PRESENTATION 3 · LEARNING WITH STATEMENTS

Avoid the walls

Ultrasonic sensors: how they hear walls, how to use them in statements, and Session 3 step by step.

TheBotCup 2026 · AiBotCup Simulator



SO FAR

Timelines work, until the world is different

Presentation 1

Statements, two wheels, the **Time** sensor.

Presentation 2

Position and **Compass**; small turn errors add up.

Today

The robot **senses the walls** and decides for itself when to turn.

PART 1

The mission: Session 3

Two walls · one FINISH pad · no touching

SESSION 3 · AVOID THE WALLS

Steer around both walls

3

Session 3 · Avoid the walls

Steer around both walls and stop on the pink FINISH pad.

Each wall passed without touching anything: +50. Each hit: −10. Reach FINISH: +100. Time limit 4:00.

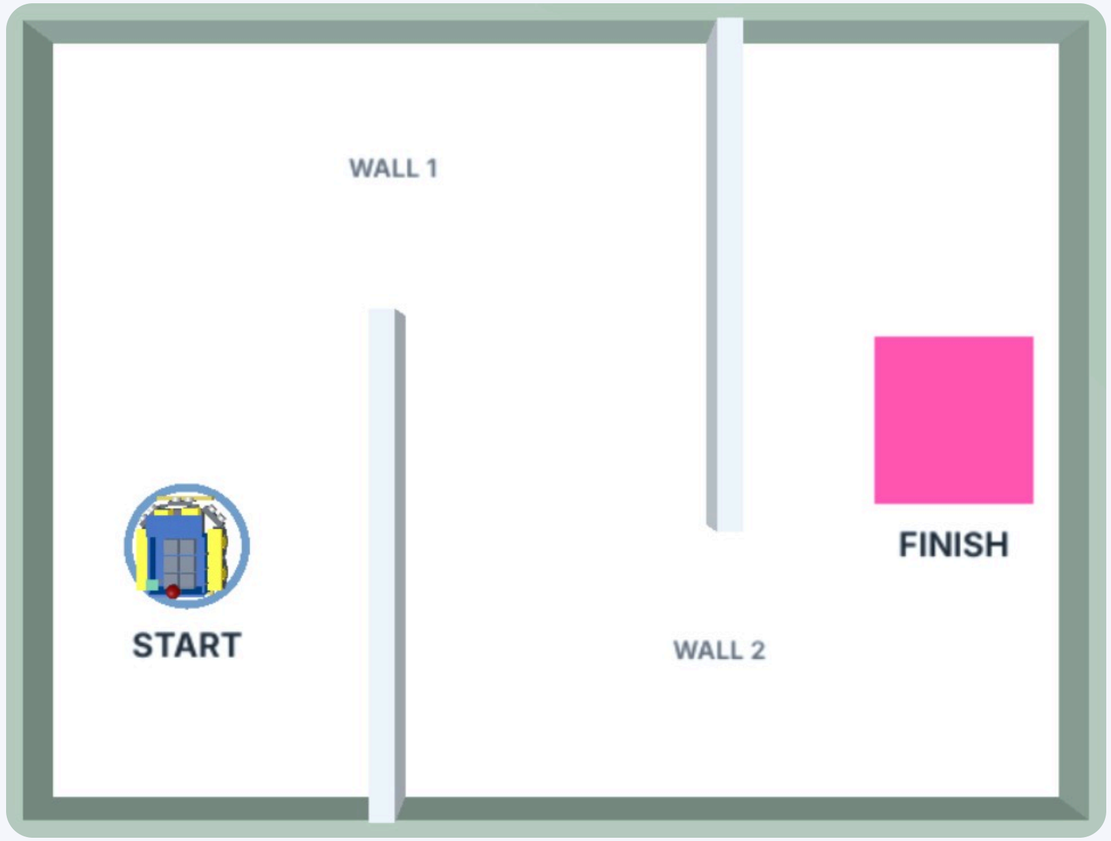
Not done yet

START bottom left, facing **up**.

Wall 1 grows up from the bottom: the gap is at the **top**.

Wall 2 hangs down from the top: the gap is at the **bottom**.

FINISH pink pad on the right.



POINTS

200 points for a clean run

+50

Past **wall 1** without touching anything

+50

Past **wall 2** without touching anything

+100

Reach the **FINISH** pad

−10

Every time the robot **hits** a wall

Time limit **4:00**. Touch a wall and you also lose the +50 for passing it.

PART 2

What is an ultrasonic sensor?

Seeing with sound, like a bat

ULTRASONIC SENSOR

Send a sound, listen for the echo



Too high to hear

“Ultra-sonic” = above what people hear. Many sensors use 40,000 vibrations a second.

Bounces back

A hard surface reflects the sound, like a ball off a wall.

Time = distance

A longer wait for the echo means the wall is farther away.

ULTRASONIC SENSOR

From echo time to centimetres

distance = speed of sound × time ÷ 2

÷ 2 because the sound goes **there and back**.

Speed of sound

About 343 m/s in air = **34.3 cm every millisecond**.

Echo after 2 ms

34.3 × 2 ÷ 2 = **34 cm** to the wall.

Wall 1 m away

The echo takes about **5.8 ms**: fast!

ULTRASONIC SENSOR

Real robot and simulator

Real sensor

The sound spreads out like a **cone**.

Soft or slanted surfaces may send back a weak echo.

Readings can jump a little.

In the simulator

One thin, straight **line** from the sensor.

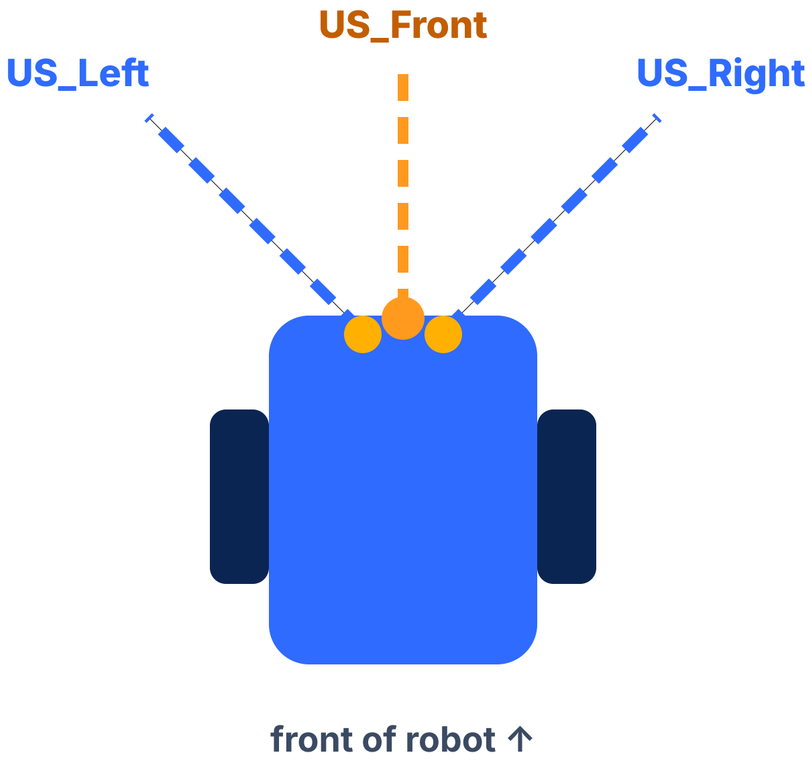
Whole centimetres, **0 to 255**. Nothing ahead = 255.

Sees walls, obstacles and the other robot, **not** colours on the floor.

PART 3

Ultrasonic in the simulator

US_Front · US_Left · US_Right



THREE SENSORS

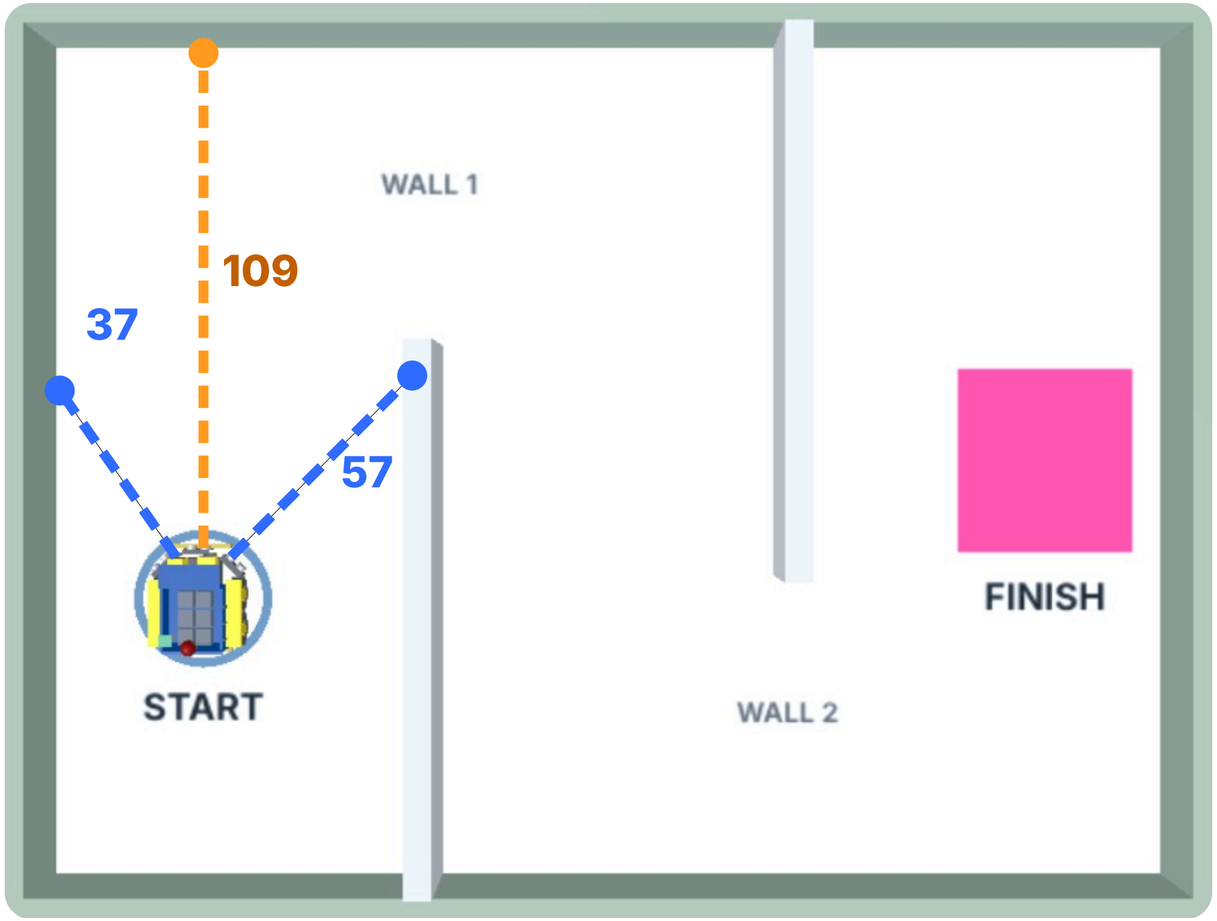
Ahead, front-left and front-right

US_Front: straight ahead.

US_Left: 45° to the left.

US_Right: 45° to the right.

They sit at the **front** of the robot. The robot's centre is about **11 cm** behind US_Front.



AT START

What the robot hears

Ultrasonic Sensors

Front	109	(US_Front)
Left	37	(US_Left)
Right	57	(US_Right)

109: the top wall, far ahead.

37: the left wall.

57: wall 1, front-right.

ULTRASONIC IN STATEMENTS

Min and Max turn a distance into a question

0 – 25

US_Front: “Is a wall **closer than 25 cm** ahead?”

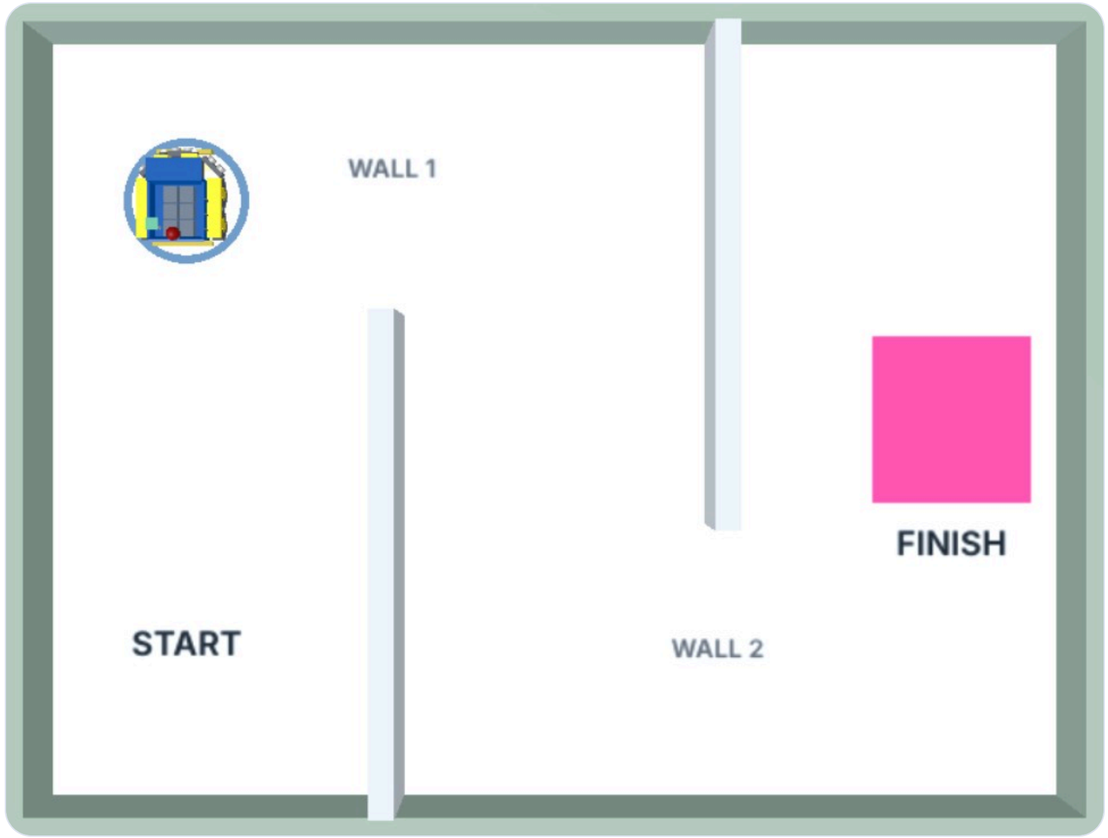
26 – 255

US_Front: “Is the way ahead **clear**?”

0 – 255

Full range: this sensor **does not matter**.

A statement can ask about **several sensors at once**. It runs only when **all** its conditions are true.



CHOOSING THE NUMBER

Why 25 cm?

Ultrasonic Sensors

Front	27	(US_Front)
Left	37	(US_Left)
Right	41	(US_Right)

At 27 cm/s the robot moves only **1.6 cm** between two checks (60 ms).

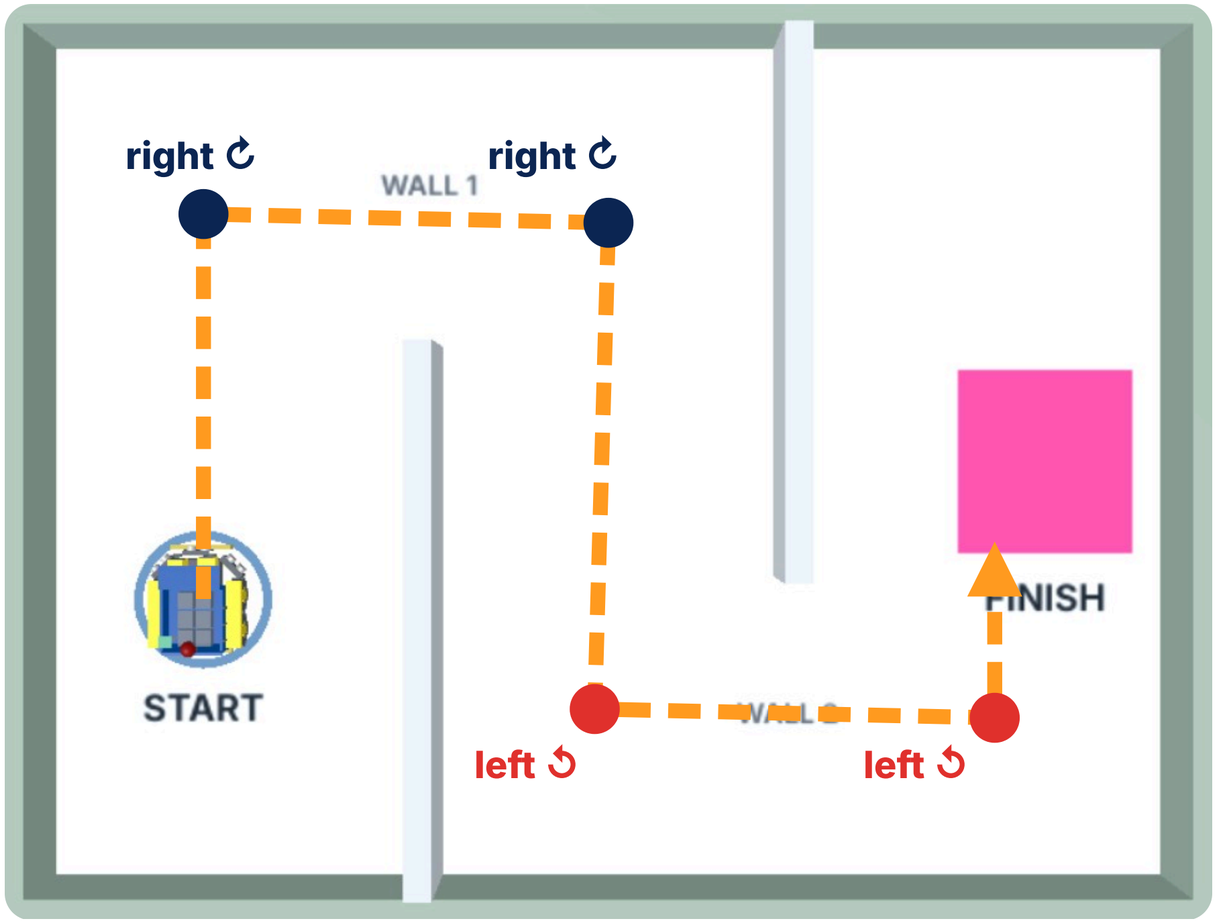
The robot is **22 cm** wide: it needs room to spin.

25 stops it close enough to pass the gaps, far enough not to touch.

PART 4

Solving Session 3

Plan · first idea · better idea · test



STEP 1 · PLAN

Drive until a wall, then turn

Up → right → down → right → up.

Every turn happens when a **wall is ahead**.

At the **top**: two right turns.

At the **bottom**: two left turns.

STEP 2 · FIRST IDEA

“Wall ahead? Turn right.”

1ST · TURNRIGHT

WHEN US_Front 0–25
DO spin right

2ND · FORWARD

WHEN anything else
DO drive 4.5, 4.5

At the top it works: **+50** for wall 1.

At the bottom it turns right, **back towards START**, and drives in circles.

STEP 3 · BETTER IDEA

Two sensors in one statement

Near the top

US_Front 0–25 **AND** **PositionY** 100–1000

→ turn **right**

Near the bottom

US_Front 0–25 **AND** **PositionY** 0–99

→ turn **left**

The field is 180 cm tall, so **Y = 100** splits it into top and bottom.

STEP 4 · THE TURN

Duration 980: finish the whole turn

DURATION 60 · TESTED

The wall leaves the front after a **small turn**, so Forward takes over. The robot drives at an angle and hits walls: only **60 points**.

DURATION 980 · TESTED

The turn keeps going for **0.98 s**: −2 and 2 ≈ 92° a second → about **90°**. Clean run: **200 points**.

A Default statement holds its action until its **Duration** ends, then the list is checked again.

STEP 5 · WRITE

The whole program: three statements

Statement	US_Front	PositionY	WheelLeft	WheelRight	Duration
1 TurnRight	0 – 25	100 – 1000	2	−2	980
2 TurnLeft	0 – 25	0 – 99	−2	2	980
3 Forward	(any)	(any)	4.5	4.5	60

All **Default**, LED 0.

Turns go **above** Forward: order matters.

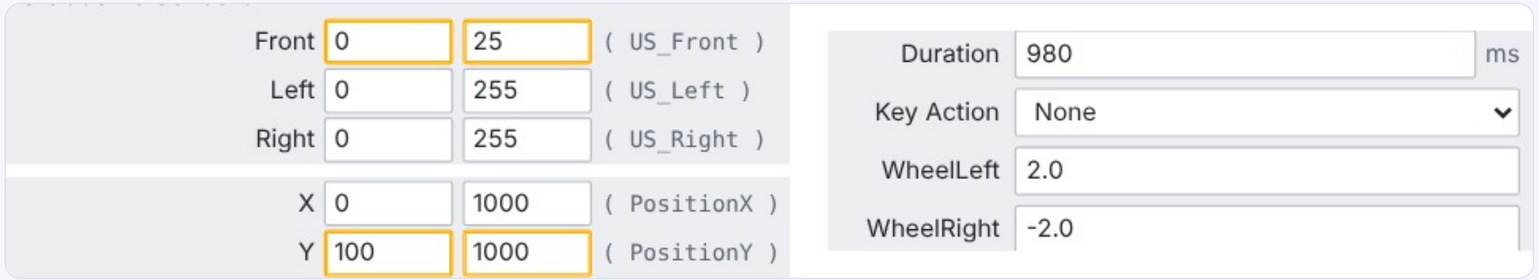
No Time at all: the robot **reacts** to the walls.

STEP 5 · WRITE

The three statements in the AI panel

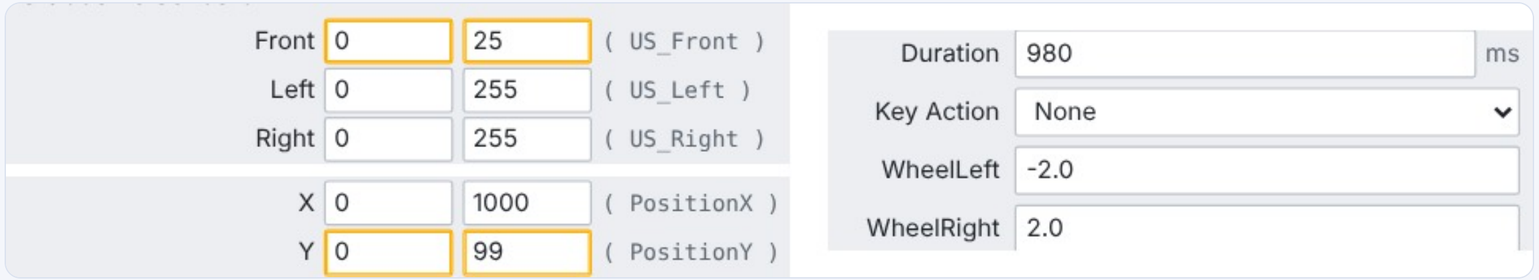
1st

TurnRight



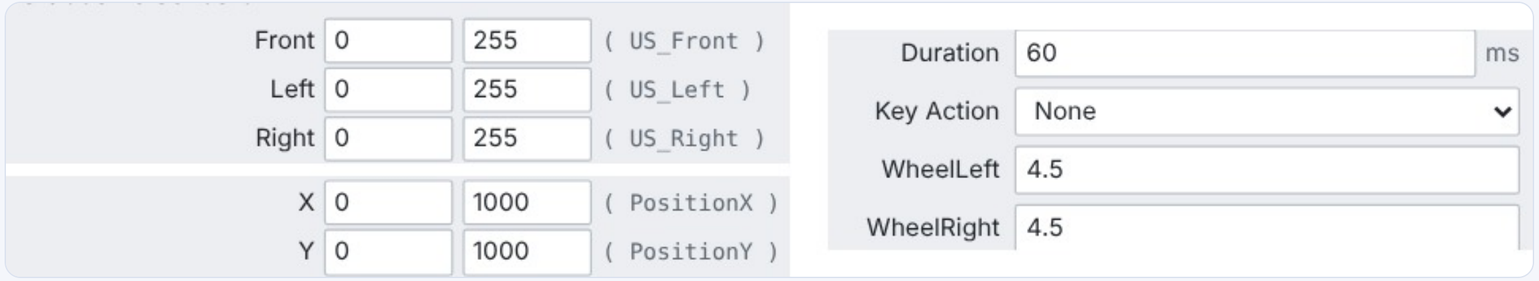
2nd

TurnLeft



3rd · always true

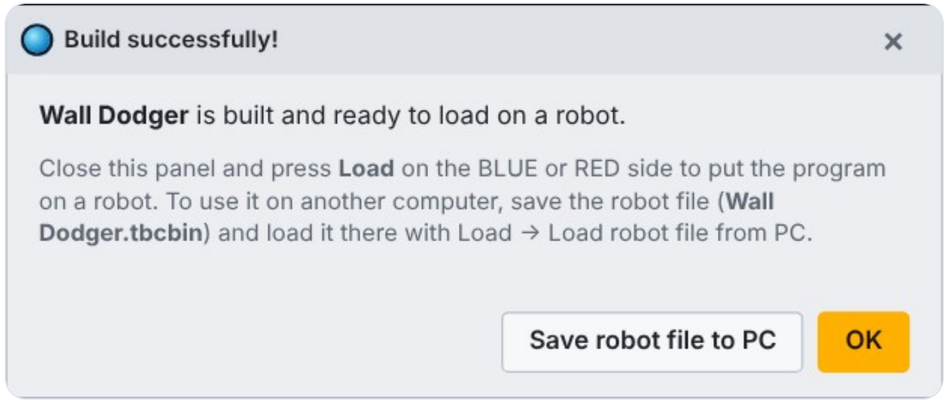
Forward

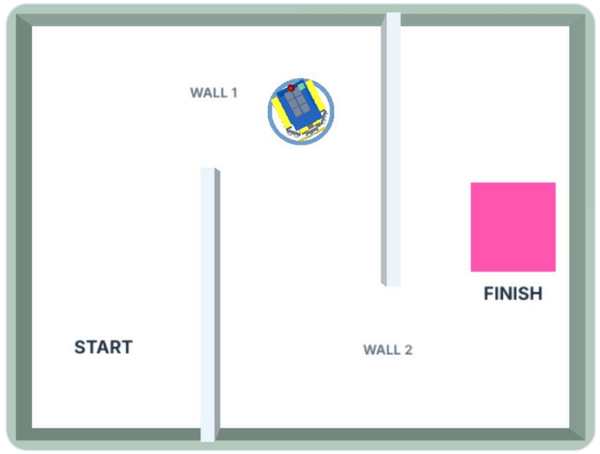


STEP 6 · TEST

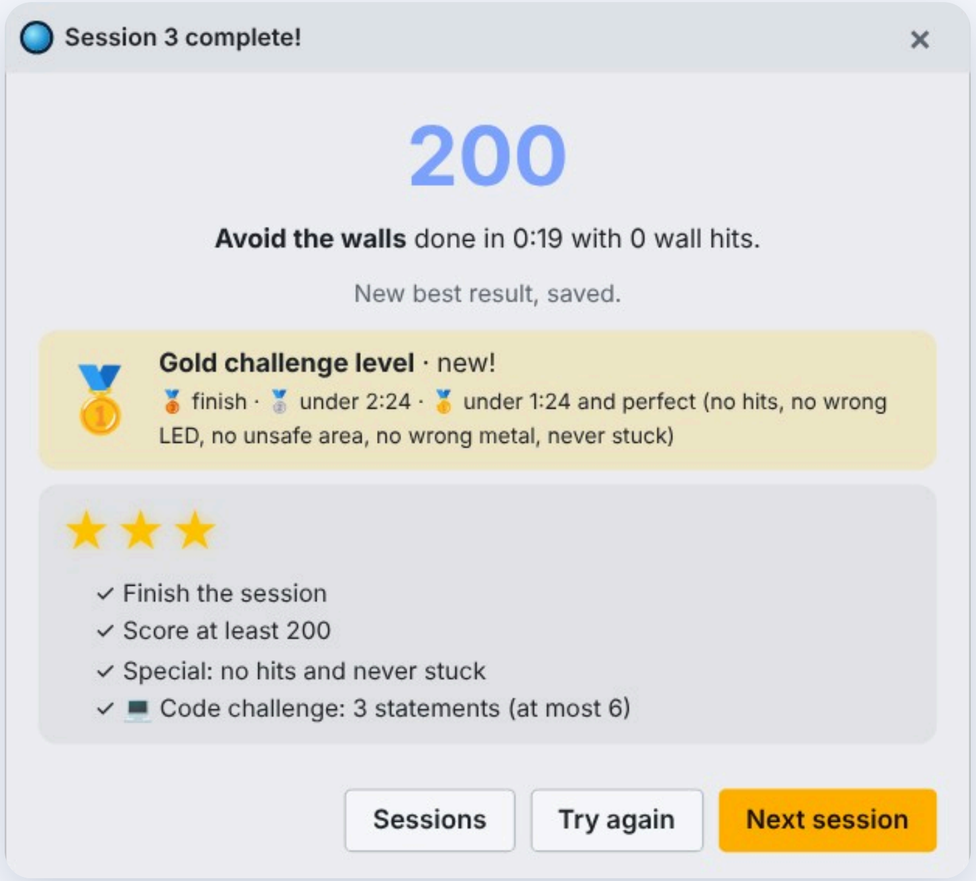
Build, Load on BLUE, Play

1 Build → OK → **2 Save to PC** → **3** BLUE **Load** → Wall Dodger → **4 ▶ Play**





At 8 s the robot has passed wall 1 (**+50**) and turns right in front of wall 2.



RESULT

200 points in 0:19 · 0 hits

Medals · Bronze: finish · Silver: under 2:24 · Gold: under 1:24 and perfect.

Stars · finish · score 200 · no hits and never stuck.

Code challenge · at most 6 statements. We used 3.

DID NOT WORK?

Watch the numbers, change one thing

What you see	What to change
Drives straight into the top wall	Check US_Front **0–25** in both turn statements
Never turns at all	Turns must be **above** Forward in the list
Turns a little, then drives at an angle	Turn **Duration** must be 980, not 60
Turns the wrong way at the bottom	Check the **PositionY** ranges and the wheel signs
Spins on the spot forever	**Forward** must be 4.5 and 4.5, both the same
Touches a wall right after a turn	Check the turn wheels (2, −2 and −2, 2) and Duration 980

TRY IT YOURSELF

Three challenges

Faster

Try wheels 5 and 5. Do you need a bigger number than 25?

Watch the sensors

Open **Debug** and follow the Ultrasonic graph during the run.

Next session

Presentation 4 · **Simple maze**: follow a wall with a side sensor.