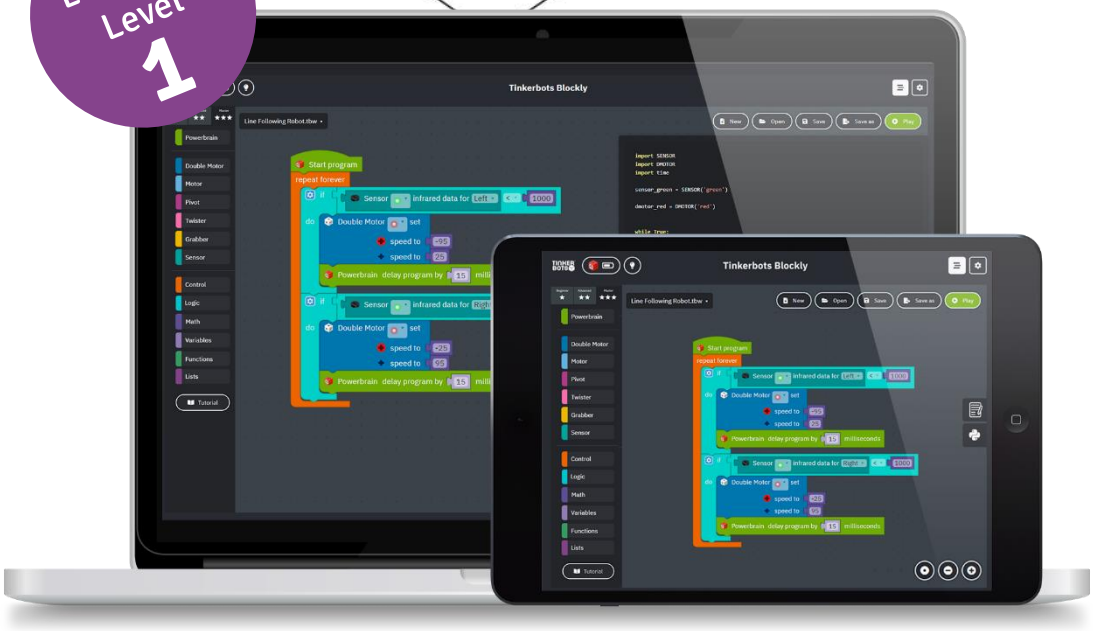
LEARNING WITH ROBOTS I

Teacher's Guide

for secondary level I and II

Learning Level 1



Lessons 1-4

This teaching material supports schools and teachers at secondary level I and II in helping children and young people to develop the areas of competence defined in the competence framework of the Conference of Ministers of Education and Cultural Affairs. Their aim is to teach young people safe, creative, and responsible use of media, and to foster individual and self-directed learning, thus enabling them to competently participate in a digital society.

Concept and implementation:	Helliwood media & education, Kinematics GmbH
Design and typesetting:	Helliwood media & education, Kinematics GmbH
Authors:	Helliwood media & education, Kinematics GmbH

Title of the work:	Learning with robots I
Rights holder:	Kinematics GmbH
Format of the work:	Multiple formats
Version:	1.0 | 08.01.2020

Content

Foreword

Kinematics GmbH is a leading international supplier of robotics-based educational products for acquiring STEAM skills. With the help of Tinkerbots products, pupils can learn skills in the fields of robotics, programming and computational thinking. The overarching approach of Kinematics' educational products is to promote the playful, haptic and creative communication of future-relevant knowledge.

It would be hard to imagine a digitalized world without the topics of robotics and programming. Teaching these future technologies to children is therefore necessary to prepare them for the challenges and opportunities of the 21st century.
STEAM skills are not just important for children who want to pursue a career in IT, engineering or research. The use of media and modern teaching aids can benefit every child. But Tinkerbots products don't just promote the teaching of classic STEAM knowledge, they also strengthen self-confidence, problem-solving skills and social competence.

Overview

The **teaching material** focuses on programming Tinkerbots robots with the Tinkerbots Blockly app – for grade 5 and up. The robots described in the material can be built with the two different Tinkerbots Education Sets.
The material is based on curricula and allows for an introduction to the basics of computer science, programming and robotics as well as preparation for using the Tinkerbots Education Sets in subjects such as physics, technology, math, music and art.

Many of the tasks in this teacher's handbook can be solved by the pupils through independent experimentation, with the help of the worksheets. The experience gathered in this process will help pupils to discover general problem-solving strategies. With the description and analysis of simple processes as starting point, pupils learn to understand basic problem-solving strategies for a variety of tasks, and describe them as algorithms.

The teaching material is designed for use with the Tinkerbots Blockly app in learning level 1, and includes 4 lessons – each of which is designed to last 45 minutes. The times given for the individual units are based on experience and may vary, or can be adapted according to the learning ability of the pupils. Now, with the following 4 lessons you can teach your pupils, step by step, the basics of the Tinkerbots robotic system, the associated programming interface, and general programming concepts.

Lesson 1 – What is a Tinkerbots robot?

In lesson 1, the pupils learn about the functions of a Tinkerbots robot and explore the components. To prepare for later lessons, the pupils create their first program.

Figure 1 Tinkerbots robot in exploded view

Preparation

Age group	**Grade 5 up**
Area	STEAM subjects and robotics work group
Learning level	**1** (This unit uses the categories and blocks of learning level 1 in the Tinkerbots Blockly programming app)
Competence framework	Pupils know and understand the functionality and basic principles of the digital world
Social form	Class discussion and partner work
Materials	• Computer (Windows, Mac) with USB interface, or tablet (iOS, Android) • Tinkerbots Education Set with Bluetooth dongle • Power supply unit • Tinkerbots Blockly app • Worksheets 1-2
Topics	Understanding Tinkerbots robots | 10 min
	Exploring the Tinkerbots modules | 10 min
	The Tinkerbots Blockly app | 10 min
	The Powerbrain makes music | 15 min

Understanding Tinkerbots robots

Duration

10 minutes

Learning objectives

The pupils

- understand that – as a minicomputer – the Tinkerbots robot receives input, processes the input, then produces an output.
- learn about the variety of different types of information that the Tinkerbots robot can process as input.

Discussion

Discuss the components of a Tinkerbots robot with the pupils. Refer to the following components and draw the following diagram on the blackboard.

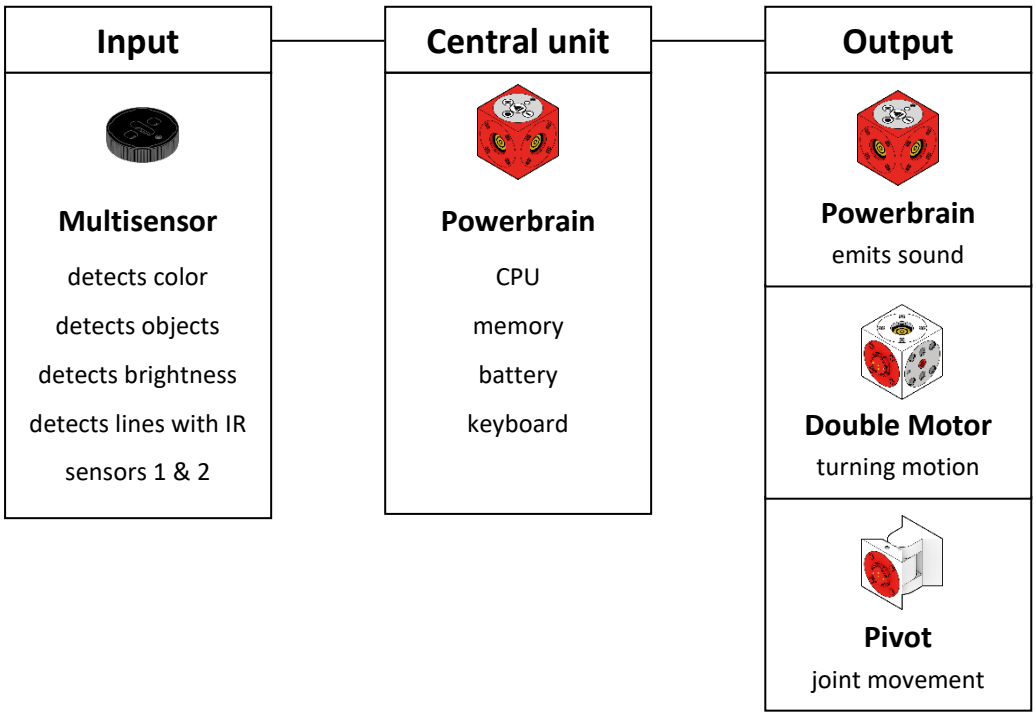


Figure 2 The inputs and outputs of a Tinkerbots robot

- **Central unit**: The Powerbrain is the central processing unit of every Tinkerbots robot
- **CPU:** This is a small chip with which the computer processes and converts information. The CPU is the most important part of the computer and stands for Central Processing Unit. You can think of it the computer's 'brain'.
- **Memory:** This is where the Tinkerbots robot remembers the information.
- **Battery:** This is a rechargeable battery in the Powerbrain, which stores electrical energy.

- **Input:** This is how a Tinkerbots robot gathers information from its environment. People gather input through their *sensory organs*, whereas the Tinkerbots robot has *sensors* that detect objects, colors, brightness and lines. The sensors are built into the Multisensor module.
- **Output:** This is how the Tinkerbots robot displays information or moves. People communicate information with their mouths, for example, by speaking, or they move using their limbs. The Tinkerbots robot moves with the help of its motion modules, and with the speaker it can emit signals.

Exploring the Tinkerbots modules

Duration

10 minutes

Learning objectives

The pupils

- learn abotu the Tinkerbots modules haptically.
- learn the functions of each component.

Discussion

Let the pupils explore the Tinkerbots components themselves, and discuss the following questions with them:

- Where does Powerbrain get its name from?
- Why do Tinkerbots robots need a Powerbrain?
- What do the symbols on the Powerbrain mean?
- What do the colors on the two different motor modules mean?
- How do you connect two blocks to each other?
- How does the Pivot module move and how does it differ from the Motor module?
- How do you attach wheels to the Tinkerbots robot?
- How do you charge the Powerbrain?

All computers need electricity to operate. Tinkerbots robots can be charged with the included 9V power supply. Charging takes about 45 to 60 minutes and the battery will last for about two to eight hours, depending on use.

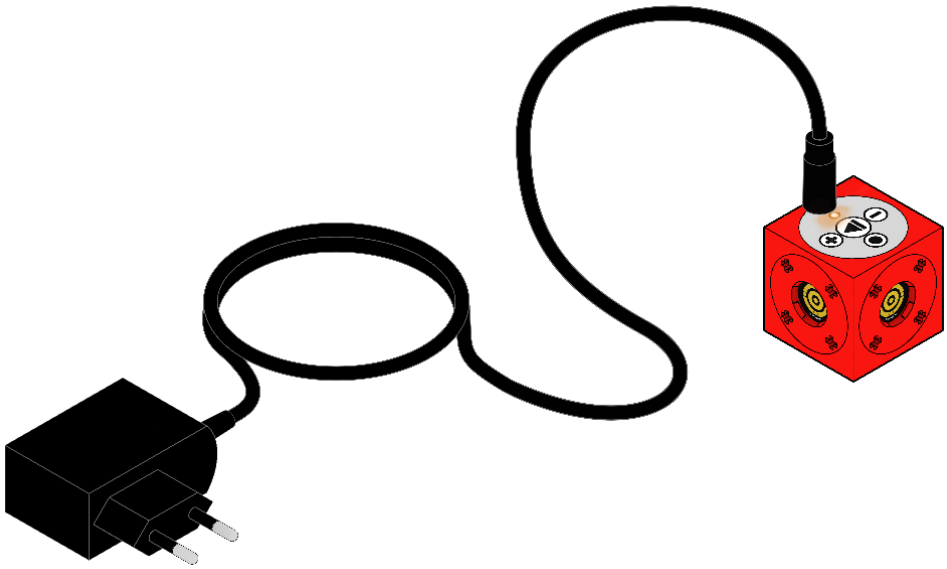


Figure 3 Powerbrain with connected power supply

Task

Have the pupils write down the functions of each component on **Worksheet 1**.

Hand out **Worksheet 1** to the pupils.

We recommend handing out the worksheets to the pupils. Of course, you can also present the worksheets orally, or project them onto a smartboard.

Evaluate

Discuss the answers with the pupils. Let some pupils present their solutions and discuss possible mistakes and problems.

The Tinkerbots Blockly app

Duration

10 minutes

Learning objectives

The pupils

- learn that programs are transferred to the robot via the Tinkerbots Blockly app.
- learn how to connect the Powerbrain with the Tinkerbots Blockly app.
- learn where the commands for the Tinkerbots robots are located.

Discussion

Discuss the features of the Tinkerbots Blockly app with the pupils.

- What does the LED colour on the Powerbrain signal?
- How are programs transferred to the Powerbrain?
- What is a program?
- Which module gives the commands?
- What are the functions of the categories in the Tinkerbots Blockly app?
- How do you connect the Powerbrain to the Tinkerbots Blockly app?

Task

Let the pupils try out how to connect the Powerbrain with the Tinkerbots Blockly app.

The Powerbrain makes music

Duration

15 minutes

Learning objectives

The pupils

- learn how to work with the Tinkerbots Blockly programming app.
- create their first program.
- transfer their first program to the Powerbrain**.**

Task

Let the pupils create a first program – a playback of a sequence of sounds.

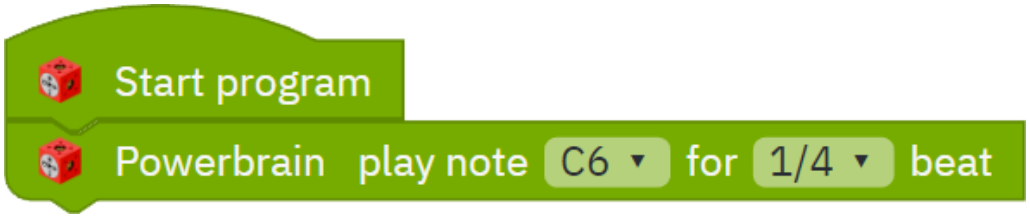
Hand out **Worksheet 2** to the pupils. Of course, you can also present the worksheets orally, or project them onto a smartboard.

Instructions for creating the program

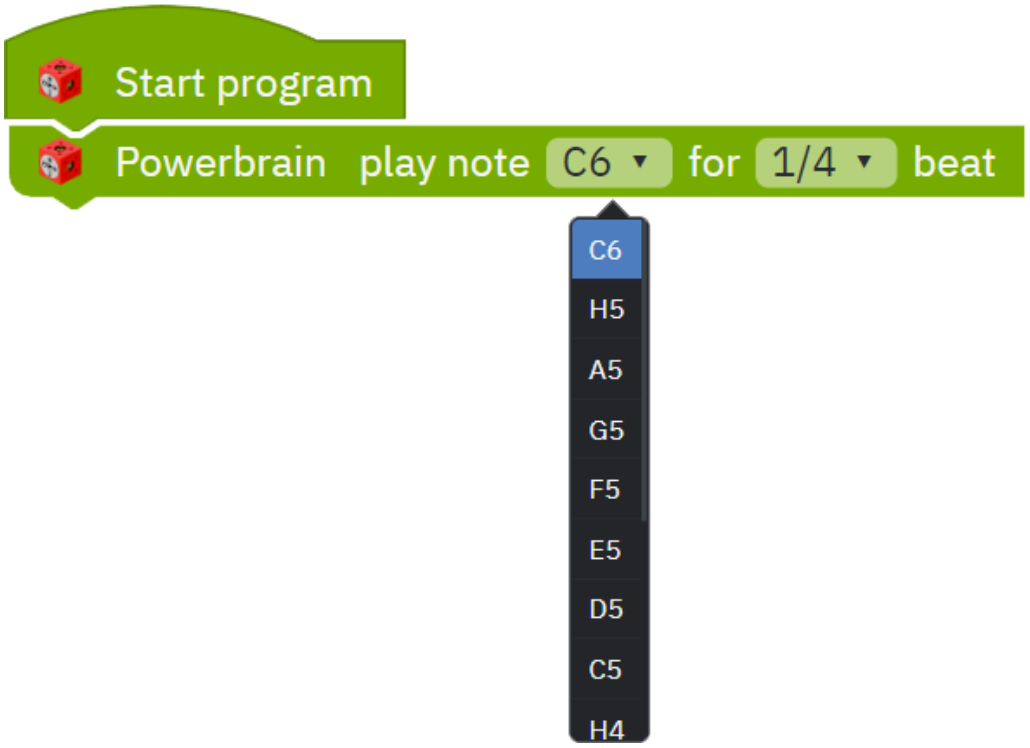
Help the pupils to create the program given in task 1. Guide the pupils, if necessary, through the following steps:

First, drag the *Play note* block from the toolbox in the *Powerbrain* area into the workspace. The block is initially greyed out

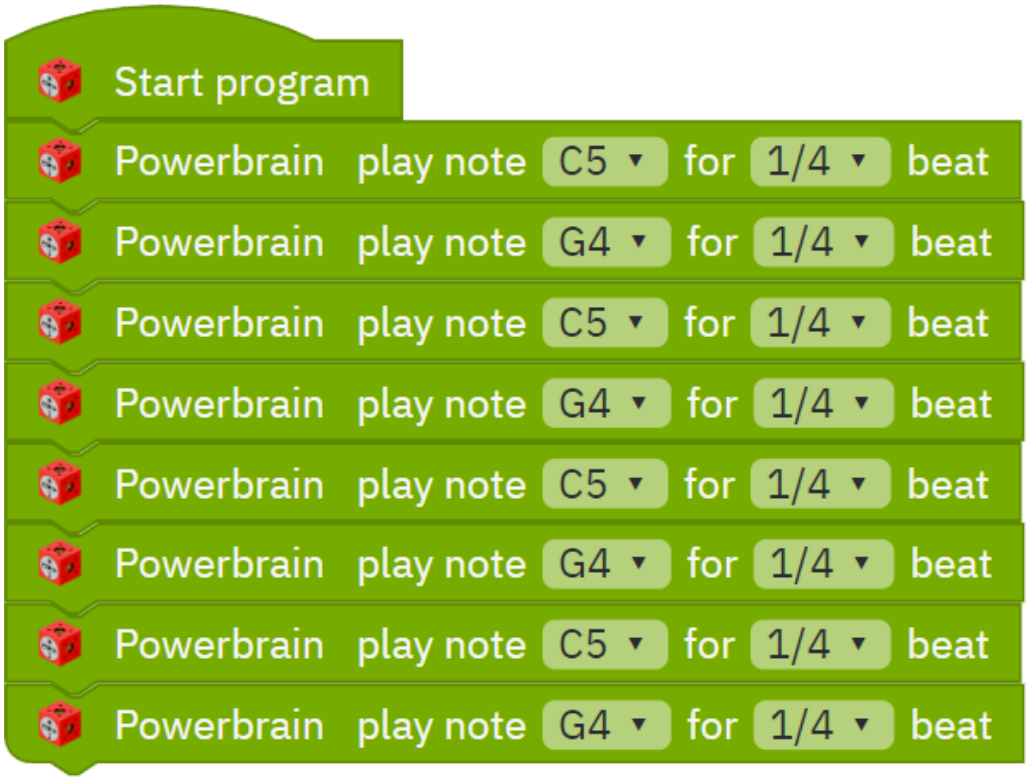
Next, attach the *Play note* block to the *Start program* block by dragging and dropping it into position below the *Start program* block. It will spring into position automatically. A white background indicates that a connection is possible. The block becomes opaque once attached.



Then the note C5 is set in the drop-down menu of the *Play note* block.



Example solution, task 2



Evaluate

Discuss the solutions with the pupils. Let some pupils present their solutions and discuss possible mistakes and problems. If none of the pupils' solutions is identical to the example solution, present the example solution.

Lesson 2 - Robots as useful helpers

In this lesson we will discuss collaborative robots. Furthermore, you and your pupils can now deepen your knowledge of the Tinkerbots robotic system and the associated programming interface. After assembling the first Tinkerbots robot, you will write pseudocode to make the robot drive in a square and transport packages.

Figure 4 A Tinkerbots robot transporting packages in a square

Preparation

Age group	**Grade 5 up**
Area	STEAM subjects and robotics work group
Learning level	**1** (This unit uses the categories and blocks of learning level 1 in the Tinkerbots Blockly programming app)
Competence framework	Pupils know and understand the functionality and basic principles of the digital world
Social form	Class discussion and partner work
Materials	• Computer with USB interface (Windows, Mac), or tablet (iOS, Android) • Tinkerbots Education Set with Bluetooth dongle • Power supply unit • Tinkerbots Blockly app • Worksheet 3 • Construction manual
Topics	Robots assist us humans | 10 min
	Assembling a Tinkerbots robot | 10 min
	Writing pseudocode | 10 min
	Transporting packages in a square | 15 min

Robots assist us humans

Duration

10 minutes

Learning objectives

The pupils

- learn why robots can do the work of humans for us.
- learn about examples of robots cooperating with humans.
- learn about the use of robots in our world.

Discussion

Discuss with the pupils why collaborative robots can assist us humans.

Suggestions for discussion

- Robots that drives up and down along shelves to transport goods quickly and safely.
- Industrial robots that perform complex work steps quickly and efficiently.
- Vacuum cleaner robots that clean the house.

An age-old dream of mankind… Machines that do the work for us. In the production industry, – such as in car or machine manufacturing – industrial robots are already a standard feature. At home, vacuum cleaner and lawn mower robots also perform routine work for us.

The logistics industry is increasingly putting robots to use to assist people in certain work operations. Here, collaborative robots are changing supply chains fundamentally. Logistics robots assist in the picking and packing, for example, as well as in the transport of goods

Assembling a Tinkerbots robot

Duration

10 minutes

Learning objectives

The pupils

- discover how to connect the individual modules of a Tinkerbots robot.

Task

Have the pupils assemble a Tinkerbots robot as shown in the picture.

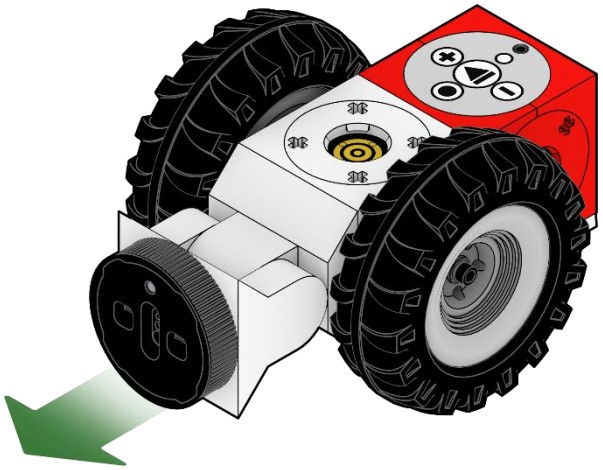


Figure 5 An assembled Tinkerbots robot

Hand out the **step-by-step instructions** of the first Tinkerbots robot.

You can also demonstrate how to assemble it in front of the pupils or project the instructions on a smartboard.

Writing pseudocode

Duration

10 minutes

Learning objectives

The pupils

- learn how to plan programming tasks with pseudocode.

The first step in writing a computer program is to create a plan for what the program will do. The plan should include what type of information the program receives, how the input is processed, what output the program will produce and how the output will be recorded or presented.

The notes do not have to be written in whole sentences and do not have to contain any code. This type of detailed notation is called pseudocode and is a mixture of natural language and code. Pseudocode is like a detailed draft or rough sketch of the program.

Task

Give the pupils the task of getting the Tinkerbots robot to drive in a square. The pupils should develop the pseudocode for this together orally. Note down the commands that the pupils say on the blackboard.

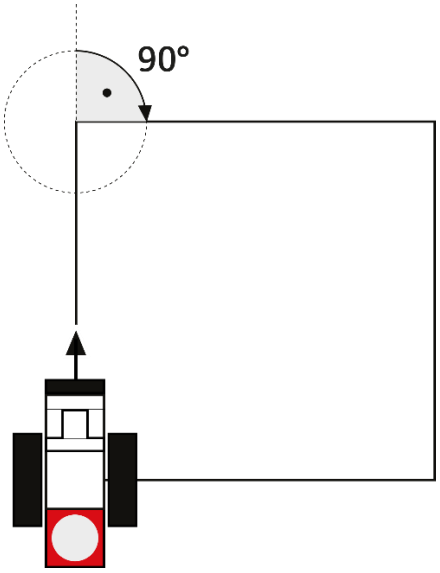


Figure 6 Sketch for the robot to drive in a square

Example solution

The pseudocode program that the pupils produce could look like this:

- drive forward a short distance,
- turn 90 degrees to the right,
- drive a short distance,
- turn 90 degrees to the right,
- drive a short distance,
- etc.

Transporting packages in a square

Duration

20 minutes

Learning objectives

The pupils

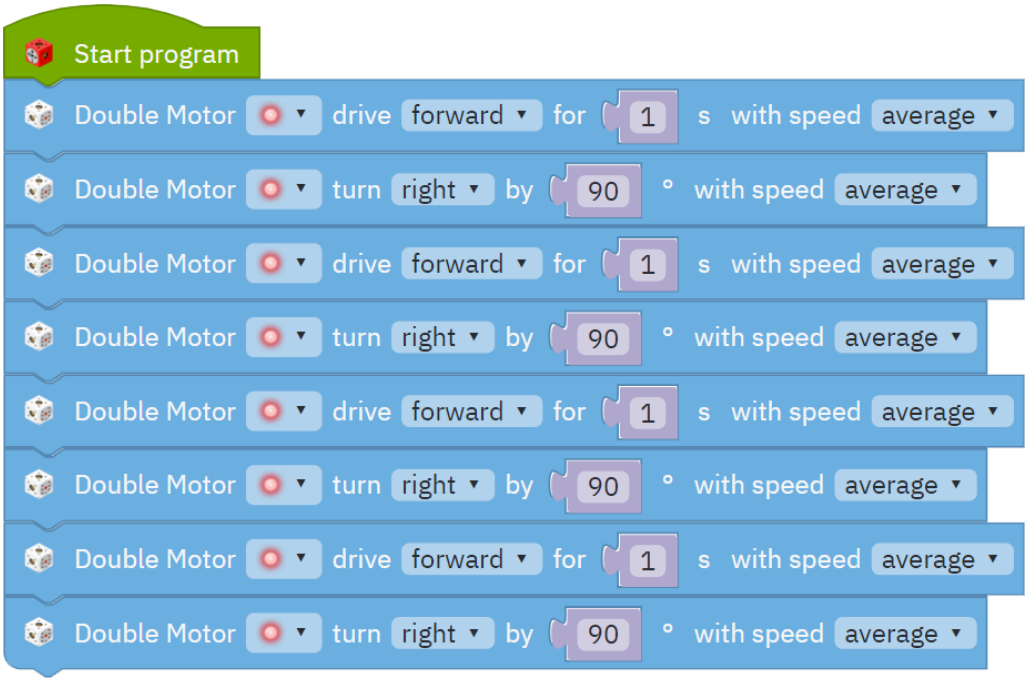
- learn about the use of the *Double Motor drive* block for driving straight ahead.
- learn about the use of the *Double Motor turn to* block for turning on the spot.
- practice driving in a geometric pattern with simple instructions.
- experiment with the code until the Tinkerbots robot drives in a square.

The following tasks prepare the pupils for the programming principle of loops in lesson 3.

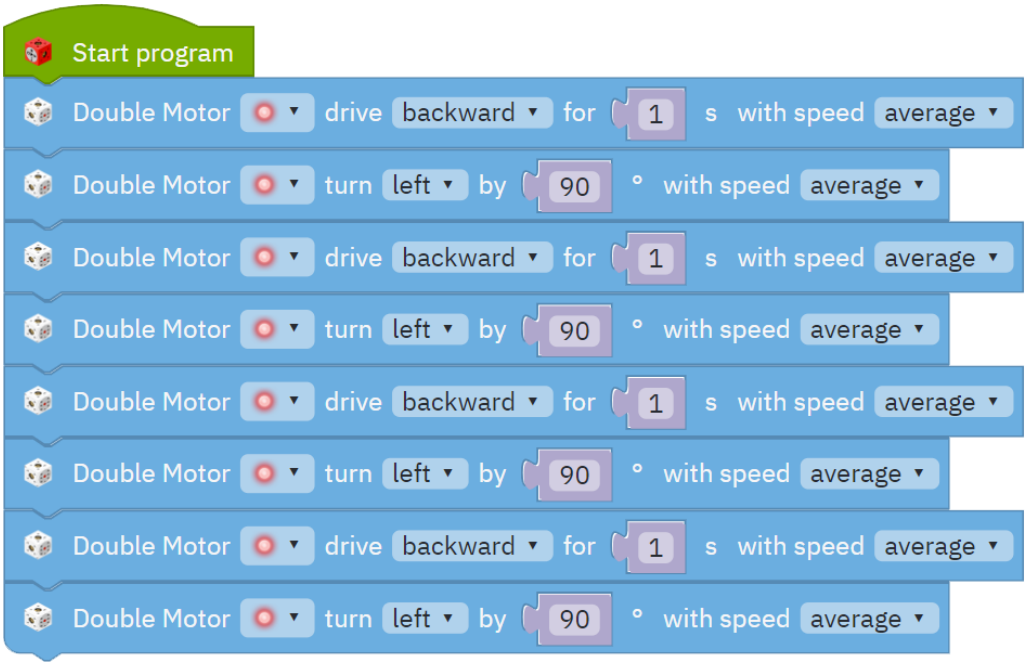
Task

Let the pupils put together the 3 different colored cubes (packages). After that, have the pupils create a program that lets the Tinkerbots robot drive in a square.
Hand out **Worksheet 3**!

Example solution for the task



Example solution for the additional task



Evaluate

Discuss the solutions with the pupils. Let some pupils present their solutions and discuss possible mistakes and problems. If none of the pupils' solutions is identical to the example solution, present the example solution.

Lesson 3 – Loops

In programming, a 'loop' is the repetition of a code sequence. A loop repeats the code until a certain condition is met. Tinkerbots Blockly has two different loop blocks; the *repeat x times* block and the *repeat forever* block. The following lesson teaches the recognition of patterns and introduces the concepts of loops step by step, allowing time for experimentation and application.

Figure 7 A Tinkerbots robot transporting packages between 2 assembly lines

Preparation

Age group	**Grade 5 and up**
Area	STEAM subjects and robotics work group
Learning level	**1** (This unit uses the categories and blocks of learning level 1 in the Tinkerbots Blockly programming app)
Competence framework	Pupils can identify problems to be solved and find solutions or develop problem-solving strategies. In the digital tools that are used, pupils can recognize and formulate algorithmic structures. Pupils can plan and use a structured algorithmic sequence to solve a problem.
Social form	Class discussion and partner work
Materials	• Computer (Windows, Mac) with USB interface, or tablet (iOS, Android) • Tinkerbots Education Set with Bluetooth dongle • Power supply unit • Tinkerbots Blockly app • Worksheets 4 and 5
Topics	Patterns and repetitions in everyday life | 10 min
	Driving in a square with a loop | 20 min
	Endless loops | 15 min

Patterns and repetitions in everyday life

Duration

10 minutes

Learning objectives

The pupils

- learn what patterns are.
- learn what repetition is.
- learn to recognize patterns and repetitions in everyday life.

Discussion

Discuss with pupils where they encounter patterns and repetitions in everyday life or in nature. Afterwards, look at the program code from the previous task from **Worksheet 3** (driving packages around in a square) with the pupils and reflect as a group on whether the program could be written with fewer lines of code. The aim is to recognize that certain block stacks produce a pattern, and can be repeated.

Suggestions for discussion

- Can you think of any examples from everyday life which use the principle of looping or repetition? (e.g. a video playing in an endless loop or a siren on a police car)
- Where can examples of patterns be found in nature? (honeycombs, waves in the sand or stripes on a zebra)
- Which block stacks produce a pattern? (Drive forward and turn on the spot)

Driving in a square with a loop

Duration

20 minutes

Learning objectives

The pupils

- understand the value of loops in programming.
- understand repetition as a repeated run-through of a program.
- learn to apply a pattern in a repetition.
- learn how and when the *repeat x times* block can be used.
- learn about the *wait* block.
- learn about the pivot turn to block
- apply the knowledge and skills they acquire to create a program that uses loops and repetitions as an integral part of the program.

The pupils apply the loop concept for the first time in programming. The *repeat x times* block is a loop and is located in the toolbox in the *Controls* area.

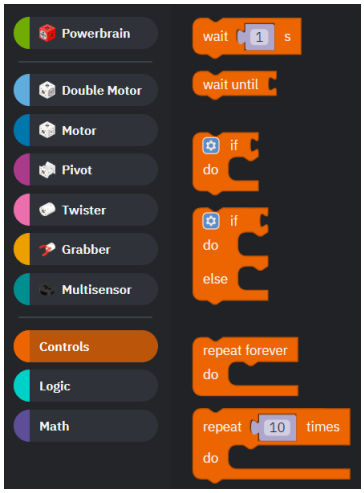


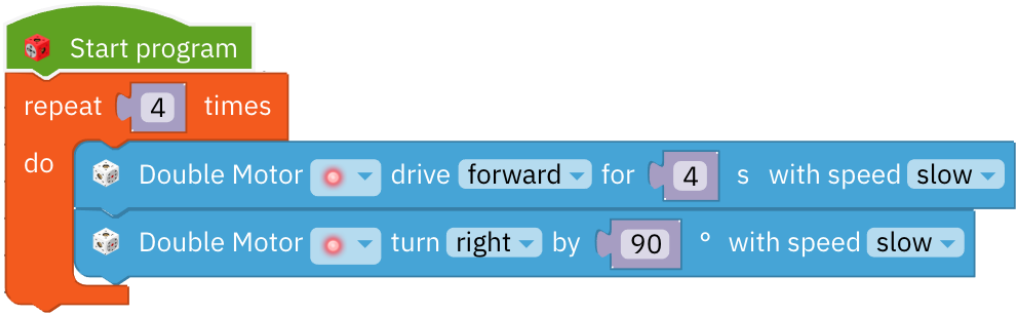
Figure 8 Controls category in the toolbox

Task

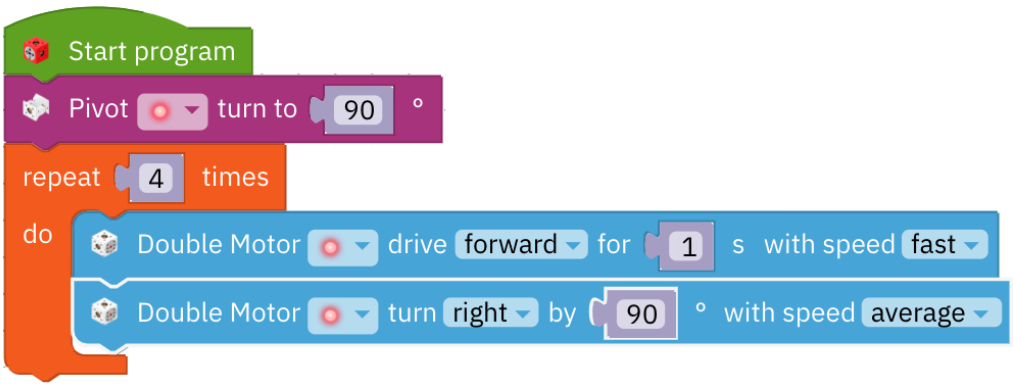
Have the pupils create a program that lets the Tinkerbots robot drive in a square and includes the *repeat x times* block. Hand out **Worksheet 4**!

In the two motor blocks, positive and decimal numbers can be used. Since programming languages are based on (American) English, decimal numbers are written with a dot instead of a comma: **5,1 -> 5.1**

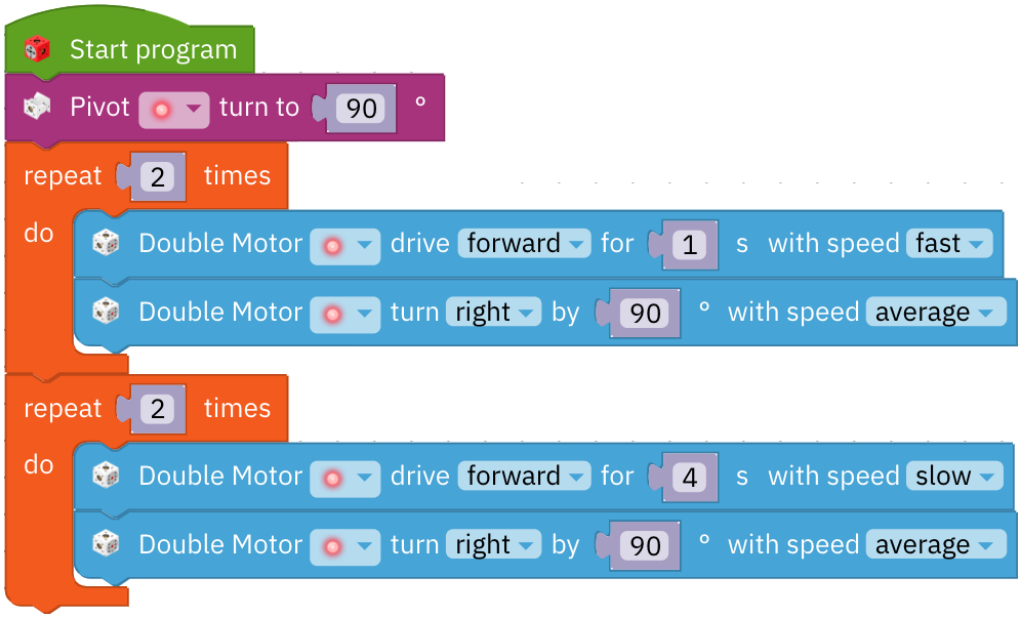
Example solution for task 1



Example solution for task 2



Example solution for additional task 1



Evaluate

Discuss the solutions with the pupils. Let some pupils present their solutions and discuss possible mistakes and problems. If none of the pupils' solutions is identical to the example solution, present the example solution.

Endless loops

Duration

15 minutes

Learning objectives

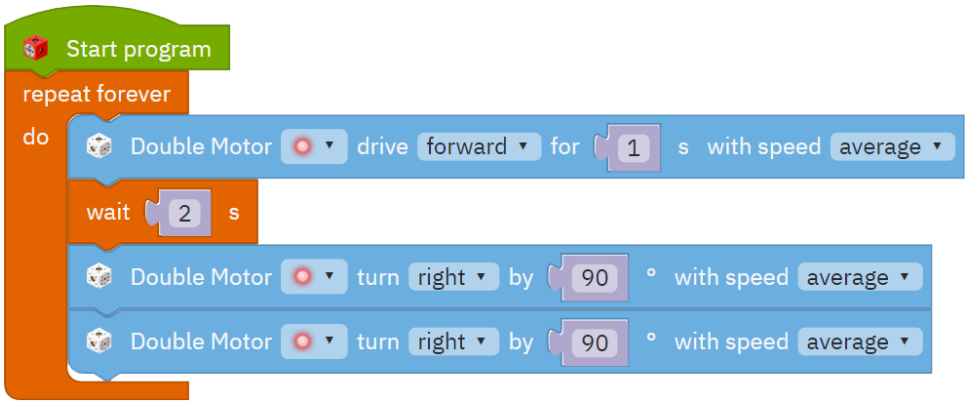
The pupils

- learn about the *repeat forever* block.
- learn how a pattern behaves when it is executed endlessly.
- learn that an infinite loop leads to no end to a program.
- learn about different ways to end the endless loop.

Task

Have the pupils create a program that lets the Tinkerbots robot execute an endless pattern. Use the *repeat x times* block. Hand out **Worksheet 5**!

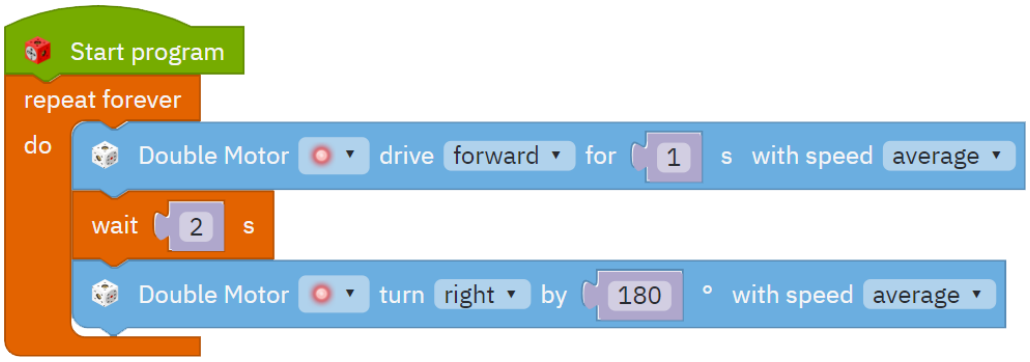
Example solution for task 1



Example solution for task 2

1. Press the Stop button in the Tinkerbots Blockly app.
2. Shut down the Powerbrain.
3. Wait until the battery of the Powerbrain is empty.

Example solution for the additional task



Lesson 4 – Conditions

In programming, a condition is used to query a state. If the condition is met, the subsequent program code is executed. Tinkerbots Blockly uses a variety of conditions. The following lesson teaches two conditions (*if* block and *wait until* block) in connection with the Multisensor.

Figure 9 A Tinkerbots robot used as an alarm system

Preparation

Age group	**Grade 5 and up**
Area	STEAM subjects and robotics work group
Learning level	**1** (This unit uses the categories and blocks of learning level 1 in the Tinkerbots Blockly programming app)
Competence framework:	Pupils can identify problems to be solved and find solutions or develop problem-solving strategies. In the digital tools that are used, pupils can recognize and formulate algorithmic structures. Pupils can plan and use a structured algorithmic sequence to solve a problem.
Social form	Class discussion and partner work
Materials	• Computer (Windows, Mac) with USB interface, or tablet (iOS, Android) • Tinkerbots Education Set with Bluetooth dongle • Power supply unit • Tinkerbots Blockly app • Worksheets 6-8
Topics	Sensors in everyday life | 10 min
	Simple alarm systems | 10 min
	Optimized alarm systems | 10 min
	Motion detector | 15 min

Sensors in everyday life

Duration

10 minutes

Learning objectives

The pupils

- discuss where the use of sensors can be beneficial in everyday life.
- learn about the uses of sensors.
- discuss the topic of alarm systems and motion detectors.
- learn what conditions can be used for.

Discussion

Discuss with the pupils the concept of applying a condition in order to query a state in everyday life. Make reference to the Multisensor. The Multisensor can detect not only objects, but also light and color.

Suggestions for discussion

- What examples of conditions do pupils know from their everyday life? E.g.:
  - When the alarm clock goes off, you have to get up.
  - When the traffic light is red, you have to stop.
  - Waiting for the command "On your mark, get set, go."
- Formulate a condition using an everyday example
  - If the sensor detects an object, do the following...
  - If the sensor detects no object, then do the following...
- Which conditions must be met for an alarm system or motion detector to be triggered?

Simple alarm systems

Duration

10 minutes

Learning objectives

The pupils

- understand the function of a condition in programming.
- learn how and when the condition *wait until* can be used.
- apply the acquired knowledge and skills to create a program that uses conditions as an integral part of the program.
- learn about the *Multisensor detects object* block.

The *wait until* block can be used to query a value; for example this could be a sensor value. Only when the value is "true" are all further blocks executed; otherwise the program waits until the value is "true". This is called querying a condition.

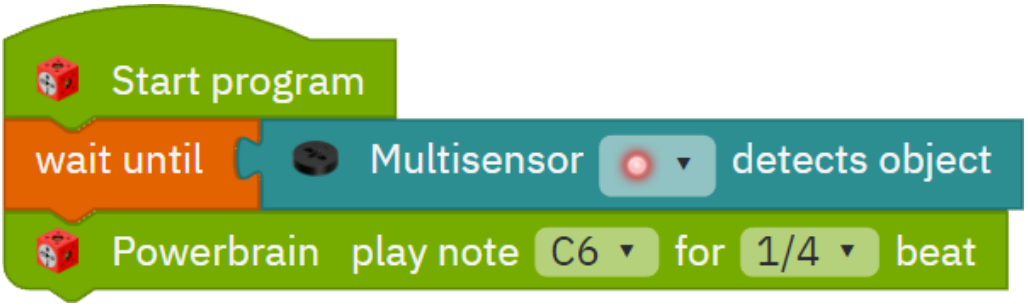
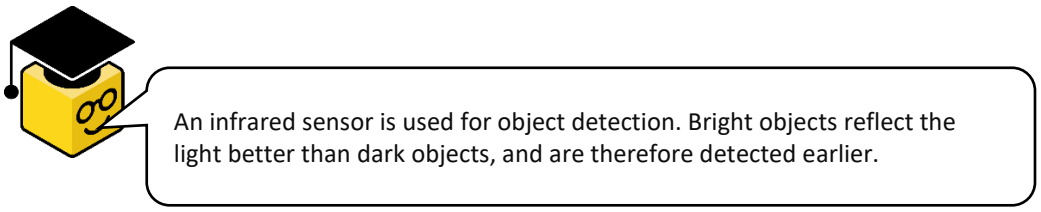


Figure 10 The 'wait until' block checks a condition

The figure depicts an example of a condition query. A *Multisensor* block is attached to the right of the *wait until* block. When the Multisensor detects an object, "true" is communicated back to the *wait until* block, and only then can the program run further, and a sound is played. Then program terminates.

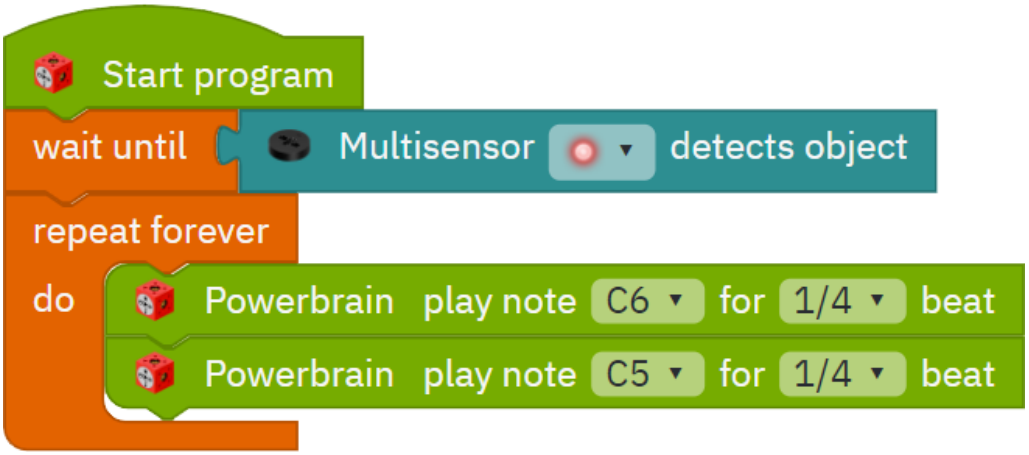


Task

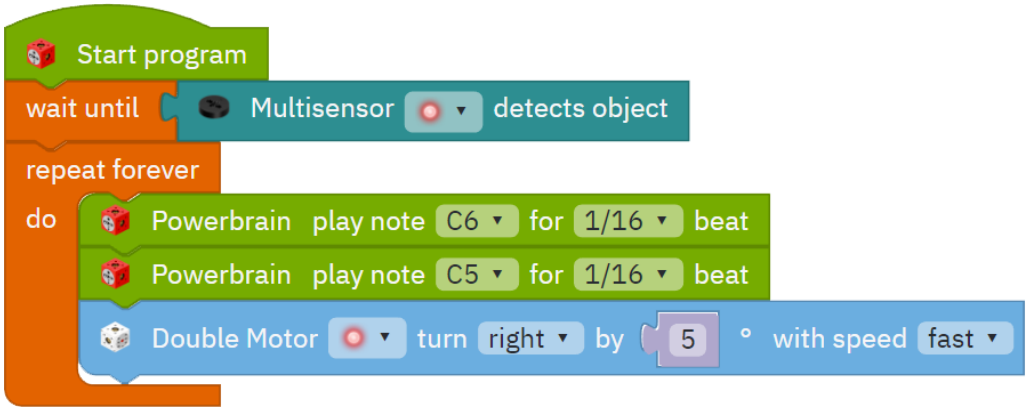
Have the pupils create a program in which the Tinkerbots robot works like an alarm system. Hand out **Worksheet 6** and let the pupils experiment.

If necessary, solve the tasks together and look at the corresponding blocks with the pupils.

Example solution for the task



Example solution for the additional task



Evaluate

Discuss the solutions with the pupils. Let some pupils present their solutions and discuss possible mistakes and problems. If none of the pupils' solutions is identical to the example solution, present the example solution.

Optimized alarm systems

Duration

10 minutes

Learning objectives

The pupils

- learn about the *Multisensor recognizes line with IR sensor* block.
- learn about the *pivot turn to* block.

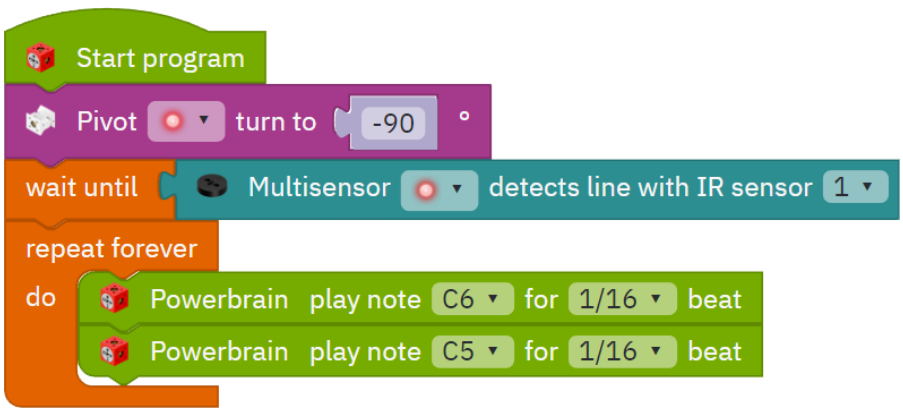
With the *Multisensor detects line with IR sensor* block, the robot can react to where it is going. For example, it is possible to follow a line on the floor or to stop at a marker.

Task

Have the pupils create a program that will make the Tinkerbots robot work with an optimized alarm system. Hand out **Worksheet 7** and let the pupils experiment.

If necessary, solve the tasks together and look at the corresponding blocks with the pupils.

Example solution for the task



The pivot must be pointed to the ground with the Multisensor!
It can take up an angle of -90° and 90°.

Motion detector

Duration

20 minutes

Learning objectives

The pupils

- learn how and when the condition *if* can be used.
- apply the acquired knowledge and skills to create a program that uses conditions as an integral part of the program.

The *if* block can be used to query a value, for example also a sensor value. If the value is "true", all further blocks are executed. If the value is "false", the program terminates.

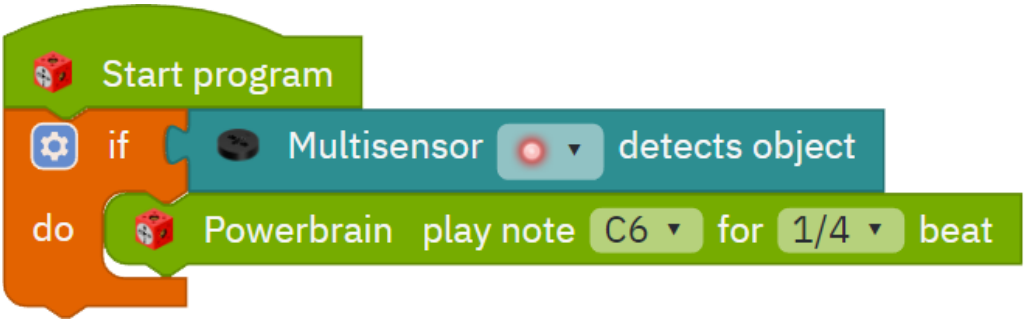


Figure 11 The if block checks a condition

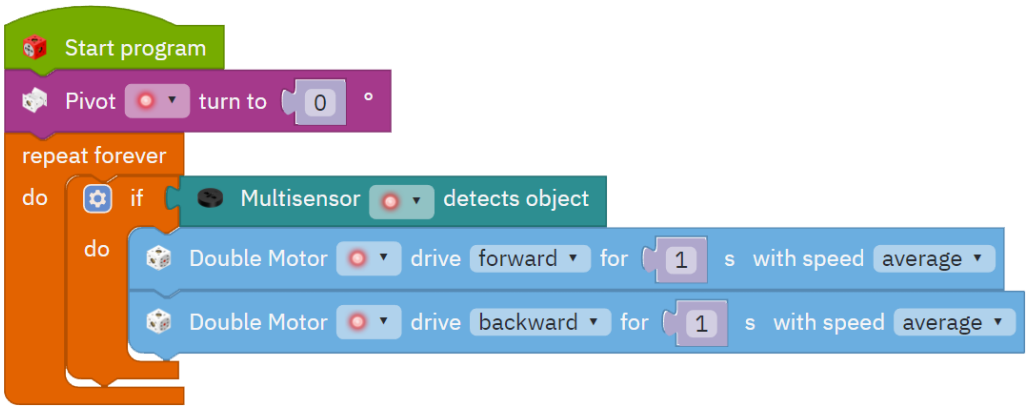
In the example above, if the program starts and the Multisensor does not detect an object, the program would terminate, because it has processed all instructions. No sound would be played. To query the condition again and again, a loop must be added to the program.

Task

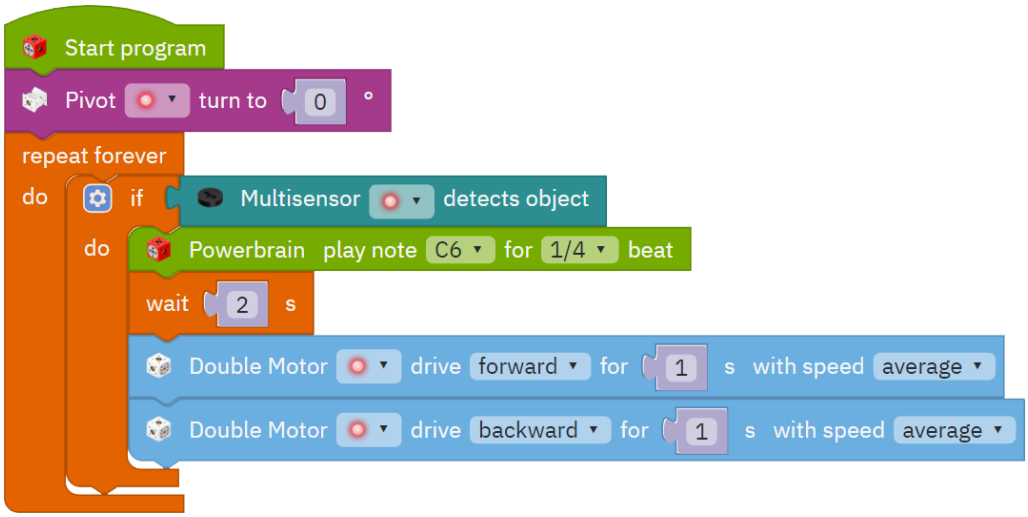
Have the pupils create a program that makes the Tinkerbots robot act as motion detector. Hand out **Worksheet 8** and let the pupils experiment.

If necessary, solve the tasks together and look at the corresponding blocks with the pupils.

Example solution for the task



Example solution for the additional task



Evaluate

Discuss the solutions with the pupils. Let some pupils present their solutions and discuss possible mistakes and problems. If none of the pupils' solutions is identical to the example solution, present the example solution.

Conclusion

With lessons 1 to 4, the pupils have completed the first basic course at learning level 1. You can find further teaching material in the shop at www.tinkerbots.com .