Teaching a Machine

RESET AN AEOP EFFORT aeop

Authors

Ramona Singleton

SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: Middle School

Materials

- Slides
- Worksheet x 3
- Chromebooks + chargers
- Dog/cat cards
- Account in https://teachablemachine.withgoogle.com/
- A whiteboard or flipchart to write on so all can see.
- Two flip chart / whiteboard pens
- A copy of the intelligent piece of paper (possibly laminated)
- (optional) A musical greeting card that plays some appropriately horrible song. Choose one that is recognizable by the age group.
- Edu.readyai.org Account
- Cozmo Robot
- Code.org Account

STANDARDS

Next Generation Science Standards

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem

LESSON OBJECTIVE(S)

By identifying and applying the five Big Ideas of Artificial Intelligence to train and test a machine-learning tool to classify drawings the students will be able to give examples of a bias that can arise in machine learning and understand how biases may arise.

CAREER CONNECTION(S)

Mentor Background: Dr. Benjamin D. Nye is the Director of Learning Sciences at the University of Southern California, Institute for Creative Technologies. Ben's major research interest is to identify best-practices in advanced learning technology, particularly for frontiers such as distributed learning technologies (e.g., cloud-based, device-agnostic) and socially situated learning (e.g., face-to-face mobile use). His research interests include modular intelligent tutoring system (ITS) designs, modeling social learning and memes, cognitive agents, and educational tools for the developing world and low-resource/low-income contexts. He received his Ph.D. in Systems Engineering from the University of Pennsylvania in 2011. Ben currently leads projects focused on areas such as mobile adaptive learning ecosystems (Personal Assistant for Life-Long Learning), open-source and user-authorable tutoring chat dialogs (OpenTutor), a studio for career mentors to self-record their own virtual mentors (CareerFair.ai), and augmented reality experiences with the La Brea Tar Pits to understand complex concepts (Re-Living Paleontology) In his prior work as a Research Professor at the University of Memphis, Ben led work on the Shareable Knowledge Objects (SKO) framework integrating ITS services such as AutoTutor for the ONR ITS Grand Challenge, helped data mine effort a corpus of 250k human-to-human online tutoring dialogs (part of the ADL PAL initiative), collaborated on ONR's PAL3 tutoring architecture for supporting life-long learning, and is an advisor and book editor for the ARL Generalized Intelligent Framework for Tutoring (GIFT) advisory panel. Ben's research tries to remove barriers to the development and adoption of ITS so that they can reach larger numbers of learners, which has traditionally been a major roadblock for these highly-effective interventions.

STEM Careers: Artificial Intelligence Engineer, Computer Vision Engineer, Machine Learning Engineer, Robotics Engineer, Software Engineer, Analytics Consultant, Business Analyst, Data Scientist

ENGAGEMENT

Brief Description: The Intelligent Piece of Paper. The purpose of this activity is to inform students how computational intelligence is created. Students will learn that even a machine needs instructions to learn.

Procedures:

The grab: Announce that the piece of paper you are holding is more intelligent than anyone in the room (even the highly intelligent teachers there). Wax lyrical (enthusiastically) about how intelligent it is without saying why. Wave it around while keeping the written side hidden from the audience.

The set-up: Ask the audience if they believe you and have a show of hands: first, those who believe it is intelligent and then those who "believe I am talking total garbage and no way just a piece of paper could be intelligent". Usually, most will go for the garbage option. Congratulate them on their wisdom (both for believing such a wise person as you and especially those that don't – after all no good scientist believes claims of random people making great pronouncements, however great they are, without some evidence. Ask them to bear with you for a while – perhaps it is intelligent, perhaps not, but ask for suggestions of what it might be about the paper that could be the basis of such an outrageous claim. You may get suggestions such as it is something special about the ink, or that it is laminated. With

suggestions like the former, praise them for an interesting idea but ask how that exactly might make it intelligent. Ask if the rest of the audience thinks it would be enough. If the latter, explain that the plastic covering is not a special thing. It is just there to protect the piece of paper. After discussing other claims from the students, draw a tic tac toe chart on the whiteboard and ask for two volunteers.

One volunteer represents the paper and the other represents humankind. Give each student a marker. The one who represents the paper must read the instructions aloud and is only able to make moves as instructed on the paper. Refer to http://www.cs4fn.org/teachers/activities/intelligentpaper/intelligentpaper.pdf for instructions. The other student can make moves freely. Results should represent either the paper winning or it will be a draw.

The explanation: Point out they asked for evidence and you have given it. Ask again for a show of hands as to who now believes the paper is intelligent and who believes you are talking garbage and paper can't be intelligent. Usually everyone now is sure it isn't intelligent, despite the evidence of its abilities. Point out that it did show intelligent behavior so there is intelligence somewhere. Where is it? Someone will almost certainly say it is in the person that wrote the instructions. Ask if everyone agrees that that is where the intelligence is and get a show of hands. (You can then thank them from me for recognizing my great intelligence :-)) Now explain that what is on the paper is essentially a computer program: instructions to be blindly followed. Everything they have ever seen a computer do, it was just doing by blindly following instructions in the same way. Point out that if they are saying that the paper is not intelligent because it is just following rules, then they are saying no computer could ever be intelligent either. These instructions were written in a language so that a human can follow them. If they were to be written for a computer they would be written in a programming language: just a language a computer can understand precisely and so follow. Point out that if they think that it is the writer of the instructions who is the creative intelligent one, then they are saying that computer programmers are intelligent and creative (which is true). It is computer programmers who have written all the instructions all those computers are following.

EXPLORATION

Brief Description: AI introduction. Students will learn about the 5 Big Ideas in AI. (Perception, Representation & Reasoning, Machine Learning, Human-AI Interaction, and Societal Impact)

Procedures:

5 Minutes: The teacher will introduce AI and the 5 Big Ideas. **(Teachers should take the course prior)**

20-30 Minutes: Students will complete the AI and Me course provided through Readyai.org. The purpose of this course is to introduce students to the five big ideas of AI. The course goes into great detail about AI perception, decision making, machine learning, interactions and impact on the world around us. **(Teachers can create a paper copy of the course information and complete it whole group or individually)**

5 Minutes: The teacher and students will review what they have learned in the course.

EXPLANATION

Brief Description: AI Introduction Continued Students discover the importance of effective communication of information.

Procedures:

15 Minutes: The teacher will begin by asking, "What is a robot?"
Students will brainstorm and fill in the mind map to answer the question.
The teacher will then play two videos. Car Factory - Kia Sportage factory production line . The teacher will ask students about what they saw in the video. The teacher may choose to write down ideas visually for students. Waymo's fully autonomous driving technology is here. The teacher will ask students what students saw in the video. The teacher may also ask how what students saw was different. The teacher may differentiate between robots completing tasks and AI making decisions.
Check for understanding: What did the AI in the car do that the factory robots producing cars could not do?

15 Minutes:

1. Teacher introduces Cozmo ($350+)
    - Teacher identifies Cozmo's parts: Treads, Lift, Camera and Head
2. Teacher then asks, "How do we wake Cozmo up?"
3. Teacher introduces AI-IN-A-BOX™ and how to connect the components
    - Teacher identifies AI-IN-A-BOX™ parts, Fire 7 Table, Controller, Cozmo's charger and Quick Start Guide
4. Teacher says, "Now that I have the components set up, what can I do with Cozmo?"
    - Teacher demonstrates Cozmo's basic functions, programming and executing them
        - Teacher demonstrates facial recognition. (Teacher Resources 0.2)
            - Teacher may also demonstrate facial recognition on a student
            - Teacher also discusses functionality of facial recognition (i.e. box around face, items he does not recognize)
    - Teacher asks, "What else does Cozmo recognize?" (Teacher Resources 0.3)
        - Teacher holds items up in front of Cozmo. Teacher points out that a box surrounds each item he recognizes. Teacher demonstrates object recognition.
        - Teacher may ask students to present items to Cozmo to see if he recognizes them.
    - Teacher asks, "Once Cozmo recognizes a person or an object, what can he do with it?"
        - Teacher demonstrates three additional functions to students
            - Speech Generation: Naming recognized people and objects (Teacher Resources 0.4)
            - Landmark-based Navigation: Moving towards recognized objects (Teacher Resources 0.5)
            - Object Manipulation: Picking up the cube (Teacher Resources 0.6)

*(5 Minutes) Teacher may use videos from Ready AI's YouTube page to demonstrate functionality:

- AI-in-a-Box Tutorial 1: Visual Recognition of objects & custom markers (WAICY 2018)
- AI-in-a-Box Tutorial 2: Landmark-based Navigation (WAICY 2018)
- AI-in-a-Box Tutorial 3: Object Manipulation (WAICY 2018)

20 Minutes:
Teacher distributes Handout 0.2. Students check off items they can complete from the list.
(Alternatively, the teacher may orally prompt students to complete tasks.)
Students may add new items to Handout 0.2 in the blank spaces, indicating what further applications they attempted with Cozmo.
(Alternatively, the teacher may ask students at the end of the guided practice to indicate what further applications they attempted with Cozmo.)
Lesson Extension: (15-20 Minutes) As an additional activity, the teacher may prompt students to drive Cozmo using the controller. For resources on this functionality, please see Teacher Resources 0.8.

ELABORATION

Brief Description: Students will use their knowledge of the 5 big ideas of AI along with their experience with Cozmo to use the concept of machine classification. Students will explore Google's Teachable Machine tool. Students will learn about supervised machine learning. The students will be asked to build a cat-dog classifier but are unknowingly given a biased dataset. When the classifier works better on cats than dogs, students have the opportunity to retrain their classifiers with their own new datasets.

Procedures:
5-10 Minutes: The teacher will demonstrate how to use the Google Teachable Machine tool. The teacher will instruct the students to complete the cat-dog classifier simulation and then create a classifier simulation of their own comparing items of their choice. (Examples: Cars vs. Trucks, Tree vs. Bush, Fish vs. Octopus, Doll vs. child)
20-30 Minutes: In groups of 2 or 3 students will complete the cat-dog classifier simulation. Students should make observations. The group will discuss their findings. They should recognize that the system is biased. The students will then retrain the machine to decrease the bias.

EVALUATION

Brief Description: Recognizing Fish. Students will program a robot to recognize fish during its clean-up process.

Procedures:
The teacher and students will review machine learning.
The teacher will guide students through level one of Recognizing the fish code program. At the end of the lesson the teacher will ask, If we wanted A.I. Bot to become better at recognizing fish, how do you think we could help it do that? The goal is to help students understand that A.I. Bot learn better when they have more examples. The best way we can improve its ability to recognize fish is by giving it more examples to look at. Students may also make the connection that this is how humans learn, especially young children - the more examples we have, the better we learn.

Students will complete level two of Recognizing the fish features. This will allow the A.I. bot to recognize color and body type. Students will choose a word that they want to train A.I. Bot to recognize and record this information on their Activity Guide. Students should progress through the level on their own, recording information on their activity guide.
The teacher will circulate and check that students are filling in their activity guide as they complete the stages.
The teacher and students will discuss What features did A.I. Bot think were the most important? Are those the features you were expecting to be most important?
Note: Students may find that A.I. Bot thinks some features are important when they're actually completely unrelated to their word. For example, thinking that the mouth of a fish is important when trying to determine if the fish is red. Students can verify this by looking for patterns in the fish that A.I. Bot has accepted - maybe all of their example fishes happened to have the same type of mouth and A.I. Bot mistakenly thought this was important.
After level two students complete the final level Recognizing Expressions. Students will choose an expression that they want to train A.I. Bot to recognize, and record this information on their Activity Guide. Students should progress through the level on their own, recording information on their activity guide. On the final screen, have students press the information icon and record the features that A.I. Bot learned were most important.
The teacher will circulate and check that students are filling in their activity guide as they complete the stages. The teacher will ask students what features they're looking at to determine if a fish meets their criteria. Students will probably say they primarily use eyes and mouth to help determine expression, but when they click the Information icon on the final screen, A.I. Bot may be using additional features such as color and body to make its decision. The teacher will prompt students to think about how they feel about this and compare it to their personal experience - For example, if someone thought they were "silly" or "angry" primarily based on their clothing.
The teacher and students will discuss, ``Do you think it's okay to consider a fish "angry" by its color?"
Students will complete a reflection survey.
Students will complete a video via flipgrid to summarize what they learned. They will focus on the following:

1. How their perception of A. I. developed.
2. Identify the A.I. big ideas and how they impacted this set of lessons.
3. Compare and contrast Cozmo's functionality to the activities on code.org.

REFERENCES

- https://teachablemachine.withgoogle.com/

- http://www.cs4fn.org/teachers/activities/intelligentpaper/intelligentpaper.pdf
- https://youtu.be/sjAZGUcjrP8 Car Factory - Kia Sportage factory production line
- https://youtu.be/aaOB-ErYq6Y Waymo's fully autonomous driving technology is here
- https://www.readyai.org/teacher-handbook-middle-school/#02
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