| **Lesson Name**  | Machine Learning: Detecting Trash with a Data set |
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| **Grades and Contents:** | Middle School Computer Science, Science or Art |
| **Topics** | * Artificial Intelligence: Machine Learning
* Image Classification and Transfer
* Pattern Recognition
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| **Enduring Understanding** | Machines can be trained to recognize patterns in images. |
| **Primary Standards/Indicators** | Computer Science Standards1. 2-AP-17-Systematically test and refine programs using a range of test cases.2. 2-AP-16- Incorporate existing code, media, and libraries into original programs, and give attribution.Science StandardsLS2.4.C: Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in its populations.Art StandardsAnchor Standard #4. Select, analyze and interpret artistic work for presentation. |
| **Secondary Standards/Indicators** | Reading Standards: [CCSS.ELA-LITERACY.CCRA.R.4](http://www.corestandards.org/ELA-Literacy/CCRA/R/4/)Interpret words and phrases as they are used in a text, including determining technical meanings |
| **Objective** | 1. Students will analyze data systematically, either to look for salient patterns of the question: “Is this water safe?”
2. Use images and information collected from drones and synthesize the data using computer AI technology to summarize, and display data which will explore relationships among pollution created in an ecosystem from manmade sources.
3. Students will explain the ecosystem pollution with multiple variations of images gathered.
4. Students will recognize that computer AIs are built on mathematical models that incorporate underlying assumptions about the systems being studied.
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| **Academic Language**Vocabulary | * Artificial Intelligence
* Machine Learning
* Data Set
* Teachable Machine
* Ethics
* Training/ Programming
* Workflows
* Spectogram
* Under the Hood
* Export
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| **Assessment Plan** | * Pre-Assessment-
	+ Google Quick Draw Warm-Up Brainstorm HOW DOES THIS WORK?
* Post-Assessment-
	+ Functioning Google Teachable Machine or completion of alternate activity [AI for Oceans on Code.org](https://studio.code.org/s/oceans/lessons/1/levels/1)
* Criteria for Mastery-
	+ Select appropriate images for a data set
	+ Upload images into a file for Google Teachable Machine and train a model
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| **Materials** | NOTE: These linked materials have been linked in the LESSON SEQUENCE as well for easier understanding of when they should be utilized.* Google SlideShow [“Is this water safe?”](https://docs.google.com/presentation/u/2/d/1j10JicJzby3ASJi1I_PsGNP1nZPt353E8hUV4aTNh2s/edit)
	+ Start on slide 26!
* Google Teachable Machines Videos
	+ Google [Quick, Draw!](https://www.youtube.com/watch?v=X8v1GWzZYJ4),
	+ [Teachable Machine 2.0: Making AI easier for everyone](https://www.youtube.com/watch?v=T2qQGqZxkD0&t=1s),
	+ [Teachable Machines: Gather](https://www.youtube.com/watch?v=DFBbSTvtpy4),
	+ [Teachable Machines: Train](https://www.youtube.com/watch?v=CO67EQ0ZWgA),
	+ [Teachable Machines: Export](https://www.youtube.com/watch?v=n-zeeRLBgd0)
* Code.org Resource Videos for Further Explanation
	+ [How AI Works](https://youtu.be/Ok-xpKjKp2g)
	+ [Machine Learning](https://youtu.be/KHbwOetbmbs)
* [Guided Notes](https://drive.google.com/file/d/1qu6qNZYgH2JSXzHrZ6CucE-Pw0UiDMet/view?usp=sharing) for the above videos
* [Teachable Machine Website](https://teachablemachine.withgoogle.com)
	+ IMPORTANT: [Folder with the Datasets!](https://drive.google.com/drive/folders/1MYmLlARq_QxWAHARepI5WLpvXHNGCXJU?usp=sharing)
	+ [Activity and Key](https://drive.google.com/file/d/1yObuXySQJD5tYAukvxZJ_R5UHNsYg9o1/view?usp=sharing) for Teachable Machine Website
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| **Teacher Preparation** | 1. Review slides 26 through 49(?) on [“Is this water safe?”](https://docs.google.com/presentation/u/2/d/1j10JicJzby3ASJi1I_PsGNP1nZPt353E8hUV4aTNh2s/edit) Google Slide
2. Play the game [Google Quick, Draw!](https://quickdraw.withgoogle.com) to gain a sense of how the game works.
3. Review the [guided notes](https://drive.google.com/file/d/1qu6qNZYgH2JSXzHrZ6CucE-Pw0UiDMet/view?usp=sharing) for the videos on slides 31 through 37
4. Complete the [Teachable Machines activity](https://drive.google.com/file/d/1yObuXySQJD5tYAukvxZJ_R5UHNsYg9o1/view?usp=sharing) that the students will do to try and troubleshoot items with which students could potentially struggle
5. Read through the [Tips and Tricks](https://drive.google.com/file/d/1yObuXySQJD5tYAukvxZJ_R5UHNsYg9o1/view?usp=sharing) page for Teachable Machines.
6. SHARE the folder which under Materials is labeled IMPORTANT with your students.
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| **Lesson Sequence** | * **Hook**
1. PREFACE NOTE: This is Lesson 2 in a series. It can be used as a solo lesson as well.
2. The hook for this lesson is Slide 26 which explains a scenario in which parents have taken footage from their drone and want to sort it using AI to see if they want to vacation in a certain place because of trash pileup.
* **Brainstorm**
	+ Teacher explains the guidelines/rules of the game. Teacher should be sure to tell students that the game is fast-paced.
	+ Students play Google’s Quick, Draw! To experience the idea of how AI can work to pattern recognize.
* **Prototype**
	+ Students take notes on videos which are linked in the presentation on slides 31 to 37, and there are [(Guided notes here)](https://drive.google.com/file/d/1qu6qNZYgH2JSXzHrZ6CucE-Pw0UiDMet/view?usp=sharing) to synthesize the in’s and out’s of these videos which are also linked here:
		- [Quick, Draw!](https://www.youtube.com/watch?v=X8v1GWzZYJ4)
		- [Teachable Machine 2.0: Making AI easier for everyone](https://www.youtube.com/watch?v=T2qQGqZxkD0&t=1s)
		- [Teachable Machines: Gather](https://www.youtube.com/watch?v=DFBbSTvtpy4),
		- [Teachable Machines: Train](https://www.youtube.com/watch?v=CO67EQ0ZWgA),
		- [Teachable Machines: Export](https://www.youtube.com/watch?v=n-zeeRLBgd0)
		- [How AI Works](https://youtu.be/Ok-xpKjKp2g)
		- [Machine Learning](https://youtu.be/KHbwOetbmbs)
	+ These notes are important for understanding how to do the SHARE portion of this lesson plan.
		- **NOTE**: If you need to cut out some notes, please cut out : How AI works and What is Machine Learning. These could be cut out because some of it has redundancy with the other videos.
		- **NOTE**: If a teacher needs to cut videos due to time constraints, it is completely necessary to watch these three videos: [Teachable Machines: Gather](https://www.youtube.com/watch?v=DFBbSTvtpy4), [Teachable Machines: Train](https://www.youtube.com/watch?v=CO67EQ0ZWgA), [Teachable Machines: Export](https://www.youtube.com/watch?v=n-zeeRLBgd0)
* **Share**
	+ After watching the final three videos: Teachable Machines: Gather, Train and Export, students will work with a [digital training set: "Teachable Machines: Vacation without Trash](https://drive.google.com/drive/folders/1MYmLlARq_QxWAHARepI5WLpvXHNGCXJU?usp=sharing) and use these three folders to train the teachable machine along with the [Activity and Directions](https://drive.google.com/file/d/1yObuXySQJD5tYAukvxZJ_R5UHNsYg9o1/view?usp=sharing).
		- **NOTE**:
			* This will take a decent amount of class time
			* Recommend students upload 5 images at a time
* **Synthesize**
	+ For a final wrap-up, the teacher can go over the questions on the bottom of the activity page. Further there are extra questions to think about on [slides](https://docs.google.com/presentation/d/1j10JicJzby3ASJi1I_PsGNP1nZPt353E8hUV4aTNh2s/edit?usp=sharing) 41 through 49 which students could either share out to the class or turn and talk to answer said questions. Further discussion could be on an exit ticket and these discussion questions are found under the discussion cells of this table.
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| **Student Learning Accommodations** | * **ELs**- Partnering an English Language learner with an English speaker could be effective, but for the online portions, google can be translated into their Native language by scrolling to the bottom of the website.
* **Grade Level adaptations**- There is a detailed step-by-step instructions for lower grade levels and abridged instructions for higher grade levels.
* **Advanced students**- Abridged instructions for advanced students because the guided notes explicitly explain how to program a Teachable Machine.
* **Additional supports**- The detailed instructions can be split apart to act as a chunked step by step guide on how to program a teachable machine.
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| **Discussion Guides**  | * After Brainstorm
	+ How does this work?
* Synthesize
	+ What was surprising about image 1?
	+ In image 3, what might have skewed the data to not make it 100% either way?
	+ In image 4 and 8, what might have skewed the data to not make it 100% either way?
	+ What images were clearly 100%?
	+ Why do you think the AI detected it 100%?
	+ In the instance of spotting trash in the natural waterway, how effective was the AI? What if there were 500 drone photos of the vacation spot?
	+ Where could this technology be applied in other instances?
	+ What kinds of biases were created within our datasets?
	+ What is artistically important about the photos uploaded into the training datasets?
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| **More to Explore (Resources)** | * Scroll down to “For Learning” section of this website to get more ideas to teach and use Google’s Teachable Machines. [Teachable Machine](https://teachablemachine.withgoogle.com)
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