Teacher introduction with classroom activities

vpleducation

Summary

The robot and its programming interface

Thymio is a mobile robot with sensors and actuators that can be easily programmed.

VPL *(Visual Programming Language)* is a visual programming interface based on "condition" blocks and "action" blocks.

The goal of **VPL Education** is to provide you with a dedicated environment to create and conduct computer science activities in your classroom.

General objectives

This document allows you, as a teacher, to accomplish the following goals:

Introduce the sensors and actuators of the Thymio robot

Student discovery the VPL interface

Teach Computer Science concepts

Encourage an investigative approach in class

Discovery of the robot

To discover the Thymio robot and its programming interface, we suggest the following activities (pages 6 to 14).

Naturally, these activities are to be used and adapted according to your approach, audience, and classroom conditions...

In addition, resources will be given to you throughout this chapter.

Important!
During Activities 1- 5, the students are asked to pool their knowledge. These 3 moments are essential to allow students to progressively move from the observation of the robot to its programming interface.

1. Take the first steps

What's in the box?

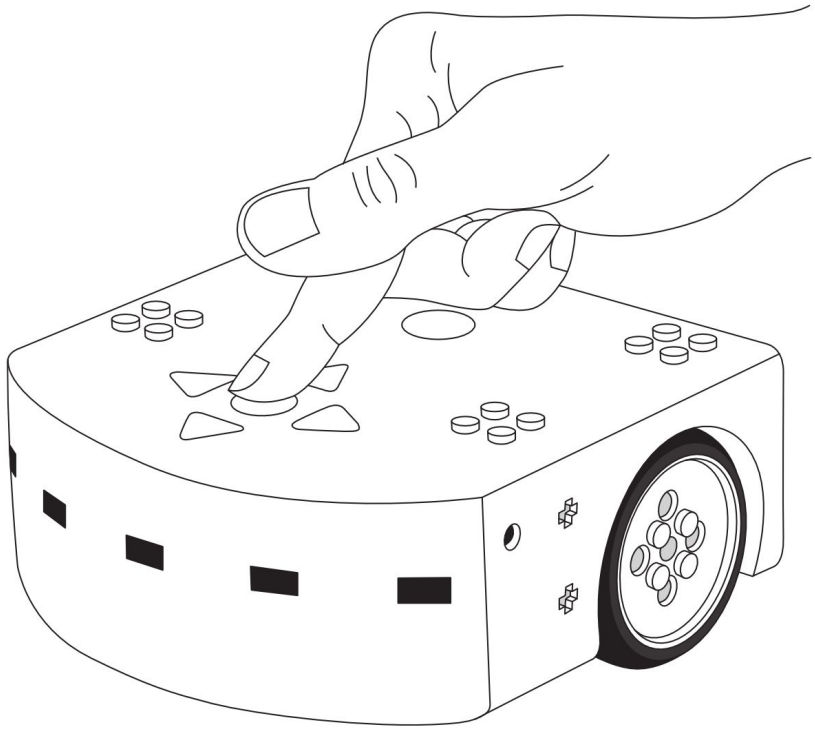
How do you turn it on?

To turn on Thymio, touch and hold the center button: it lights up in green.

Then touch the arrow buttons: What happens?

Now you have seen 6 different colors that correspond to 6 pre-programmed behaviors in the Thymio robot.

We call them: green mode, red mode, yellow mode, magenta mode, cyan mode and blue mode.



2. Test the pre-programmed behaviors

In the yellow mode Thymio explores the environment around itself. Its behavior can be reminiscent of a robot vacuum cleaner... except that Thymio does not vacuum!

To activate one of the 6 modes, you have to touch the center button (you will see a kind of pulsating halo indicates that the mode is active). To return to the menu, simply touch the same center button again, then the arrow buttons.

1. Test each of the modes and describe the behaviors.

2. Distribute Student Handout 1 and ask students to identify the events perceived by the robot and the actions performed for each behavior.

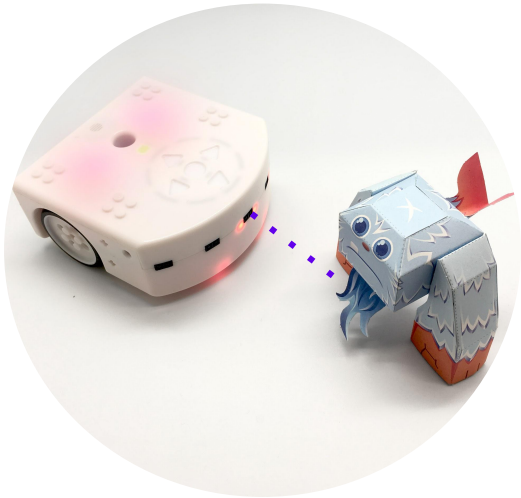
Pool the behaviors observed for each mode.

3. Identify the causes of the observed behaviors

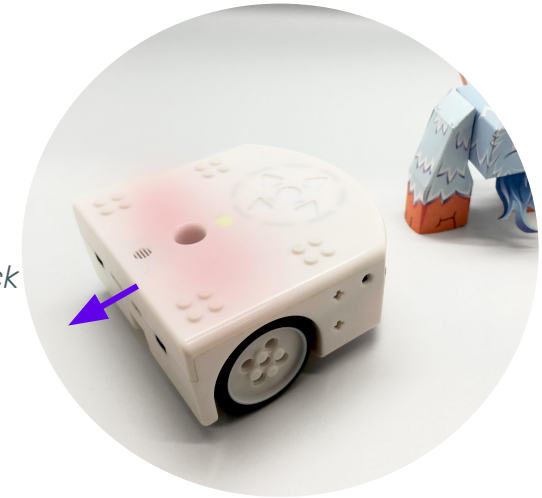
Until now, you could observe that Thymio performs actions according to what it perceives.

By completing Student Handout 2, now identify each behavior in the form:

"When Thymio detects something in front of itself



then it moves back



Pool all the sentences from the students (see all the possibilities on the Teacher's Sheet 1 in the appendix).

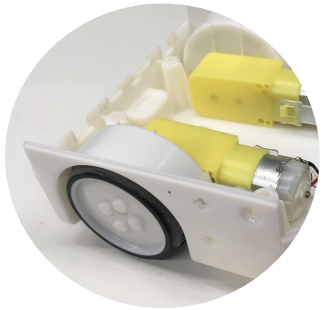
4. Identify the sensors and actuators

For each behavior, identify the sensors and actuators involved.

Example:

"In the red mode, when Thymio detects something in front, then it moves back."

The red LEDs tell us that the sensors are detecting something.



Thymio moves thanks to its two wheels, each driven by a motor.

Share and explain the operation of the sensors and actuators with the help of the Teacher's Sheet 2 in the appendix.

5. Switch to the programming interface

After having observed the robot, it is now time to depict these observations. The passage from real to symbolic is a first step towards the computer language used to program Thymio.

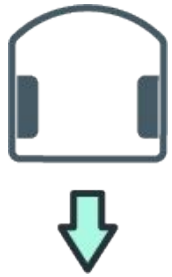
Now write on the board the event perceived by Thymio and the action it performs for one of the observed behaviors. Use the programming interface (page 11) to represent each event and each action.

Example:

When...

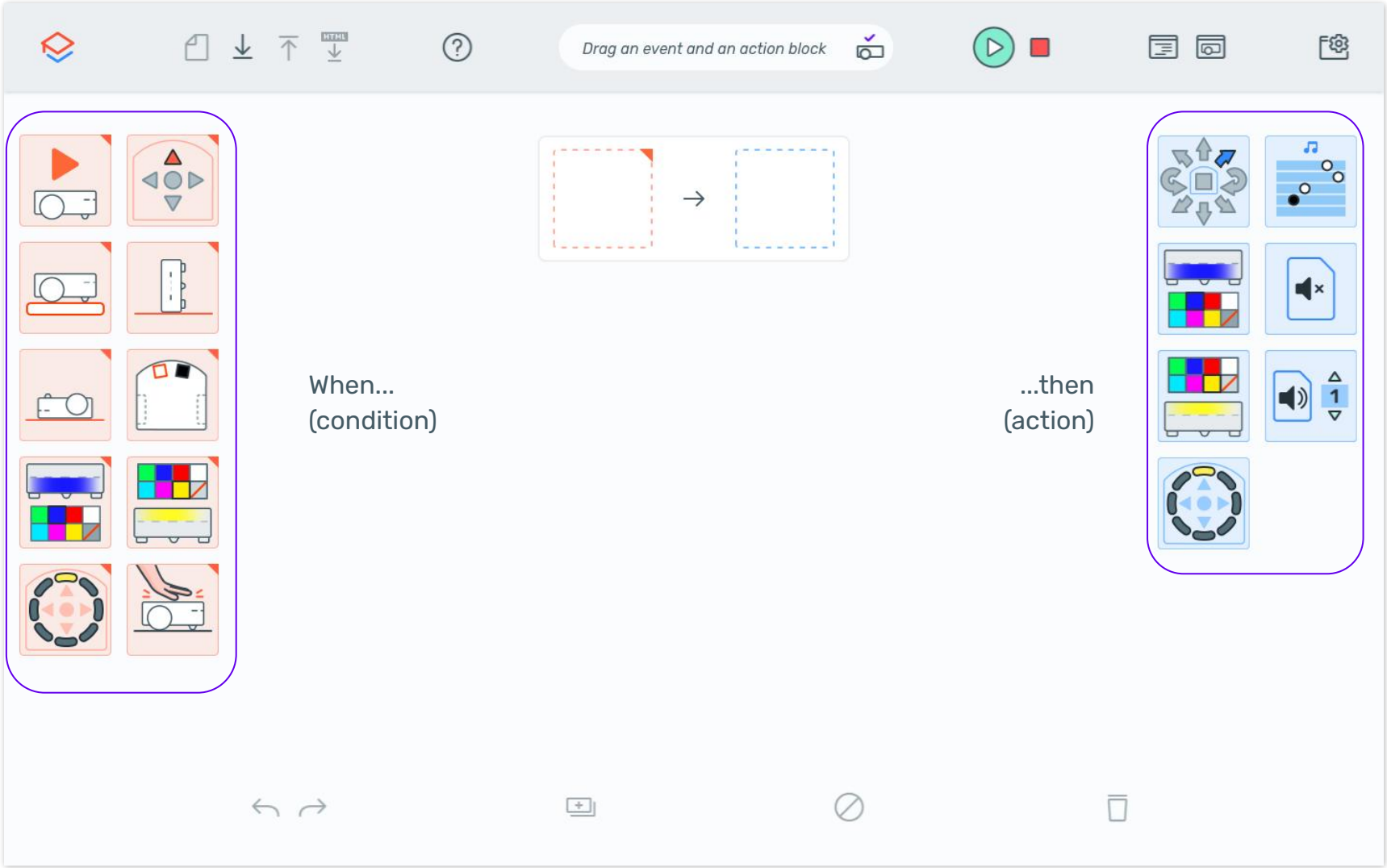
...Thymio detects something in front of itself (through its sensors)

then...



...it moves back (with its motors)

The previous activity is an introduction to the VPL3 programming interface you see here, which works with "condition" blocks and "action" blocks.
Try to identify the different blocks.

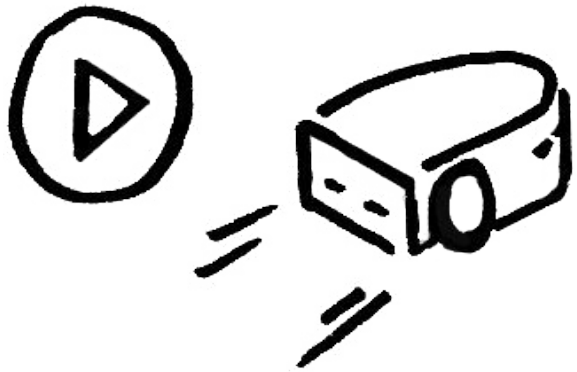


6. Get used to the interface (Mini-Missions)

In order to familiarize yourself with the VPL3 programming interface, we suggest that you carry out the following missions (page 13). Each assignment is designed to introduce you to a feature of the interface.

This approach is very suitable for your students. Although it takes time, it is undeniable that it contributes to the appropriation of the abstract tools that are the programming tools!

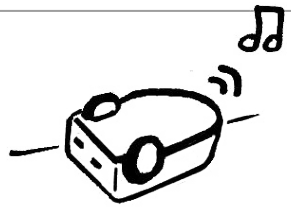
At the end of these missions, the VPL3 interface will be more easily understandable and usable for your students.

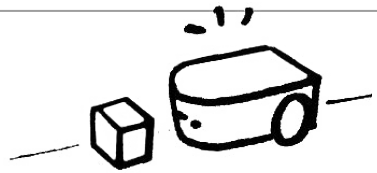


Mini-Missions

The missions below are designed for the VPL3 interface. Some of the missions can be done with VPL 1.6, they are marked * for simple mode and ** for advanced mode.

1	When I launch the program ( ), then Thymio lights up in blue on its top	5*	When Thymio detects something behind itself, then it emits a sound.
2*	When I touch the forward button of Thymio, then it moves forward and when I touch the center button, then it stops.	6	When I launch my program, Thymio moves forward and as soon as it reaches the edge of the table, it stops.
3**	When I place Thymio on its back, it then emits a sound.	7**	When I touch the left arrow button then Thymio turns left and the left LED on the circle lights up. Same thing for the right side.
4*	When Thymio detects something in front of itself (for example a hand), it lights up in green. When it doesn't detect anything it lights up in red.	8**	Configuration mode ( ): if Thymio detects a clap then a countdown of 2 seconds starts. When the countdown is over, Thymio emits a sound and lights up in green.



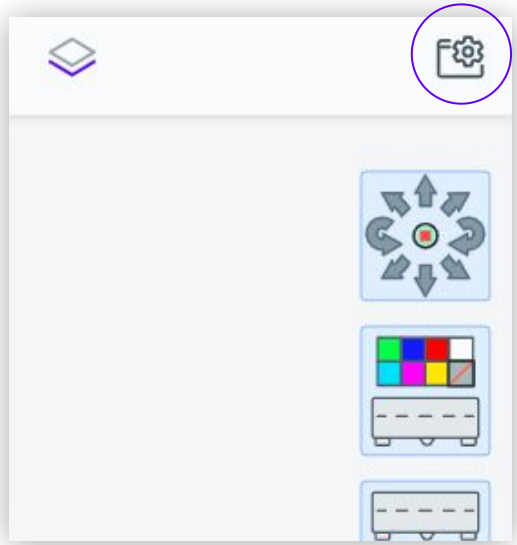


7. Discover the configuration mode (VPL3)

You have just tested some small programming assignments (missions) that put the VPL3 tool in your hands. Maybe you found some of the missions difficult for your students to complete... if so, you are able to propose a progression of learning for your students according to their needs.

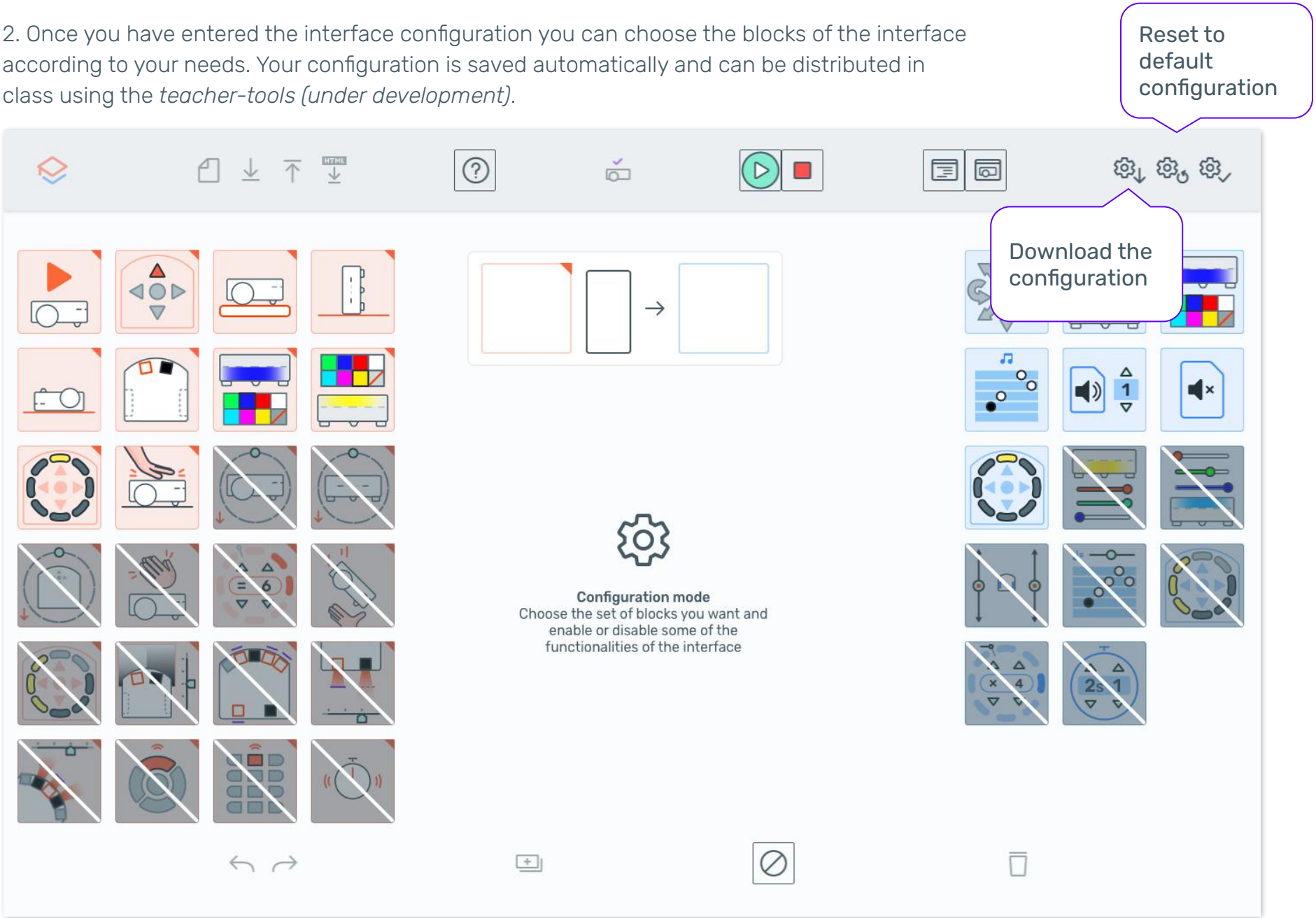
Thanks to the "configuration" mode, you will be able to adapt the interface for your students by choosing the blocks that you think are most appropriate for the activity.

The following page explains the details of this mode.



1. The configuration icon is located at the top right.

2. Once you have entered the interface configuration you can choose the blocks of the interface according to your needs. Your configuration is saved automatically and can be distributed in class using the *teacher-tools (under development)*.




Student
Activities

Student Activities

The following pages present activities to be carried out in class and include the procedure to follow, the pooling of information, as well as the cards and material necessary for understanding. The aim is to help you to best utilize the material and to adapt the procedure to your own situation as necessary.

For each activity you also have the concepts and skills shown, like this:

Computer Science skills

Transversal skills

Other skills

1. Line tracking

Concepts and skills involved:

Algorithms, components of a robot

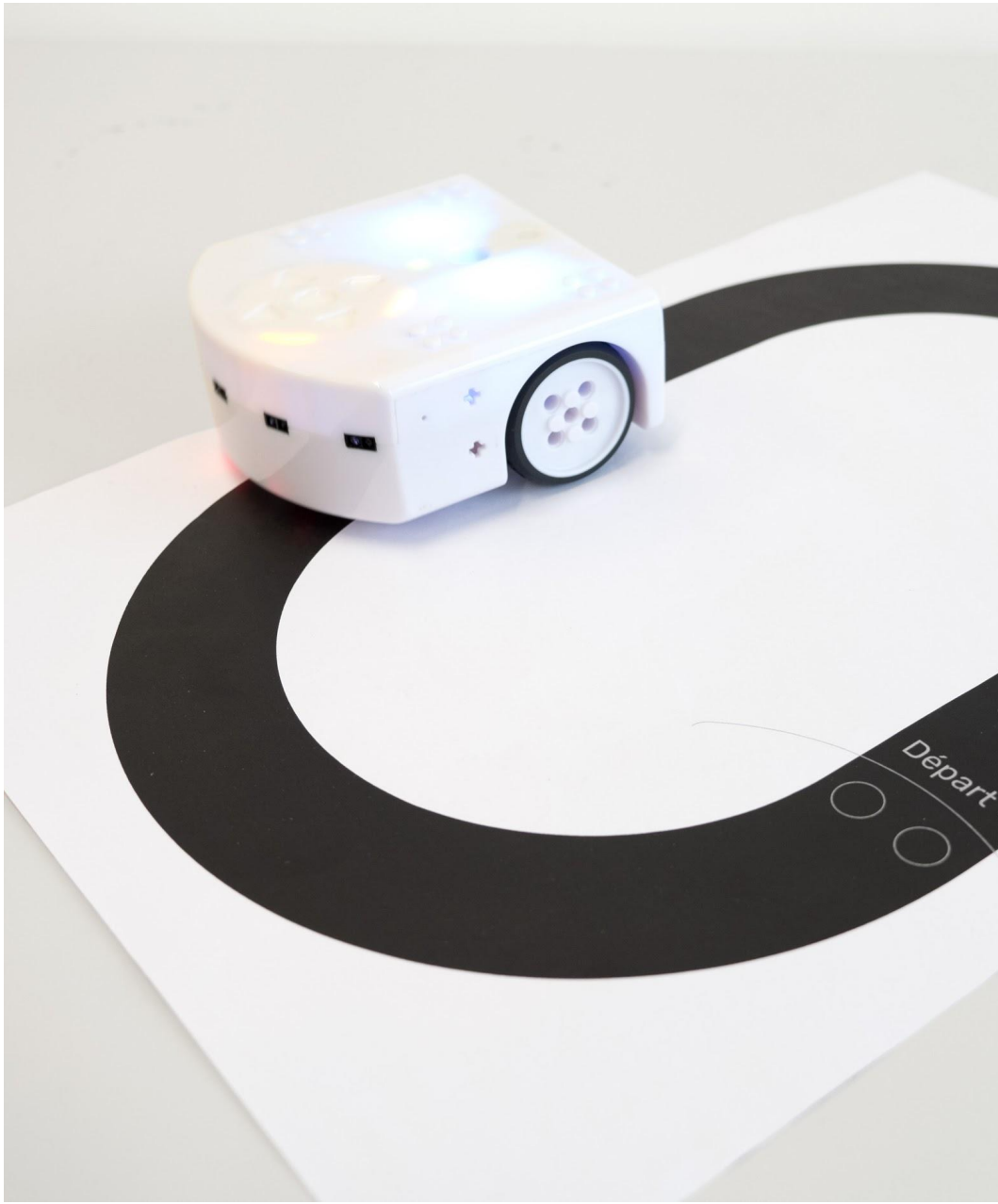
Collaboration, communication, problem solving

Goals:

- Understand the vision system of Thymio through its two ground sensors
- Identify all the possibilities for the sensors
- Recognize the components of Thymio

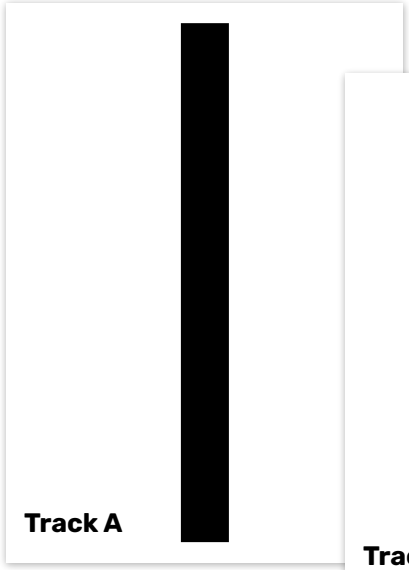
Materials:

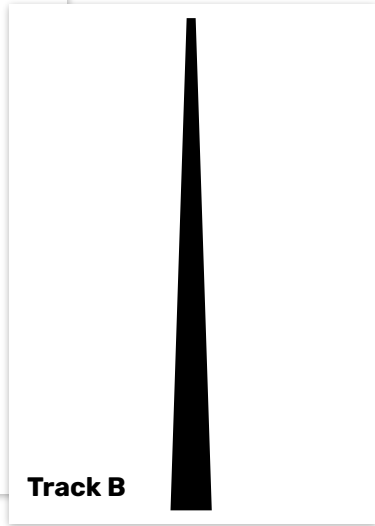
- Tracks A, B, C and D (in Appendix)
- Thymio stencil to cut out (Handout 3)
- Thymio robot
- Student Handouts (4 to 6)

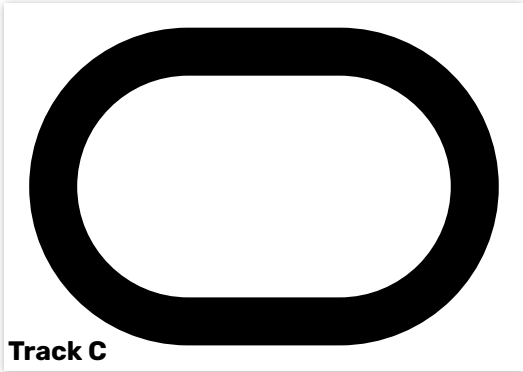


Summary of the approach

1. Predict the behavior of Thymio in the cyan mode on a black track (Track A). Make a hypothesis as a group.
2. Present the Thymio paper stencil and simulate the behavior hypothesized on Track A with the Thymio paper stencil.
3. Observe and compare the cases with the robot in cyan mode and deduce the elements of Thymio's program (sensors and actuators)
4. Now change the track (and the problem). Predict the trajectory of the robot on Track B.
5. Model with the Thymio paper stencil.
6. Observe and compare the cases given with the robot in cyan mode and deduce the elements of Thymio's program (sensors and actuators).
7. Conclude with the new cases.
8. Pose the challenge/problem: program Thymio to follow Track C, using Thymio's language (ex. VPL3). Give 3 minutes for team discussion first, then approximately 5 minutes of access to VPL to do the program in the VPL interface and test.
9. Test the program on all Tracks (A, B and C).
10. Discover that it is possible to decouple the sensors and associate different actions to each one (Track D).
11. Program Thymio to follow a Track according to different scenarios (see Tracks on side).







Chapter 1

Observe behaviors to better understand the operation of ground sensors.

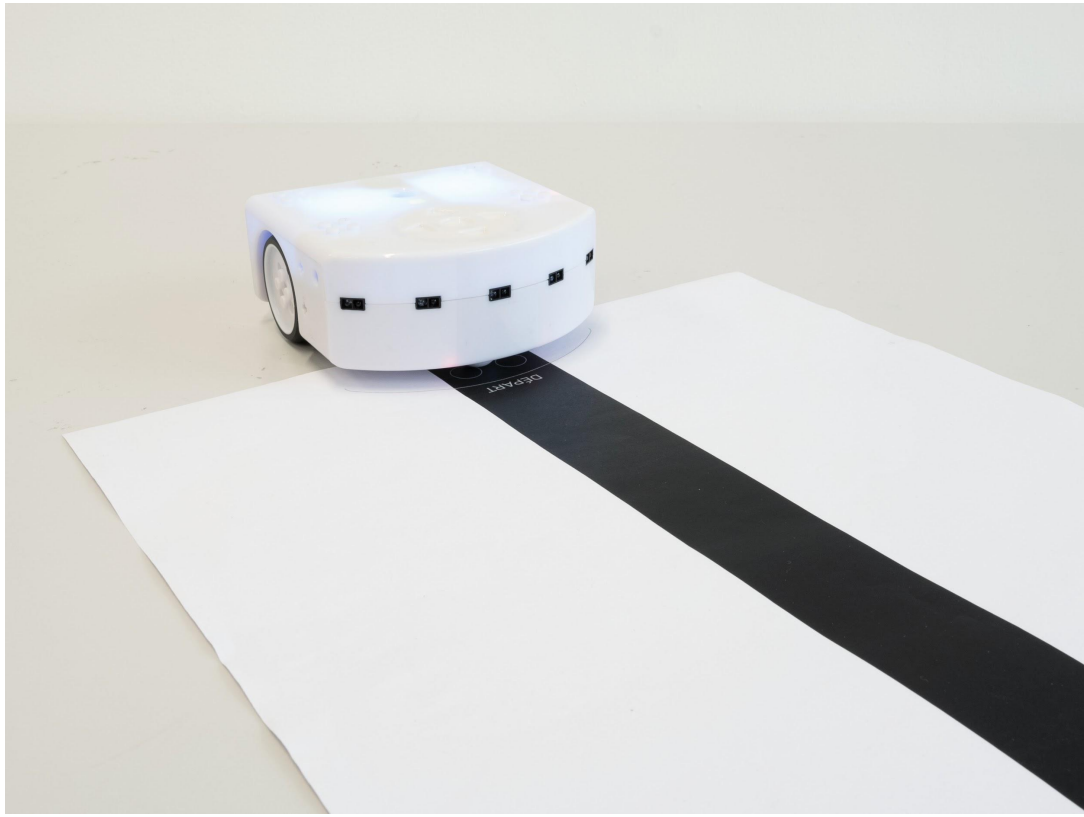
1. Show Track A (straight line), provided in the Appendix, and ask students to predict (or recall)* the path of the Thymio in cyan mode.

2. Show the students the Thymio stencil (Handout 3). The stencil has 2 holes at the location of Thymio's ground sensors. Tell the students: "Let's imagine that this stencil is Thymio, and these holes are its sensors". Simulate Thymio following track A.

3. Distribute Handout 4 for students to fill out and ask them to describe the behavior of the stencil on the track.

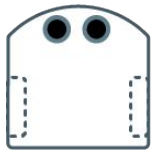
Pool the observations and ask:
How many configurations for the sensors did you observe?
How does Thymio react each time?

4. Check by testing with the robot on the track.



**This activity assumes that you have seen the basic behaviors with the students.*

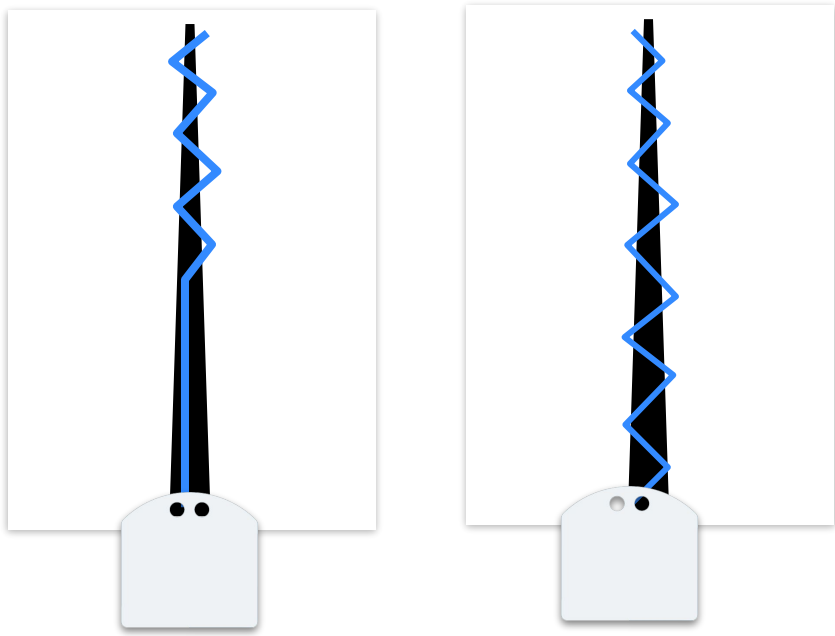
The behavior on Track A can therefore be described as follows:

When  **the Thymio moves straight forward**

When  **then Thymio turns right**

5. Now show Track B and again ask students to predict the trajectory of the robot, this time using Handout 5.

Share the trajectories found.



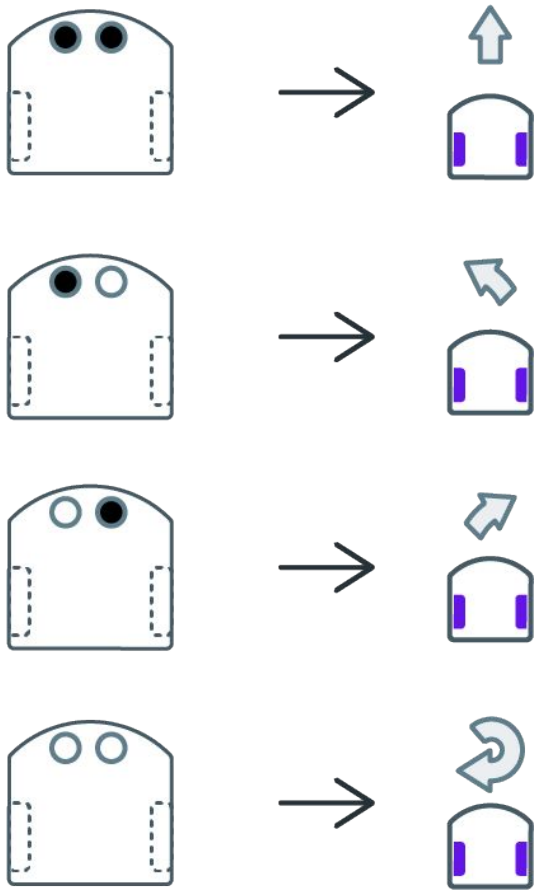
Possible trajectories (depending on starting position).

6. Distribute Track B and a stencil to each group. Ask them to simulate Thymio following the track and to finish filling in previously distributed Handout 4.

7. Go to each group to address their hypotheses directly with the robot.

Pool and conclude on all cases of sensors and actuators.

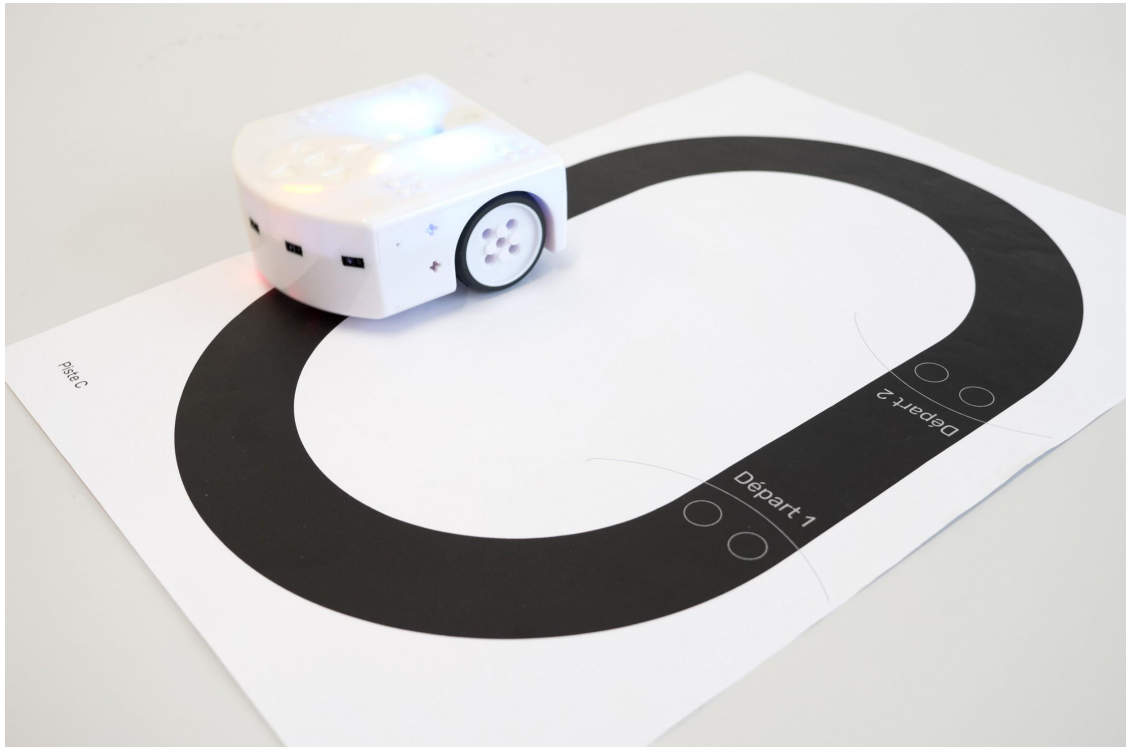
Suggestion of solution:



8. Finally, hand out Track C with a Thymio paper stencil and challenge students to complete the program so that Thymio follows Track C in both directions.

9. Allow the students approximately 3 minutes for discussion. If necessary, recall the cases found during the previous step.

10. Now give access to the programming interface (VPL3) and allow each group approximately 5 minutes to complete the program and test with the robot.

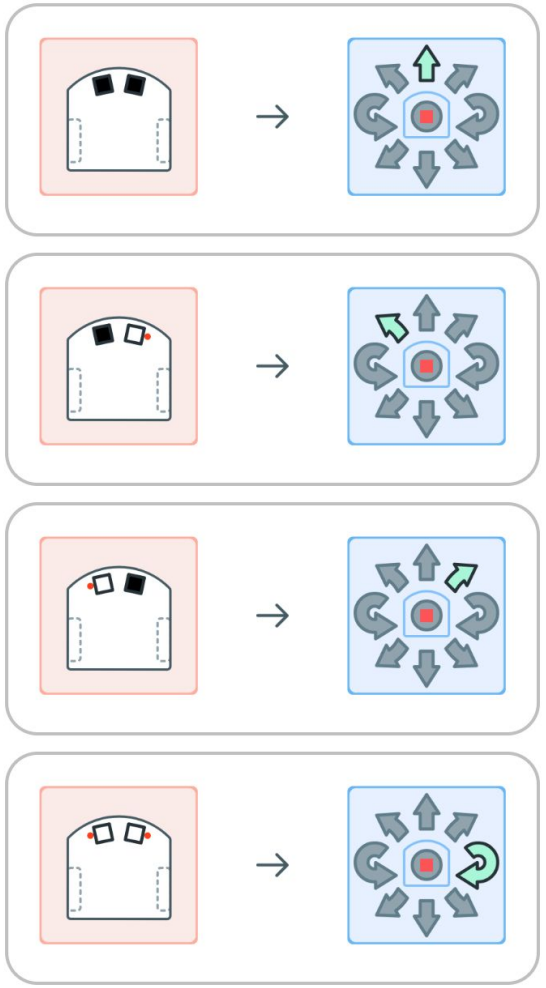


Pool the programs that have been created. Also test the program on tracks A and B to confirm.

Lessons learned

To follow a black track on the ground, Thymio uses its two proximity sensors facing the ground. Each sensor has two states (detection of black or white) which makes four possible combinations, each associated with a different action.

Suggestion of solution:



* Here Thymio can turn in the other direction too.

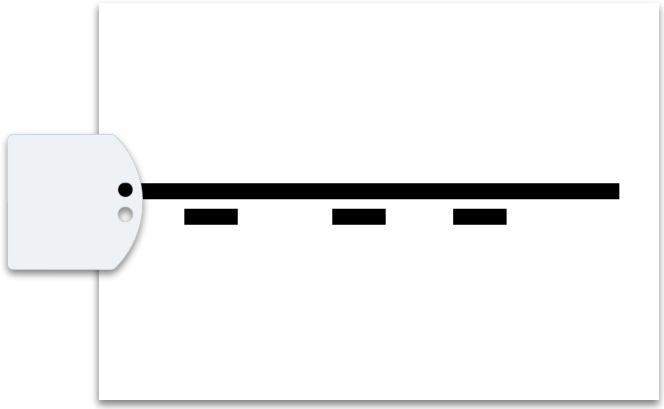
Chapter 2 Practice and go further

1. Now take Track D and associated objects with each small black line to create a scene.
   Examples of objects to put next to each line, or even in place of each line, are provided on the handout.

2. Launch a new challenge: Have Thymio move along the track and react each time it comes across a character/item (by making a sound and/or lighting up in a certain color).

Each line can be a character or a flat element.

Pool the different proposals, let each group demonstrate by linking their program and the structure of their story.

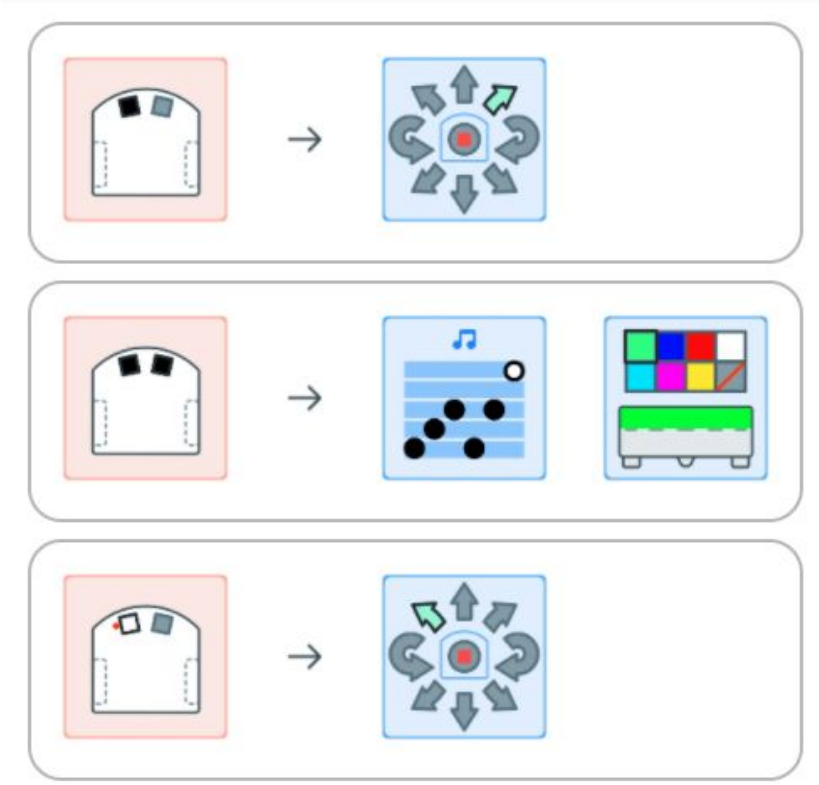


Thymio can therefore be programmed to follow a narrow line using only one of its sensors, and use the other sensor separately to program another action.

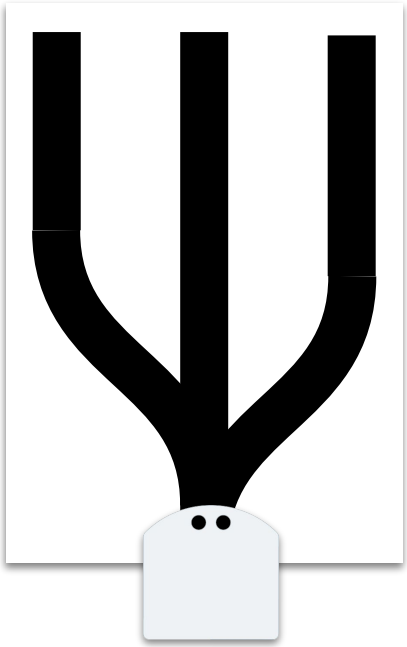
How can I make Thymio stop every time it encounters a character?

As a bonus activity, you can combine line tracking with obstacle detection with the front proximity sensors (page 39). You can make Thymio stop when an obstacle (character) is detected on one side, then continue its way as soon as it disappears.

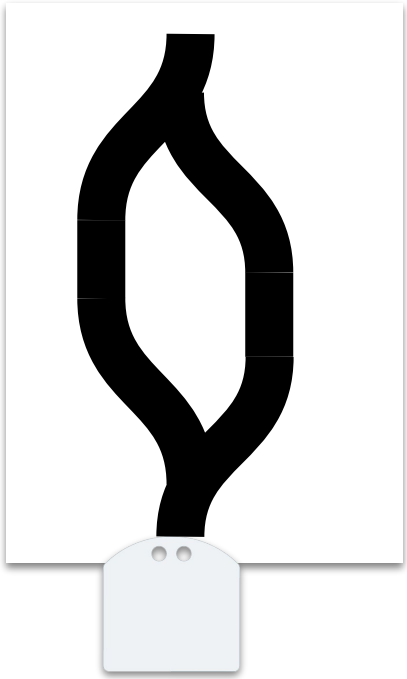
Suggestion of a solution:



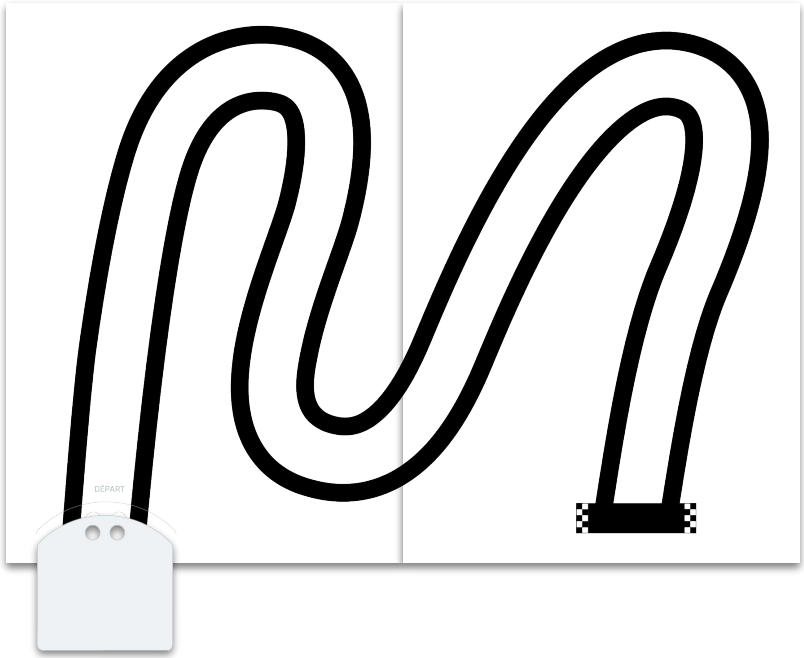
Other possible activities (All Tracks in appendix):



Program to go first to the left, then to the middle, then to the right (objects to reached can be placed at the end).



Program to choose the right path (a trap can be placed on one of the two choices).



Program Thymio to reach the finish line by staying inside the track. A time constraint can be added, the Thymio that will follow the track the most efficiently will be the winner.

2. Rotation and speed control

Concepts and skills involved:

Actuator of a robot. Relation between speed and rotation.	Collaboration Communication Problem solving	Synchronization

Goals:

- Identify and understand the relationship between the speed of the wheels and the rotation of the Thymio robot.
- Learn how to set the speed of the wheels of the VPL block to make Thymio turn.

Materials:

- Handouts A3 in appendix.
- Two pens
- Cardboard and a Double Hole Punch

Summary of the approach

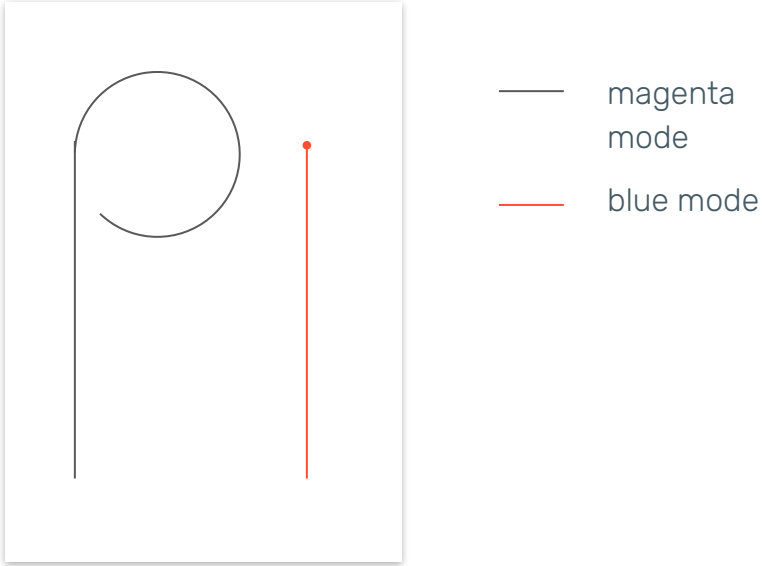
1. Observe the behavior of Thymio (the rotation), in magenta mode and in blue mode.
2. Verbalize and share the differences observed.
3. Ask the students to make (DIY) the device for attaching two pens together (see next pages).
4. Challenge them to draw the specified shapes.
5. Share to highlight the connection between speed and rotation.
6. First challenge: Go down the slalom track with the pens simulating Thymio.
7. Associate each direction with speeds in the wheels.
8. Final challenge: Program Thymio to draw circles of different sizes.

Chapter 1

Observe different parameters for the same function

1. You will observe two different ways in which Thymio rotates. First, turn on Thymio and choose the magenta mode. Place it on a white sheet of paper and put one of the pens in its hole. Touch the front arrow and then the left or right arrow to make Thymio turn, touch the center button to stop it.

2. Then change to the blue mode. Choose a different color pen to distinguish the two tracings on the paper. Move Thymio forward and then rotate it by clapping your hands. Observe the rotation.

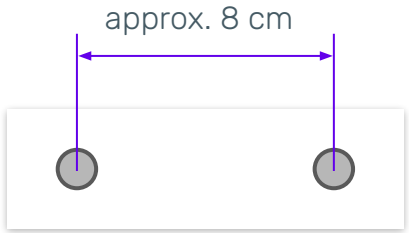


Tracings left by Thymio

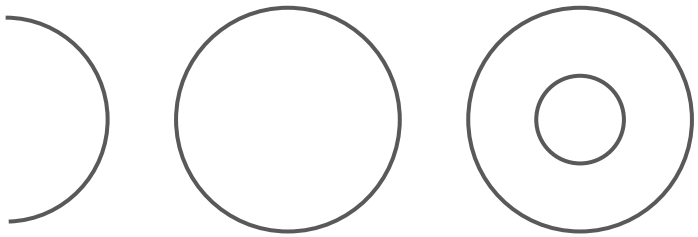
Share observations. Describe precisely what happens to the wheels in each case.

3. Then have students form pairs.
   Ask them to take 2 pens and attach them with a cardboard strip (as shown on the right). Then ask them to draw the shapes on the right, with each student handling 1 pen.

4. The students try to move at the same time and draw one of the given shapes.



Shapes to draw:



Verbalize what has just been experienced, make the link between speed and rotation.

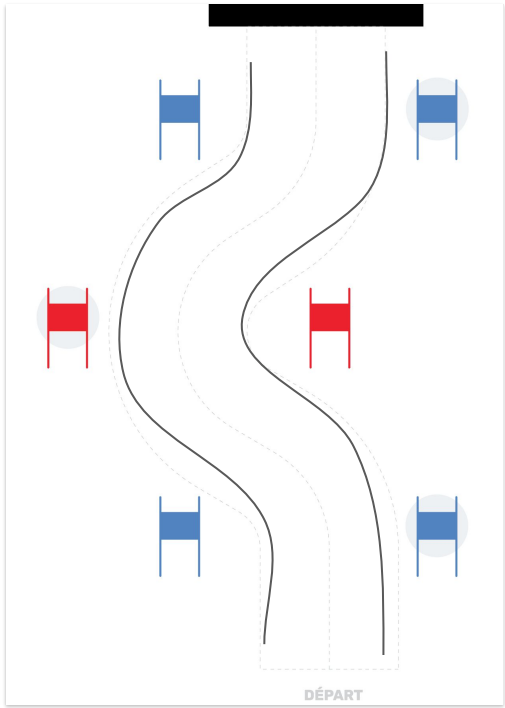
Chapter 2 Settings for the situation

1. Have students pair up again and attach the pens as in the previous activity.

2. Give each team Track E, which is a slalom track. Each pair must coordinate to run the track while avoiding obstacles. As students try to complete the course by moving at the same time, they must adjust their speed accordingly.

Verbalize what has just been experienced. What parameter needs to be adjusted to succeed in the course? And how?

3. Have students complete Handout 6 by matching directions to wheel speeds.

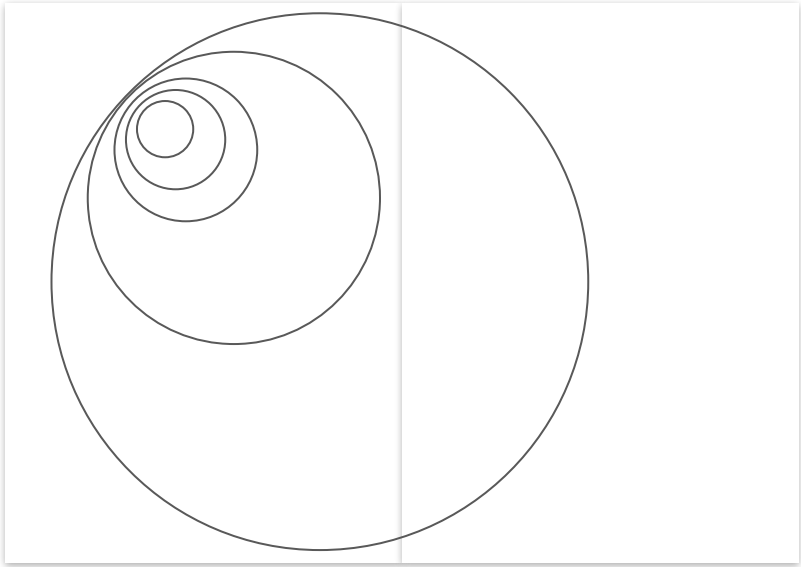


Example:

The setting of the wheel speed allows the execution of different curves.

4. Now students will program the robot by setting the wheel speeds.

   Give each pair large white sheets of paper or several sheets of A3 size. Have the students program Thymio to draw circles of different sizes by putting a pen in its back pen holder hole.



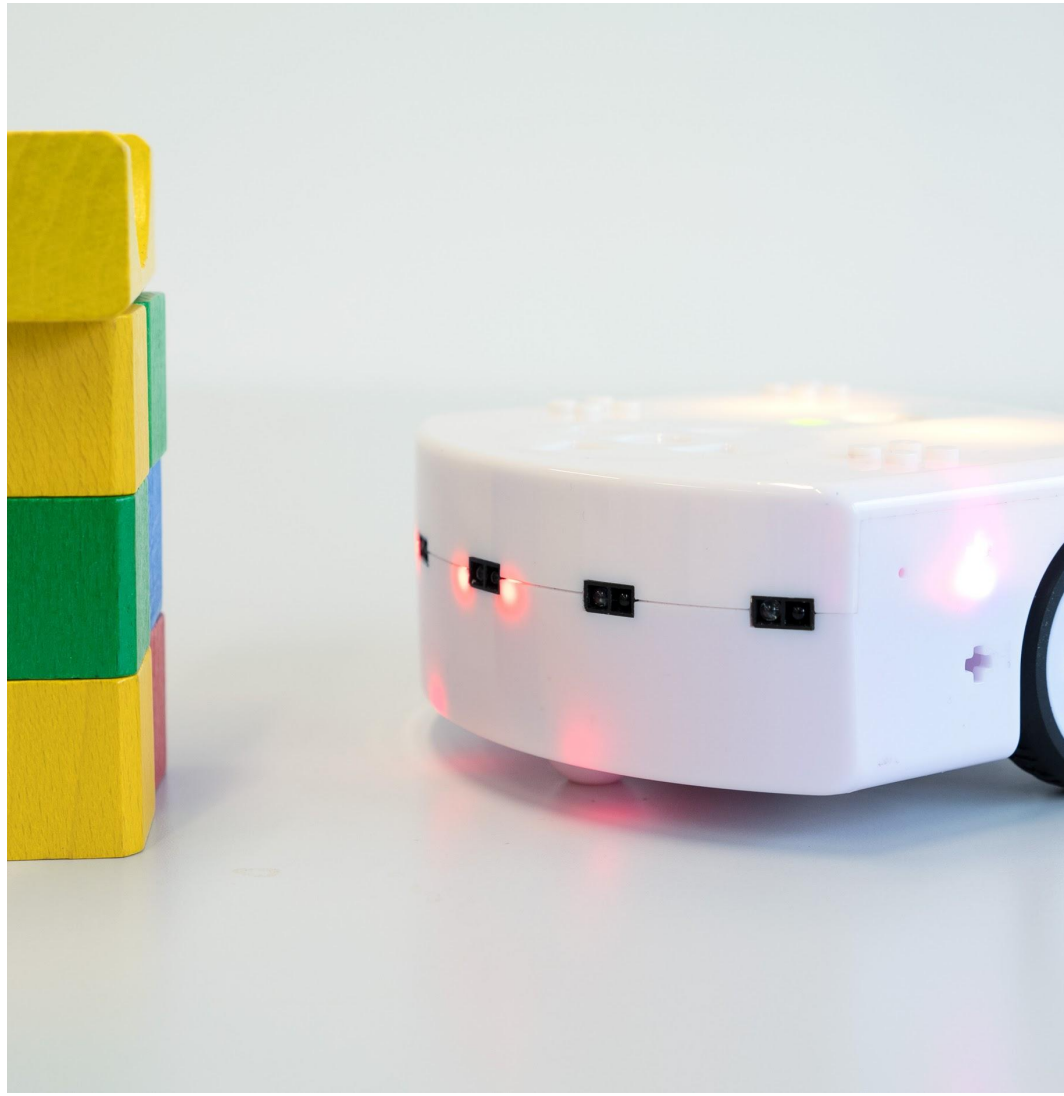
Pool the results.
What is the smallest circle that Thymio can draw?
What is the largest?

3. Proximity sensors

Concepts and skills involved:

Algorithm
Orientation
Sensors of a robot

Collaboration
Communication
Problem Solving



Goals:

- Understand Thymio's vision system through its horizontal proximity sensors
- Identify the difference between "and" and "or" for a condition
- Recognize the components of the Thymio

Materials:

- Thymio robot
- Thymio stencil on transparent acetate, to be printed or drawn with felt pen (Teacher Sheet 7)
- Enclosure to be printed (in Appendix)
- Elements to collect/positions (Teacher Sheet 6)
- Books or cardboard to form the enclosure

Summary of the recommended approach

1. Observe the behavior of Thymio in yellow mode and verbalize how the sensor LEDs react to obstacles.

2. Make a parallel with the "Line tracking" activity, highlight the possible cases for the sensors.

3. Set up an enclosure with "objects" inside (see instructions on the next page).

4. Explain the challenge that the students are going to do: Program Thymio to go through all the points in the enclosure.

5. Choose a path that the whole class will try to follow.

6. Model Thymio and its sensors using the transparent template.

7. Launch the challenge.

8. Share all the programs that have been created.

Chapter 1

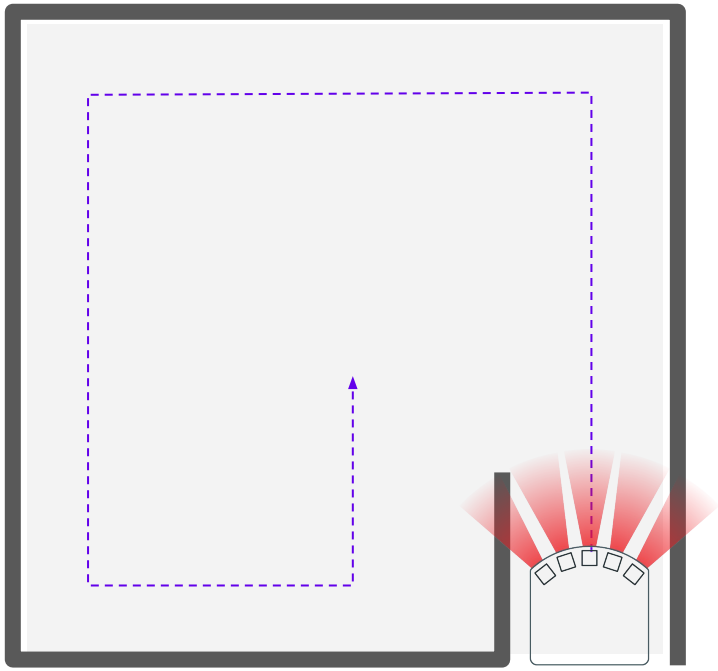
Group events and program the robot to accomplish a task

1. Set Thymio to yellow mode and observe its behavior when it finds obstacles. Ask students to describe the feature on the Thymio that indicates a sensor is in use.

2. Recalling the "Line tracking" activity, extract the possible cases for a proximity sensor.

3. Prepare the enclosure (Appendix) by placing "objects" (examples are provided on Handout 6) to be picked up or points to be reached everywhere inside (one per square). Then place the "walls" (paper, cardboard strips, books, etc.) according to the diagram on the right.

4. Present the challenge to the students: Thymio has to go through the enclosure, passing through all the squares. First, ask the students to imagine Thymio's path through the enclosure and to explain their choice.



planned route

enclosure walls

Pool and choose a route that the whole class will simulate afterwards.

5. Present the transparent Thymio stencil (Teacher Sheet 7) with the proximity sensor beams and explain how it works. By distributing Student Sheets 7 and 8, collectively simulate Thymio's path by extracting the events from the sensors each time.

Pool observations:
Are there any repeated events?
What does "when several sensors are active" mean?

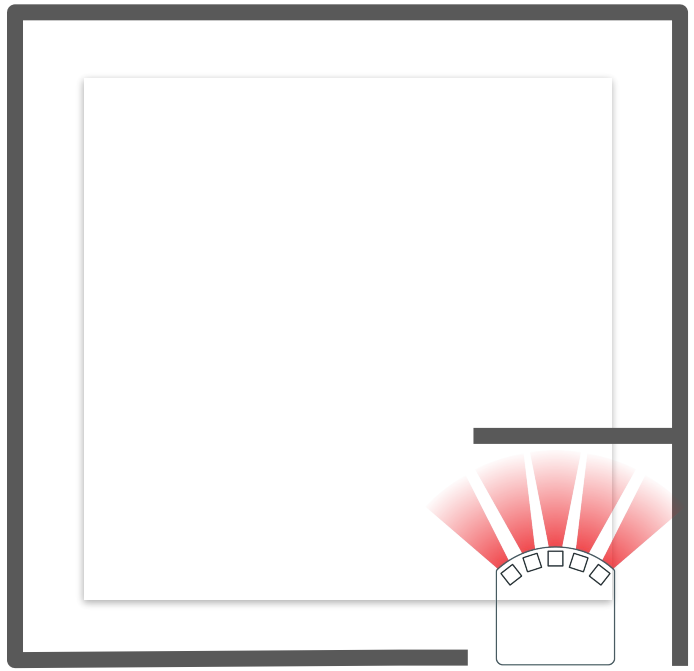
6. With the students divided into groups, each with an enclosure and a Thymio, launch the challenge. To check that Thymio is passing through everywhere, you can use a felt-tip pen so that Thymio leaves a trail.

7. You can combine unplugged and plugged moments to get the students to verbalize and reflect if Thymio is not behaving as expected.

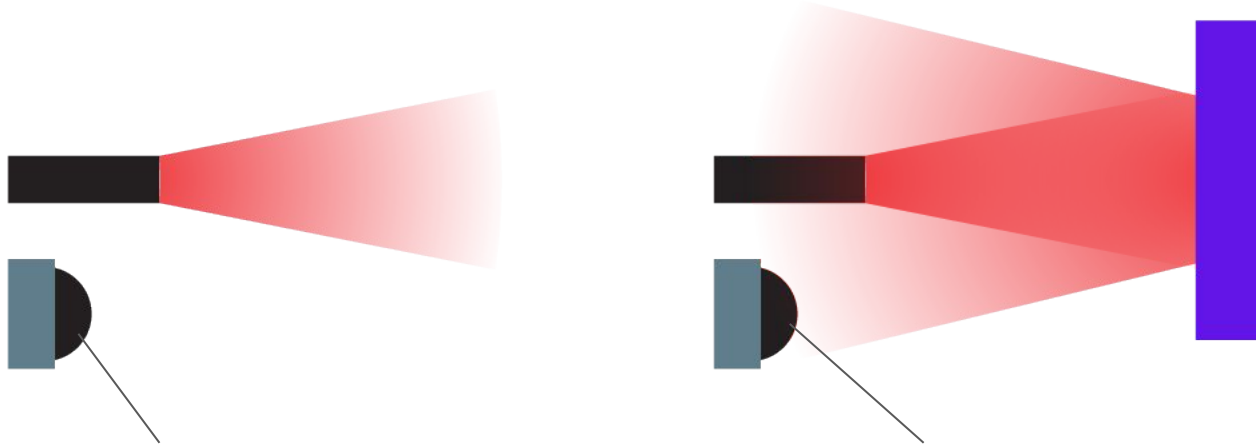
Pool the possible solutions. Ask each group to present their code.

8. To go further, change the position of the inner wall according to the diagram on the right. Then run the corresponding program and test.

9. Also Test the path with white walls, and then with dark grey walls.



Pool observations: does the color of the wall make a difference? Why or why not?
Conclude on how the infrared sensors work (see diagram below).



No object, no signal reception

Presence of an object, detection of the return signal

Bonus

Thymio's Tale

Concepts and skills involved:

Algorithms
Components of a robot

Collaboration
Communication

Oral and written expression

Goals:

- Know how to combine events in VPL3

Materials:

- Track D to print
- Toys, wooden blocks (at least 5cm high)
- Thymio robot

You now know how to program Thymio to follow a track, and even make it make sound and light if it comes across elements on its way.

1. Recall what was seen last with the track following activity. What sensor could be used along with the ground sensors to make Thymio stop and then continue on the track?

Pool

2. Launch a new challenge: make Thymio move forward on the track and each time it meets a character it stops, reacts and then leaves (find the right event to make it leave).

Credits

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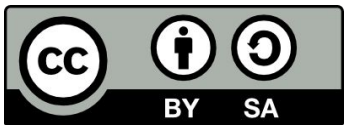

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WISSENSCHAFT.
BEWEGEN
GEBERT RÜF STIFTUNG

EPFL

thymio
by MOBSYA

Appendix

Student Handouts

Handout 1
Pre-programmed behaviors

Write down your observations below:

Handout 2
Pre-programmed behaviors

Green

- When Thymio detects something _____ then it moves forward.
- When it detects something on the side, then _____.

Cyan

- When thymio detects _____ on the ground, then it moves forward.
- When Thymio detects white then _____.

Magenta

- When the forward button is touched then _____.
- The the backward button is touched then _____.
- When the left button is touched then _____.

Yellow

- By default Thymio _____
- When it detects something in front then _____.
- When it detects something on the side then _____ to avoid it..
- When _____ _____ then it stops.

Bue

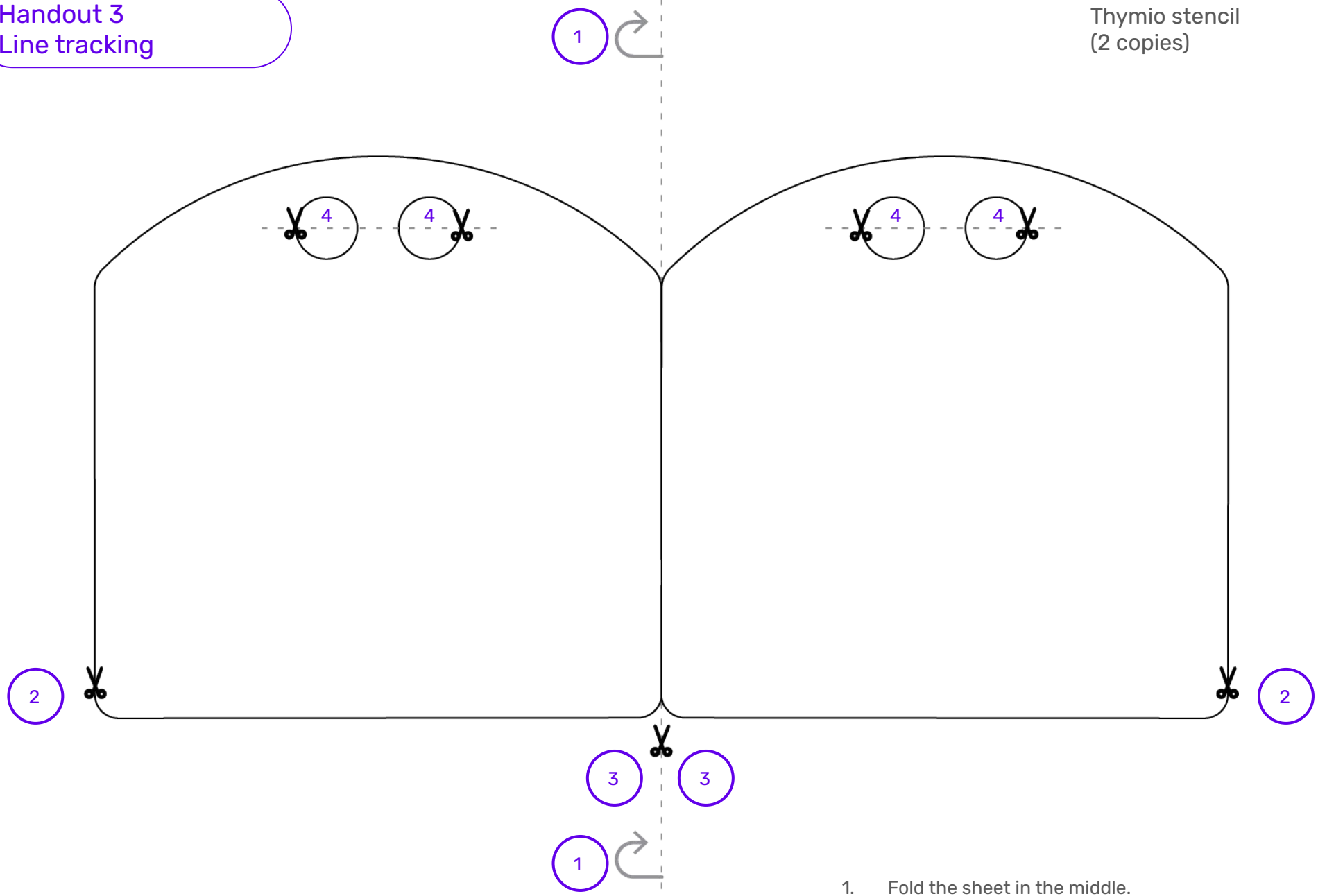
- When we clap our hands twice Thymio moved forward..
- When we clap _____ then it starts turning.
- If Thymio is turning when we clap once then it _____.
- If Thymio is moving when we clap twice then _____.

Red

- When Thymio detects something _____ then it moves back.
- When it detects something behind then _____.
- When it detects something _____ and _____. then it starts making noise.

Handout 3
Line tracking

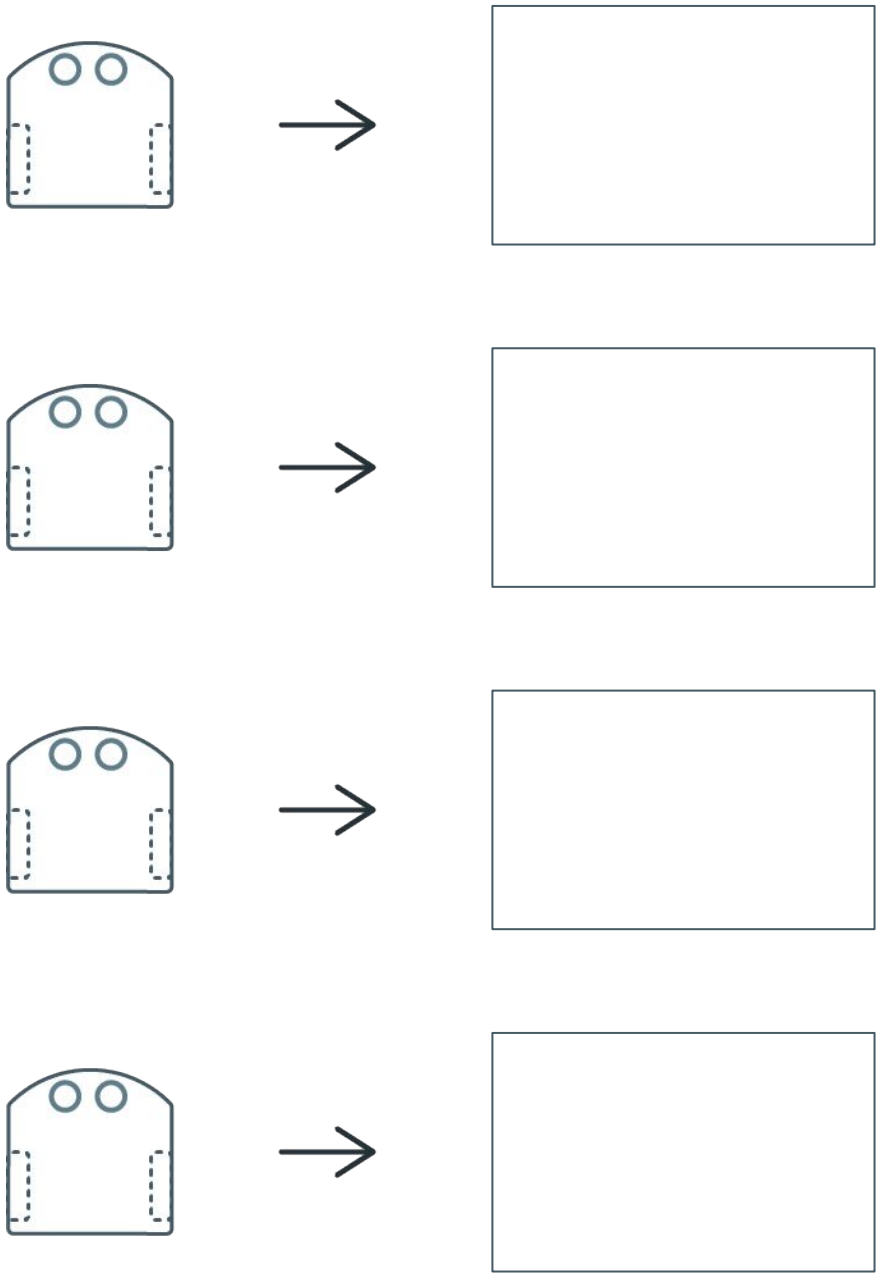
Thymio stencil
(2 copies)



1. Fold the sheet in the middle.
2. Cut around the shape.
3. Separate both stencils.
4. Cut the holes of the sensors.

Handout 4
Line tracking

For Track A and then for Track B, color the possible cases for the sensors then draw for each case the action that Thymio performs.



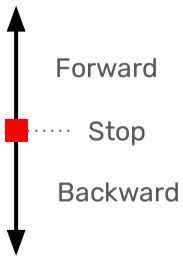
Handout 5
Line tracking

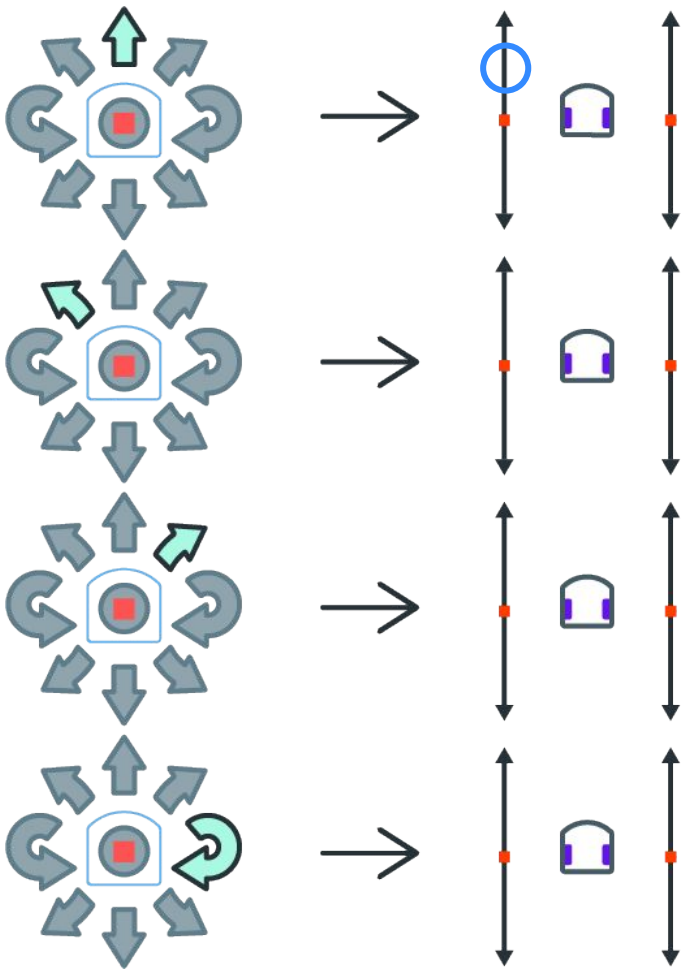
Track B

Draw the trajectory that you think Thymio will follow on this track:

Handout 6
Rotation and speed control

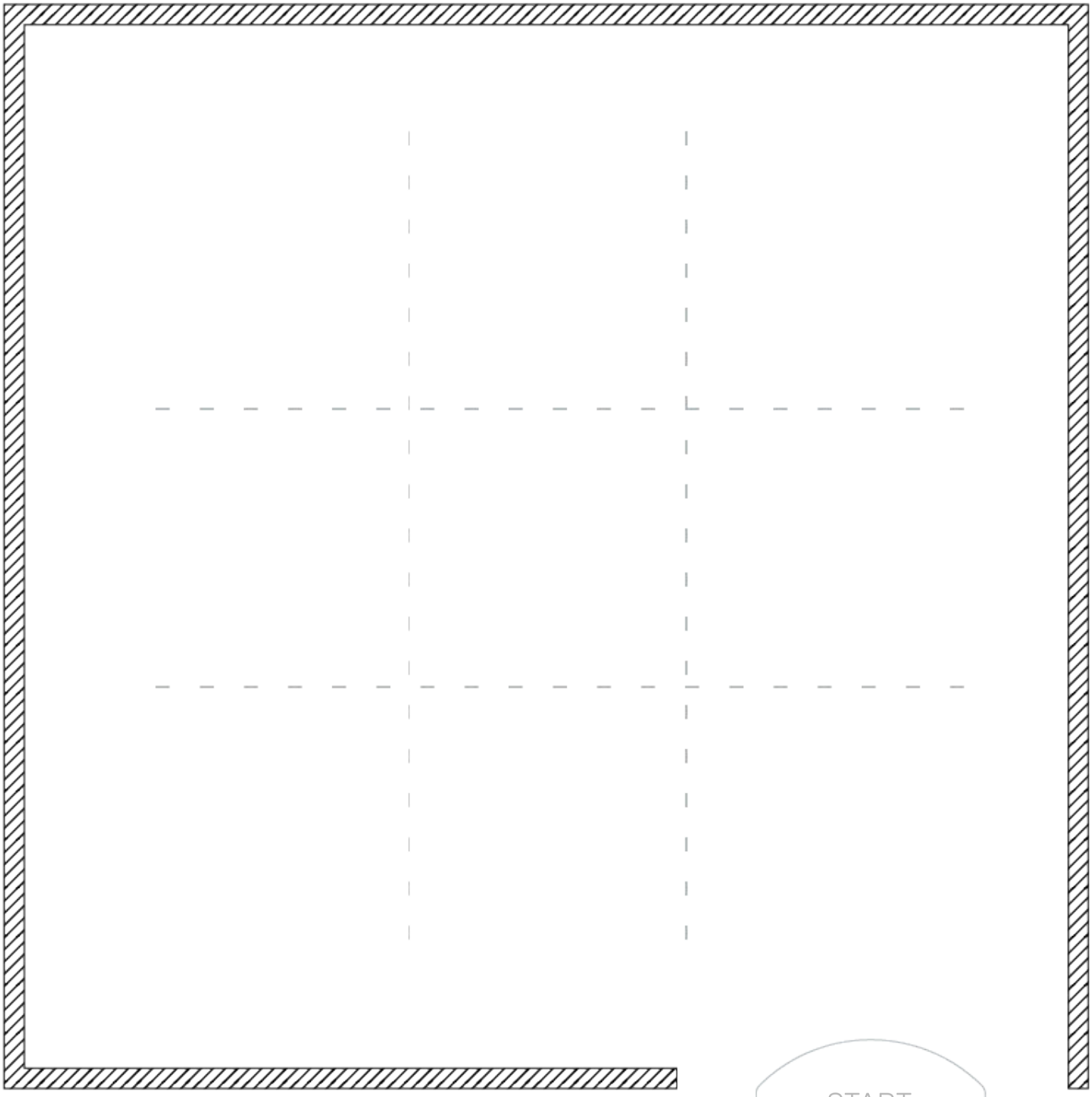
After doing the activity with the pens, you could see how the speed of each wheel determines the rotation of the Thymio. Now mark on the diagrams to the right the speed (and direction) of the wheels according to the desired direction (forward, left...)





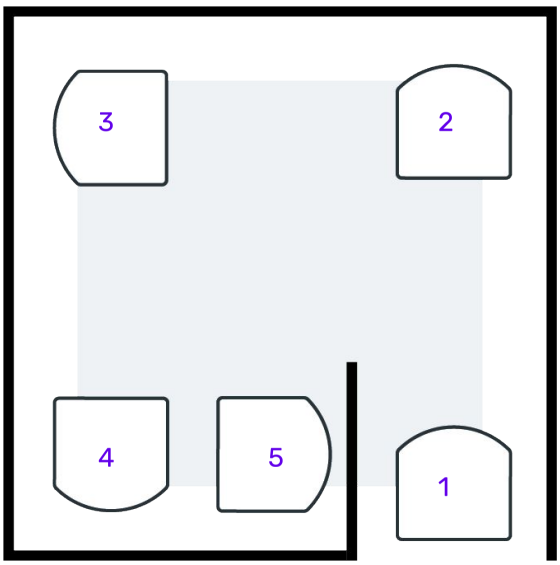
Handout 7
Obstacle detection

Simulate Thymio's route through the enclosure using the transparent Thymio stencil. Make sure you pass through all the square cells.

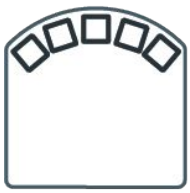


Handout 8
Obstacle detection

Simulate Thymio's route with the help of the transparent Thymio stencil on the sheet that represents the enclosure. Fill in the diagram according to your observations concerning the different sensors.



1



2

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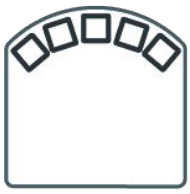

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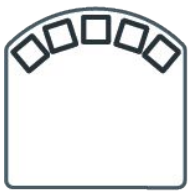

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Appendix

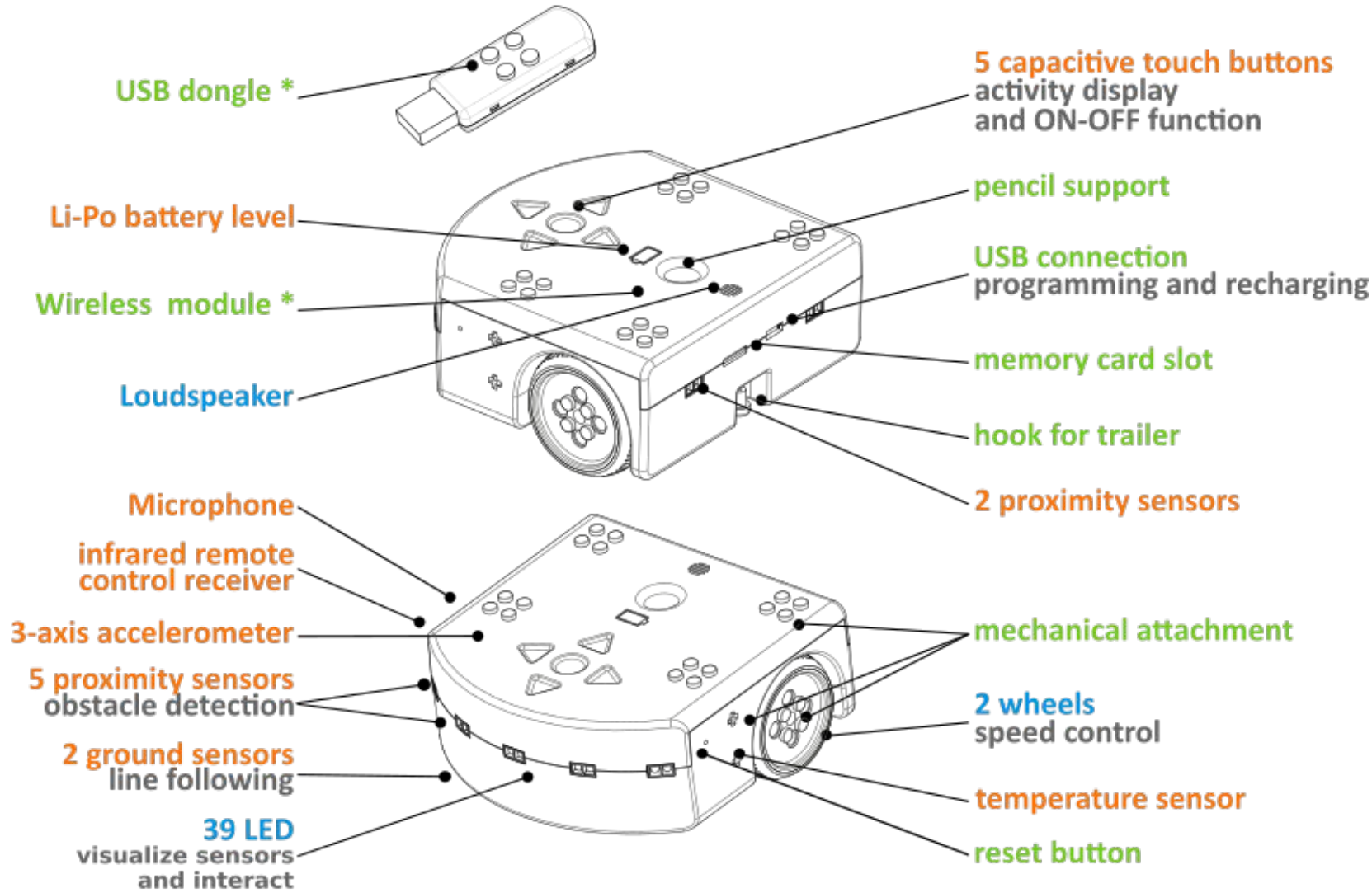
Teacher
Sheets

Sheet 1
Pre-programmed behaviors

Green	• When Thymio detects something in front then it moves forward. • When it detects something to one side then it turns in the same direction. • BONUS: When it detects something very close in front, then it moves back.	Cyan	• When Thymio detects black on the ground, it moves forward • When Thymio detects white it turns on itself.
Yellow	• By default, Thymio moves forward by itself. • When it sees something in front then he moves back. • When it sees something on the side then it turns to avoid it. • When it detects a void underneath it then it stops (edge of the table).	Blue	• When you clap twice it moves forward. • When you clap once it turns. • When you clap once while it turns, it goes straight. • Other behaviors exist, the list here is not exhaustive.
Red	• When Thymio detects something in front then it moves backwards. • When it detects something behind then it moves forward. • When it detects something in front AND behind then it emits sound.	Magenta	• When you touch the forward button, Thymio moves forward. • When you touch the backward button, Thymio goes backwards. • When you touch the left or right button then Thymio turns.

Sheet 2
Thymio's features

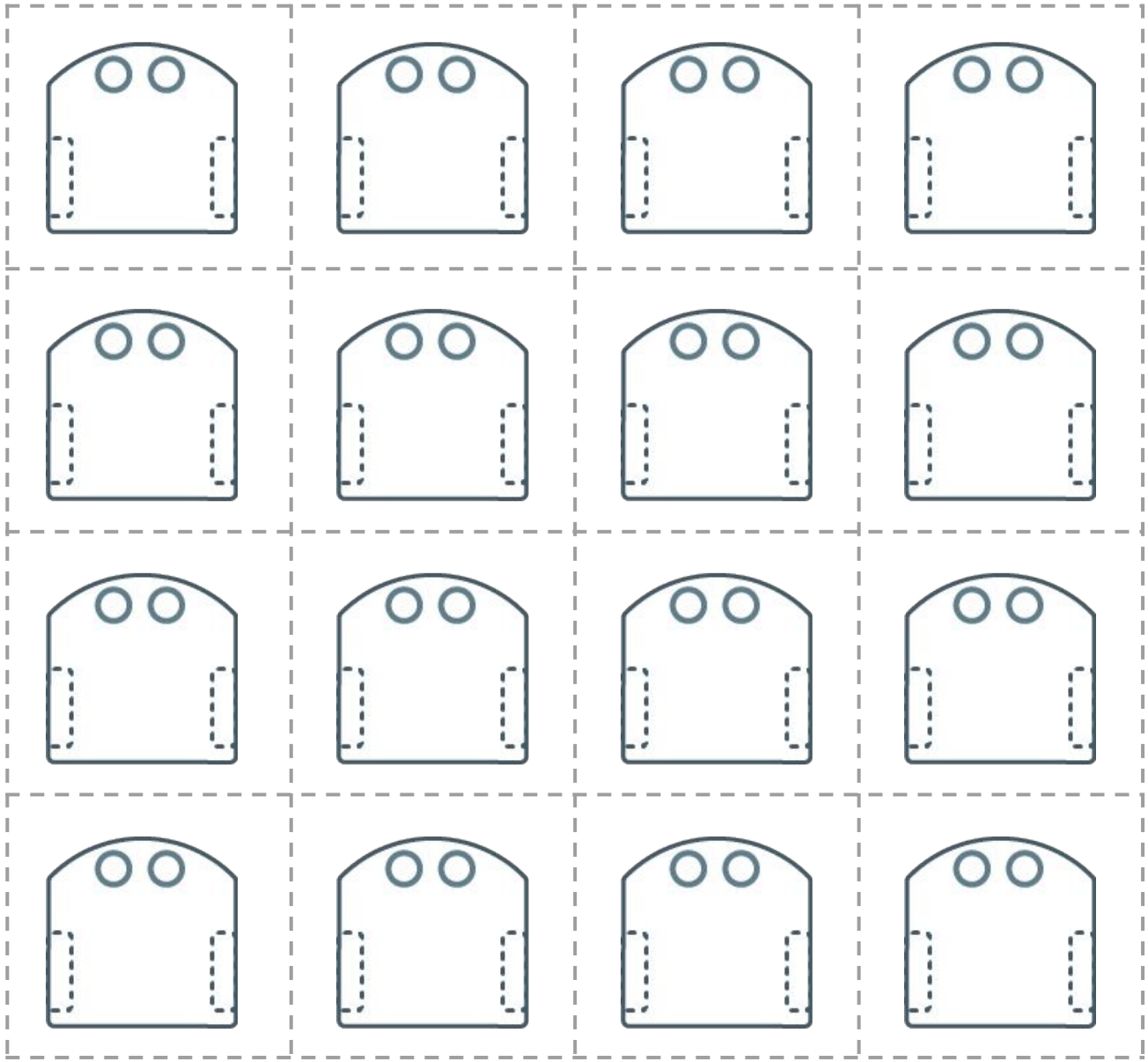
Sensors
Actuators
Other



* available only with Wireless Thymio

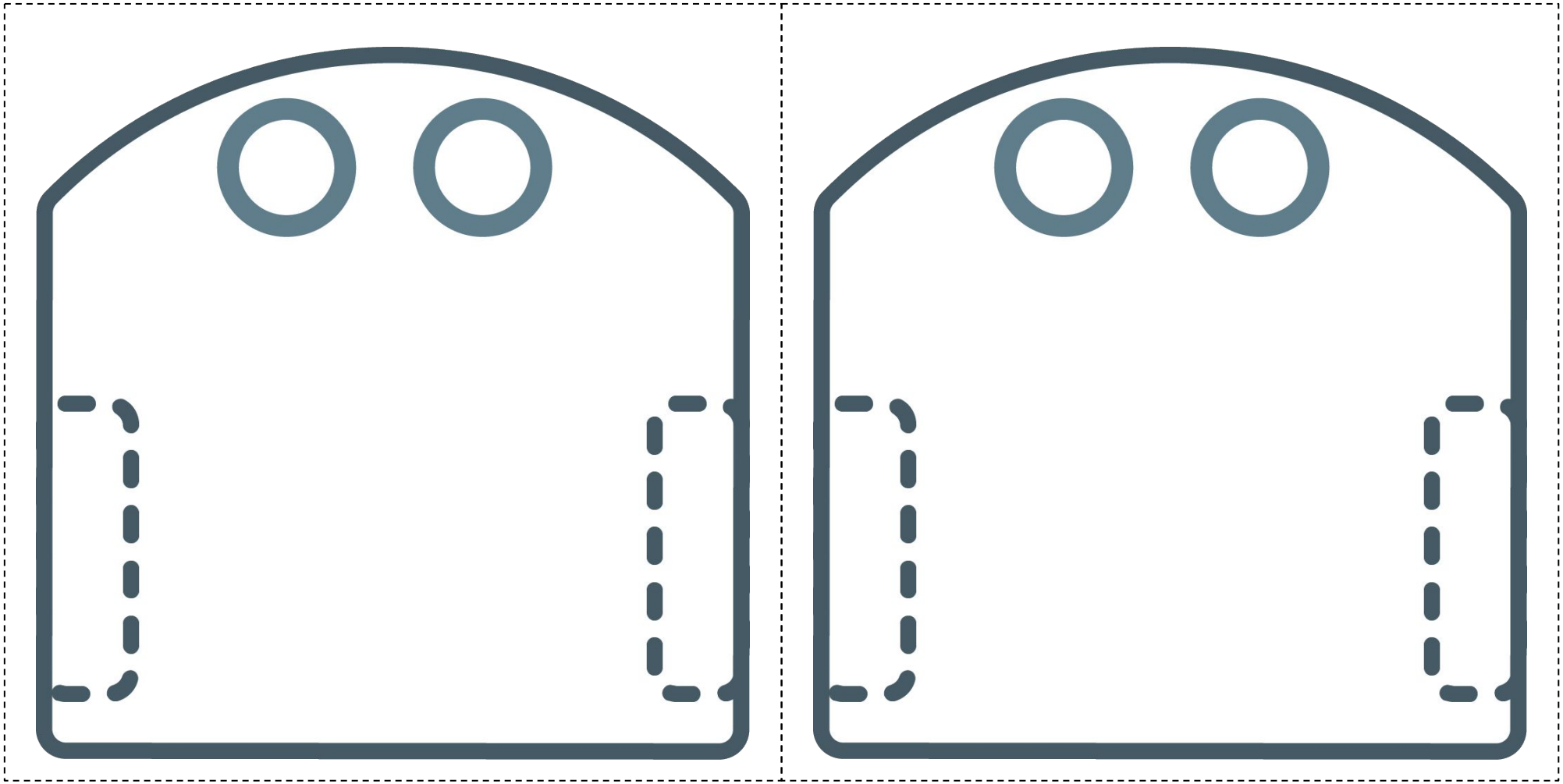
Sheet 3
Line tracking

Cut out and distribute these cards for students to color the sensors according to the cases they observed.



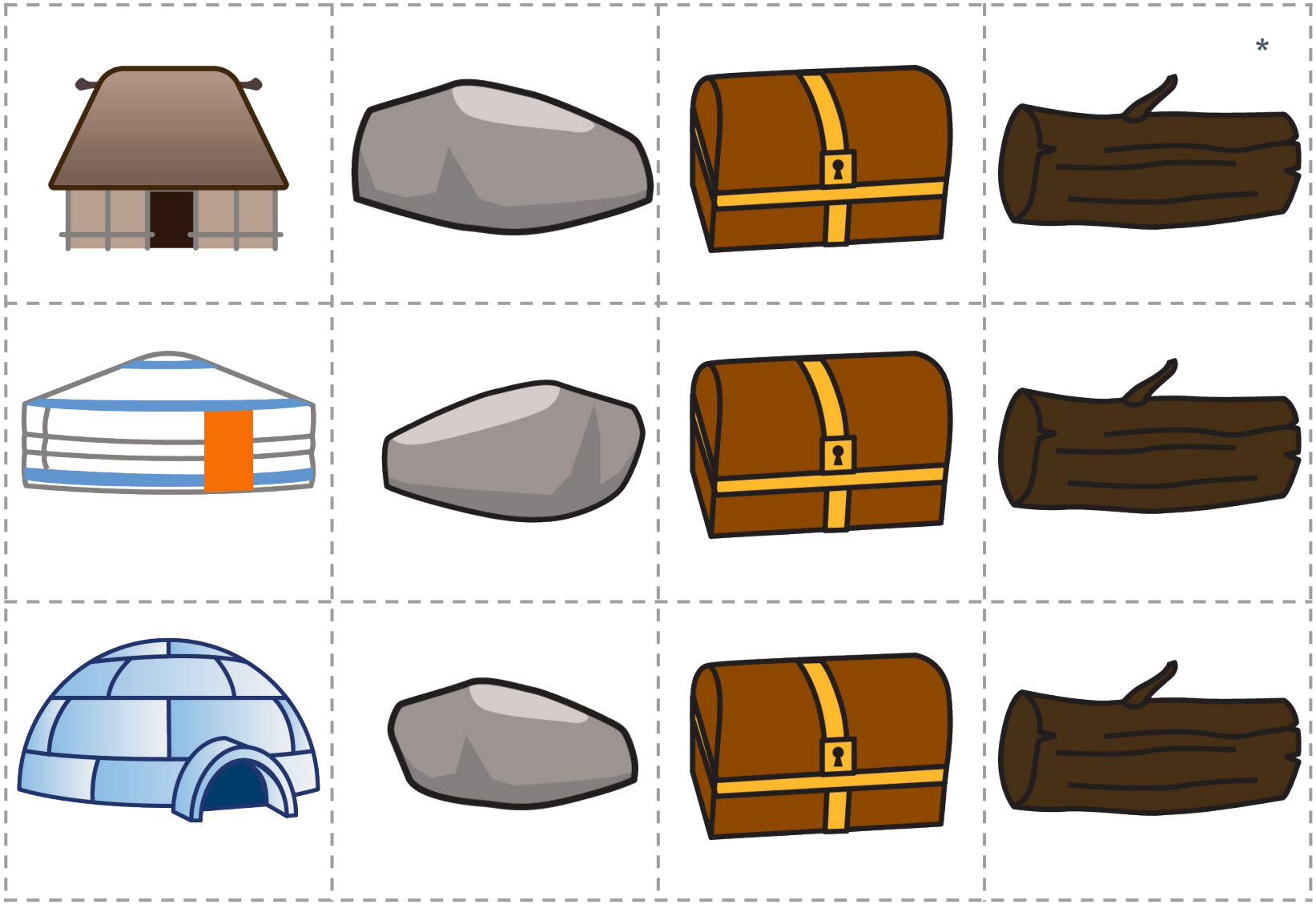
Sheet 4
Line tracking

Cut out the cards if necessary to share observations on the board.



Sheet 5
Line tracking

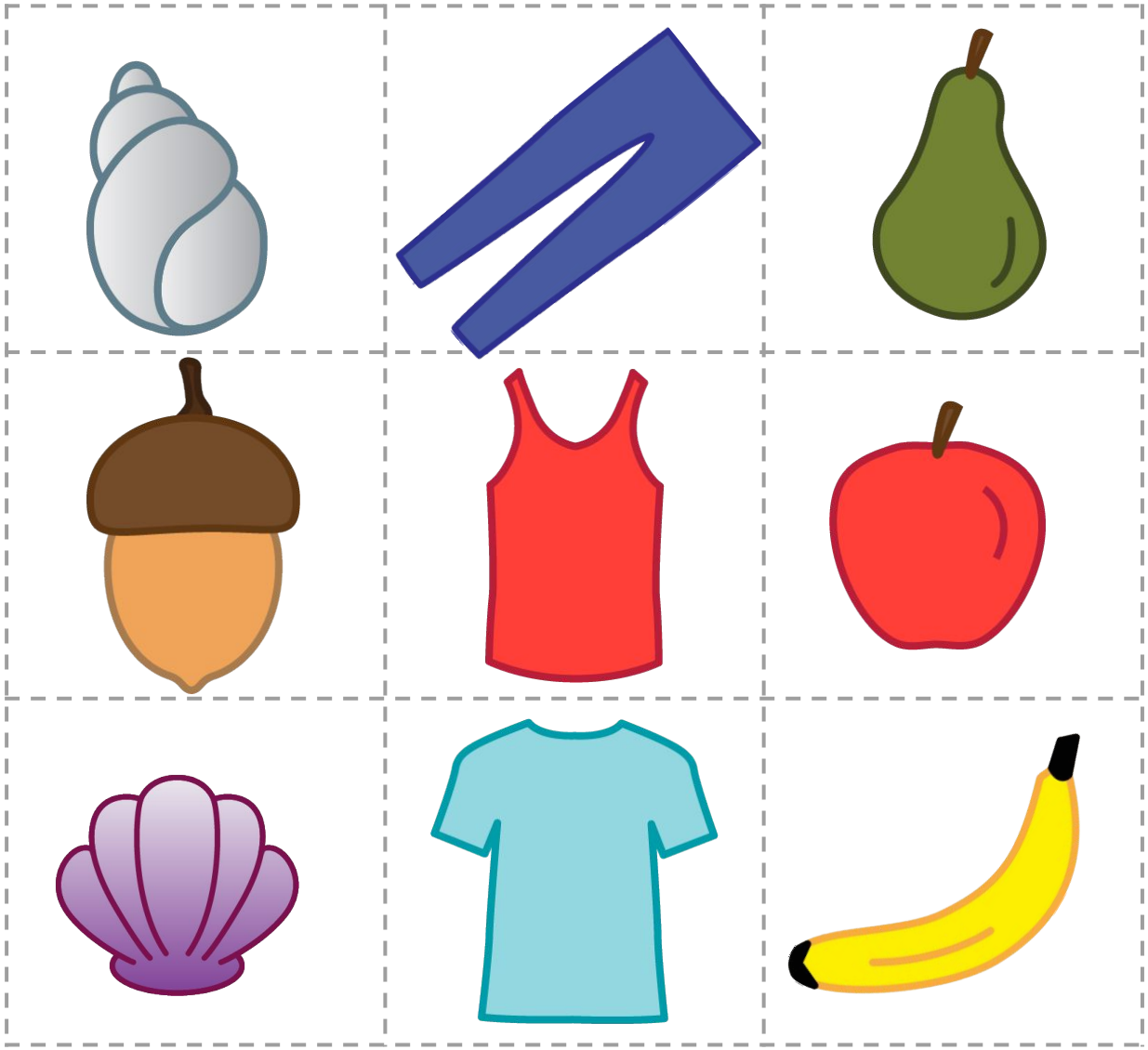
Examples of objects that Thymio may come across on its way (Track D).



*The tree trunks can directly replace the black lines on the track.

Sheet 6
Proximity sensors

Examples of objects to pick up or reach in the enclosure.



Sheet 7
Proximity sensors

Thymio stencil to be printed directly on transparent acetate or on a white sheet and then traced (only the contours) on transparent acetate.