香港浸會大學 HONG KONG BAPTIST UNIVERSITY

香港浸會大學理學院 HKBU Faculty of Science

Laboratory Teaching Manual

Workshop 1

SCIE 1006

Big Data and Smart Technology

Hong Kong Baptist University

Faculty of Science

AI tasting

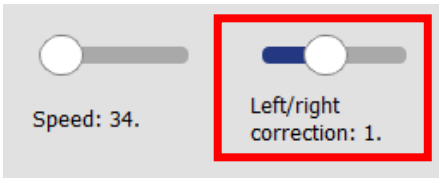
Learning Outcomes

By finishing this workshop, you should be able to

- Train the AlphaAI robot to run on a track using supervised learning with infra-red sensors
- Train the AlphaAI robot to recognize human faces using supervised learning with camera
- Visualize the training data and neural networks in the AphaAI software

Read the following tips before working on the robot

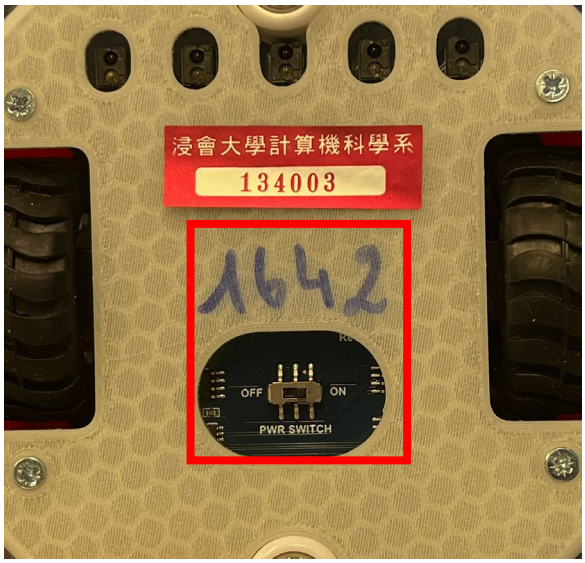
- Connection of robot:
  - Use one lab laptop to connect the robot via Wi-Fi.
  - Use another laptop for internet connection.
- Handling the Robot:
  - Do not drag the robot.
  - **Always pick it up by its base with two hands.**
  - Beware that the cover of the robot is loose, **do NOT hold the cover** to pick up the robot.
- Correcting Robot Movement:
  - If the robot cannot walk straight, adjust the left/right correction setting (bottom-right of the AlphaAI interface). The default is 1.
    - Usually, 1 is preferred.
    - For slight turns: Try 0.95–1.05.
    - For larger turns: Try 0.9–1.1.



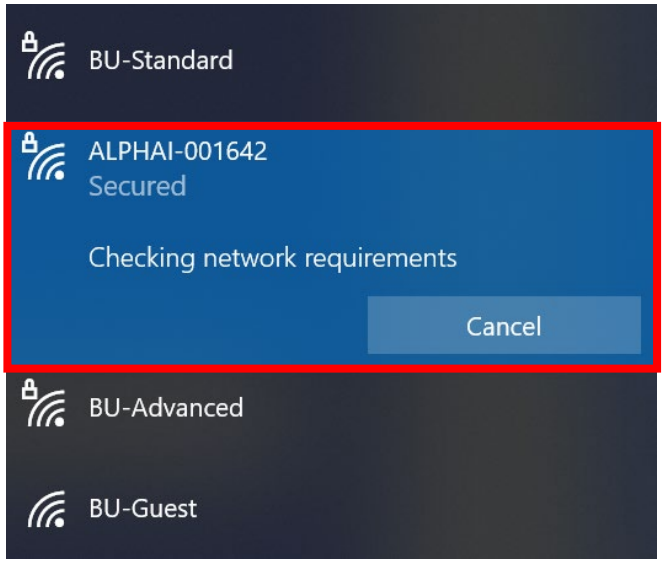
Introduction to the AlphAI software

Before working on the tasks, this introduction could help you acquire basic knowledge about the AlphAI software.

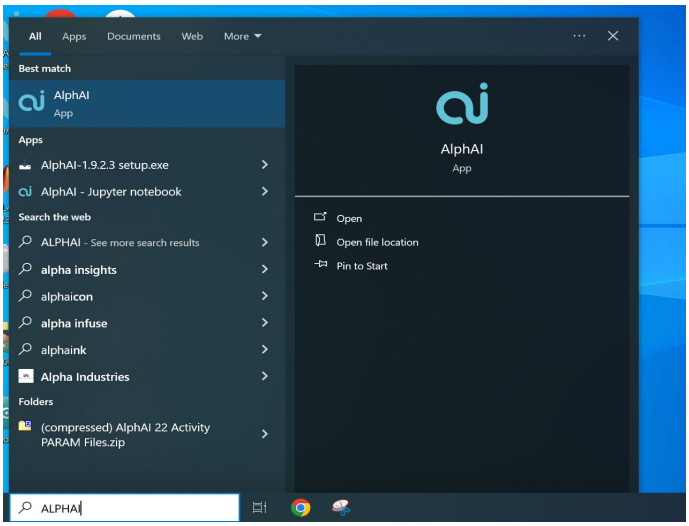
1. Power on the robot
    - At the bottom of the robot, power on the robot and check the robot code (e.g. 1642 in the figure).



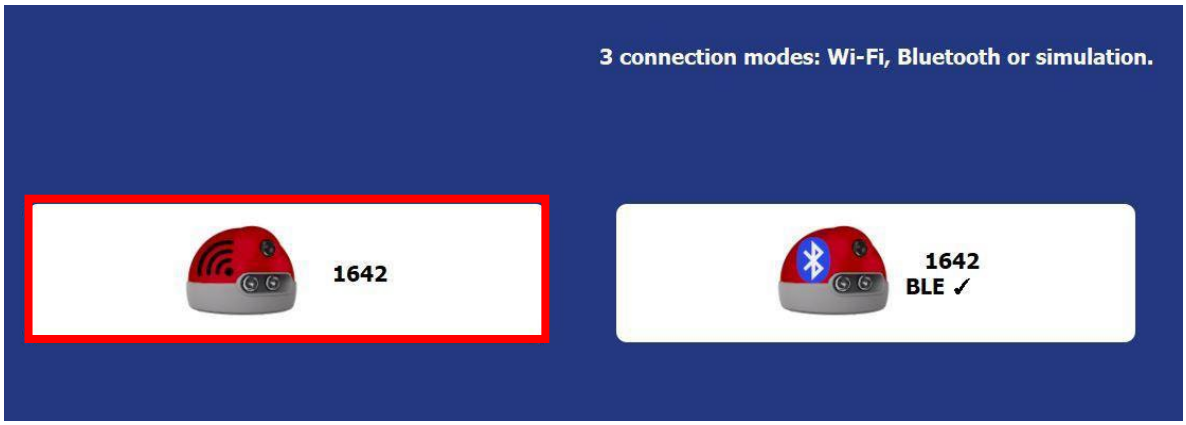
2. Connect to your robot's Wi-Fi: ALPHAI-00[robot code] (e.g., ALPHAI-001642 if the robot code is 1642). It may ask you for the password, **password is the same as the Wi-Fi name**.



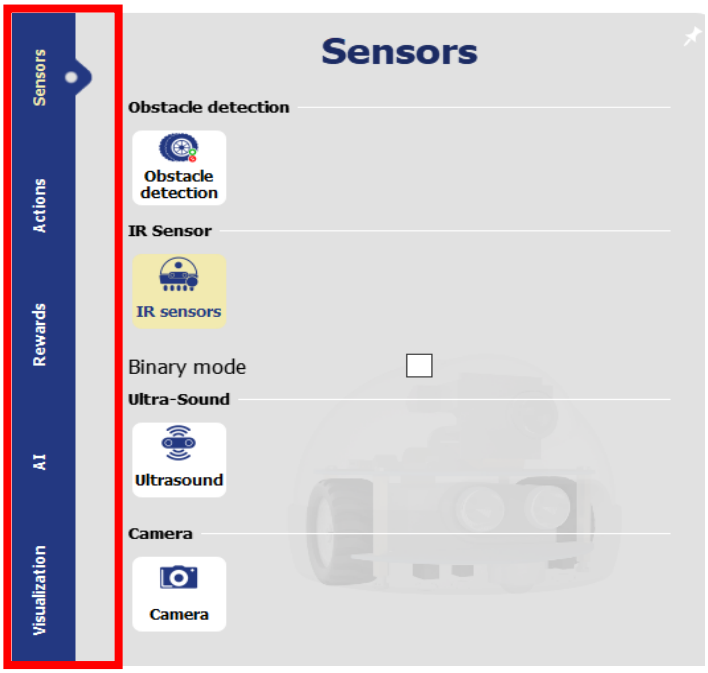
3. Run AlphAI
   - Open the software AlphAI through the start menu.



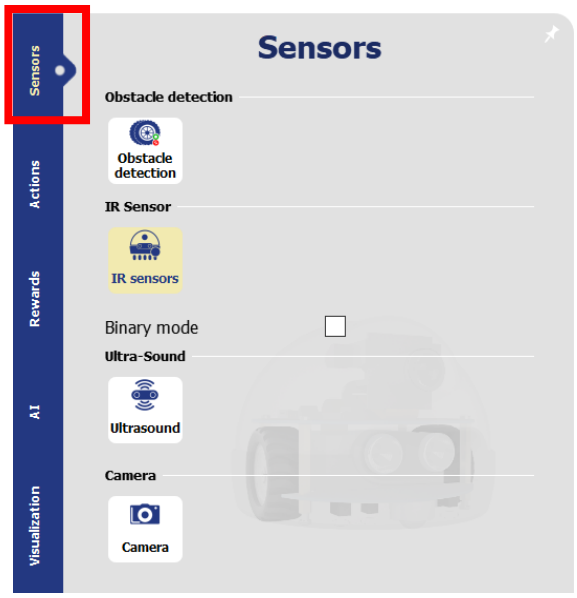
4. Connect to the robot
   - Click the **Wi-Fi icon with the code** of your robot to pair up.



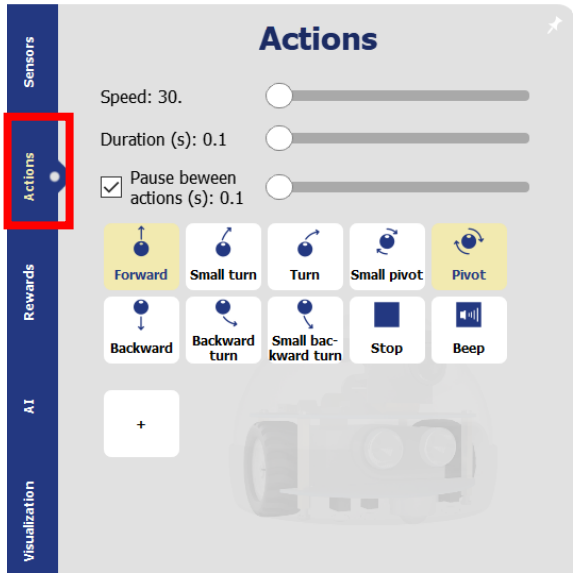
5. The AlphAI software has five tabs on the left-hand side: Sensors, Actions, Rewards, AI, and Visualization (The Rewards tab will not be used in this workshop).



6. In the “Sensors” tab, you can switch on or off the sensors of the robots (in the figure, we are using IR sensors) and the measurement of the sensors will be used as the input of the AI model. There are four main sensors:
    - Obstacle Detection: Detects if wheels are stuck.
    - IR Sensors: Detect the brightness of the floor (e.g. check whether the area is black or white).
    - Ultrasound: Measures distance to obstacles.
    - Camera: Captures images.

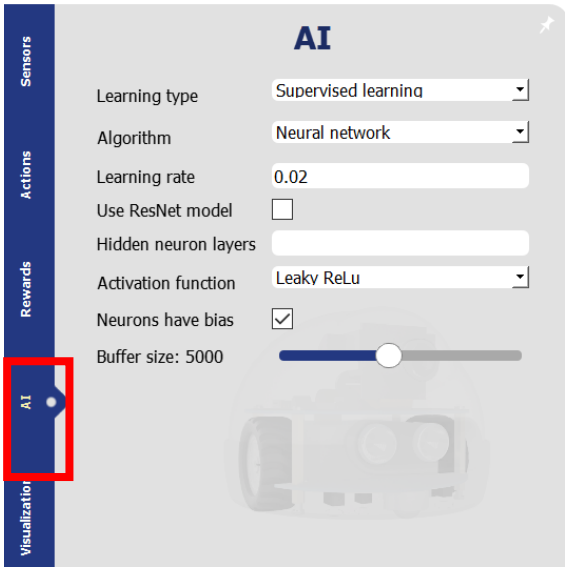


7. In the “Actions” tab, the upper part contains three configurations:
    - Speed: speed of the robot
    - Duration: the period of each action lasts
    - Pause between actions: the break between each decision made by the robot

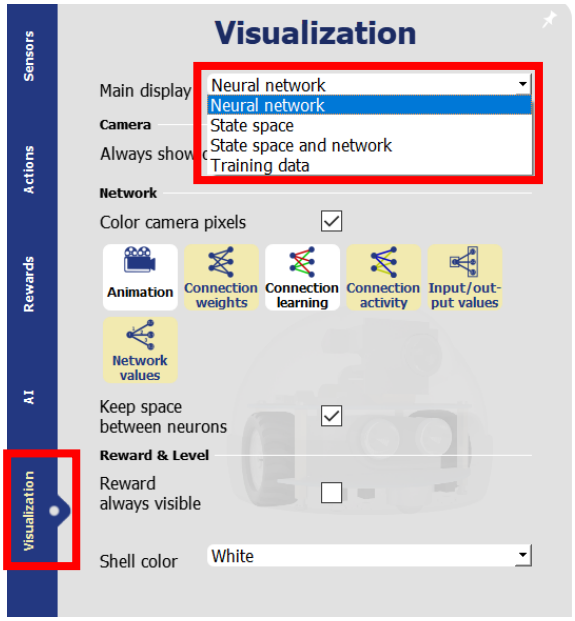


The lower part contains the different actions. You can pick the moving actions you want by clicking the icons of that movement (Actions “Forward” and “Pivot” are picked in the figure below). You may also add your own actions by clicking the “+” icon. The robot will perform one of the selected actions based on the trained AI model and its current status.

8. The “AI” tab is used to choose the machine learning method. For line tracking and face recognition, we use the default setting of the learning type and algorithm (i.e. supervised learning and neural network).



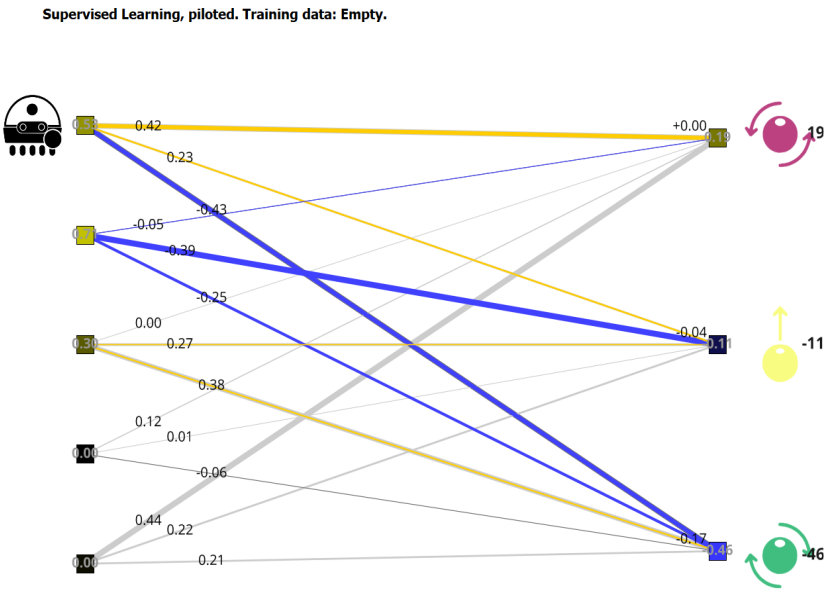
9. For the “Visualization” tab, there are two display modes that you will use in this workshop:
   - Training Data: Edit and show training data
   - Neural Network: Show the status of neural network model



9.1. Training data: In the following figure, there are two data points for action “pivot left”, seven data points for action “move forward”, and three data points for action “pivot right”. By moving your mouse to a particular training data point, you can either delete it or move it to

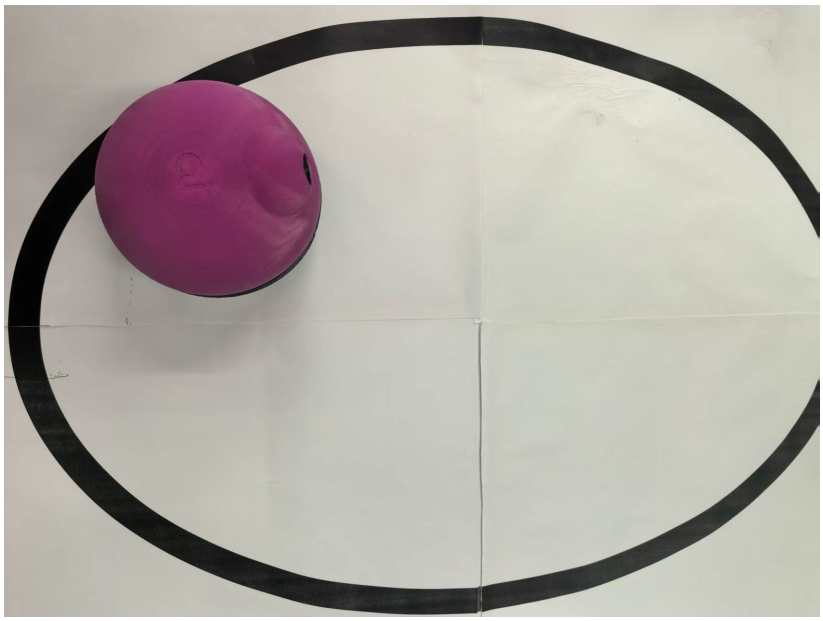
another action. If you click one of the actions, the robot will perform that action. At the same time, the measures from the sensor at that moment will be added to that action as new training data.

9.2. Neural network: The following figure shows a neural network with IR sensors as input and three actions as output. The left-hand side is the input layer of the neural network, in which there are five measurements that come from the five IR sensors. In the middle, each line means a connection between the input layer and output layer, and the number on it represents the weight. The right-hand side is the output layer with the three selected actions. The number besides the actions is the weighted sum of sensor values, and the robot will take the action with the largest output value. In this case, the robot will pivot left.



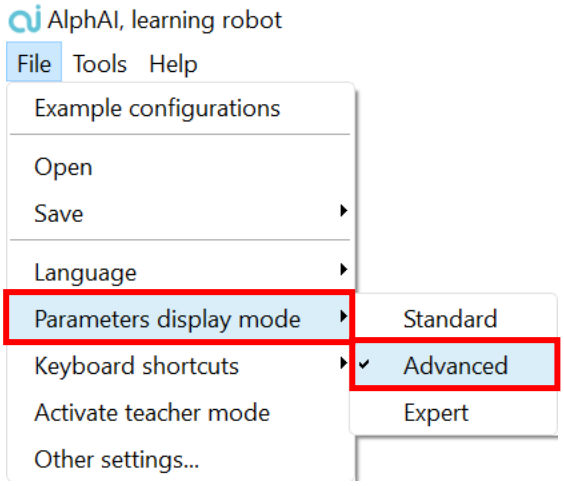
Part 1: Stay in the black oval

Goal: Train the robots to move continuously while remaining inside the black oval for at least 30 seconds.

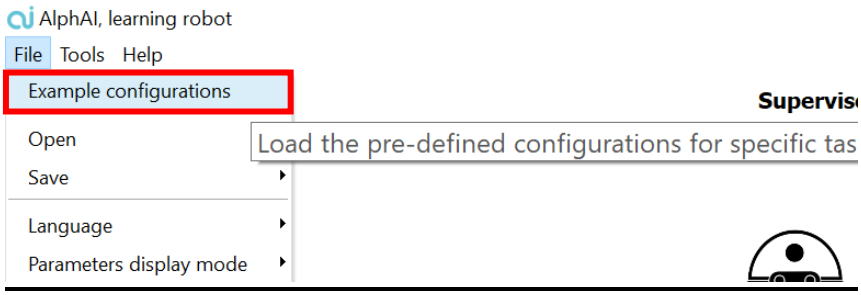


Steps:

1. Choose “File” in the top left corner, then select “Advanced” in the “Parameters Display Mode”.

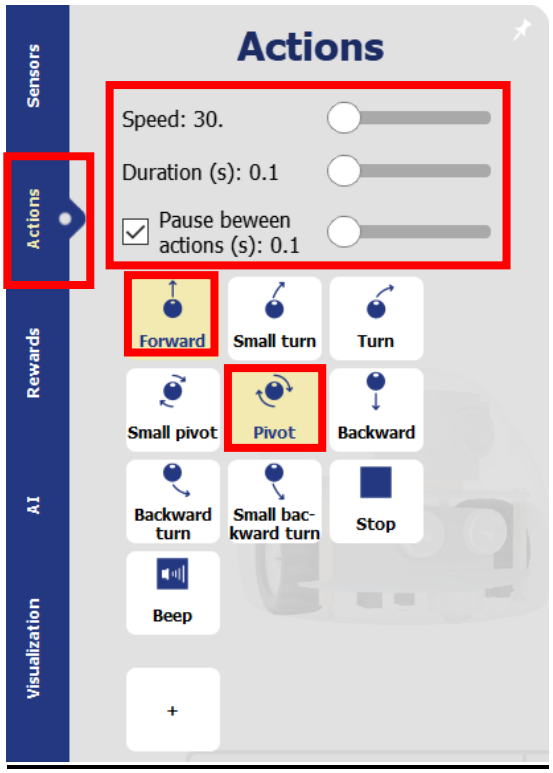


2. Choose “File” in the top left corner, then click “Example configurations”.

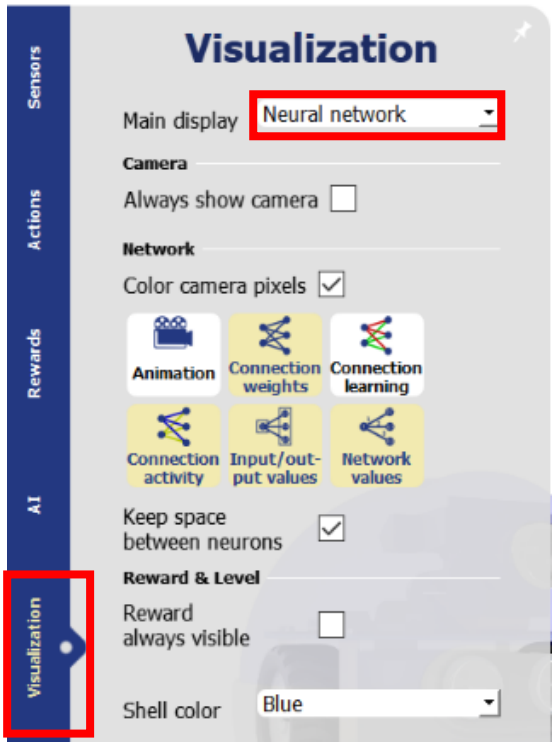


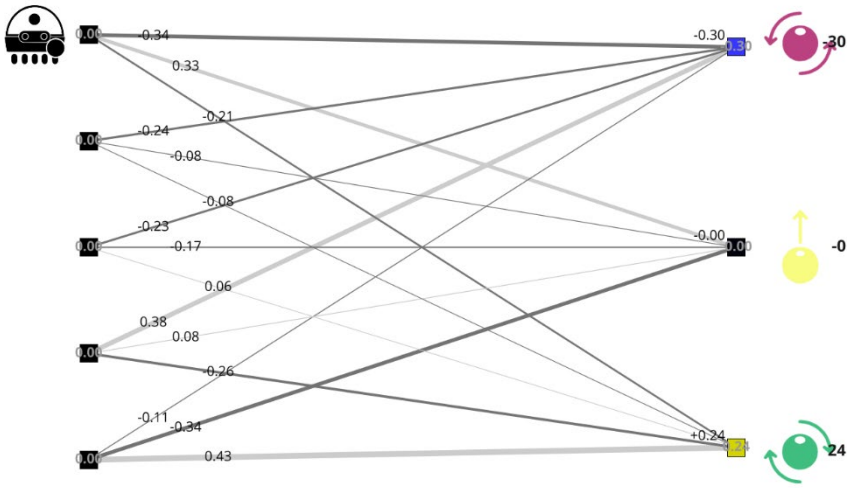
3. Select “Line Tracking” under category “Supervised Learning”.

4. Configure actions:
   - In the “Actions” tab, select “Forward” and “Pivot.”
   - Set Speed, Duration, and Pause Between Actions to minimum values as below.

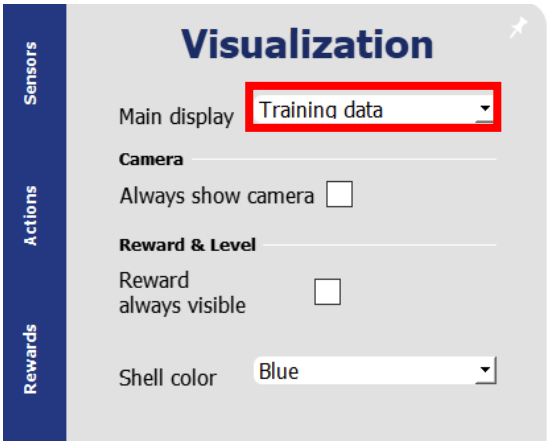


5. In the Visualization tab, select “Neural network” and take a look at the current model: There should be 5 inputs (IR sensors), and 3 outputs (actions).





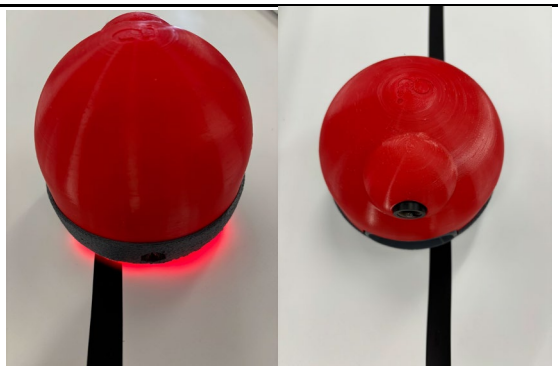
6. In the Visualization tab, switch to “Training data”.



7. In case, there are already some training data, click “Reset learning” to clear them.

8. Turn on “Learning” to start collecting training data.

9. Placing the robot on different locations within the oval and clicking right actions for those locations to train the robot. **Note: Always check the sensor data as well before clicking the actions. It should be more accurate than direct observation of the location.**

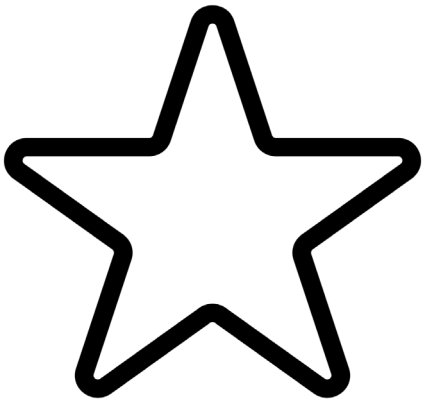
 	 If the right IR sensor detects black color, choose "Pivot Left" to turn away from the line.
 	 If no black color is detected, choose "Forward".
 	 If the left IR sensor detects black color, choose "Pivot Right" to turn away from the line.

10. Moving autonomously:
    - Turn off “Learning” and turn on “Autonomous”.
    - After turning on “Autonomous”, the robot will start making movement decisions according to the trained model.
    - Make sure that your robot can stay inside the oval for 30 seconds.

11. If unsuccessful, turn off “Autonomous” and repeat steps 7 and 8 to add/edit the training samples. Make sure that you provide the right training data for your network.

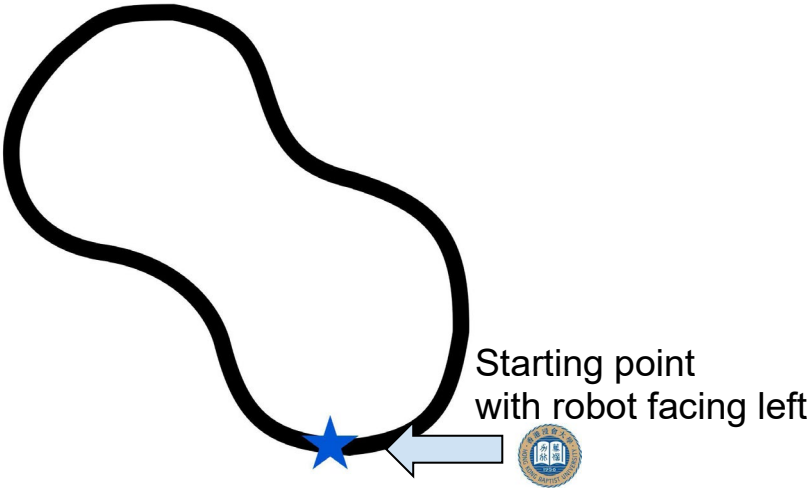
Discussion

Question 1: Is your current model sufficient to handle a more complex map, such as the star-shaped map below? Explain your answer. (Enter your answer in the submission box on Moodle.)



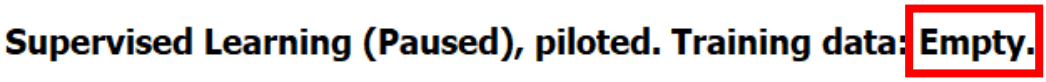
Part 2: Line Tracking

Goal: Train the robot to track the entire black circular path of following map autonomously. The robot should **start off facing left and move in a clockwise direction**.

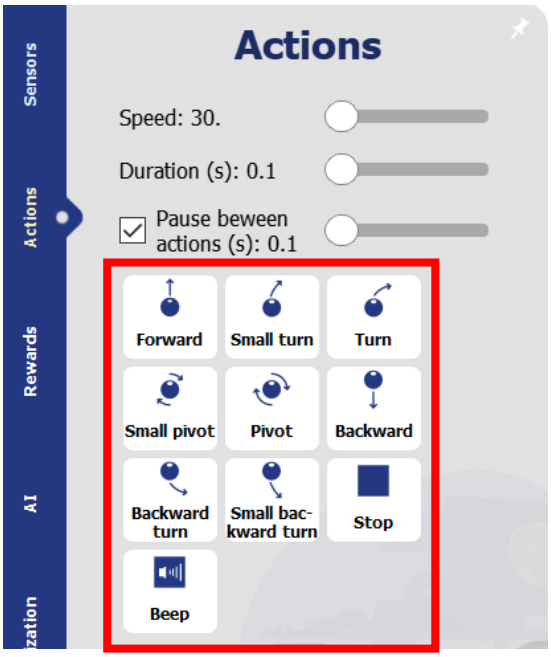


1. Reset learning data: Click “Reset Learning”.

2. Ensure “Training Data: Empty”.



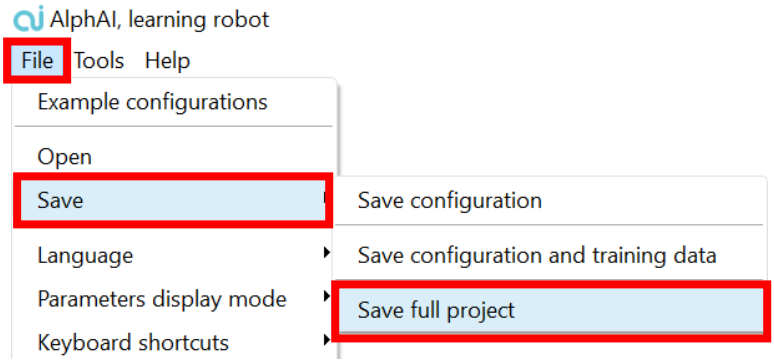
3. For setting the tab “Actions”, you can **freely pick the actions** that you think is necessary for the robot to complete the tracking task.

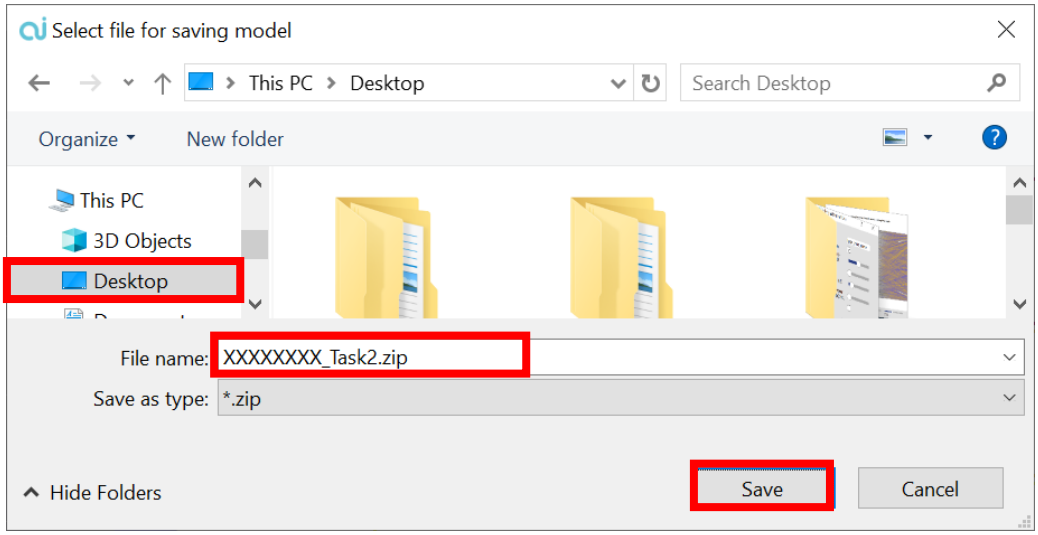


4. After completing the configuration, turn on the "Learning" button.

5. Now, train your robot to track the path on the map.
   - Similar to part 1, collect necessary training data until your robot can move correctly, i.e. track the black line and complete one lap.
   - Record an MP4 video named **XXXXXXXX_Task2_video.mp4** (replace XXXXXXXX with the student ID of one groupmate) showing the robot successfully completing the entire black circular path. **Throughout the video, the robot, the map, and the software interface must all be visible**.

6. After completing the task, choose “File”, then click “Save” and “Save Full Project”. Rename the file as **XXXXXXXX_Task2.zip** (replace XXXXXXXX with the student ID of one groupmate) and save it to your desktop.





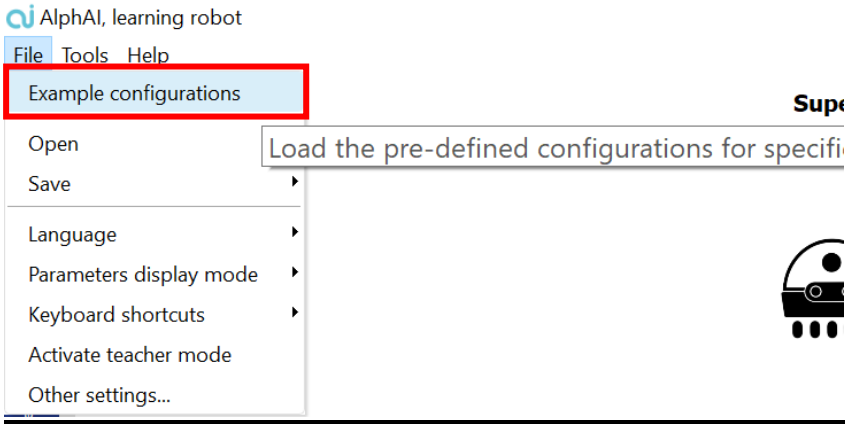
Discussion

Question 2: Describe the training data collected and the actions selected. Explain your choice. (Enter your answer in the submission box on Moodle.)

Part 3: Face Recognition

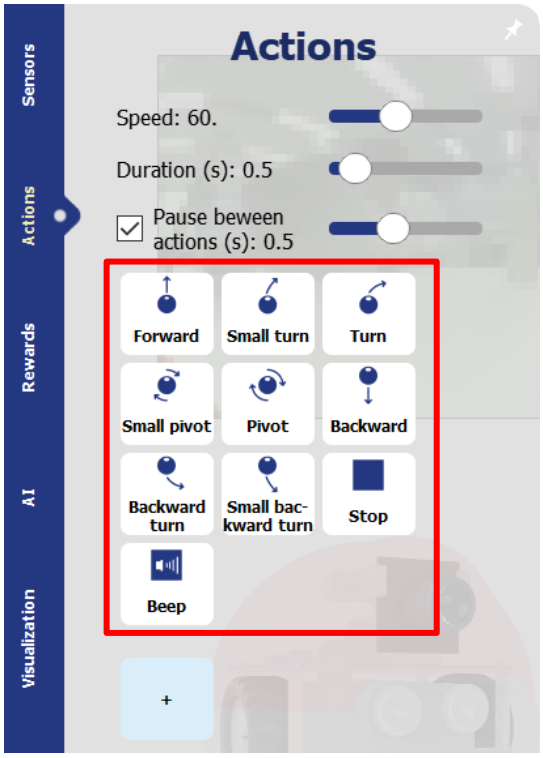
Goal: Train the robot to recognize each group member's face.

1. Click "Example configurations" under "File".

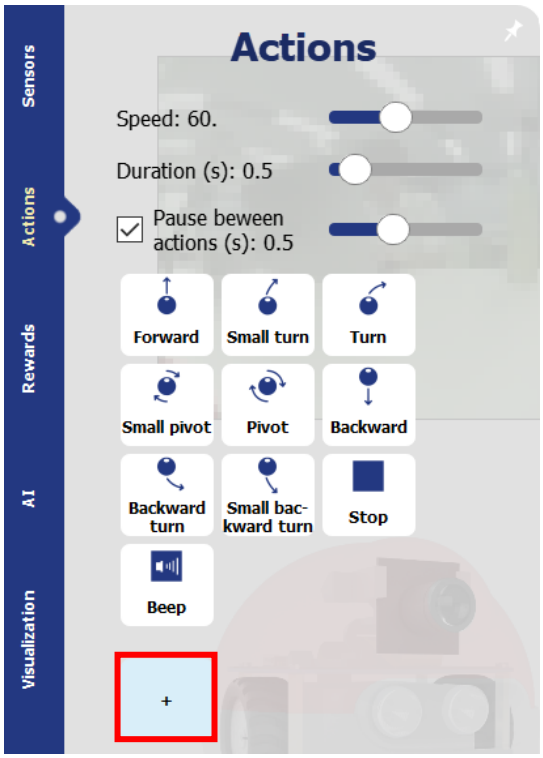


2. Select "Image Recognition" under Supervised Learning.

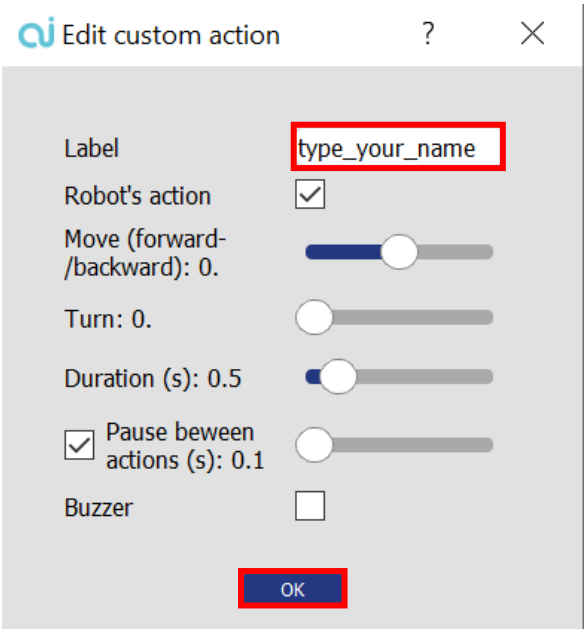
3. In the tab “Actions”, **un-select** all the actions.



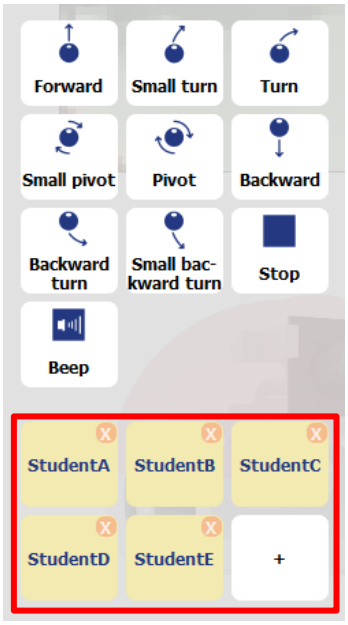
4. Add a new action **for each group member**.
   - Click “+” to add new action



- Type in the group member's name in the "Label" textbox and click "OK".

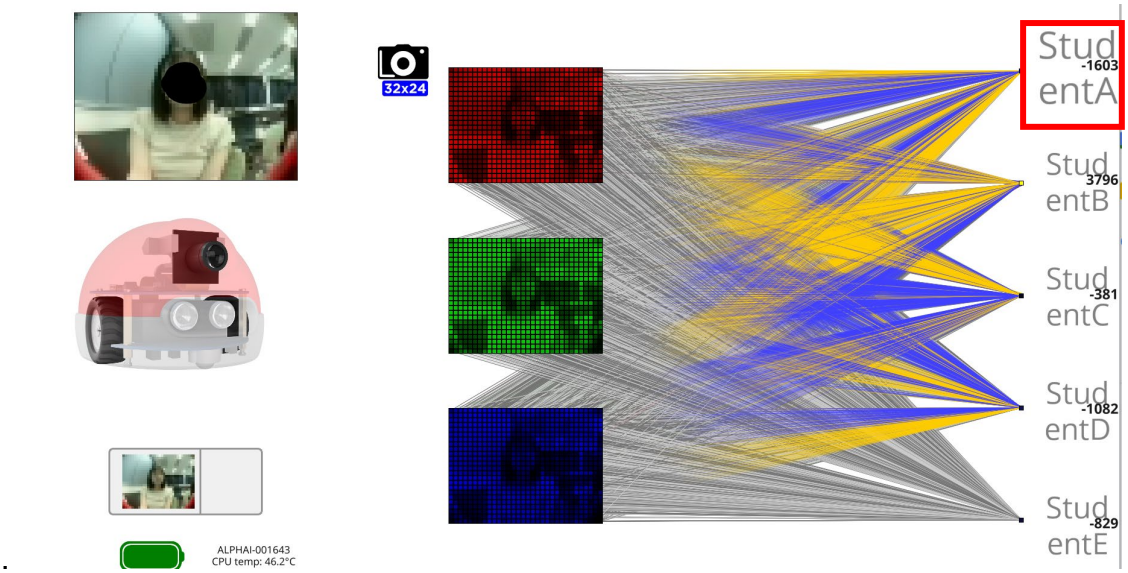


5. Once the new actions have been properly established, you should see the actions along with the names of each group member as shown below.



6. Turn on "Learning".

7. For each group member, show their face to the camera and click the corresponding name action several times. (e.g., “StudentA”). This will teach the robot to recognize the members.



8. Test recognition:
   - Turn off “Learning” and turn on “Autonomous”
   - Show each group member’s face to the camera
   - Ensure that the robot correctly recognizes each group member

9. If unsuccessful, repeat step 6 to 7 to add/edit training data.

10. You have to **demonstrate** the face recognition results to the instructor(s) before the end of the class.

Discussion

Question 3: If your robot is in a different environment, such as another room or an outdoor location, do you think it can still accurately recognize faces? Explain your answer. (Enter your answer in the submission box on Moodle.)

Question 4: What smart solution can we build to develop a green campus in HKBU? Describe your solution in terms of “Sense-Think-Act” framework and justify your answer in no more than 500 words. (Enter your answer in the submission box on Moodle.)

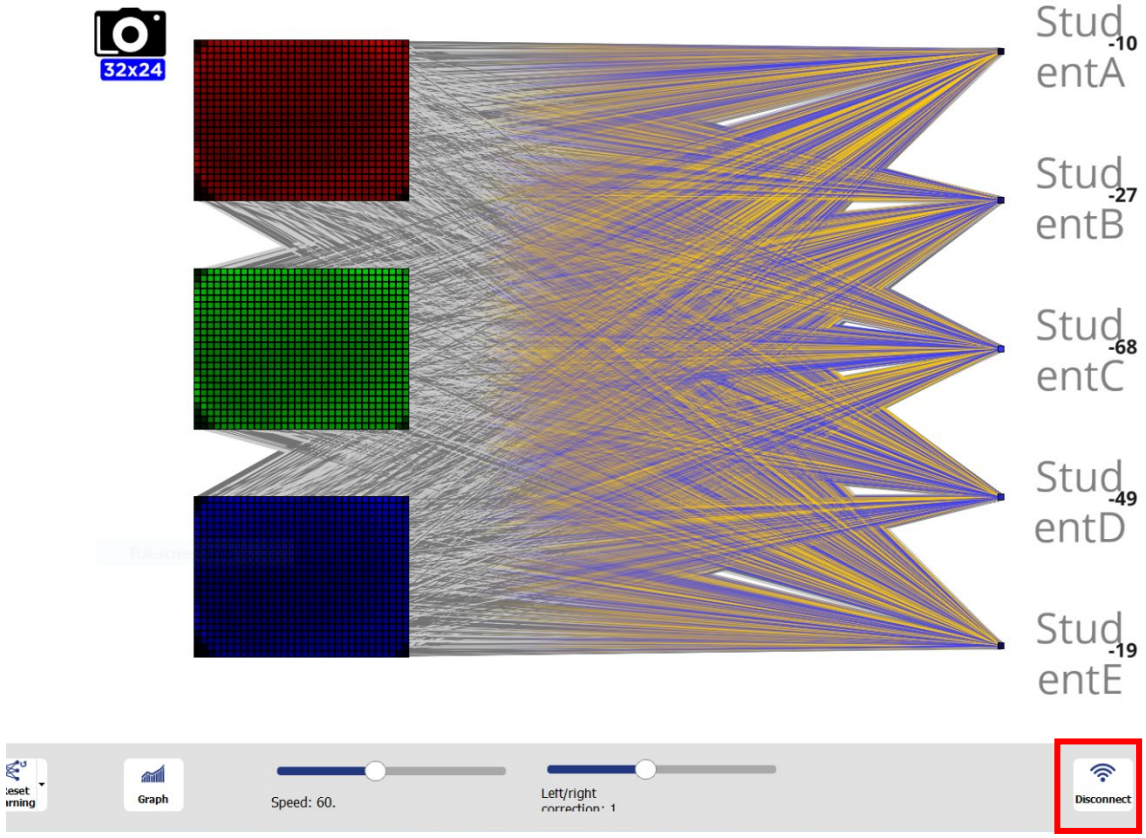
Submission

You have to submit the following items to the Moodle submission box:

- MP4 video (XXXXXXXX_Task2_video.mp4)
- XXXXXXXX_Task2.zip
- Discussion Questions

Closing Procedures: Disconnect and Power off

1. After finishing all the tasks, click “Disconnect” in the bottom right corner of the software.



2. Power off the robot.

REFERENCES

1. *Coding and STEM*. (n.d.). etchk: Sites. https://etchk.screenstepslive.com/s/codingnstem
2. *Introducing the AlphAI robot.* (n.d.). L’intelligence artificielle accessible à tous avec Learning Robots. https://www.learningrobots.ai/en/categories/alphai