AI and Agriculture: Solving Hard Problems

Gr. 8-12 Activity Write Up

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AI and Agriculture: Solving Hard Problems

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AI and Agriculture: Solving Hard Problems

Activity Summary

In this activity, participants will explore the concept of precision agriculture and how AI (Artificial Intelligence) and ML (Machine Learning) can support agricultural practices. After examining the potential use of AI in classifying crops, participants will create a list of features that can be used to classify plants. After practicing classification, participants will label a photo set and work with Google's Teachable Machine to train an AI to accurately classify a plant.

Developed by Actua, 2025.

Delivery Environment	Activity Duration	Intended Audience	Tech
In-Person	1 Hour and 30 Minutes	Grades 8-12 (*Ages 13-18*)	Certain activities will require a laptop/tablet. With modifications, it is possible to run this entire lesson in pairs/groups. **Facilitators should have access to a laptop, projector, speakers, and a screen or blank wall to project onto.** • Projector • Speaker • Screen/Blank Wall • Laptops/Tablets

Achievement Goals

Learning Goals

Following this activity, participants will:

- **Understand** the role of precision agriculture in agricultural practices**.**
- **Discuss** the potential of AI in supporting agriculture's challenging problems.
- **Apply** the processes that are used to train an AI to classify objects.

Success Criteria

Following this activity, participants can express:

- **I can describe** why precision agriculture is important when growing crops.
- **I can give** reasons why AI is helpful in solving difficult agriculture problems.
- **I can label** and classify images to train an AI to recognize a certain plant.

Logistics (Timing, Group Sizing, Materials)

Section Title	Time	Group Size	Materials
Opening Hook	5 minutes	*Whole Group*	**Facilitators** • Precision agriculture uses ... (Microsoft Research; 4:50s)
Section 1: Hard Problems	20 minutes	*Whole Group*	**Facilitators** • AI and Agriculture - Activity Slide Deck (*Appendix C*)
Section 2: Machine Vision	15 minutes	*Pairs or Small Group (3-4)*	**Per Pair or Small Group** • Finding Features - Activity Page (*Appendix C*) • Writing Utensil

Section Title	Time	Group Size	Materials
Section 3: Machine Learning	40 minutes	*Pairs or Small Group (3-4)*	**Facilitators** • AI and Agriculture - Activity Slide Deck (*Appendix C*) • Computer Device with Internet Access **Per Pair or Small Group** • Computer Device with Internet Access • Plant Photo Set (Appendix C)
Reflection & Debrief	10 minutes	*Whole Group*	• N/A

Safety Considerations

Safety considerations have been provided below to support safety during this activity, however they are not necessarily comprehensive. It is important that you review the activity and your delivery environment to determine any additional safety considerations that you should be implementing for the delivery of these activities.

Emotional Safety

- Facilitators should understand that participants have different lived experiences and prior knowledge about AI safety, AI, and digital citizenship. This activity may involve or lead to discussions of sensitive topics, such as ethical implications of AI. Facilitators should encourage open, respectful discussions and acknowledge all perspectives. Facilitators should always keep the participants' emotional safety in mind in these discussions, and defer to training from their institution and training received.

Electronic and Technology Use

- Participants are to be advised about safe practices for handling electronic devices such as laptops/computers. This includes guidelines for avoiding liquids, using devices in safe locations to prevent accidental falls and damage.
- Facilitators should check cords and electronic components for damage before distributing them to participants.

Online Safety

Some components of this activity require the use of devices connected to the internet.

- Facilitators should review the provided videos and read/explore provided websites and materials to determine if they are suitable for your participants.
- Where applicable, facilitators should remind participants to stay on task and only use the links provided within this activity.
- Facilitators should also model and encourage appropriate online behaviour by all participants in the group (e.g., using chat boxes to answer and ask questions, using positive and encouraging language, using devices for the purpose of the task).
- Discuss the use of any online application with your team and/or supervisor and follow any organizational guidelines and policies related to technology use. Ensure participants' privacy and consent are respected.

Curriculum Links

This activity aligns with these components found in the UNESCO AI Competency Framework for Students:

AI Techniques and Applications: AI Foundations

- Learners are expected to develop basic knowledge, understanding and skills on AI, particularly with respect to data and algorithms, and understand the importance of the interdisciplinary foundational knowledge required for gradually deepening understanding of data and algorithms. They should also

be able to connect conceptual knowledge on AI with their activities in society and daily life, concretizing a human-centred mindset and ethical principles through an understanding of how AI works and how AI interacts with humans (p. 32-34).

AI Techniques and Applications: Application Skills

- Learners are expected to be able to construct an age-appropriate knowledge structure on data, AI algorithms and programming, and acquire transferable application skills. (p. 41).

AI Techniques and Applications: Creating AI Tools

- Learners are expected to deepen and apply knowledge and skills on data and algorithms to customize existing AI toolkits to create task-based AI tools. Learners are expected to integrate their human-centred mindset and ethical considerations into the assessment of the existing AI resources and the test of self created AI tools. They are also expected to foster social and emotional skills needed to engage in creation with AI including adaptivity, complex communication and teamwork skills.(p. 49).

Human-Centered Mindset: Human Agency

- Learners are expected to be able to recognize that AI is human-led and that the decisions of the AI creators influence how AI systems impact human rights, human-AI interaction, and their own lives and societies (p. 29-30).

AI Systems Design: Problem Scoping

- Learners are expected to be able to understand the importance of 'AI problem scoping' as the starting point for AI innovation. They are also expected to acquire the knowledge and project-planning skills needed in order to conceptualize and construct an AI system (p. 35).

This activity can be connected to the following subject areas:

Science

- Understanding the role of science and technology in society and the environment.
- Analyze the characteristics of living things and the principles of classification.
- Developing skills in scientific inquiry and data analysis

Mathematics

- Collect, organize, and interpret data to identify patterns and make informed decisions.
- Apply mathematical modeling and representations to explain and investigate complex systems.
- Apply logical reasoning, pattern recognition, and problem-solving strategies to analyze information and draw conclusions.
- Explore and interpret probabilities and predictions to understand uncertainty and variability in outcomes.

Community Connections

Community connections are suggestions from Actua, grounded in our approach, on how facilitators can adapt the activity to reflect the strengths, interests, and priorities of the community where or with whom it is delivered. Consider the following guiding questions to adapt the activity in meaningful ways:

- **Consult with community:** Are there local organizations, Knowledge Keepers, or community members who could contribute insight or context to this topic?
- **Draw on youth experience:** How can you give participants opportunities to share, reflect on, and apply how this learning is relevant to them or their community? Invite participants to identify what knowledge, who, and where they already learn from.

- **Integrate local examples:** How can you tailor this activity to local or regional interests, industries, or community priorities (e.g. land and environment, health, technologies)?

Activity Procedure

To Do in Advance

SECTION	PREPARATION

General	• **Think ahead and be ready to adapt:**
	  ◦ Determine your **delivery method** and leverage ideas from the delivery recommendations and adaptations sections.
	  ◦ While **estimated times** are provided, it will be helpful to think about how much time you would like to spend on different activities and discussions.
	  ◦ While **group sizes** (individual, pairs, groups) are suggested, many activities are flexible for whatever will work in your classroom.
	• **Prepare for the content:**
	  ◦ Have **answers in mind** to share with participants for the various reflection questions asked.
	  ◦ Examine the provided materials to determine if they are **suitable** for your participants.
	• **Equipment:**
	  ◦ Ensure device, screen and projector are set up.

Section 2: Machine Vision	• Ensure that there are enough copies of the Finding Features - Activity Page (*Appendix C*) and writing utensils for each pair or small group.

SECTION	PREPARATION

Section 3: Machine Learning	• Ensure each participant device has the Plant Photo Set (*Appendix C*) downloaded and unzipped where participants can easily access it.
	• Explore and understand the interface of Google Teachable Machine, and familiarize yourself on how to prepare, train, and test a machine learning mode.
	• Refer to the following videos for additional support:
	  ○ Teachable Machine Tutorial 1: Gather (Experiments with Google, 2:15s)
	  ○ Teachable Machine Tutorial 2: Train (Experiments with Google, 0:55s)
	  ○ Teachable Machine Tutorial 3: Export (Experiment with Google, 0:59s)

Opening Hook

1. Explain to participants that today they will be exploring Artificial Intelligence (AI) and how it can support agriculture.
2. Play the following video on Precision Agriculture:

   Precision agriculture uses computer science to make farms more efficient...

   (Microsoft Research; 4:50s)
   a. Ask participants: “What did you find interesting about the concepts mentioned in the video?”
   b. Ask participants: “Did you learn anything new? What was it?”

Section 1: Hard Problems

1. Using the AI and Agriculture - Activity Slide Deck (Appendix C), explain to participants that they will be exploring Artificial Intelligence and how it can support agriculture.

2. Debrief the scenario with participants. Explain that these are examples of "easy" and "hard" problems for computers. Establish the definitions of each:
    a. Generally speaking, *"easy" problems* are problems that don't require a lot of computing power and that have a clear solution. They can be solved with a set of rules or a process (an algorithm). When there was no overlap between the plants, it was easy to know which plants were where and to plan accordingly.
    b. *"Hard" problems* are problems that don't have a clear or simple solution and/or require a lot of computing power to reach a solution. These can't be solved just with a set of rules. Once the planting areas overlapped, this became a hard problem: we need to be able to tell the plants apart to know what's growing where.
3. Artificial intelligence and machine learning can be used to address "hard" problems. Explain to participants that today they will be making their own AI model to try to solve a similar problem to the one that the farmer is having.

Section 2: Machine Vision

1. What's "hard" about the farmer's problem? Since we don't know what plants are where, we need to be able to figure it out. Humans and computers perceive and understand the world differently.
2. How would we, as humans, deal with it? Divide participants into groups of 2-3 and distribute the Finding Features - Activity Page (*Appendix C*).
3. Explain what **a feature** is.
    a. A feature is a characteristic of an object that will be used as input for the machine learning program.
4. Ask participants to flip the page over and draw a circle and a square on the back on the page.
    a. Ask participants: “What features could you use to describe a circle and a square?”
        i. Examples could include: number of edges, number of vertices, number of equal sides, number of equal angles.

b. Now that we have a list of features, use the features you came up with to label the shapes. Do any of the labels match?

Feature	Square	Circle
Number of Edges	4	1
Number of Vertices	4	0
Number of Equal Sides	4	?

c. Ask participants: "If we wanted to make a flow chart to classify a circle, what questions could we ask? Can we classify a circle using one question?"
   i. Yes! Does the shape have 1 or more vertices?
   ii. This will produce a yes (it is a circle) or no (it is not a circle).

d. Unfortunately, plants have many more features than circles and squares. If we wanted to train an AI to classify plants we would need to provide more features.

5. Using the Finding Features - Activity Page (*Appendix C*), have participants come up with things that could be used to describe a plant (e.g., presence of leaves, leaf shape, flower, type of flower, color, height).
   a. Participants will write these in the features column.
6. Now have participants label each plant based on the features they determined. How many features were the same between plants? How many were different? What might it mean if many were the same or different?
   a. Conclude by noting that humans are very good at classifying things. Our brains can recognize objects in a variety of circumstances and contexts.
7. Ask participants: "How might computers deal with it? What might a computer "see"?"
   a. Computers can classify things too, but a computer doesn't know what a "plant" is. They recognize everything in shapes and patterns.
   b. With enough training a computer can learn to understand patterns based on large sets of data.

Section 3: Machine Learning

1. We've explored how a machine can "see" like a person might. How can this be useful in helping solve the Farmer's Problem from earlier?
    a. By leveraging AI technology! Today you will be training an AI model to correctly identify two different plants; Canola and Canada Thistle.
2. Explain to participants that they will be using a piece of Google software called Teachable Machine. It uses Machine Learning to analyze sets of photos (or audio) for various patterns and then labels them based on its predictions.
3. Distribute participant devices and display your device on a screen for participants to follow along.
    a. ***Note:*** The procedure below can be explained all at once or in stages depending on your participants. Participants can follow along with you step by step or work independently with their group.
    b. ***Note:*** If using devices that participants are not familiar with, review how to create folders and move files from folder to folder with participants.
4. To program our AI model, we will use Google Teachable Machine (teachablemachine.withgoogle.com), a free, browser-based tool, to create and train our model.

Defining Classes

1. Explain to participants that **defining classes** is a key part of a classification task: you need to tell your model what you are looking to identify.
    a. As humans, we can rely on a number of sensory inputs (as well as our own memories) to help us complete classification tasks.
    b. An image classification AI model only has the data from the images that you've shown to it to make its guess.
2. In this case we will be training the AI to classify **two plants; Canola and Canada Thistle**. These are our two classes.
3. Ask participants to rename the two classes to the left of the middle box titled, "Training".

Creating Training Data

1. Explain to participants that you will be teaching your AI model to recognize plant shapes through a process called **training**. Your image classification model learns by looking at visual examples of each class, so that it can begin to tell the difference between them.
2. Ask participants to open the folder on their device called Plant Photo Set *(Appendix C)*.
    a. Participants should find two folders inside labelled:
        i. "Test Images"
        ii. "Training Images"
3. We will begin with the "Training Images" folder. Ask participants to create two new folders within the "Training Images" folder called "Canola" and "Canada Thistle".
4. Explain to participants that they will need to sort the images into the two folders based on whether they are Canola or Canada Thistle.
    a. Give participants time to sort their images.
5. Once participants have finished sorting they can upload the photos into Teachable Machine under the correct Class.
    a. The Upload button can be found under the class name and to the right of the "Webcam" button.
    b. ***Note:*** You can drag and drop folders directly into the Teachable Machine window if this is more familiar to participants.

Training a Model

1. Now that you've uploaded examples of what you want your AI model to recognize, you can have your model examine the images in each class and begin distinguishing between them. To do this:
    a. Click on the "Train Model" button in the box labelled "Training".
2. Wait for training to complete. Below the training button, you will notice a timer counting up and a number out of 50. Your training is complete once that number reaches 50 out of 50. This might take a few moments.

    a. ***Note:*** Remind participants **not** to close the tab during training. This will interrupt the training process and they will have to click “Train Model” again.
3. When training is complete, the “Preview” box should have an “Output” section which displays your trained model’s classification of your image and its confidence level (indicated by a percentage beside the Class Name) in its classification.

Testing a Model

1. We will now use the “Test Images” folder of the Plant Photo Set (*Appendix C*) in the final step of the process, which involves testing your AI! Direct participants to the “Test Images” folder, found within the “Plant Photo Set” folder.
2. This particular model can only test one image at a time. To use the test images, participants will need to upload the image into Teachable Machine.
    a. Participants can find the upload button below the “Preview” title. Ensure the dropdown menu beside “Input” is set to “File” and not “Webcam”.
3. Depending on the image uploaded, the AI may or may not correctly classify the plant. Ask participants to test each photo and discuss the results with their partner or group.
    a. Did all the images produce the correct result? Why or why not do you think this is?
    b. What do you notice is similar or different about the sets of photos?
    c. How might the accuracy of the model change if the photos were taken in a field instead of in a greenhouse lab like these ones were?

Reflection & Debrief

1. Gather participants for a group discussion to reflect on what they learned.
    a. Ask participants: “What might be some of the challenges of using machine learning?”
    b. Ask participants: “Our data set (the photos) was quite small, how does the size of the data set relate to the effectiveness of the machine learning model?:
2. Briefly discuss ideas for other applications of artificial intelligence for agriculture. Keep it surface level and ask participants their opinion.
    a. *Possible responses: Machine vision for aerial imaging/monitoring, Disease/Pest detection (insect damage to cash crops, or presence of weeds), Predictive modelling of climate data)*
3. Discuss the different careers listed in *Appendix A: Career & Mentor Connections*.

Delivery Adaptations

How might you adapt the time, space, materials, group sizes, or instructions to make this activity more approachable or more challenging? **Modifications** are ways to make the activity more accessible, **extensions** are ways to make the activity last longer or more challenging.

Modifications

SECTION 2: MACHINE VISION

- Encourage participants to use yes or no questions as features, such as the presence of flowers, branches, seeds, etc.

SECTION 3: MACHINE LEARNING

- Train the machine together on the screen asking participants to help you sort and place the images in their correct folders.

Extensions

SECTION 2: MACHINE VISION

- Encourage participants to choose more descriptive features such as the length of an individual “flower”, the thickness of the stem, the number of branches, etc.
- Ask participants to create a decision tree that would correctly classify a square if you had a rectangle and a square to try to correctly classify.

SECTION 3: MACHINE LEARNING

- If possible based on your organization’s internet policies, ask youth to find Google images of each plant and use them to test their model.
    - Does using other photos not from the data set affect the model?
    - What if the images found on Google were used to train the machine as well? Would that be beneficial to training the machine?

REFLECTION & DEBRIEF

- Have participants briefly research how precision agriculture is used in other parts of the world.
- Have participants explore the climate or topography of a region different from their own and identify one way that precision agriculture can be used to address it.

References & Gratitude

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Appendices

Appendix A: Career & Mentor Connections

AI/MACHINE LEARNING ENGINEER

- Builds and trains artificial intelligence systems that can learn from data to make predictions or perform complex actions. They support the machine learning researcher.

AGRONOMIST

- An agronomist is an expert in the science of soil management and crop production. They study how plants can be grown or modified to benefit society.

BOTANIST

- A botanist, or plant biologist, studies all plant life from microorganisms to giant trees. They apply their knowledge to many fields including agriculture, horticulture, land use planning, forestry and conservation.

COMPUTER PROGRAMMER

- A computer programmer is a person who creates computer software. They write code to build websites, computer games, financial analysis and many more.

ETHNOBOTANIST

- Ethnobotanists are scientists, historians and anthropologists combined! They study a specific region's plants and their uses through traditional knowledge of local people and the culture. Ethnobotanists work alongside knowledge keepers to understand how plants are used.

Appendix B: Background Information

ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) is a branch of Computer Science that deals with a machine's ability to simulate intelligent behaviour. This includes cognitive functions we associate with human minds, such as perceiving, reasoning, learning, and adapting.

AI is becoming increasingly vital in our lives. From digital assistants, GPS navigation, and autonomous vehicles to tools like Siri/Google Home and generative AI tools (e.g., OpenAI's Chat GPT), its impact on our daily lives is growing. AI plays a crucial role in various aspects of work, enhancing efficiency, and taking on hazardous or monotonous tasks. As AI applications grow, discussions on AI ethics and responsible practices are increasingly important.

MACHINE LEARNING

Machine learning (ML) is a type of artificial intelligence where computers learn from data, improve at tasks over time, and adapt without being programmed step by step. Instead of giving the computer every possible instruction, we give it ways to learn from experience, similar to how people practice and improve.

For example, you might teach a computer to play checkers. Rather than listing every possible move, you could program it to learn from playing many games. Eventually, it could get so good that it plays better than the person who wrote the program

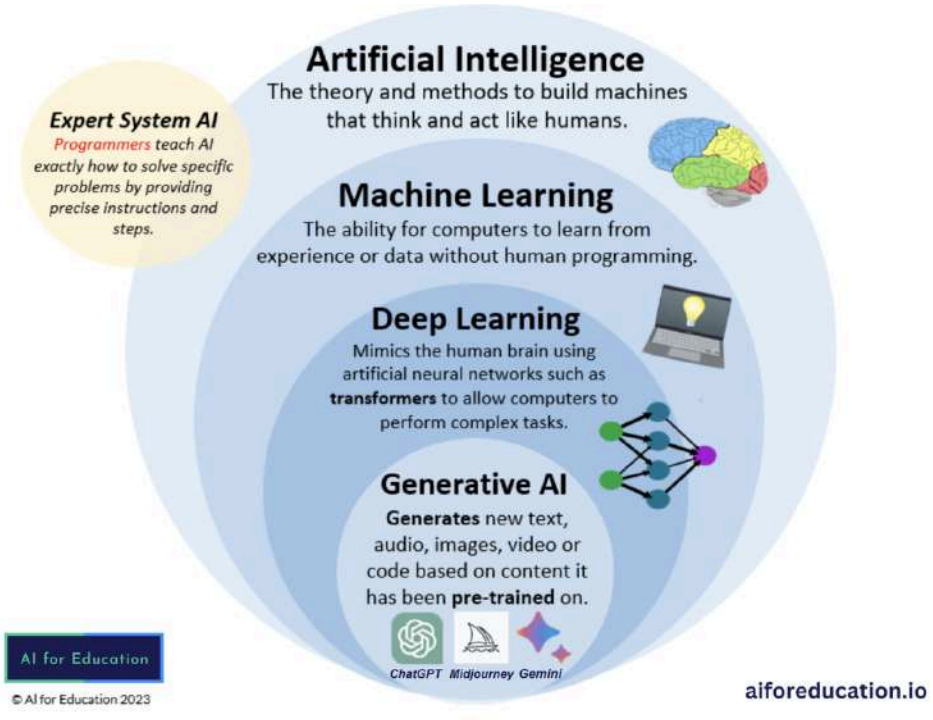
The learning process usually includes a few steps:

1. **Give it Data:** First, the computer is given a lot of data to process. This could be pictures, numbers, text, or sounds.
2. **Find the Patterns:** The computer then analyzes all this data and starts to find patterns, building its own "rules" based on experience.
3. **Make Predictions or Actions:** Using these patterns, the computer can make decisions or predictions when it encounters new data.

4. **Get Better and Better:** As the computer gets more data, it can adjust its patterns to become more accurate. The more data and computing power it has, the better its predictions become

Machine learning is used across different fields and in our everyday lives. In your daily life, ML works quietly behind the scenes in many of the tools and apps you use. It powers autocorrect and predictive text on your phone, suggests videos to watch on streaming platforms, and runs the filters on social media apps that recognize and track your face. It also helps your phone unlock through facial recognition by learning your unique features, and it keeps your email inbox clean by filtering out junk mail.

In addition, ML is making an impact in the wider world. In healthcare, it helps doctors diagnose illnesses more accurately, such as spotting broken bones in X-rays. It is also the "brain" behind self-driving cars, enabling them to observe and respond to the world around them. In industries like agriculture and manufacturing, ML supports smarter ways to grow food and produce goods more efficiently.



AI for Education. (2023). *Generative AI Explainer*. aiforeducation.io/ai-resources/generative-ai-explainer

Artificial Intelligence VS Machine Learning VS Deep Learning

You might come across the terms “artificial intelligence” and “machine learning” used together, but they aren’t exactly the same thing. AI is the broad idea of creating machines that can act or think in ways similar to humans. This can range from simple tools like a smart thermostat that adjusts the temperature based on rules, to more advanced systems like voice assistants or even robots. AI systems can learn over time, sense their environment, and make decisions on their own. Within AI, there are different types:

- **Classification AI**: Systems that identifies and sorts things (e.g. Tiktok or Snapchat face filters).
- **Predictive AI:** Systems that use data to make decisions about the future (e.g. Spotify and Apple Music recommendations).
- **Generative AI:** Systems which create new things, such as text, images, or music (e.g. CoPilot and ChatGPT).

Machine Learning is a specific approach within AI. It’s a specific way of achieving AI by having computers learn from data instead of being programmed with a long list of rules. So, all machine learning is AI, but not all AI uses machine learning.

Deep Learning (DL) is a more advanced type of ML that uses structures called neural networks, designed to work a bit like the human brain. Deep learning is what enables high-performance AI systems, including many generative AI tools that can create new and transformative outputs.

Types of Machine Learning

Machine learning methods are usually grouped into three main types, depending on the goal and the kind of data they use.

- **Supervised learning** happens when the computer is trained with examples that already have the right answers (called labels). The computer learns the link and patterns between the input and output so it can predict answers for new data. This is used in things like email filters that sort *spam vs. not spam*, or in predicting numbers, like house prices.

- **Unsupervised learning** is when the computer is given data without any labels and has to find patterns on its own. It might group similar things together (clustering), or uncover hidden connections in the data. This is used for things like grouping customers into types or making product recommendations.
- **Reinforcement learning** is like learning by trial and error. A computer "agent" makes decisions in an environment, gets rewards or penalties for its actions, and learns strategies to do better over time. This approach is often used in robotics and training AI to play video games.

PRECISION AGRICULTURE

Precision agriculture refers to the use of technology to enhance agricultural practices, especially when it comes to using data to target specific problems that may arise. Robotics and automation both play a role in enabling precision agriculture by, for example, providing a means of collecting many different kinds of data reliably and over long periods of time (automation); and then providing a technological means of acting on this data in targeted and purposeful ways (robotics). In practice, this can take many forms, with varying degrees of robotics and automation being integrated, such as:

- Wireless sensors that can continuously monitor changing levels of water and fertilizer and send this data to a system that can trigger irrigation or fertilizing equipment.
- A system that can identify and count pests based on images of field traps that can be taken remotely.
- A computerized feeding system for livestock that can also track data for each animal and over the course of the animal's life, for example, the amount of milk production of each cow in a herd of cows.
- Remote-controlled aerial vehicles (drones) that can take pictures using visible light and also in other areas of the spectrum, such as infrared (IR), where things such as plant damage and growth might be better shown. This information can be used to plan the most efficient pesticide and fertilization approaches.

Appendix C: Additional Resources

GENERAL

Activity Slide Deck

- AI and Agriculture - Activity Slide Deck
    - ***Note:*** This link will automatically download to your device.

OPENING HOOK

Video(s)

- Precision agriculture uses computer science to make farms more efficient... (Microsoft Research; 4:50s)

SECTION 2: MACHINE VISION

Activity Page(s)

- Finding Features (refer below)

SECTION 3: MACHINE LEARNING

Activity Page(s)

- Plant Photo Set
    - ***Note:*** This link will automatically download to your device.

Supporting Resources:

- Teachable Machines with Google - FAQs
- Teachable Machine 2.0: Making AI easier for everyone (Google, 2:08s)
- Teachable Machine Tutorial 1: Gather (Experiments with Google, 2:15s)
- Teachable Machine Tutorial 2: Train (Experiments with Google, 0:55s)
- Teachable Machine Tutorial 3: Export (Experiment with Google, 0:59s)

AI and Agriculture

Finding Features

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What types of features do plants have?
Can you label the two plants below?

Canola - *Brassica Napus*

In addition to cooking oil, Canadian canola is used in biofuel production around the world because it's a low-carbon, sustainable and renewal resource.

Barley - *Hordeum vulgare*

Used in soups and stews, and in barley bread of various cultures. Grains are commonly made into malt in a traditional and ancient method of preparation.

Feature	Label - Canola	Label - Barley
Colour	Yellow	Brown
Flowers/No flowers		