Mini-Project Overview

The goal of the mini project is to design a **single controller** that enables the fly to successfully find an odor source (i.e., food) across a variety of different challenging environments.

Levels

There are 5 different levels of increasing difficulty (starting from 0 to match python's indexing).

Level 0. Empty arena
- An odor source is placed randomly in a flat empty arena
- The fly needs to reach the odor source to pass the level

Level 1. Pillars arena
- The fly is spawned inside a circular arena surrounded by pillars
- An odor source is placed randomly outside the pillars
- The fly needs to reach the odor source to pass the level

Level 2. Looming balls arena
- An odor source is placed randomly in a flat empty arena
- While the fly is walking, large red balls will randomly spawn and move towards the fly
- If the fly is hit by a ball, it might be knocked away or flipped, so it's better to avoid them
- The fly needs to reach the odor source to pass the level

Level 3. Pillars and looming balls arena
- The fly is spawned inside a circular arena surrounded by pillars
- An odor source is placed randomly outside the pillars
- While the fly is moving, large red balls will randomly spawn and move towards the fly
- If the fly is hit by a ball, it might be knocked away or flipped, so it's better to avoid them
- The fly needs to reach the odor source to pass the level
- *Hint: one way to distinguish between static pillars and moving balls as visual features could be that the visual motion of one set of features depends on the fly's own motion and therefore proprioception*

Level 4. Path integration arena
- The fly is spawned inside a circular arena surrounded by pillars
- An odor source is placed randomly outside the pillars
- While the fly is moving, large red balls will randomly spawn and move towards the fly
- If the fly is hit by a ball, it might be knocked away or flipped, so it's better to avoid them
- To pass the level, the fly first needs to reach the odor source. This will cause the pillars and looming balls to disappear. Then, the fly should return to the center of the arena (where it spawned) and send a signal when it thinks it has arrived there

Code for the project

Code for simulating the different levels can be found at the following location: https://github.com/NeLy-EPFL/cobar-miniproject-2025. You can test the different levels by running the explore_levels.py script with different arguments for the --level parameter, and using the keyboard to control the fly.

Designing a controller

Your controller needs to transform observations of the fly's environment into appropriate actions. To do this, you should extend the BaseController class (see https://github.com/NeLy-EPFL/cobar-

miniproject-2025/blob/main/cobar_miniproject/base_controller.py). An example basic implementation is shown in the submission folder of the repository. We will provide further submission details before the deadline

Mini-Project Grading Guidelines (Total: 100 points, 40% of final grade)

The mini-project grade is split between controller performance and the report / code.

1. Controller Performance (50 pts)
Your controller will be evaluated in all 5 arena levels. Each level will be tested with 10 simulations using different random seeds (total: 50 simulations per group). The seeds determine the locations of the target and the obstacles.
- 3 seeds (45, 38, 25) are given; 7 are kept secret.
- All groups are evaluated using the same set of seeds.

Scoring (10 pts per level):
- Levels 0–3: (binary score)
  - 10 points if the fly reaches a circle (radius = 3) centered on the target odor source,
  - 0 otherwise.
- Level 4:
  - The controller must send a signal when the fly returns home after reaching the odor. The score (X/10 points) is proportional to the fly's final proximity to the home (initial spawn) location.

Time limits:
Your controller must achieve the goal within the following time limits, or else it will be terminated.
- Levels 0–3: Maximum 100,000 simulation steps
- Level 4: Maximum 200,000 simulation steps

2. Report & Code (50 pts)
Report (28 pts)
- Organization (4 pts)
- Figure quality (4 pts)
- Conciseness (4 pts)
- Completeness (4 pts)
- Writing quality (4 pts)
- Methods: reasoning (4 pts), rigor (4 pts)

Code (6 pts)
- Structure (2 pts)
- Cleanliness (2 pts)
- Documentation (2 pts)

Working Style (16 pts)
Evaluation based on collaboration, communication, and planning.

Bonus (up to 10 pts)
A bonus of up to 10 points will be awarded based on the quality of your 5-minute presentation.
Note: Bonus points cannot increase the Mini-Project score beyond 100 pts.