AI for Children

Artificial Intelligence Curriculum for Elementary and Secondary Schools

Robots at the Cat Exhibition

Learning from Examples

05

National Pedagogical Institute of the Czech Republic

We create methodologies in cooperation with the National Pedagogical Institute.

Teaching material for Elementary Schools–AI in Computer Science

Learning from Examples – Robots at the Cat Exhibition

About the story

The robots found themselves at a cat exhibition – and there were cats everywhere! So many breeds, colors, and sizes! But how are they supposed to recognize a cat when each one looks so different? To learn how to identify cats properly, the robots need to see lots of them. Let's see how well they do – and which ones they'll end up taking home from the show.

Robot Hoo

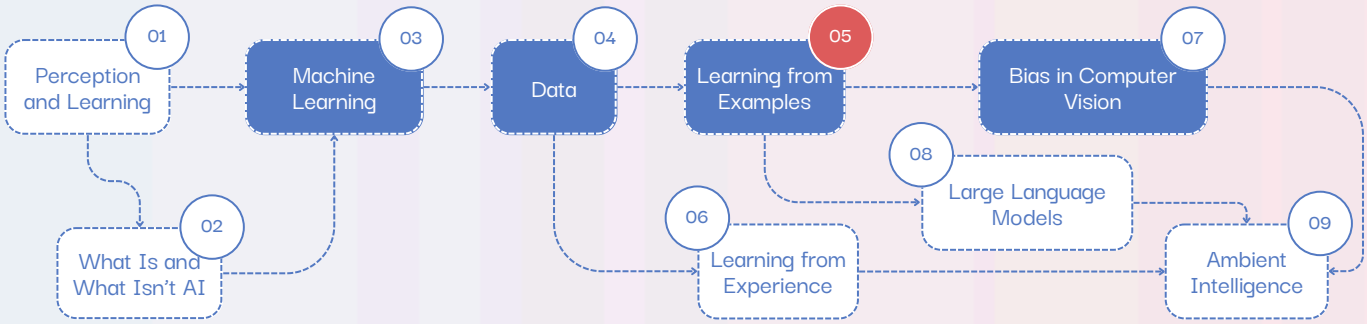
Hoo is programmed as a curious and slightly unsure robot. He always tries to understand others. He also collects various human artifacts he finds online–rare memes or old internet trends. He then shows them to Ray, who sees no value in them.

Robot Ray

Ray is programmed for practicality. He constantly looks for ways to process data efficiently. Human emotions don't interest him –what matters are the numbers. He always generates fast and accurate responses, though he often takes things too literally. Ray spends his time building complex mechanical models.

Learning progress map

The Learning Progress Map outlines the key concepts that children should understand during elementary school. The most essential ones are marked in solid blue, while the recommended concepts are shown in white. Each concept is accompanied by a teaching material and a presentation.



All materials can be found at kurikulum.aidetem.cz/en.

Created by: Bára Karpíšková
Concept: Eva Nečasová
Expert guarantors: Cyril Brom, Zbyněk Filipi, Tomáš Mlynář, Pavel Kordík
Artistic design: Jindra Janíček
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Presentation

Editable template in Canva

Feedback form

These teaching materials were translated using ChatGPT.
Please note possible imperfections in the expressions or wording.

Glossary of terms

Artificial Intelligence (AI)
There is no single, universally accepted definition of artificial intelligence.
However, all definitions agree that it refers to a system that simulates human thinking and behavior.
AI usually takes the form of a computer program designed to solve tasks that once required significant human intelligence and were considered the domain of humans (or animals).
It is also a scientific field, with roots dating back to the first half of the 20th century, focused not only on understanding intelligent systems, but above all, on creating them.

Machine Learning (ML)
Just as humans can learn from examples and experiences, so can human-made machines. Machines use a method called machine learning, which enables AI systems to go beyond simply following pre-programmed instructions and instead come up with new solutions on their own.

Supervised Learning
Supervised learning is one of the ways artificial intelligence systems can learn – in this case, for example, how to recognize objects in images or videos. If we wanted to build an app that can distinguish between cats and dogs, we'd first need to tell the program which images show cats and which show dogs (this is called data annotation). In this approach, humans act as teachers – which is why it's called supervised learning.
Once the images have been labeled as cats or dogs, we train the program. After that, we show it new images of cats and dogs it has never seen before, and observe whether it identifies the animals correctly. If the program makes mistakes, we improve the dataset – for example by adding more pictures of cats and dogs – and train the model again.

Lesson Overview

Recommended Age, Lesson Length
Children aged 8-11, 45–90 minutes.

Building Blocks
Supervised learning (learning from examples).

What Are the Students Learning?
Computers can learn to recognize different things based on examples prepared by humans.

Why Are They Learning This?
Understanding the principle of supervised learning is an important piece in the mosaic of machine learning.

How Do We Know They Have Learned It?
In their own words, students explain how computers learn from examples and what kind of examples they need.

Tools
Teacher: Presentation to be shown.
Students: Writing supplies, possibly printed worksheets.

Digital Competence
Facilitating Learners' Digital Competence.

Bloom's Taxonomy
Remembering: Students recall and identify key characteristics of objects.
Understanding: Students compare and sort objects based on set criteria.
Analyzing: Students recognize situations where recognition might go wrong and identify possible sources of errors.

Five Big Ideas
1-B-I Processing (Sensing vs. Perception).
1-C-I Domain Knowledge (Types of Domain Knowledge).
3-A-I Nature of Learning (Humans vs. machines).

Note: Gender equality is key for AI for Children, but for brevity we use masculine formulations in our methodologies.

Engage

min 00

Presentation slide 01

Read part of the story to the students.

Hi! It's us again – Hoo and Ray! On our last adventure in the clouds, we had tons of fun feeding on data. Today, we're going to look at how machines like me learn to recognize different things around us. Sometimes it's not as easy as it looks. Everyone makes mistakes sometimes - and that's completely okay!

We've got some awesome activities lined up for you, where you'll get to step into the shoes–or rather the metal casing–of a machine for a bit. And who knows, maybe by the end, you'll be the ones teaching us again!

Imagine you're walking through a park and you see a tree with beautiful colorful blossoms and a very unusual shape. You've never seen a tree like that before. How do you know it's a tree?
Children might say: if it has a trunk, crown, branches, leaves or needles, then it's probably a tree. These are the typical features or characteristics we associate with a tree.

And what do you think – could a robot like Hoo or Ray recognize a tree too?
Students will probably answer similarly. Lead them to realize that in order for a robot (or any artificial intelligence system) to recognize something, it first needs to see a lot of examples. It learns to spot patterns (like shapes of branches, leaves, bark, etc.) and uses these to recognize what it sees.

Can you think of any situations where a robot might get confused?
Let the children explore and then reveal the following image in the presentation.

Presentation slide 02

The image is made up of 16 smaller pictures showing alternating muffins and chihuahuas with chocolate chips or similar markings. For the computer, distinguishing between them was extremely difficult, even though it seems obvious to us.

Source: www.freecodecamp.org/news/chihuahua-or-muffin-my-search-for-the-best-computer-vision-api-cbda4d6b425d/

Do you think that if you drew a large number of pictures of trees for a robot, it would be able to recognize the tree in the photo?
Answer: It probably wouldn't be able to do that, because a tree drawn by a child looks completely different from a tree in a photograph. Even though a child's drawing will likely contain a crown, trunk, leaves/needles, the computer will "see" crayon strokes, etc., not real structures like bark...

Understand

min 10

Presentation slide 03

Read the story.

After connecting to the cloud and gaining a bunch of new experiences, Hoo and Ray became fascinated by every internet trend imaginable. The internet opened up to them like an endless book full of animal memes, dance challenges, and much more. With every new digital image and piece of information, their excitement grew – but they also found themselves facing a tricky question: what is it that makes people happy and connects them all? Their reasoning seemed simple–but it definitely wasn't. If we manage to find something that all humans universally like, then surely we'll be able to understand their needs. The trouble is, people are so incredibly different...

Ray took a logical approach. "We need to find out what's most talked about online. That will help us understand what people like best!" So they dove into search engines and trending topics. Bold letters popped up everywhere: "The secret behind YouTube's success: whiskers, fur, tiny noses, and friendly faces are taking over the internet! Cats are the #1 online phenomenon!"

"If cats rule the internet," murmured Hoo, "then we need to understand their magical appeal." Holding a note titled Whiskers, fur, heart-shaped noses, pointy ears, and something called maximum friendliness, they came up with a plan: they'd head to a cat show – the perfect place to find the best candidate to help them understand humans.

The show was packed with cats of every kind. Some had whiskers that even a wizard would envy. Each one had something unique, but not all of them matched the description exactly. When Hoo and Ray tried to identify maximum friendliness, they realized something unexpected – none of the cats quite fit the bill. The robots were left puzzled.

Still determined, they explored every corner of the cat exhibition – until something caught their eye: a wide, beaming smile. A cat sitting calmly in the center of the room had everyone's attention, including the robots'. She had it all: whiskers as long as a lion's mane, a nose shaped like a heart, and the pointiest little ears you've ever seen.

Presentation slide 04

The robots were just about to take their new discovery home when suddenly, a deep voice boomed from under the whiskers: "What on earth are you doing?" Their "perfect specimen" turned out to be none other than Caretaker Carl! Look, Ray," whispered Hoo. "This is our new feline friend!" Ray paused for a moment, ran a few calculations in his memory, and then smiled. "You're right, Hoo – he's got everything we were looking for!"

Caretaker Carl assured them he was flattered, but he might not be the ideal choice for couch cuddles. Instead, he suggested they adopt one of the actual cats – and offered to help them find the perfect match.

We've prepared two special challenges for you–so you, too, can dive into the world of recognition, discovery, and maybe even make a few furry friends along the way.

First activity

Presentation slides 05 and 06

min 15

Hand out worksheet 01 or show the presentation on slides 05 and 06.
In the story, we heard how Hoo and Ray were looking for the perfect feline friend – but instead, they found Caretaker Carl, who looked exactly like the cat friend they had imagined. Take a look at the pictures in worksheet 1. Your task is to find and mark the ones that match all of the following features: They must have whiskers, a nose shaped like a heart, and pointy ears.

Students should correctly circle only Caretaker Carl – picture number 20.

Activity 02

Presentation slide 07

min 20

Show the presentation to the children and discuss.
For humans, seeing something once is often enough to recognize it again. But robots – and computers – don't have it that easy. They need to see many different examples, like lots of pictures or photos of cats. And these need to show cats of many different breeds, colors, and sizes… and also in various situations. Sometimes, the cat might be partly hidden, in bright sunlight, or in shadow. The photos might be blurry, rotated, or taken from odd angles. Even people might get confused if they're only shown a small number of examples. That's exactly what happened to Hoo and Ray. At the cat show, they hadn't seen enough cats. And they didn't know much about what cats really look like. All they knew was: they have whiskers, pointy ears, and a heart-shaped nose. That's why they mistook a cat for Caretaker Carl.

Think, pair, share
Think: Students first reflect on the topic individually.
Pair: They pair up and discuss their ideas.
Share: Selected pairs then share their thoughts with the class.

Look at the pictures of cats in the presentation. Help Hoo and Ray understand what cats look like. Try to describe them as clearly as possible. Try to find as many shared features as you can.

Presentation slide 08

min 30

Show the presentation to the children and have a chat.

Have you ever sent someone a postcard, letter, or package? You might recall that part of the mailing address also includes a set of five numbers called a postal code. Do you know what they are for?
A postal code (ZIP code) helps determine where a letter or package should go. Each district in the United States has its own number, so the post office knows exactly where to send what.

Post offices often sort letters automatically. Computers read the postal codes on the letters and sort them into different boxes based on that. How do you think computers can distinguish the numbers in a postal code? We all write differently.
Answer: Computers have been trained on many examples of numbers written by humans and have found similarities that allow them to recognize numbers they have never seen before. You can show children a small section of training images from the MNIST dataset. This dataset contained 60,000 training examples of numbers.

Source: paperswithcode.com/dataset/mnist

You might also discuss with your children that these examples do not include any example of the number one with a "beak", but we often write one with a beak. So would it be a problem for a computer to recognize the one we write if it only had ones without a beak in its training data? The computer could mistake the one we write for the number seven, for example.

Reflect

min 35

Read part of the story to the students.

So, how did you enjoy our cat adventure with Caretaker Carl? We hope you had fun! But now comes the most important moment – let's pause and think about what we actually learned. Do you remember how Ray and Hoo had some trouble figuring out whether something was a cat or not? Yes, it was a little embarrassing... But it was also a great chance to learn – because even robots can learn from mistakes! Now it's time for some questions:

Do you know why Ray and Hoo needed to see so many different cats before they really started to understand what a cat looks like?
Answer: The more examples they see, the better they get at recognizing cats.

What do you think would help Ray and Hoo learn to recognize cats just as well as you? What could help them improve?
Answer: They'd need to see a lot of different cats. The more, the better! Ideally millions of pictures of cats in all kinds of conditions. People use many senses to recognize cats – robots mostly rely on camera input.

Today we learned that robots and computers need to see lots of examples in order to recognize things accurately. Imagine a self-driving car – what kinds of things would it need to recognize on the road?
Possible answers: Traffic signs, traffic lights and their colors, road markings, other cars, bikes, pedestrians, sidewalks, lines, lanes, roadblocks... and all of that in different weather and lighting – rain, fog, snow, bright sun...

Where else might a computer or robot need to recognize things?
Possible answers: For example, in healthcare, computers can detect when something isn't right on an X-ray, or robotic arms used in surgeries need to recognize many different things as well. In agriculture, drones equipped with cameras can monitor the condition of crops, spot sick plants, or determine whether produce is ripe. Another example is facial recognition software–like the one in cameras or the system that unlocks your phone.

What kinds of information can robots and computers use to learn how to recognize new things?
Answer: Images, videos, voice recordings, sounds, movement, text, numbers – basically anything that can be turned into data and analyzed.

If there's extra time

Presentation slide 09

Try the Quick, Draw app!

You can find it at: quickdraw.withgoogle.com

Quick, Draw! is a free browser-based app from Google that doesn't require any sign-in. It's often used to help children understand how machine learning works. Kids are given five prompts (in English) of things to draw–like a picture frame, a tiger, or a chair–which they can sketch using a mouse, tablet, finger on a phone, or even on a smartboard. As they draw, the app tries to recognize their drawings in real time (make sure the sound is on!).

It recognizes children's drawings based on a neural network that powers Quick, Draw!–trained on the largest dataset of doodles ever collected. You can show this dataset to the children (each category can be opened and explored) and explain that without having "seen" this huge number of drawings, the app wouldn't be able to recognize what they've sketched.

You can find the drawings here: quickdraw.withgoogle.com/data.

Dear children! Which furry friend will Hoo and Ray take home from the cat show?

It will be the one that meets all of the following conditions. That means it must have:

1. whiskers or facial hair,
2. s heart-shaped nose,
3. pointy ears.

Look carefully at the pictures and circle the one that matches all the criteria!