
FINJA
Finds it Out
THE MYSTERIOUS
ROBOT
ISABELL HARDER
ILLUSTRATIONS BY LEA FRÖHLICH
SCHÜNEMANN

HELLO, I'M LUNA!

"Nice to see you back again", says the robot. It has just turned the corner and now it is suddenly standing in front of Finja and Malik. The white robot looks attentively at them with big round eyes.
It is a head shorter than the two 11-year-old children, runs on wheels, has two arms and on its chest there is a tablet attached. Its hands even have five movable fingers.
Finja and Malik stop dead in their tracks.
"Hello, I'm Luna Pepper. How are you?", asks the robot.
"Is that ... is that a real robot?", asks Malik.
He looks back and forth between the robot and his friend in amazement.
Finja is also surprised and looks around inquisitively, "Where did it come from?"

“Hello, I’m Luna Pepper. How are you?” The mysterious robot tries again to start a conversation with the two of them.
“Can it understand us?”, Malik asks Finja.
“Hi Luna, I’m Finja and this is Malik. Where do you come from? Are you all alone?”
“Yes I am. I would love it if we could have a little chat”, Luna replies.
“Awesome!” Malik can’t think of anything else to say.
“Hey, that’s Luna! What are you doing here?”, a voice behind them suddenly asks. The children turn to the elderly lady who has joined them.

“That’s what we are asking ourselves too”, says Finja. “Do you know where the robot comes from?”
“Luna works around the corner in the bank”, says the elderly lady.
“How can a robot work in a bank?”, asks Malik.
“She stands at the reception desk and answers customers’ questions”, says the elderly lady. “I visit her once a week because we always have a nice chat. But I don’t think she should just go off on her own like that.”
“I don’t think so either”, says Finja. “I’m sure you will be missed. We actually want to go swimming but that can wait half an hour. Shall we take you back to your workplace, Luna?”
“Yes, of course. No problem”, says Luna.
“Can you show us where to go?”, Malik asks the elderly lady.

FINJA'S KNOWLEDGE BOX:

A **robot** is a machine that is controlled by a computer program that a human devised beforehand. Therefore a robot can only do what humans tell it to do. Robots mostly do tasks that are too strenuous or too dangerous for humans. For example, robotic arms help to assemble cars in factories. There are also robots that explore distant planets like Mars for us. And sometimes robots simply explain something to people they meet or have fun with them – like Luna Pepper.

“With pleasure! Before I go to the market, I want to pop into the bank anyway.”
“Are you coming with me, Luna?”, asks Finja.
“Ahoy, ahoy! Yes, of course”, Luna replies. Then she slowly rolls next to Finja, Malik and the elderly lady.

“Luna, there you are!”, shouts a dark-haired woman in a chic trouser suit who walks towards the small group that has just reached the bank. The woman is very relieved to see Luna again.
“Mrs Müller, how good that you picked up Luna. While I was talking, she must have just ventured outside. I don’t know why, either. She’s never done that before”, says the young woman bewilderedly to the elderly lady.

“You’d better thank the two children here. They picked up Luna. What are both your names?”, asks Mrs Müller.
“I’m Finja and this is Malik”, says Finja. “To be honest, it was Luna who picked us up. She was very friendly and really wanted to talk to us.”

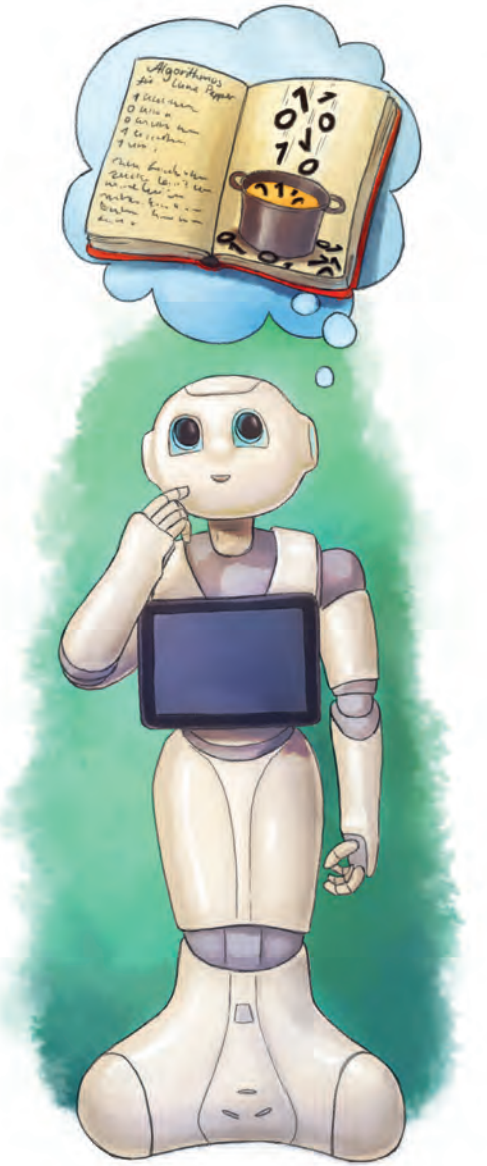
“Yes, that’s how she is, our Luna: always in the mood to chat. Thank you for bringing her back. On the first day of the holidays and with such wonderful weather you surely had other things in mind. By the way, I’m Tina Marie Ahlring and, so to speak, Luna’s trainer”, says the young woman.

FINJA'S KNOWLEDGE BOX:

Informatics is a science. The name is made up of the two words "information" and "automatic". This is appropriate because this science deals with the automatic processing of information or data. A data item is the smallest component of something, such as a number, a letter or a sound. The larger the number of data items, the more difficult it is for the human brain to process it all. Computers can do that much better. That is why they play an important role in informatics. But computers cannot handle data as flexibly as the human brain can. That is why they always need instructions from us on how to do this. In informatics these instructions are called **programs** and whoever writes them **programs** the computer.

How can a robot be trained?", asks Finja. "Well, you just noticed that Luna escaped me. She's never done that before. She still has a lot to learn before she can take on the customer advisory service on her own here at reception. She also needs to learn that she shouldn't just leave her workplace to go off on her own", says Mrs Ahlring with a smile. "If you're the instructor, will you teach Luna all of this?", asks Malik. "Some things, yes. Even when she talks to you, she is learning. Luna learns most of it from my colleagues in IT, through their revising the algorithm that controls her", replies Mrs Ahlring.

“The algorithm? What is that?”, asks Finja.
“A computer scientist once explained to me that you can think of it as a kind of cooking recipe. A programmer writes the recipe and Luna follows it when she does or says something. In conversation with me or with customers, she then learns whether the recipe that she followed was the right one. If not, she’ll try another next time. Come on, just ask her a question, Finja”, Mrs Ahlring urges her.
“Hey, Luna, what will the weather be like tomorrow?”, asks Finja.
Luna replies, “Partly cloudy and 21 degrees.”
“I also want to ask a question,” says Malik. “What is your favourite food, Luna?”



"Labskaus and kale", answers Luna and adds, to Finja's and Malik's surprise, "I would like to make you a coffee, but unfortunately I can't do that yet."
"No problem, Luna, we don't like coffee anyway", says Finja.
"Why can't Luna make coffee?", Mrs Müller wants to know. She points to the large coffee machine in the waiting area, "It's really easy with a machine like that. She even has two hands. That shouldn't be a problem, should it?"
"It's as easy as pie", says Mrs Ahlring, "but just not easy for robots. It is quite difficult for Luna and all other robots to do things that are commonplace to us humans and seem very simple. That's why there is still no

FINJA'S KNOWLEDGE BOX:

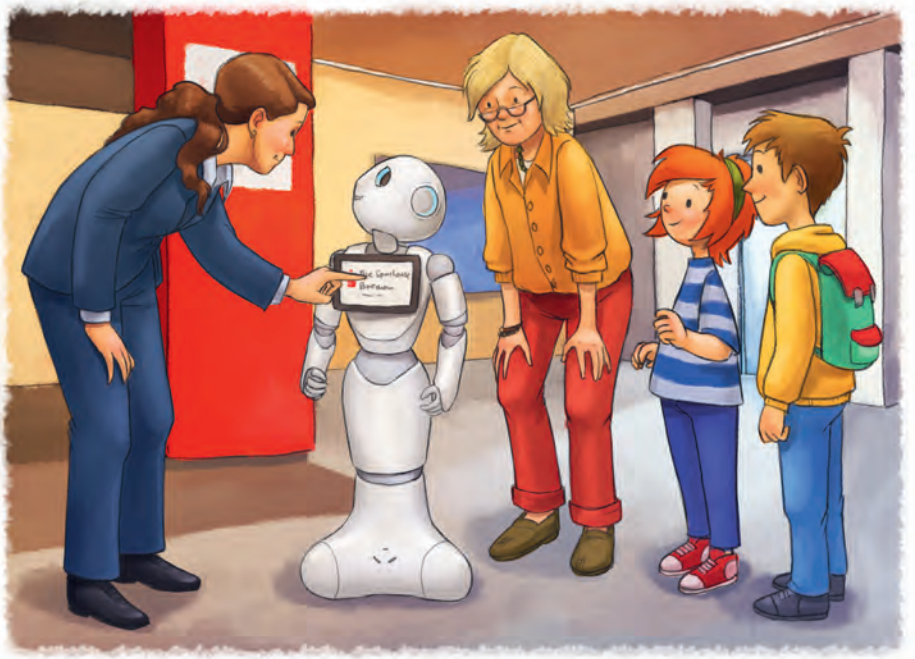
The word **intelligence** describes how capable a human brain is when it comes to solving a problem successfully. With **artificial intelligence** ('**AI**'), a computer is built and programmed in such a way that it can solve problems more and more like a human brain. However, many researchers do not find the term appropriate because they are certain that a computer can never have the same capabilities as a human brain. Even so, the word is often used to describe how a particular computer can do more than simply run a precisely specified program. For example, computers with artificial intelligence can learn something on their own from the data they collect.

robot that does our household chores. To do things like that, the artificial intelligence in Luna has to become even more like a human brain. But we're still a long way from that."
"And how do you make this artificial intelligence smarter?", asks Malik.
"You want to know exactly, don't you? Unfortunately, I don't know all the details", says Mrs Ahlring, "but there was a scientist from the university in the newspaper the other day. The interview dealt with very similar questions. He can certainly help you if you really want to know more. With Luna's help we will track him down", says Mrs Ahlring, and she goes to Luna. She types something into the tablet on Luna's chest. "Well, here is the newspaper article and here are his contact details."
"Great, we'll get in touch with him. We already know our way around the university. Research is our hobby", says Finja proudly.
"Well then, you have an exciting holiday program ahead of you. Good luck!"
"Thank you very much, Mrs Ahlring. And you too, Luna!", says Malik.
Mrs Müller and Mrs Ahlring say goodbye and go to the reception desk to talk a little more.

Finja and Malik are already feverishly excited about their new research project, but want to say a quick goodbye to Luna.

“It was nice to meet you, Luna”, says Finja. And Malik agrees, “Good luck with your training. Maybe we can come up with an idea on how to teach you to make coffee. Then we will definitely be back.”

“I’m already looking forward to meeting up again”, says Luna on parting.



PURELY A MATTER OF TRAINING

“Hello Finja, hello Malik! Can you hear and see me?”, asks the man on the computer screen. He has just appeared and is now smiling friendlily at the camera.
“Yes, everything is great”, replies Finja, “thank you for making it happen today, Professor Drechsler.”
The professor replies, “Of course, no problem. By the way, you are more than welcome to use my first name; our students do that too. I’m Rolf. I’m sorry we can’t speak in person. I’m at a conference in America right now. But a video chat should also be fine to answer your questions. So fire away: What exactly do you want to know?”
“Last week we met Luna Pepper by chance”, related Malik. “It was really fun talking to her. But we also noticed something.”

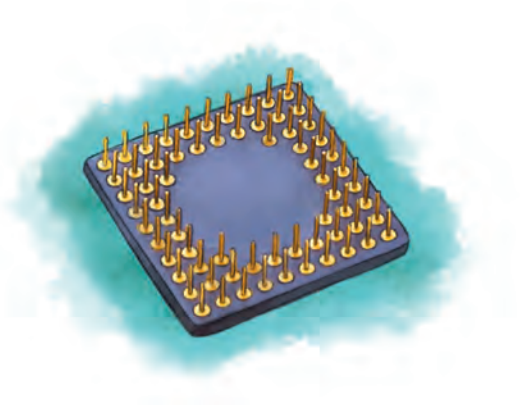
“Yes, exactly”, Finja takes over. “In films or in TV programmes, robots always know and can do a lot. Often they are even smarter and more skilled than humans. But that wasn’t really the case with Luna.”
“First she escaped from her job and got lost. She couldn’t go back alone. She also said some odd things. And she couldn’t really do things manually either, although she has arms and hands. Is that normal for a robot?”, asks Malik.
“You were very observant!”, Rolf Drechsler nods approvingly. “In fact, as a scientist who deals with artificial intelligence, I often have to deal with the fact that many people have the wrong idea of what computers and robots can actually do. Films and TV programmes are usually very far from reality.”
“What do you mean?”, asks Finja.
“Well,” says Rolf, “you have probably heard of the fact that there are computer programs or machines with artificial intelligence that can beat world chess champions, haven’t you? For a long time it was thought that if a computer program can do something like that, it must have something to do with the fact that it is very intelligent. That’s true - but only for this limited task. The human chess world champion is excellent at playing

chess, but can also do a lot more, for example solving math problems, deciphering the handwriting of a friend or deciding in the morning what to wear according to the weather. That doesn't sound like a great achievement at first. But the computer program that beats him in chess cannot do any of that. It can simply - and above all exclusively – play excellent chess."

"Does that mean that Artificial Intelligence like the chess computer is only better than humans for one very specific task?"

"Yes, exactly," replies Rolf, "and it is still currently so with all Artificial Intelligence machines. They can solve tasks in seconds that would take a human brain forever.

They can analyze huge amounts of information stored on tiny chips within a very short time and show us humans the result of their evaluation. Wait a minute! I have another chip somewhere around here. Here it is!" Rolf disappears briefly, but then comes back in view and shows a small chip in the camera of his computer. Then he goes on to explain,



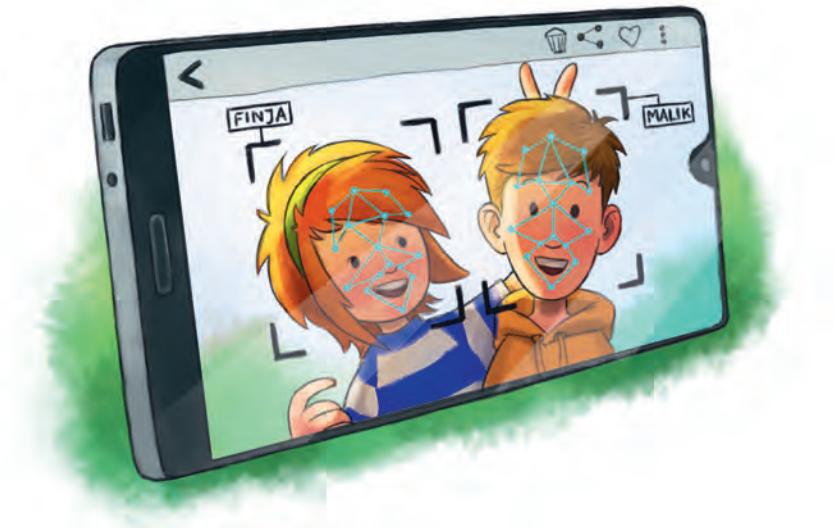
"But computers can only do all of this for a specific task that we have given them and for which we have trained them. Nothing else. That is also the reason why you had the impression that Luna sometimes misunderstood your questions. Conversing with humans in a way that makes us think we are talking to an intelligent person is a very, very difficult task for Luna. You would have to train her with a huge number of possible questions and appropriate answers so that the conversation would go completely smoothly. She cannot spontaneously come up with a suitable answer to a very creative human question.

Instead, she can certainly answer very predictable questions about the bank in which she provides services. 'Where's the cashpoint?', for example."
"That explains a lot! What kind of tasks besides playing chess are there that computers can solve particularly well with the help of this Artificial Intelligence?", Finja wants to know.
"I have a good example of this from everyday life: Have you ever used a smartphone with an app that recognizes certain people in photos?"
Malik nods, "I think my mum's cell phone can do that."
"Exactly! To start with, you mark certain people on the pictures yourself. The app registers the features

FINJA'S KNOWLEDGE BOX:

A **chip** or **microchip** is an important component in a computer. With its help, the electrical processing of data items takes place in the computer. Data processing on the chip works by having electrical current flowing or not flowing. In order to be able to process data – for example letters that are entered via the keyboard – they are first translated into numbers on the way to the microchip. The chip only uses the two digits 0 and 1 for data processing. The 0 stands for 'current does not flow' and the 1 for 'current flows'. This creates a flow of electricity that repeatedly starts and stops. The computer understands this and can display the processed data as letters on the screen.

on the face of the individual, for example the distance between the eyes or the position of the nose. All of the characteristics together are unique to each person. All new images are then searched for these features. Every now and then, when a new photo is taken, the app asks whether person X or Y can be seen on it. In this way, it

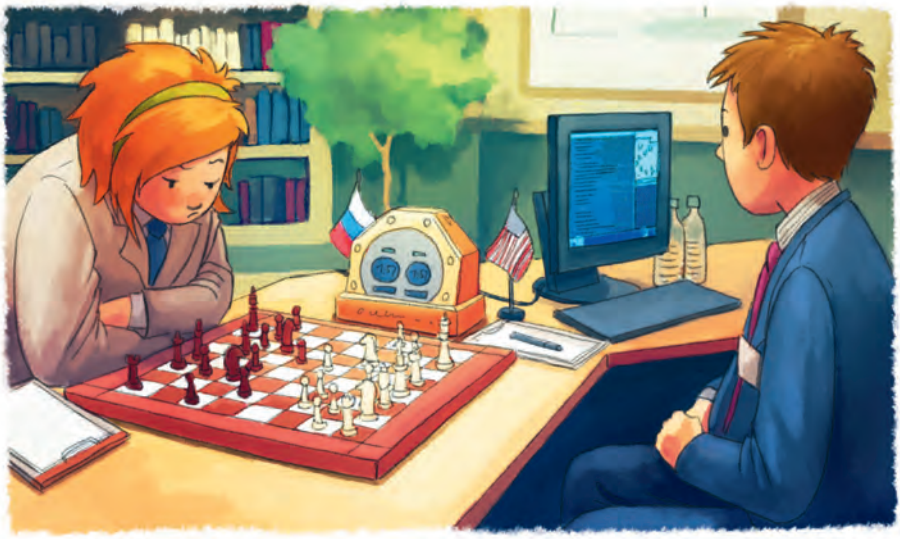


ensures that it has correctly recognized the person. The larger the number of photos the app can compare and the more feedback you give it, the better it gets at recognizing each person. This is how the app trains. And if you, Finja, then think, for example, 'Today I'll take a look at all the photos in which Malik can be seen',

then you can simply have the app display all of Malik's pictures."
"This is obviously practical if you have a lot of photos and are looking for a specific one", says Malik, "but actually it's just a nice toy. If teaching a computer is so much work, why do you and your colleagues even do it?"
"Sure, recognizing people in private photos is not one of the particularly vital tasks", replies Rolf. "But think about what else this technology could be used for. What do you think?"
"Well, if I've got it right, then it's to do with the fact that the computer recognizes certain patterns that keep recurring in a large amount of information", says Finja.
"Right!", says Rolf.
"Our new car recognizes traffic signs. Is that such a case?", asks Malik.
"Exactly; cars already use this kind of artificial intelligence. This is exciting for the development of self-driving cars. But there are also examples from medicine where pattern recognition is very important."
"Hm", says Finja, "I could also imagine that such a computer program could also recognize when a person changes in some way, due to an illness for example. Could that be possible?"

“That too. Artificial Intelligence is a particularly exciting research field that is vital for many people in the detection of cancerous tumors. Tumors are changes in cells in the human body that can be dangerous, and the earlier you spot these changes, the better you can treat them. Specially trained doctors usually look at x-rays to detect such changes. But you can imagine that people sometimes also make mistakes, and a change isn’t recognized early enough, maybe because they lack experience, have been working for a long time and are tired, or are just having a bad day. That doesn’t happen to a computer. It can also search a lot more images for cell changes in a much shorter time.”
“That sounds exciting! But these are all examples that have nothing to do with robots, do they?”, asks Finja.
“That’s right, Finja. Robots that work with Artificial Intelligence are yet another field of research and also a really big challenge”, replies Rolf.
“Why?”, asks Malik.
“Because robots are machines that are supposed to do very specific physical things. They don’t ‘just’ give us answers to our questions which, like Luna, they play over a loudspeaker or display on a computer screen. Think again about the chess computer. It can play chess, but

only virtually, in other words within its program. The pieces actually have to be moved by a human helper. It is a great challenge for robots to move a chess piece as well as a three-year-old child on a game board", explains Rolf. "Why is it so difficult for robots?", asks Finja.



"Well, I know a couple of colleagues who can answer this question much better", says Rolf. "What's more, you can also take a look at the robots in the laboratory that are being trained there. Do you fancy that? I could call and let them know that you will contact them to make an appointment to visit."

“That would be great!”, Finja and Malik say in unison, beaming at each other.
“Well, I’m happy to be able to help two enthusiastic young researchers like yourselves”, says Rolf and laughs.

From mail@finja-forscht.de
Subject Robots
To ease@uni-bremen.de

Dear Collaborative Research Centre EASE,

Professor Rolf Drechsler suggested that we could find out more from you about how robots learn. That would be great!
Since we are on holiday, we would have time to visit you at the university. We would love to take a look at your robots. Would that be possible?

Best regards
Finja and Malik

From ease@uni-bremen.de
Subject Re: Robots
To mail@finja-forscht.de

Dear Finja and Malik,

I'm Gayane Kazhoyan and I'm with the Collaborative Research Centre EASE. I'm doing my PhD on how to teach a robot to lay the table.
You are welcome to come and visit us in the laboratory. Wednesday would be convenient. Would you like to come around 9 a.m.? Then I'll answer your questions. How would that be?

Best regards
Gayane

POPCORN FROM THE ROBOT

The following Wednesday at exactly 9 a.m., Finja and Malik stand in front of a locked door to a long office corridor and ring the bell. The corridor is located in a multi-storey building at the University of Bremen that is made mainly of glass and steel.

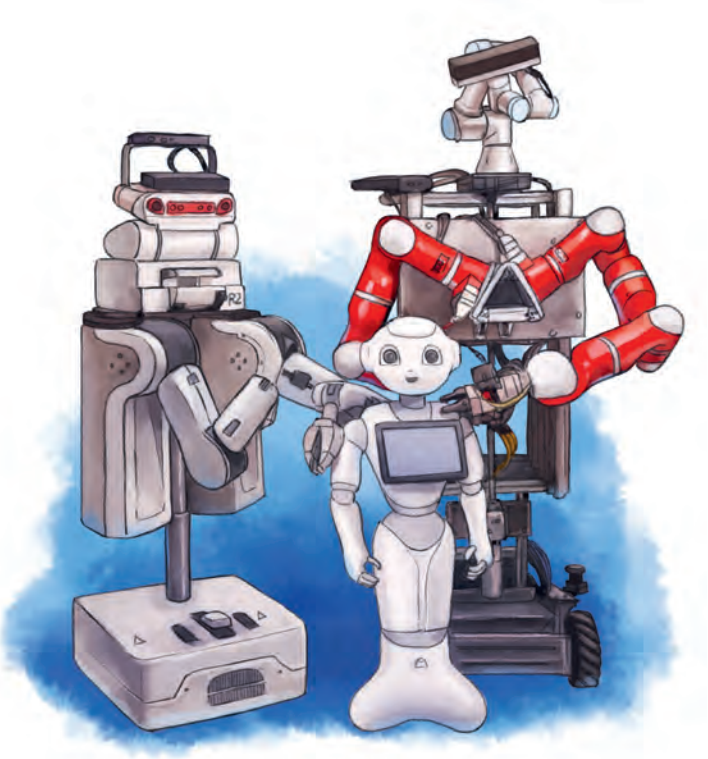
“What a coincidence that the robot laboratory is right next to the drop tower”, says Malik.

“But also useful”, says Finja, “so we could tell exactly how to get here. I wonder if Martin and Magdalena have finished their powder experiments in the drop tower in the meantime?”

But Finja and Malik are interrupted in their conversation about their first research adventure. The door opens automatically with an electric buzz.

“Hi there! You must be Finja and Malik”, a young woman

with glasses and dark curly hair calls out from the end of the hall. “Wait there, I’ll just get the key to our laboratory and then come to you.”
“All right!”, Finja replies, turning to Malik, “That’s probably Gayane Kazhoyan.” And the nice woman does introduce herself as Gayane when she comes to them, “But you can just call me Gaya. We are going through the door that’s directly opposite”, she says, and walks ahead. She holds a round plastic tag on her key ring against a small box next to the door and it clicks.
“Come in!”, says Gaya and invitingly points into the inside of the laboratory. Finja and Malik look around with wide eyes.



“Wow, you have three robots here all at once”, says Finja, impressed.
“And a real kitchen! What do you need a kitchen for in your robot laboratory?” Malik wonders.
“You will soon see what we need the kitchen for”, says Gaya with a smile. “First of all, I will introduce you to our three robots. You already know the model over there. This is Pepper. She is a ‘humanoid’, that is a human-like robot. She should recognize people and their facial expressions and gestures, and react to their feelings accordingly. At the moment the model is often used in sales rooms and behind reception desks. That’s how you got to know her, isn’t it?”
“Well, something like that”, replies Malik with a smile. “Luna Pepper works in a bank. But why is your Pepper so silent and just stands quietly in the corner?”

FINJA'S KNOWLEDGE BOX:

Gestures and facial expressions are also called body language. If we want to communicate with other people, we can do so using oral or written language. But we also do this with movements of our body (gestures) and our face (facial expressions). When someone gives you a thumbs up in the air, it usually means “Great!” or “All right!”. When someone talks to you, and their eyebrows contract and the corner of their mouth lowers, it could mean that he or she is annoyed.

“We are currently not researching with Pepper. That’s why she’s turned off. For our current experiments, the other two robots you see here are much more interesting.” The scientist points to the other side of the room. There are two robots that are significantly larger than Pepper. One looks like a metal frame on four wheels. A lot of technology is attached to the frame, including two robot arms.

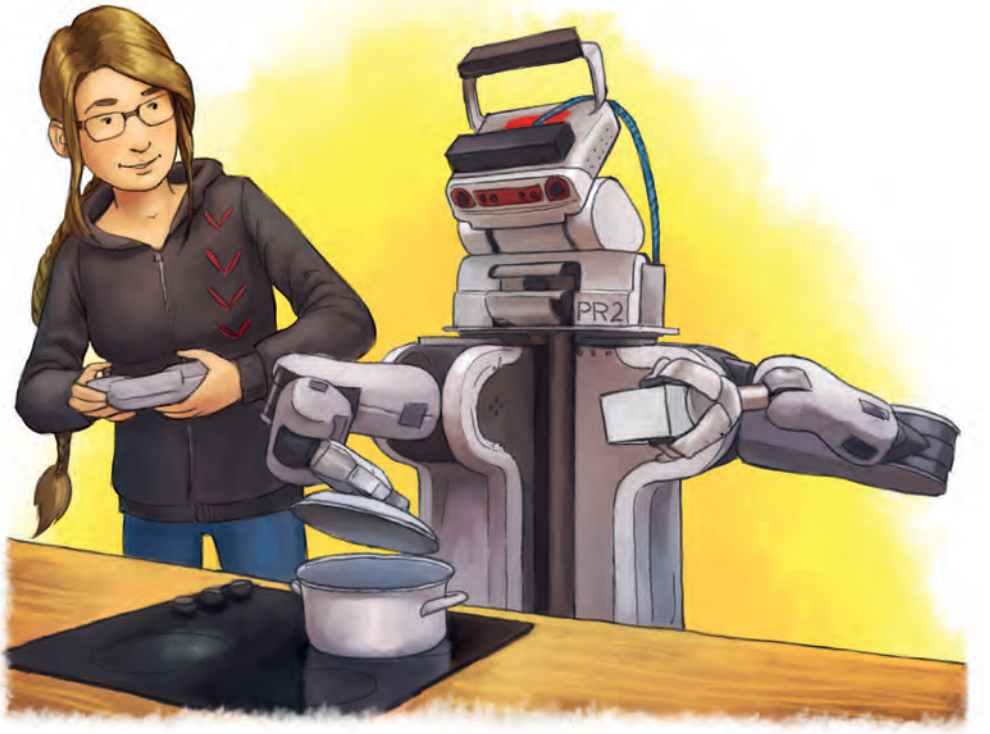
The other robot, standing in the middle of the kitchen, looks more human. It too has two arms and a head with what looks like eyes.

“Why does the robot look like it hasn’t been assembled yet; the one in the kitchen looks like it could start working straight away”, says Malik.

“One is a robot to which we can attach various tools to test them”, Gaya replies. “We have just connected two different arms and my colleagues are doing different experiments with them. And the robot in the kitchen - called PR2, by the way - is exactly as we need for our experiments in the kitchen. You’re interested in what robots can do, aren’t you? Then I’ll show you something that PR2 can do really well.”

Gaya goes to a laptop and types something. Moments later, PR2 begins to move. He moves towards a relatively

low counter. A hob is built into the counter. Next to it is a pan with a lid and a small cardboard box. With the help of his arm, PR2 first places the pan on the hob, then takes off the lid with one hand and pours the dried corn kernels from the small cardboard box into the pot with the other. Then he closes the lid and turns on the hob using a rotary switch.



“Oh, I know what this will be”, Malik exclaims enthusiastically, “PR2 is making popcorn for us!”
“That’s right, Malik”, says Gaya with a laugh. “Can you already hear something?”
They listen closely, and after a few minutes the closed pan starts to pop audibly: at first only single pops, then more and more often.
“As soon as it stops, you can take off the lid”, says Gaya.
Finja and Malik listen intently. When she doesn’t hear any more popping, Finja asks Malik, “It should be ready now, shouldn’t it?”
“Yes, now take off the lid”, Malik replies excitedly.
And indeed: it worked. PR2 made popcorn. It smells delicious!

“Help yourselves”, says Gaya. “Now think about it: How long do you think it took us to teach PR2?”
“Maybe a few hours”, Finja estimates cautiously.
“That would be nice”, says Gaya. “To be honest, it took a couple of years.”
Finja and Malik are flabbergasted. “Why did it take so long?”, asks Finja.

As Gaya is about to answer, the laboratory door opens with a buzz and a man in a striped knitted sweater comes in.

"Ah, I thought so. PR2 has made popcorn again. I can smell it in my office. May I have some of it too?", asks the man.

"Finja, Malik, this is Michael Beetz. He is a professor and heads the research group I work in. Sure, Michael, help yourself. However, there is no sugar on it yet", says Gaya. "But it's good that you're here. Our two guests here want to know why it took so long to teach PR2 how to make popcorn. You have been there from the start. I think you should answer the question."

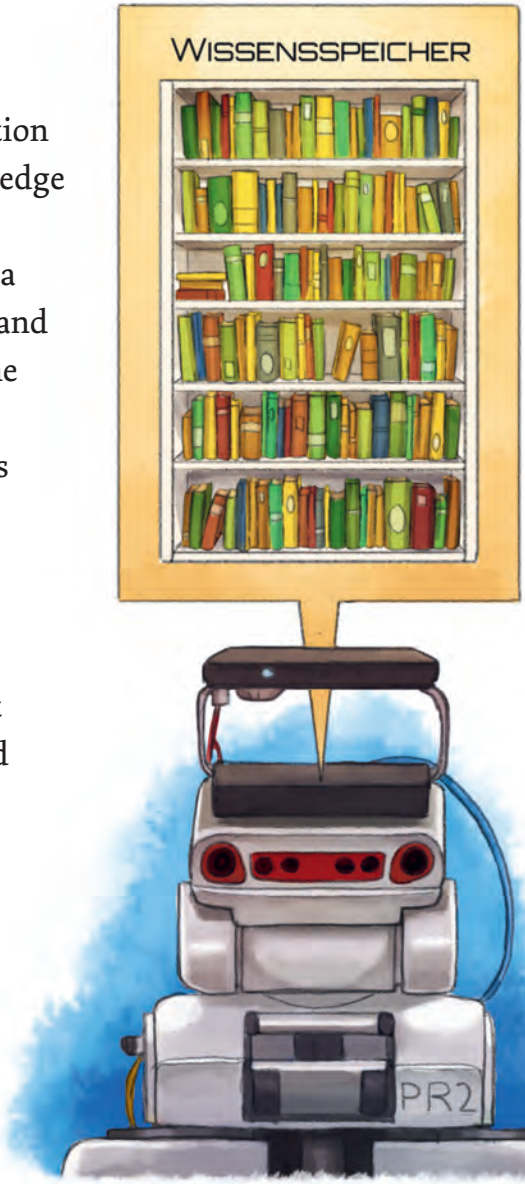
"With pleasure", he said. "Have you ever thought about how children learn things? Our brain is a real miracle tool.

From the day of birth, the human brain literally absorbs impressions", explains Michael Beetz. "Every minute, every second the baby – and later the child – learns something new. Within the first year of life, a child learns the complex movement sequences that it needs to crawl, run or speak, for example, through listening, observing and trying out. Robots don't have such a brilliant brain. They depend on us to write them a program, an algorithm, that replaces the functions of a brain to such an extent that it can perform sequences of movements. Of course, it's difficult to write such a program that contains all the information necessary for movement."

"I don't quite understand. Can you give us an example of this, Professor Beetz?", asks Finja.

Beetz replies, "Sure. And you can call me Michael by the way. For example, if a child learns to drink from a glass without spilling water, it does so by watching and imitating its parents. Before that, it had already learned the basics through many attempts and small experiments that it needed. For example: 'What is a glass?', 'How can I bring it to my mouth?', 'How much force will I have to use to lift it?', 'How and where do I put it down again?'. And that is only a fraction of the questions that the brain has to be able to answer so that we can drink from a glass

without accidents.
A robot also needs to have all this information available in its knowledge bank in order to lift a filled glass, move it a little through the air and put it down again. The task for us computer scientists is to fill this knowledge bank.
No robot can do this without help. That is the big difference to the human brain that can learn by itself and above all wants to."
"And how do you fill a robot's knowledge bank?", asks Finja.
"You can do this in different ways, all of which are very time-consuming.



On the one hand, programmers can enter this information into the knowledge bank by hand. It's like writing a library full of books at once, and it's a very difficult task because we humans do many things unconsciously in a certain way. But we also need to uncover this unconscious information and make it available to the robot in such a way that it can use it."
"That sounds like a lot of work", says Malik. "And what is the other way in which you can fill the knowledge bank?"
"You can also try to show the robot how to do it", Gaya replies.
"But Michael just said that, unlike children, robots cannot learn by simply observing", Finja wonders.
"This is also true. It can't do it in a human way. But in an Artificial Intelligence way", says Gaya. "Rolf Drechsler told me that you had already spoken to him about how Artificial Intelligence can learn to recognize faces. In doing so, it continues to expand its knowledge bank step by step. It can be used in a similar way when recognizing movement patterns in everyday activities."
"Do you then show the robot lots of photos of people making popcorn, for example, and it recognizes the patterns in them?", asks Malik.
"Since it's about movement, photos wouldn't be enough

here, Malik. For this we use information that we collect with the help of the experimental setup over there."
"Have you ever seen anything like that?", asks Michael, pointing to a table at the other end of the room. There are a lot of cables and something that looks like large ski goggles on it.
"I've no idea", says Finja and shrugs her shoulders.
"All of this is needed so that participans in the test can perform movements in virtual reality that can then be easily reproduced by the robot. It's similar to a computer game, except that the test participants are not sitting in front of a screen and holding a single controller. They put on our VR glasses here and can then move freely around the room with a controller in each hand. This allows movement patterns to be recorded more

precisely. And a robot ‘understands’ that too”, says Gaya.
“Cool! Can we maybe try it out?”, asks Finja excitedly.
“You know what,” says Michael, “we have a workshop for children on Friday in which we do exactly these things. Would you like to come back again then? Gaya explains everything very precisely and everyone can get a taste of virtual reality.”
“That’s a good idea, Michael. I still have places available. Have you got time on Friday?”, asks Gaya.
“That sounds great. Of course we’d love to come! It’s the holidays anyway”, says Finja. “Malik, you don’t have any plans yet either, do you?”
Malik shakes his head. “And even if I did, I wouldn’t pass this up”, he says enthusiastically.
“Well then, I definitely wish you a lot of fun on Friday. Unfortunately, I have to go back to my desk and continue

FINJA'S KNOWLEDGE BOX:

The word **reality** means ‘realness’. The word virtual means ‘not real but appearing real’. A **virtual reality** (abbreviated as **VR**) is a kind of artificial realness. Through this we experience something that appears to us like reality but which has been reproduced by a computer. Such a computer thus simulates (reproduces) reality.

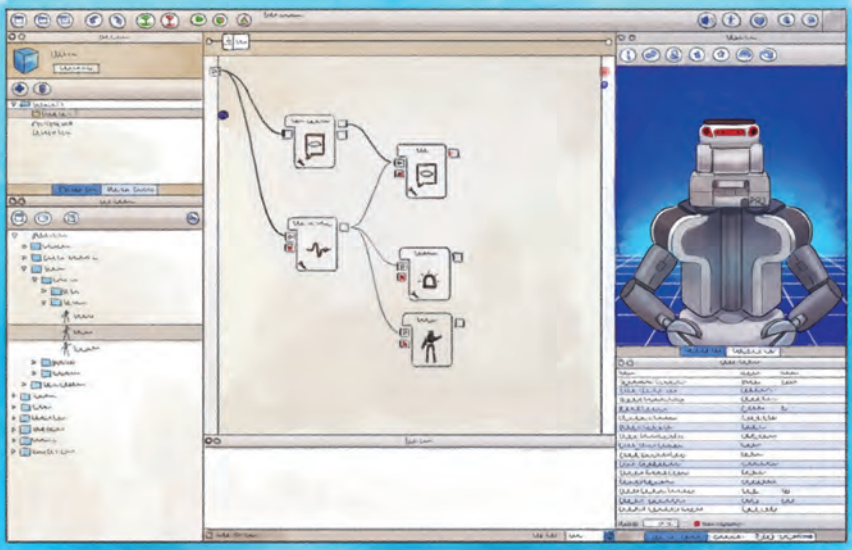
working. It was nice to meet you", says Michael and reaches for the bowl with the popcorn. "Maybe we'll see each other again! If you happen to study Informatics later, contact us. We are always looking for committed students who are interested in working here and carrying out research with us. And there's delicious popcorn here!" He winks at the children and waves goodbye.

MUESLI FOR ONE PLEASE, PR2

“The goal of today’s workshop is to teach PR2 how to set the table”, says Gaya. She stands in front of a group of around 20 girls and boys who are sitting in pairs in front of a computer. Finja and Malik are also there and are sharing a computer. Shortly beforehand, the two of them and the other children who came to the holiday workshop today watched PR2 make popcorn again. “As you can probably imagine after our little popcorn demonstration, it’s not that easy”, Gaya continues to explain. “On your screen you can see the computer program with which you will be working in the coming hours. It helps you to communicate with PR2 and to program the correct instructions into him. In the end, he should set the table for a breakfast of muesli, accident-free.”

Finja puts up her hand to ask a question, “I don’t know how it is for the others, but I’ve never programmed anything. Can we just get started anyway?” The other children are obviously feeling the same because they look at Gaya expectantly.
“Most certainly, Finja. The program you are going to use is specially designed for those learning to program. Normally you first have to master a programming language completely in order to be able to write something that the robot can then understand. It’s a bit like learning a foreign language to write to a pen pal. But today we are using a program that works with images and symbols that are easy to understand. You can then click on them with the mouse and attach them to each other in a different order to give PR2 instructions”, says Gaya and looks around. “If you don’t have any further questions for now,I would suggest that we just get started. I will now explain to you in more detail how the program works.”
Gaya sits down at a laptop. Whatever she enters there into the program is shown on a large screen that all the children can see. As soon as Gaya has explained all areas of the program, the enthusiastic children immediately get started on their own.
Finja and Malik take it in turns to try out different

sequences of individual movements. “It could work like this. Let’s try it out”, says Finja after the two of them have tinkered for a while. She presses the start button in the program. A figure that looks like PR2 is now moving in a small window at the bottom right.



“Looks pretty good, you two”, says Gaya, who has just placed herself behind Finja and Malik and is now looking over their shoulders. “I’m looking forward to seeing how

it works when we test your programming on the real PR2 later. But you also wanted to try out our virtual reality. We simply call it VR.
How about if you start, and then all the other children can try it out?"
"Why, yes!", Finja and Malik answer in unison and immediately jump up. Gaya leads the two of them to the table they remember from their last visit and first puts the large glasses on Malik. Then she hands him the two controllers.
"So what do you see now, Malik?", she asks.
"It's like standing right in the kitchen that is actually on the other side of the room. Everything looks exactly the same – but is made by a computer. And when I put my hands up, I see two hands floating freely in space. Why don't I see my whole body?", asks Malik.
"I'll hand this question over to you, Finja", says Gaya.
"Do you have an idea why?" Finja looks up from the screen, which shows in two dimensions what Malik is seeing. She hesitates, but then replies, "Well, think about it … when setting the table, the hands are actually the most important thing, aren't they? Maybe PR2 just needs to know what a person does with their hands to learn how to set a table?"

"Exactly", agrees Gaya. "PR2 doesn't need all the other information for example what the feet are doing, in order to complete this task so we save ourselves the effort of including that. Go ahead, Malik. You see a drawer in front of you. You can open it by moving your hand towards it, then pressing the button on the controller and pulling your hand back again."
"All right", says Malik and opens the drawer. In it he finds a cereal bowl, which he takes out again with hand movements and the push of a button. Thus Malik works his way through the virtual kitchen until he has everything for a breakfast of muesli on the table that is also in the kitchen.

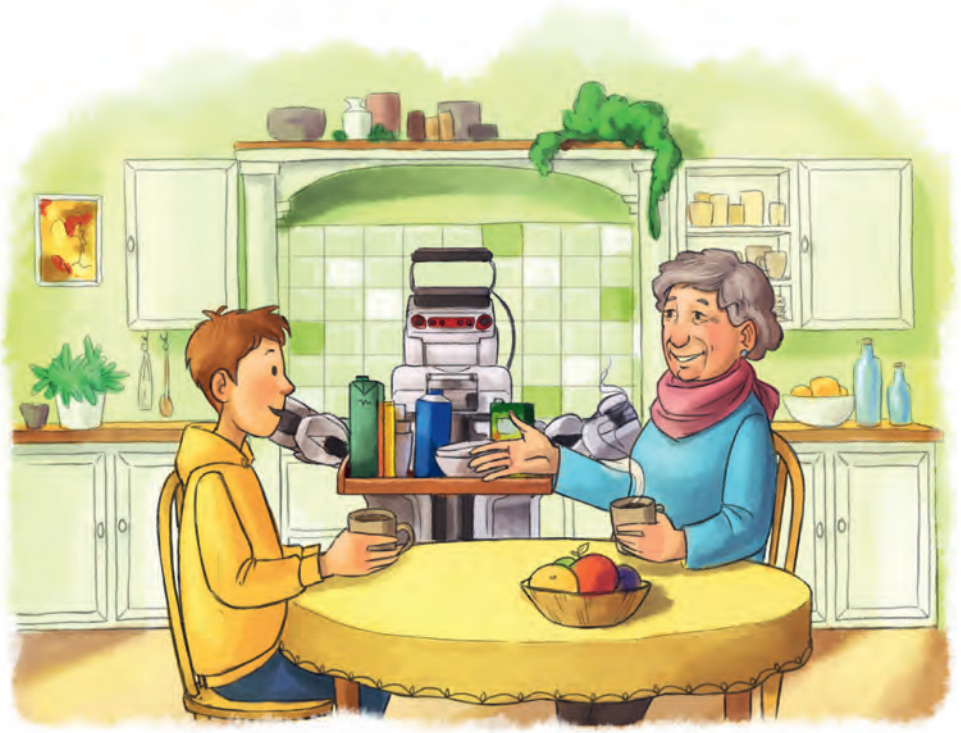
FINJA'S KNOWLEDGE BOX:

2D and 3D are abbreviations for the terms **two-dimensional** and **three-dimensional**. These terms refer to how we perceive a person or an object with our eyes. For example, when we watch a normal television program, we perceive what is happening on the screen as a flat plane. That is, we see it only expanded two-dimensionally in height and width, but there is no depth. In a 3D film in a cinema or in virtual reality, specialist technology ensures that we can perceive what is happening and our surroundings three-dimensionally. So we don't see it as a flat plane, but rather also expanded in the third dimension, the depth of the space. This makes it look more like our real world in which we also perceive things in three dimensions.

“Now I have everything together. Would you like to give it a try, Finja?”
Needless to say, Finja gladly takes over the VR glasses and the controllers. Then she also immerses herself in the world of virtual reality. Her job is to prepare the muesli.

With skillful hand movements and the push of a button, she first lifts the box of muesli and then the milk carton and, one after the other, pours some of the contents into the bowl. Finally, she puts the spoon in the bowl. “Done”, she says and takes off the VR glasses with a satisfied smile.

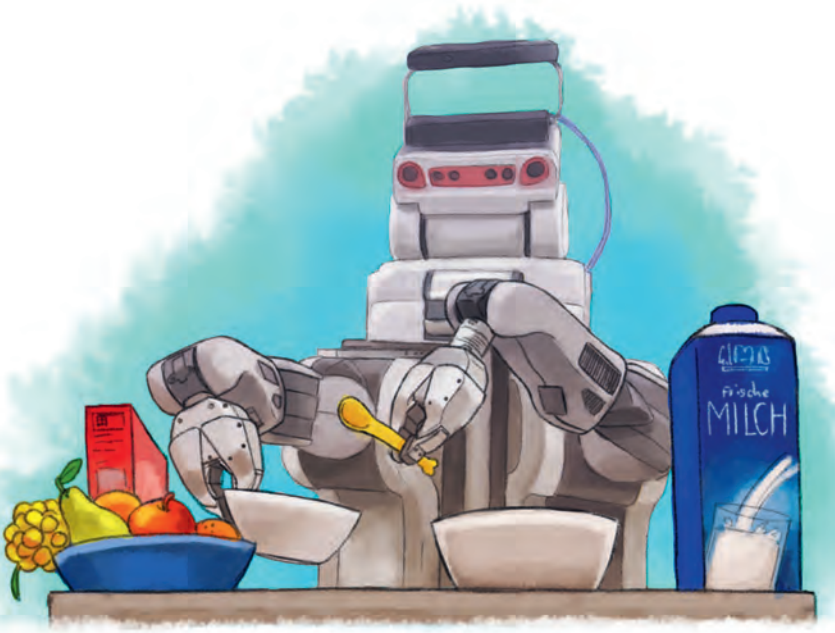
“You did a great job”, says Gaya. “Now PR2’s knowledge bank has one more example to hand from which he can learn.”
Finja has nevertheless one more question, “Let’s be honest, Gaya, teaching a robot like this is a huge amount of work. Why are you doing all this? Surely not just for fun.”
“Certainly not – otherwise we wouldn’t get any government funding for it. And we wouldn’t work with



so many companies that are investing money in the further development of robots. Robotics has many fields of application for which it is worthwhile making the effort. For example, could you imagine to whom a robot like PR2 could be of interest?"
Malik answers immediately, "Of course; it would be of great help to people who cannot set the table themselves. Ever since my grandma needed a walking frame, it has taken her forever to set the table. She can't use a tray because she always has to have one hand on the walking frame. She would certainly be delighted to have a PR2."
"And not just your grandma", Finja adds, "other people who have to deal with limitations in everyday life would also certainly love to have a robot like this to help them. People with disabilities could then probably do the housework much more independently, couldn't they?"
Gaya replies satisfied and also a little proud, "Well recognised!" We see robots as tools that help people cope better with everyday life. Our aim with PR2 is to train a robot in such a way that it helps people with disabilities to organize their everyday lives independently at home. But there are many other areas where robots can be important tools to help people. Imagine, for example, that we had robots that could independently find and save those

buried after an earthquake. Then no more human rescuers would have to put themselves in danger."
"Gaya", one of the other children calls over to the three of them a moment later and looks over the computer screen they are working on, "can we try out the VR glasses now?"
"Sure, come over", Gaya replies and beckons the other children over. One by one, they all try out the VR glasses.

When all the children are finished, they go back to their computers for a moment and choose one of the movement sequences that they have programmed for PR2. Each of these programs is to be tried out on PR2. Of course, not everything runs smoothly or PR2 stops in the middle of the movement, as if he doesn't know what to do next. But in most cases the robot manages to prepare the muesli breakfast pretty well. Finja's and Malik's programming also worked with the first attempt. The two exchange high-fives.
"We did it again, Malik!", Finja says proudly.
"We certainly did", says Malik. "I wonder if we can borrow the program to develop a program at home with which we can teach Luna Pepper to be able to make coffee."



“That is an excellent idea”, says Finja and grins. When the workshop is over and the other children have said goodbye, Finja and Malik approach Gaya again. “Gaya, firstly of course thanks ever so much for the great day. But we still have a small request. Could we possibly borrow the computer program we used today?”, asks Finja. “That shouldn’t be a problem. But I am naturally curious; what are you going to do with it?”, Gaya asks in return. Malik replies, “We want to try and see if we can get Luna Pepper to fulfill a wish. Maybe we can manage to teach her how to make coffee using your program.”

“Ah, I see,” Gaya laughs. “But then I’ll find you a program that works just like our program today only it’s specifically made for programming a Pepper robot. Making coffee with Luna Pepper will most likely be very difficult, but maybe you can come up with something else. Then you just have to ask the bank where Luna works if you are allowed to program something for her.”
“We’ll do that, of course”, says Finja, “but I’m guessing that the people there would be happy if we taught Pepper something new and also something so practical.”

AN END AND A BEGINNING

“So, Mrs Müller, please ask Luna the question we discussed earlier”, says Finja, rubbing her hands together in anticipation. Today is the big day: Malik and Finja have arranged to meet Mrs Ahlring, Mrs Müller and Luna Pepper at the bank to try out something exciting.
Malik and Mrs Ahlring also observe attentively how Mrs Müller approaches Luna and greets her.
“Hello Luna, nice to see you”, says Mrs Müller.
“Hello, nice to see you again”, says Luna. “How are you?”
“Fine, thank you”, Mrs Müller replies, “I have an appointment with my customer advisor today. His name is Thomas Schmidt. Do you know him?”
“Of course I know Thomas. His favourite food is spaghetti and he is a big fan of Werder Bremen”, says Luna.
“Great! Unfortunately, I don’t know exactly where

Mr. Schmidt and I are meeting today. Do you know and can you take me there?", asks Mrs Müller.
"Of course. I'd be happy to. Just follow me. I'll take you to the right meeting room", says Luna. She raises her hand invitingly and moves off.
Mrs Müller and, a few steps behind, Mrs Ahlring, Finja and Malik, also follow Luna. They turn a few corners and then Luna stops in front of a conference room and points to the door with her hand. "Here we are. Thomas Schmidt is expecting you. I wish you a successful conversation."
Finja and Malik start to cheer and clap their hands. "Wow, it worked", Finja exclaims.
"Finally! That was really a hard piece of work", says Malik and beams.
Mrs Ahlring and Mrs Müller also laugh loudly with the two friends and are elated. Only Mr Schmidt is a little surprised. He comes out of the meeting room and looks around in surprise.
"Well, what's going on here? What is there to celebrate?"
"These two young folk here", says Mrs Müller pointing to Finja and Malik, "have taught our Luna Pepper to show customers the way if they don't know where their appointment is."

Mr Schmidt is wide-eyed and asks Finja and Malik, “Is that right? How did you manage that?”
“Fortunately, a scientist at the university gave us a program with which we taught Luna to do that”, Finja answers. “It was still a lot of work because Luna had to learn many different things. For example, the names of all the employees and where all the meeting rooms are. She also has to always know what appointments are coming up next.”

“It was quite a challenge, but it was also a lot of fun”, Malik adds.
“I am really impressed with what you have learned about robots in the last few weeks”, says Mrs Ahlring, “I would be very happy if you could continue to help us with Luna’s programming from time to time. Would you like to do that?”
“From what we’ve seen from Luna today it certainly won’t be the last trick we teach her”, says Malik, grinning.
“We already have lots of ideas about what Luna could learn. And one day she’ll successfully learn how to make coffee!”, says Finja.
“Ahoy, ahoy! Yeah, sure!”, says Luna Pepper.
Malik snorts with laughter and all the others join in.


What unknown animals live on the ocean floor?
Why do people flee their homeland?
How does an email reach us?

WHAT ISABELL ALSO WANTED TO TELL YOU ...

This book is the second book in the series 'Finja Finds it Out!'. A few years ago, I had the idea for a series of children's books that describe exciting research ventures in Bremen. The first book in the series 'Finja Finds it Out!' was published in March 2019: "Das geheimnisvolle Pulver". In this book, Finja and her friend Malik, together with material scientists, unravel the mystery of a mysterious powder which brings Finja and Malik all the way to the drop tower.

In this second book, it's also scientists who help Finja and Malik to understand what the mysterious robot Luna Pepper is all about. And just like in the first book, these scientists exist in real life. You can find out exactly what they look like and what they are researching here:

Prof. Rolf Drechsler has been head of the Cyber-Physical Systems research area at the German Research Centre for Artificial Intelligence (DFKI) since 2011 and also a professor in the Department of Mathematics and Informatics at the University of Bremen since 2001. Prior to that, he worked in technology development at Siemens AG and at the Institute of Informatics at the Albert-Ludwigs-Universität in Freiburg/Breisgau. He completed his degree in Informatics at the Goethe University in Frankfurt/Main in 1992 and also wrote his PhD thesis there directly afterwards. Today, Rolf Drechsler's research focuses on the development and quality-oriented design of algorithms and problem-specific data structures in computer-aided circuit and system design.

Prof. Michael Beetz is Professor of Computer Science in the Department of Mathematics and Informatics at the University of Bremen and Director of the Institute for Artificial Intelligence (IAI).

In addition, since 2017 he has been coordinator of the German Collaborative Research Center EASE (Everyday Activity Science and Engineering). Michael Beetz achieved his degree in Informatics with distinction from the University of Kaiserslautern. He also did his PhD at Yale University in 1996. Michael Beetz's research interests include plan-based control of robotic agents, knowledge processing and representation for robots, integrated robot learning and cognitive perception.

Gayane Kazhoyan is a PhD student at the Institute for Artificial Intelligence (IAI) at the University of Bremen. Before joining Michael Beetz's group in November 2013, she worked for a year as a research assistant at Kastanienbaum GmbH in close cooperation with the Centre for Robotics and Mechatronics of the German Aerospace Centre (DLR). Prior to this, she acquired her Master's degree in Informatics with a focus on AI and robotics at the Technical University of Munich. Gayane Kazhoyan's research focuses on the field of cognitive robot guidance. She is currently involved in the development

of CRAM. CRAM (Cognitive Robot Abstract Machine) is a software toolbox for the design, implementation and use of cognitive deployment of autonomous robots that perform everyday activities.

Many thanks to Rolf, Michael, Gayane and their teams working in the background for their great support in researching for this book.

Special thanks also go to another person who has greatly enriched this book through her intensive experience with the real Luna Pepper:

Tina Marie Ahlring is a Community Assistant at the Neustadt branch of Sparkasse Bremen. She is responsible for the reception and the community division of the branch, which offers a wide range of services to local residents. She plans events, pop-up stores and is involved in networking within the district. Since Luna Pepper also works in the same area, Tina Marie Ahlring is her colleague and is involved in Luna's training.

Isabell Harder works in public relations for science. As a literary scholar and mother of a young daughter, she also enjoys storytelling. She combines her enthusiasm for fascinating research in Bremen and for smart children's books in her 'Finja Finds it Out!' series.

Lea Fröhlich found her calling in 2009 when she studied communication design in Hamburg with a focus on illustration after taking a shot at philosophy, history and the health sector. She then worked as a 2D artist and illustrator for a computer game developer in Bremen and has been self-employed since 2016.

This book project was financially supported by:

Universität Bremen

AGRA

EASE

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH

Artificial Intelligence

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Tina Marie Ahlring: Sparkasse Bremen

The German National Library lists this publication in the German National Bibliography; detailed bibliographic data is available on the Internet at http://dnb.dnb.de.

www.schuenemann-verlag.de

Text: Isabell Harder
Illustration: Lea Fröhlich
Editing: Caroline Simonis
English translation: Elizabeth Stewart
Overall production: Carl Schünemann Verlag

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