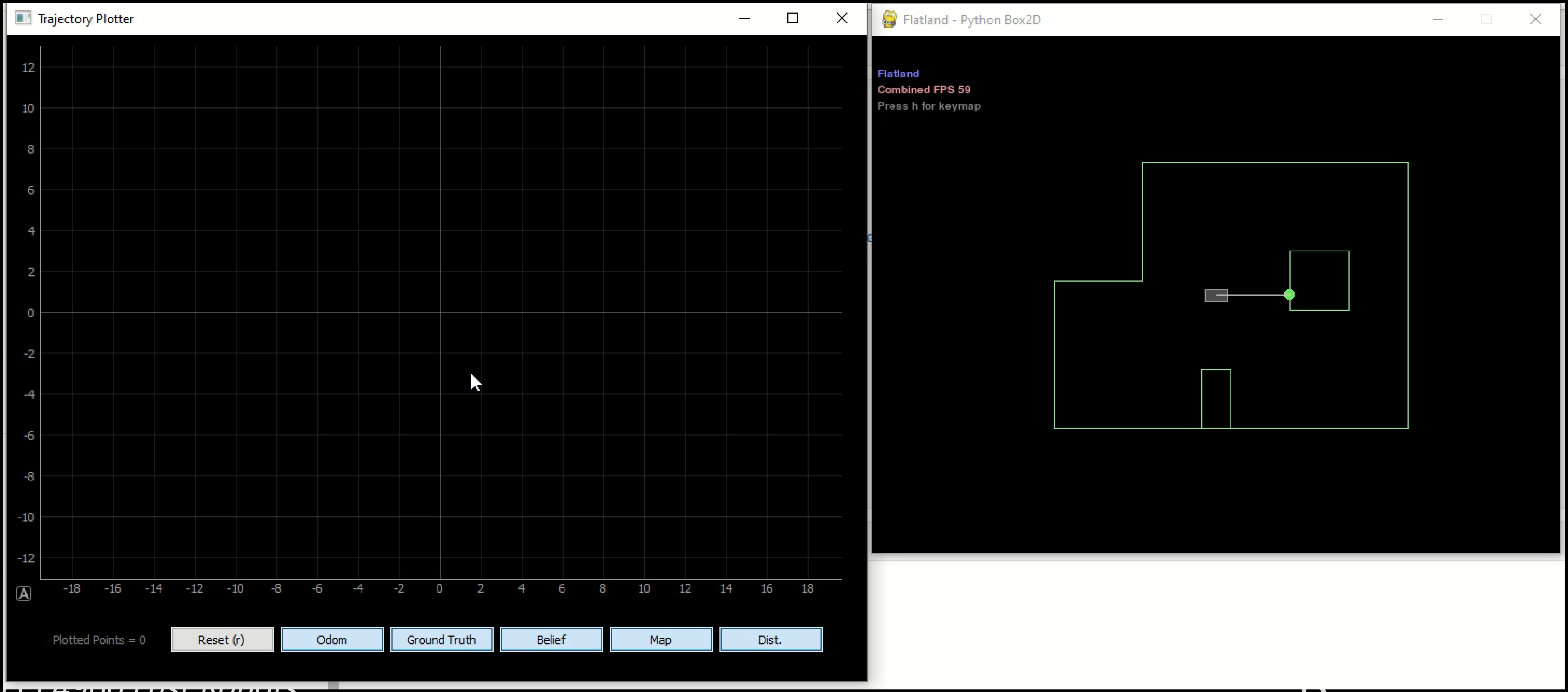
- **Task 2: Open loop control**
  - Make your robot drive in a square loop
    - Compare ground truth and odometry
    - Compare across computers (print ground truth)

- Why do think solutions differ across computers?
  - System’s load, specs, rounding, etc.



# Lab 10 – Workflow

- **Task 3: Closed loop control and obstacle avoidance**
  - *Design a simple controller in Jupyter to avoid obstacles*
    - Suggestions?



# Lab 10 – Workflow

- **Task 3: Closed loop control and obstacle avoidance**
  - *Design a simple controller in Jupyter to avoid obstacles*
    - Suggestions?

- Consider…
  - Turn size and forward speed
  - How close can the virtual robot get to an obstacle without colliding?
  - Does your obstacle avoidance code always work? If not, what can you do to minimize crashes or (maybe) prevent them completely?

# Lab 10 – Workflow

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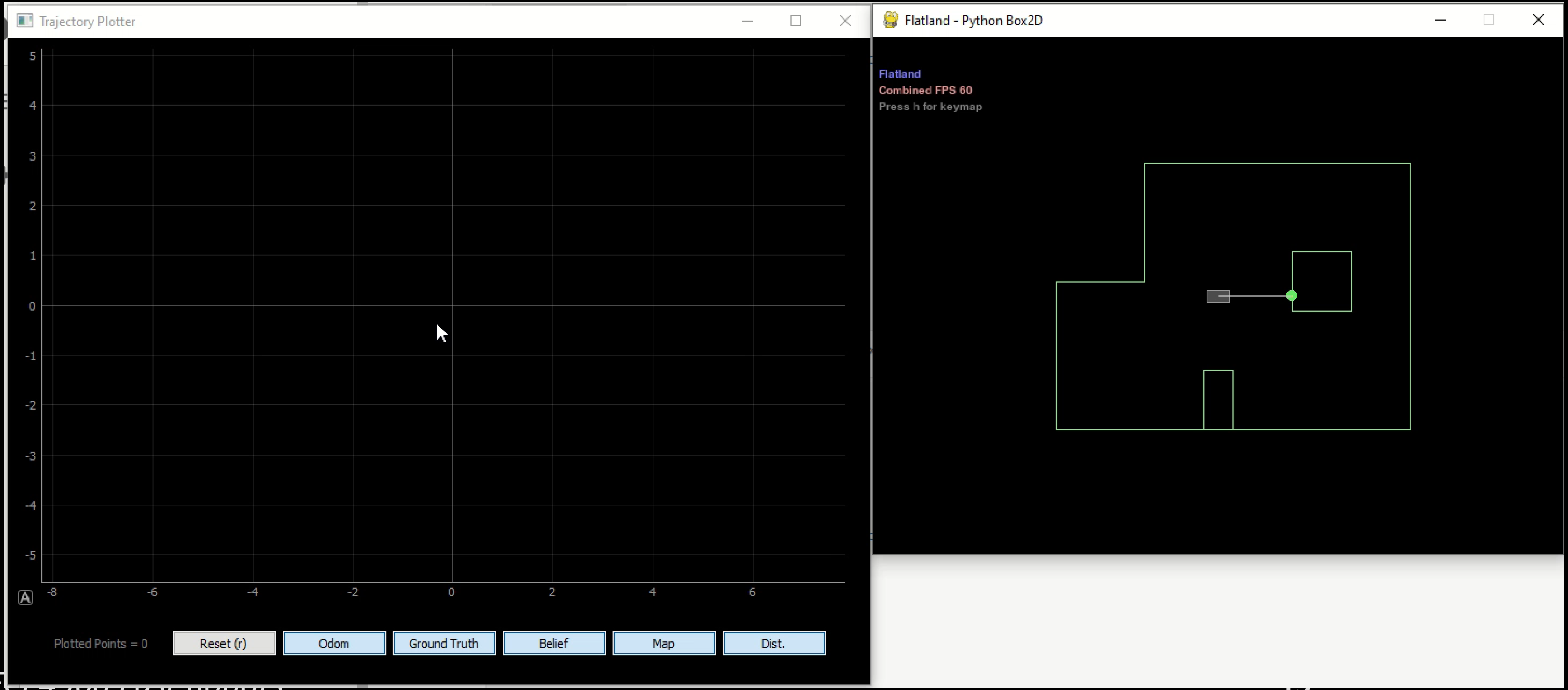

# Logistics

- **Lab 8 – Stunts**
  - Voting can start ~~today~~ Friday
  - Please submit your votes by Friday April 22nd
    - https://tinyurl.com/vp5wrten
    - 10 points for best stunt
    - 1 point for best blooper

- **Lab 9 – Mapping**
  - Yes! You still have an opportunity to get your map this week
    - We plan to start grading Friday

- **Lab 10 – Simulation**
  - If you finish early, we strongly encourage you to get a head start on the Lab 11 documentation!