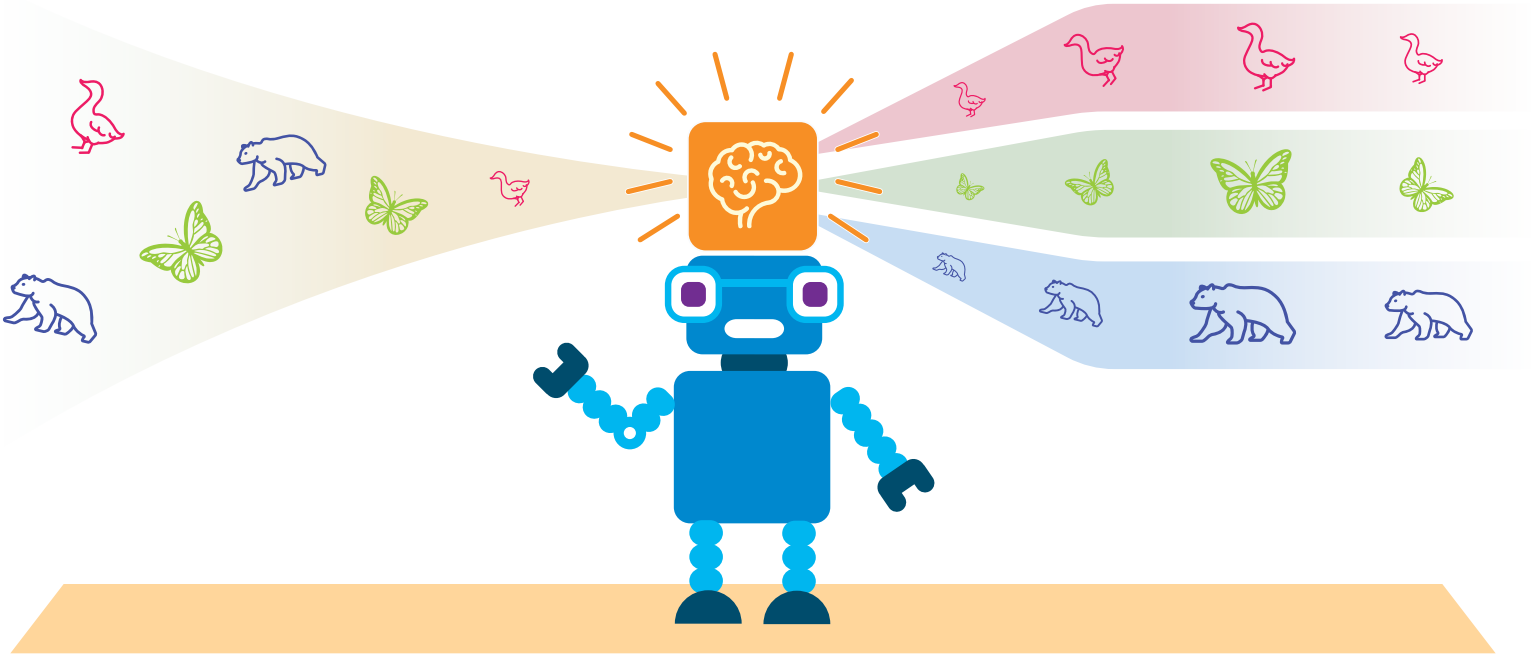
LESSON

Machine Learning Unplugged

Grade Levels: 4-12
Duration: 45 min

Who says you need a computer to learn about artificial intelligence? In this unplugged activity, take the role of a wildlife conservationist who uses data to refine and test a machine learning algorithm.



Outline

Part 1: Machine Learning Scenario	20 min total
Introduction	5 min
Test the AI Program	10 min
Debrief	5 min
Part 2: Revise and Improve	**25 min total**
Iterate	10 min
Test the AI Program	10 min
Debrief	5 min

Learn more about artificial intelligence at thetech.org/ai.

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Duration: 45 min

Concepts/Skills

Machine learning, algorithms, categorizing and identifying, training data, testing data, artificial intelligence

Objectives

Students will:

- Explore algorithms by categorizing organisms based on a set of rules.
- Gain an understanding of the basics of what machine learning is and how it can be used to identify animals.

Background Information

Artificial intelligence (AI) most often refers to a device or program designed to mimic aspects of human intelligence to complete complex tasks, such as learning, problem solving, and decision making.

AI is also used for tasks like:

- visual recognition (facial recognition, visual image search).
- speech recognition (used in software like Siri and a virtual assistant like Amazon's Alexa).
- machine translation (i.e., Google Translate).

Machine learning is a branch of AI where the goal is to create a program that improves over time or "learns" as it processes more data. Engineers provide training data (e.g., numbers, photos, text) which the AI uses as the basis for an algorithm: the set of rules for making classifications or predictions. Engineers can then provide more data, rules, or both, to test and adjust the algorithm to ensure that it is performing accurately. Some examples of machine learning are self-driving cars and recommendation systems, like you might see while using Netflix or shopping on Amazon.

For an example of AI, see this video about one of our 2021 Tech for Global Good laureates. WildMe uses machine learning to analyze photos, identify animals, and track wildlife populations. This use of computer vision aids scientists and researchers in their work with endangered species.

"Wild Me: Artificial Intelligence,"
The Tech Interactive, YouTube *(1:23 min)*

Materials and Preparation

Materials

- Print the **Data Set Cards** (1 set per group).
  - *Note:* Set aside the **Part 2** cards for distribution later in the activity.
- Plan to have learners work in groups of 3-4.

Directions

Part 1: Machine Learning Scenario

Introduction *(5 min)*

1. Provide students with a basic introduction to artificial intelligence (AI) and machine learning (ML). Use the **Background Information** above and discussion questions below:
   - *What comes to mind when you think of AI?*
   - *When do you see AI being used?*
   - *What do you think of when you hear the words "machine learning"?*

2. Introduce the **scenario**.

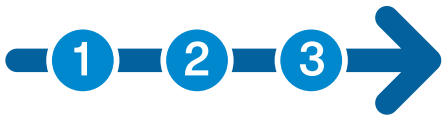
U.S. Fish and Wildlife Services (FWS) needs your help!

Wildlife conservationists work hard to protect animals and their habitats. Counting and tracking animals helps them understand the population levels of a species. FSW uses photos and video recordings to track animals, but sorting and identifying those images can take a long time. AI and machine learning can be used to identify and track animals more quickly and efficiently than human eyes can.

Your job is to test and train a new AI to correctly identify images of different animals to help FWS with their conservation work.

3. Divide students into groups of 3-4. Let them know that you will give them:
   - A set of images (testing data) of animals they are monitoring.
   - An algorithm (set of rules) created by the AI to categorize the animal.

   These data will help test how well the AI model can identify the animal.
   Their job as humans will be to test the algorithm and sort the images into two categories, A or B.



Real-world examples of algorithms:

- Recipes
- Instructions for making furniture
- Plays in sports
- Directions for building blocks sets
- Directions to a place on a map

Algorithm

Step-by-step instructions to solve a problem. When solving a problem, it is important to create a plan for your solution.

Note: Classical algorithms are written by people (usually programmers) and use the traditional step-by-step approach.

Machine learning (ML) algorithms are created by a computer based on the data provided. Essentially, ML creates its own rules based on the data.

Visiting The Tech Interactive

Want to see artificial intelligence in action? Check out Animaker on the Upper Level!

ANIMAKER

Animaker uses machine learning, 3D scanning, and visual recognition to identify the animals you show it.

Test the AI Program *(10 min)*

1. Have learners test the algorithm that the AI program created.
2. Give them 5 minutes to sort the **Data Set Cards** for **Part 1** based on the rules from the **Algorithm** (see below).
   - Remember that those are the only rules that the AI program understands, so students cannot use their existing knowledge of the species.
   - The algorithm may be imperfect or lead to errors. Remind students that they should notice them rather than correct them.
3. When time is up, have groups share the images they added to each category.
   - See if they can identify the two species which are being categorized.
   - Refer to the **Answer Key** for more information. Remind students that their goal was to test the AI, not themselves.

Algorithm

Based on the data provided, the AI program created the following algorithm (set of rules) to identify if the data goes under Category A or Category B.

	Category A	**Category B**
Wings	Wing is colorful	Wing color is dull
Body	Thin	Plump

Debrief *(5 min)*

1. Lead a discussion which considers some of the following questions:
   - *How did you decide if the image belonged to Category A or B?*
   - *How many images did you categorize correctly based on the AI algorithm?*
   - *How helpful was the AI's algorithm? If you could modify the algorithm, what would you change or add?*
   - *What is the difference between how people see and how AI/machines see?*

Part 2: Revise and Improve

Iterate *(10 min)*

1. Reassure the students that it would have been unlikely that they would have been able to categorize all of the animals correctly based on the algorithm provided.

2. Introduce them to the **new scenario**:

> The FWS has a new set of data to test with the AI. However, before testing they have asked that you try to improve the algorithm so that it will be more accurate.
>
> **Your job is to develop a revised set of rules (algorithm) which will lead to more accurate and reliable results. Then, test that the AI can correctly identify a new set of data.**

3. Students can base their revisions on the algorithm and images provided in **Part 1**.
   - They should check first that their new algorithm helps the AI correctly categorize the data set from **Part 1** before testing it on a new set of images.

Beginning Programmers

If students need additional support adjusting the algorithm, the following is a revised set of rules that can be provided:

Revised Algorithm

	Category A	Category B
Wings	• Large • Wing is colorful • When resting, wings are folded above their backs	• Small • Wing color is dull • When resting, wings are spread out
Body	• Thin • Smooth	• Plump • Hairy
Antennae	• Club-shaped with bulb at the end	• Feathery or completely narrow

Test the AI Program *(10 min)*

1. Let the groups know that they will now be provided with a new testing data set (**Part 2**) to test the revised algorithm.
2. Give them 5 minutes to sort the **Data Set Cards** for **Part 2** based on the rules from their new algorithm.
   - Remind groups that those are the only rules that the AI program understands.
   - *Note:* Learners may notice that the new testing data set has expanded to include additional species which do not fit either category. This highlights how an AI needs to be given more training data in order to consider information that does not fit within the rules created from the initial data set. Machine learning requires the AI to "learn" from these additional data and once again revise its algorithm.
3. When time is up, have groups share the images they added to each category.
   - Have them discuss how they considered the new species which were introduced.
   - Refer to the **Answer Key** for more information. Remind students that their goal was to test the AI, not themselves.

Debrief *(5 min)*

1. Lead a short debrief of the activity and the concepts. Help students make connections between the skills they used in this activity, the work of computer scientists, and real world applications of AI and ML.
   - Remind students computer scientists need to find the data they want to use to train a ML model and then test that model.
     - *Example:* Security cameras that use AI to recognize objects have large data sets that computer scientists provide the model so that they can test and "see" if it's a person, animal, or another object.
   - During the activity, students practiced this themselves by using training and testing data and revising an algorithm based on previous data.
2. Possible **Debrief Questions** include:
   - *How did your algorithm determine if the image was under Category A or B?*
   - *How many images did you categorize correctly based on the new algorithm?*
   - *Compare and contrast the algorithms you used for both data sets.*
   - *How detailed does an algorithm (set of rules) need to be to increase accuracy?*
   - *When training AI models, what is important to keep in mind?*

Tip: Try to guide students in understanding that the wider the range of training data the model was built with, the better the algorithm will be in predicting. Testing data is used to assess the algorithm for accuracy, similar to the process students used in **Part 1** and **2**.

It is important to understand that AI models can be biased if they do not include a **wide range of training data**. This means that there needs to be a large amount of data and a lot of variety in that data.

Example: Students may notice that testing data which showed different angles of a species were more difficult to identify correctly using the algorithm in **Part 1**.

- If the training data of a species is made up of images from many different angles but the total amount of images is small, then the AI will have trouble learning that the different images are all the same species.
- In contrast, if the data is only made up of images from the same angle, then the AI may assume that species is present more often than it actually is while also failing to identify the species from other angles. The AI has learned to identify the species very well but only from one angle because it was taught with a large data set with limited variation.

Encourage students to ask questions about the data they encounter and consider what they notice and wonder about how it is used.

Extension

The fun doesn't stop here! AI models can be trained to identify more than just two different types of animals. Apply this process and train a model to identify other animals such as birds, dogs, horses, etc.

Computational Thinking and Computer Programming

For more resources and activities on computer science, see thetech.org/ctlessons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Machine Learning Unplugged
Answer Key

As you review the answers with students, remind them that the goal of the testing is to check the reliability of the algorithm, not their own knowledge of these species. This is an opportunity for students to notice those errors instead of correcting it themselves – computers need to know when mistakes are made so they can "learn".

Part 1		
1: Category A - Butterfly 	**2: Category B - Moth** 	**3: Category B - Moth** 
4: Category A - Butterfly 	**5: Category A - Butterfly** 	**6: Category B - Moth** 
Part 2		
7: Category A - Butterfly 	**8: New Category - Dragonfly** 	**9: New Category - Dragonfly** 
10: Category A - Butterfly 	**11: Category A - Butterfly** 	**12: Category B - Moth** 
13: Category B - Moth 	**14: New Category - Mosquito** 	**15: Category B - Moth** 
16: Category A - Butterfly 	**17: New Category - Peacock** 	**18: Category B - Moth**