Why Should Artificial Intelligence Be Part of Georgia's CS Courses?

A Panel Discussion with Members of the AI4K12 Working Group:
David Touretzky, Vicky Sedgwick, Kelly Powers, Charlotte Dungan, and Jared Amalong

Constellations Virtual Computer Science PD Summit
June 16, 2020

Supported by National Science Foundation award DRL-1846073.

Outline

- Overview of the **AI4K12 Initiative**: David Touretzky
- Teaching AI in Grades **K-2**: Vicky Sedgwick
- Teaching AI in Grades **3-5**: Kelly Powers
- Teaching AI in Grades **6-8**: Charlotte Dungan
- Teaching AI in Grades **9-12**: Jared Amalong
- Audience Q&A

Poll (pollev.com/CSTA)

Which grades do you teach?

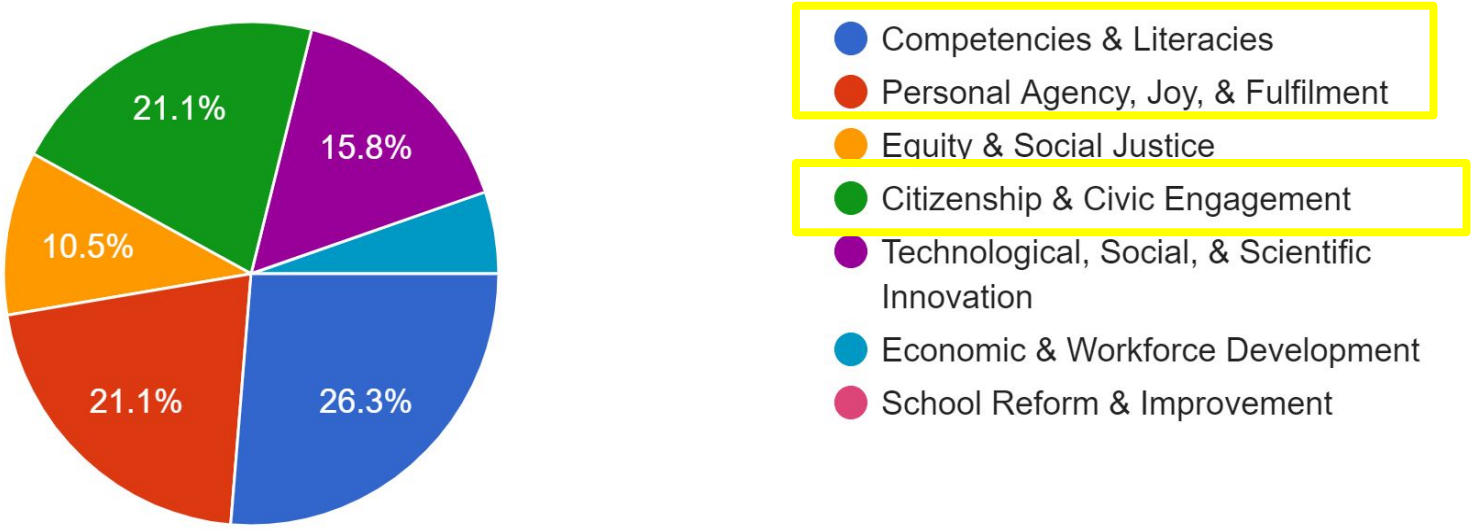
Why teach AI in K-12 CS courses?

1. AI is a **branch of computer science**.
2. AI technologies are having a profound **impact on society**.
   - Children grow up conversing with Alexa.
   - Self-driving cars, face recognition, machine translation, recommender systems (Netflix), machine learning, deep fakes, and more.
3. Preparation for **future careers**: creating AI and robotic technologies, or working alongside intelligent agents or autonomous robots.

AI4K12 Working Group Perspective on the Guidelines

What is your primary reason for wanting K-12 students to learn about AI

19 responses



The AI4K12 Initiative, a joint project of:

AAAI (Association for the Advancement of Artificial Intelligence)

Association for the Advancement of Artificial Intelligence

CSTA (Computer Science Teachers Association)

CSTA

With funding from National Science Foundation ITEST Program (DRL-1846073)

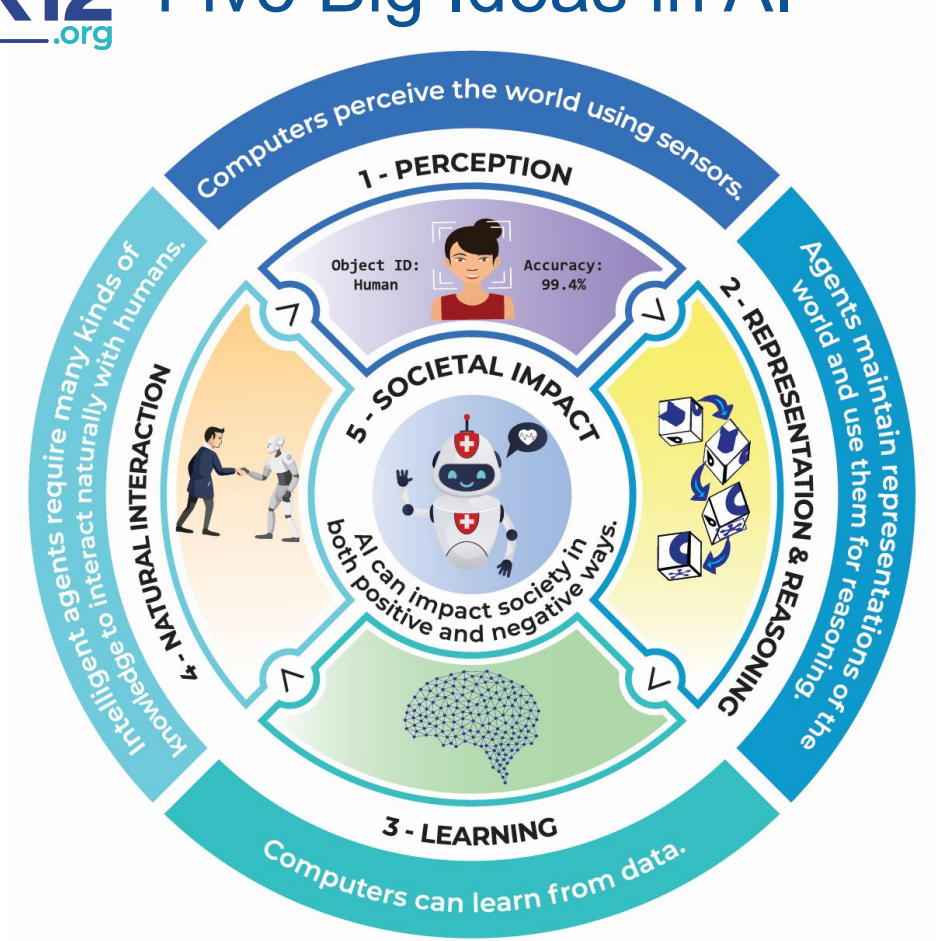
Carnegie Mellon University
School of Computer Science

The AI4K12 Working Group in March, 2019

AI4K12.org Initiative: Our Mission

- Develop national guidelines for teaching AI in K-12
  - Modeled after the CSTA standards for computing education.
  - Four grade bands: K-2, 3-5, 6-8, and 9-12
  - What should students know?
  - What should students be able to do?
- Develop a curated AI resource directory for K-12 teachers
- Foster a community of K-12 AI educators, researchers, and resource developers.

Five Big Ideas in AI



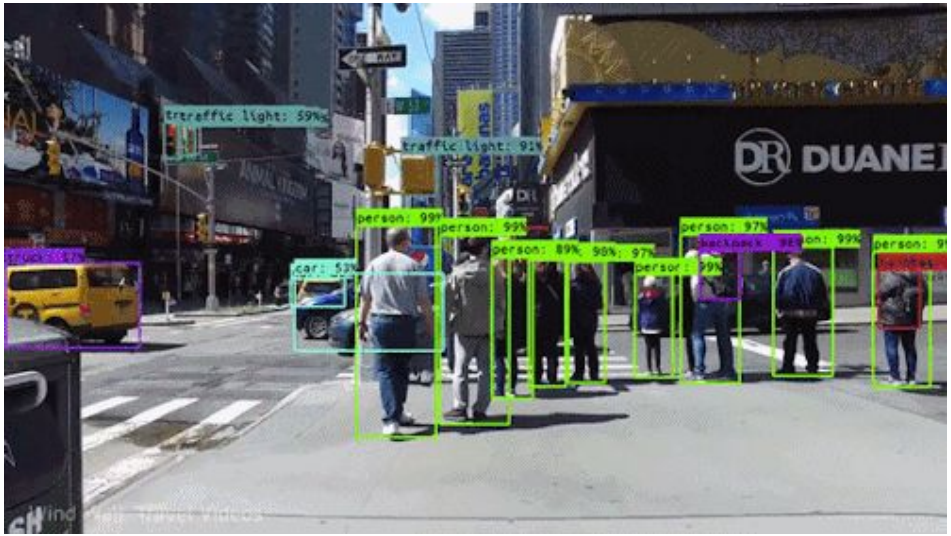
Download a free poster explaining the Five Big Ideas from our web site:

AI4K12.org

Big Idea #1: Perception

Computers perceive the world using sensors.

Perception is the extraction of *meaning* from sensory signals based on knowledge.



- Human senses vs. computer sensors
- Types of perception: vision, speech recognition etc.
- How perception works: algorithms

Example Guidelines

- Identify sensors on computers, robots, and intelligent appliances.
- Explain how sensor limitations affect computer perception.
- Explain that perception systems may draw on multiple algorithms as well as multiple sensors.
- Build an application using multiple sensors and types of perception (possibly with Scratch plugins, or Calypso).

Big Idea #2: Representation and Reasoning

Agents maintain representations of the world, and use them for reasoning.

- Types of representations
- Families of algorithms and the work they do
- Representation supports reasoning: algorithms operate on representations

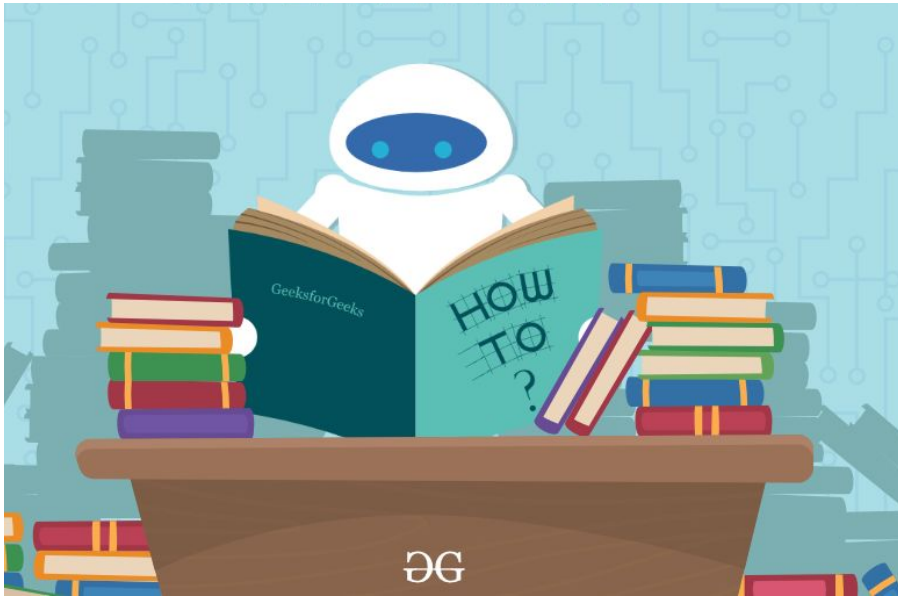
Example Guidelines

- Create/design a representation of an (animal) classification system using a tree structure.
- Draw a search tree for tic-tac-toe
- Describe how AI representations support reasoning to answer questions
- Describe the differences between types of search algorithms

Big Idea #3: Learning

Computers can learn from data.

- Characteristics of learning
- Fundamentals of neural networks
- Data sets



Example Guidelines

- Modify an interactive machine learning project by training its model..
- Describe how algorithms and machine learning can exhibit biases.
- Identify bias in a training data set and extend the training set to address the bias
- Train a neural net (1-3 layers) using *TensorFlow Playground*
- Trace and experiment with a simple ML algorithm

Big Idea #4: Natural Interaction

Intelligent agents require many kinds of knowledge to interact naturally with humans.

- Natural language understanding
- Common Sense Reasoning
- Affective computing & human-machine interaction (facial expressions, gestures, emotion recognition)
- Consciousness and philosophy of mind

Example Guidelines

- Recognize and label facial expressions into appropriate emotions (happiness, sadness, anger) and explain why they are labeled the way they are
- Experiment with software that recognizes emotions in facial expressions
- Construct a simple chatbot
- Describe some tasks where AI outperforms humans, and tasks where it does not
- Explain and give examples of how language can be ambiguous
- Reason about the nature of intelligence, and identify approaches to determining whether an agent is or is not intelligent.

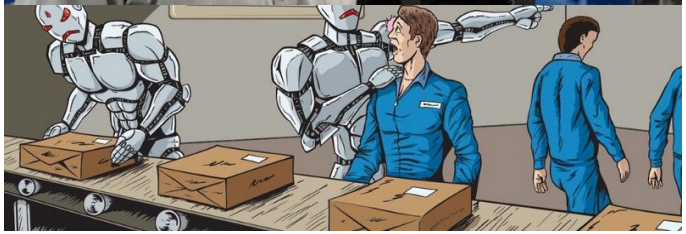
Big Idea #5: Societal Impact

“Artificial Intelligence can impact society in both positive and negative ways.”

- Economic and employment impacts of AI
- Ethics of AI making decisions about people
- AI & Culture

Example Guidelines

- Critically explore the positive and negative impacts of an AI system
- Design and explain how an AI system can be used to address a social issue
- Describe ways that AI systems can be designed for inclusivity
- Understand tradeoffs in the design of AI systems and how decisions can have unintended consequences in the function of a system



Demo: Speech Recognition

Go to: https://www.cs.cmu.edu/~dst/SpeechDemo

Try these examples:

1. “view the sea” vs. “see the view”
2. “Which witch is which?”
3. “They’re going to build their house there.”
4. “No man is an eyelid.”

Poll (pollev.com/CSTA)

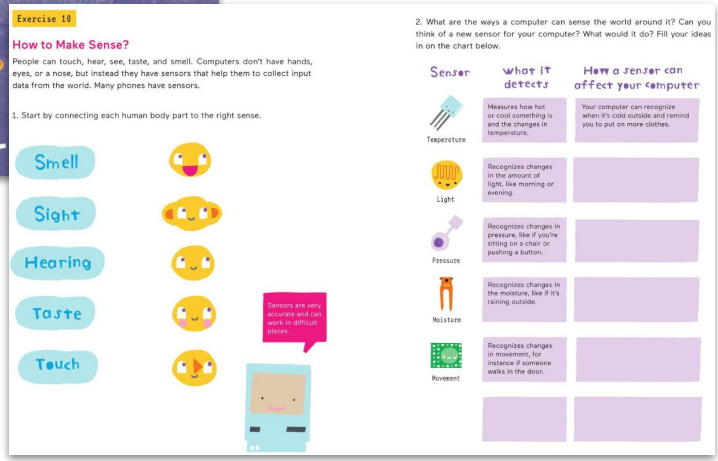
Are you currently teaching AI?

What’s stopping you?

Teaching AI in K-2

Vicky Sedgwick
Los Angeles, CA
Laurence School
Elementary Computer Science Teacher

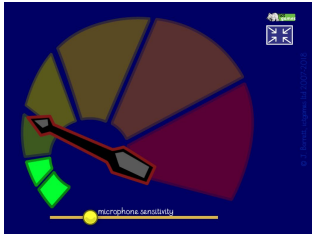
Teaching AI in K-2 - Perception



No sensors

Simple sensors

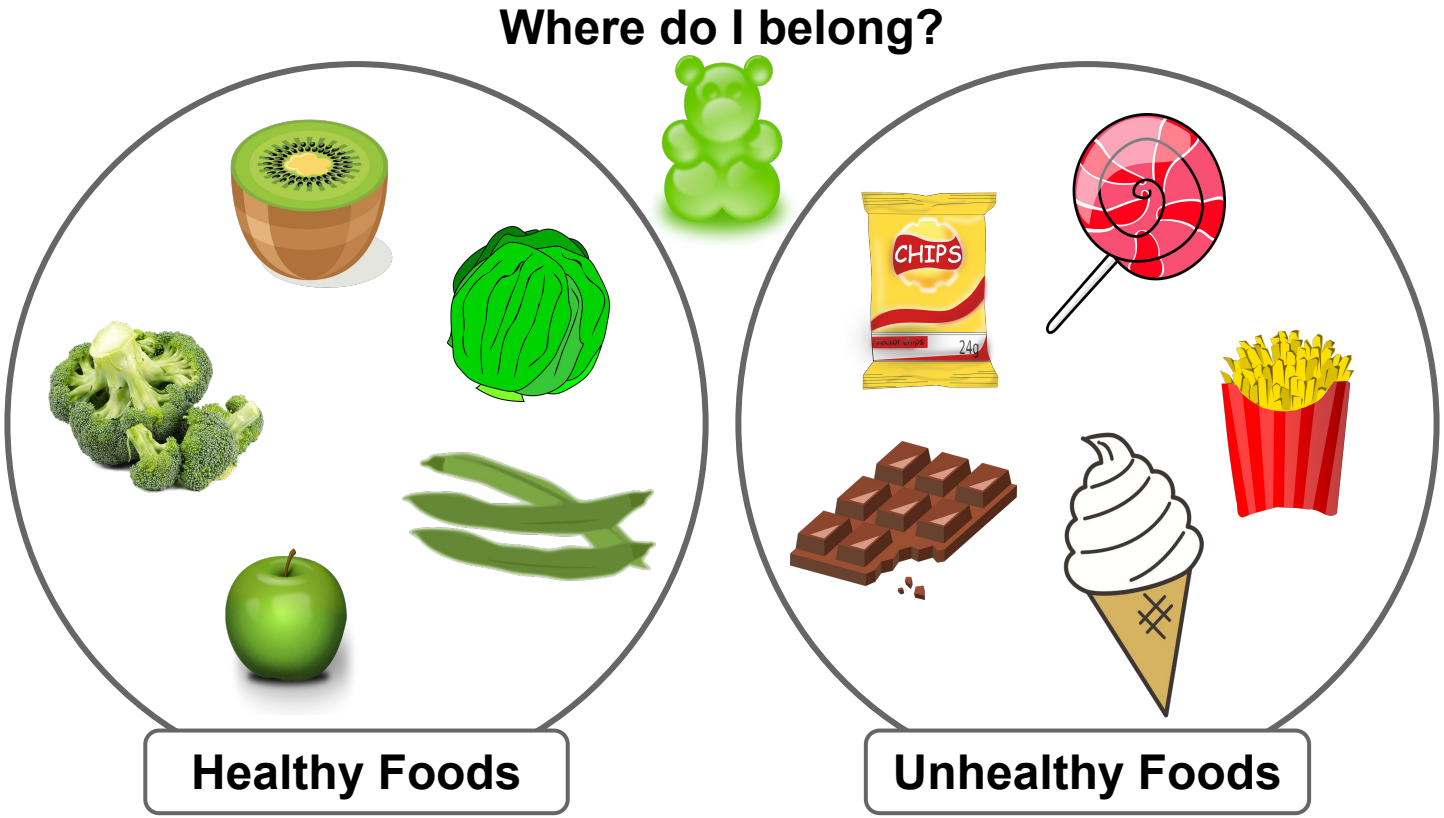
Vision & Speech Recognition



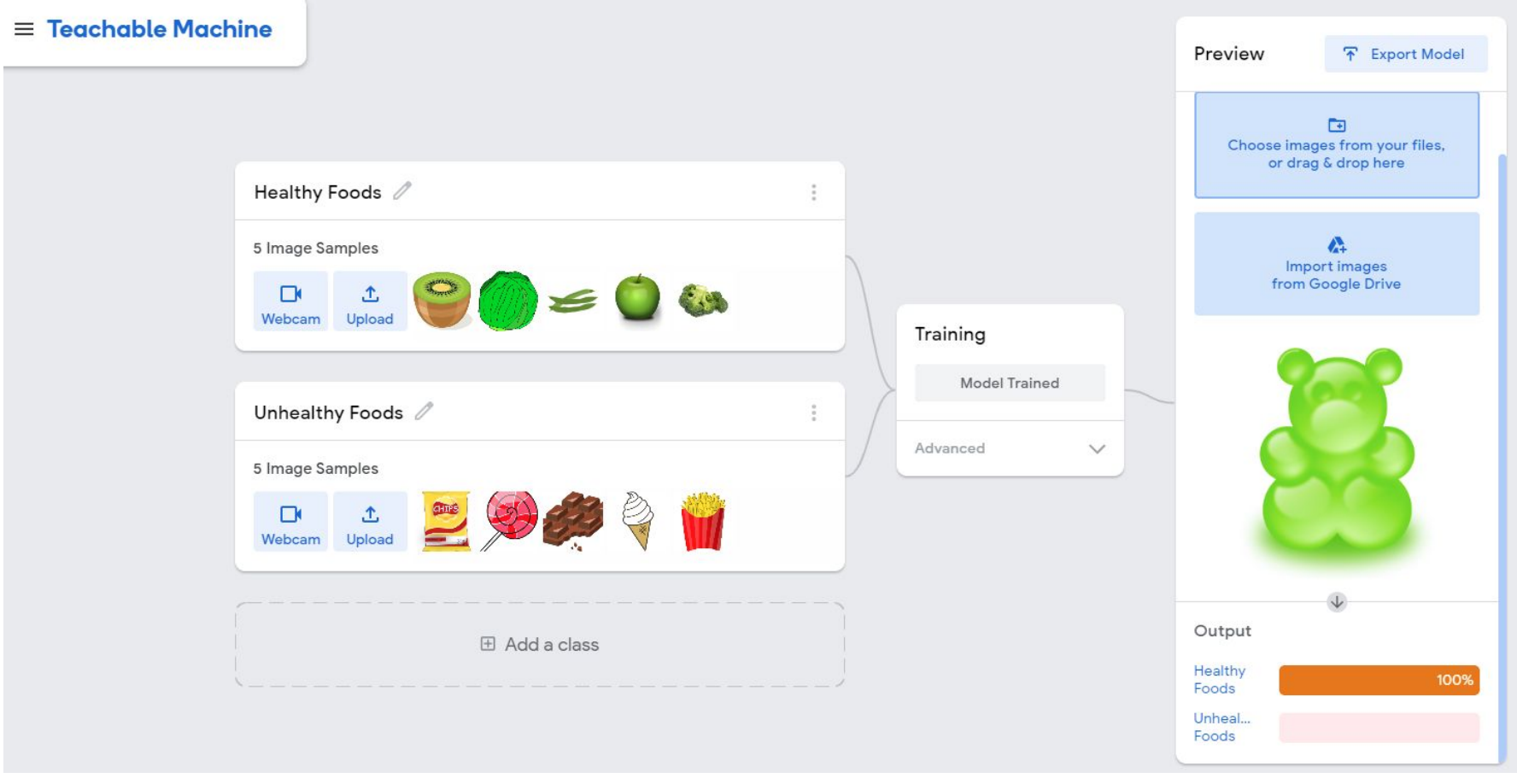
Simple sensors

Speech Recognition

Teaching AI in K-2 - Learning



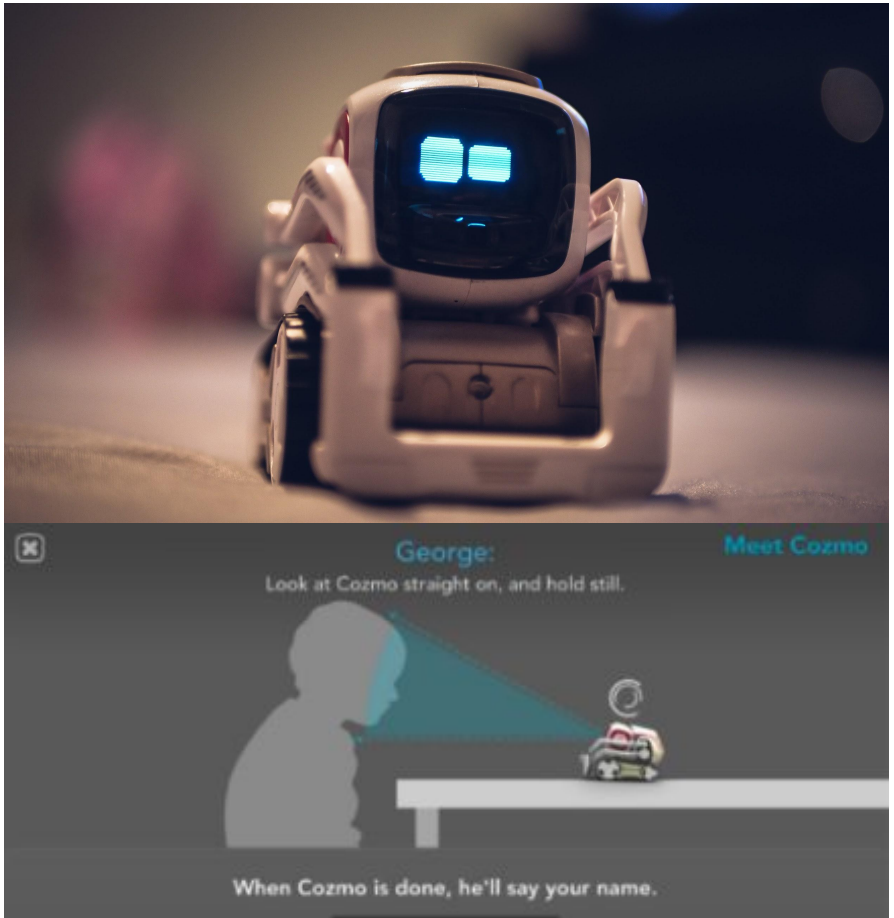
Teaching AI in K-2 - Learning



Teaching AI in 3-5

Kelly Powers
NYC
Cornell Tech
Teacher in Residence, K-12
Computer Science Coach

Teaching AI in 3-5 - Perception



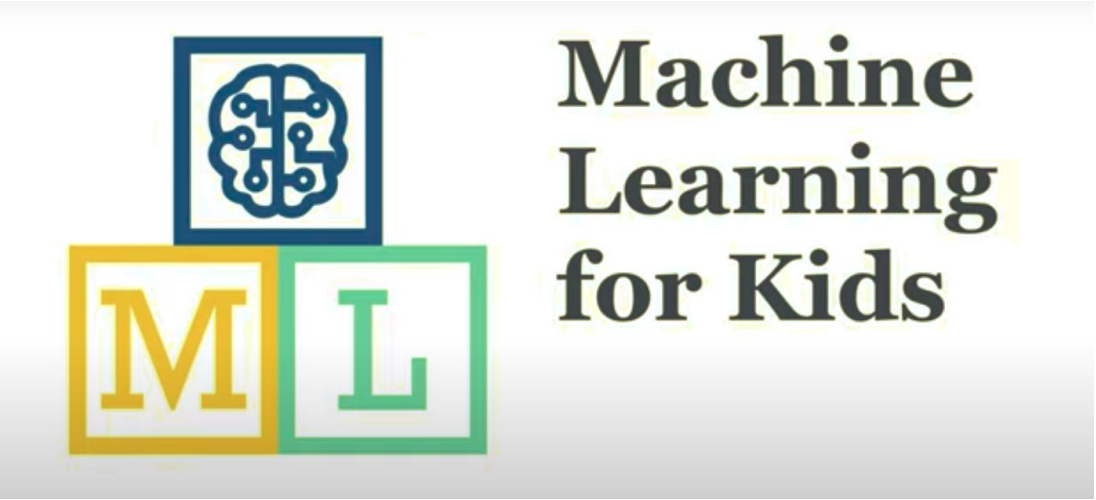
CS Big Ideas
Computing Systems
Programming & Algorithms

Sensors, AI Sensors
Input, Output, Devices
Algorithms
Programming

Teaching AI in 3-5 - Machine” Learning

Teaching AI in 3-5 - Machine Learning

How do I feel?



Collect examples of text to train a computer

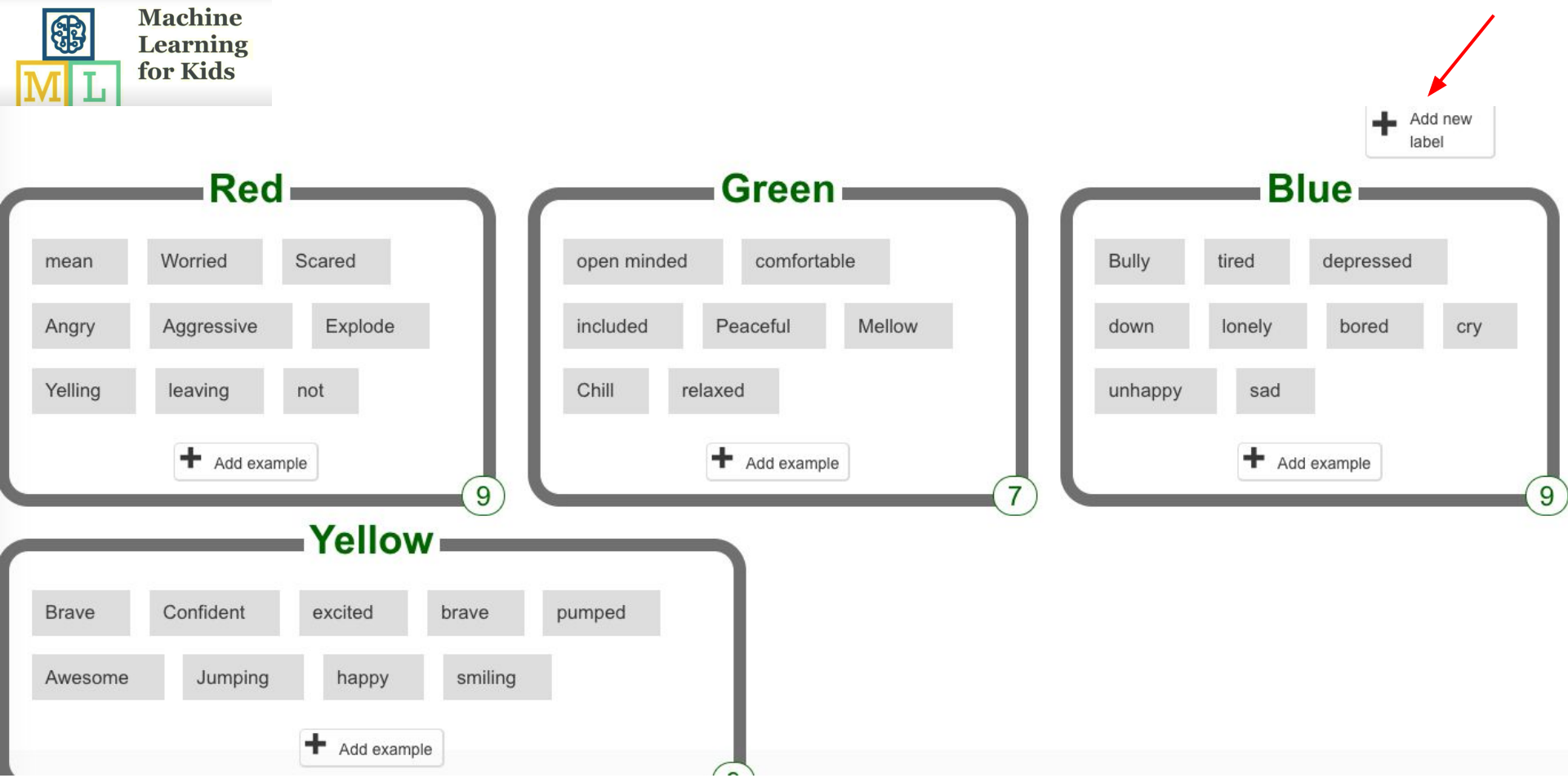
Train a Machine Learning Model

Evaluate the model in labeling text

Build a Scratch Project

machinelearningforkids.co.uk

Machine Learning for Kids



What have you done?

You have trained a machine learning model to recognise when text is Red, Green or 3 other classes.

You created the model on Monday, June 15, 2020 6:10 PM.

You have collected:

- 9 examples of Red,
- 7 examples of Green,
- 9 examples of Blue,
- 9 examples of Yellow,
- 4 examples of Neutral

What's next?

Try testing the machine learning model below. Enter an example of text below, that you didn't include in the examples you used to train it. It will tell you what it recognises it as, and how confident it is in that.

If the computer seems to have learned to recognise things correctly, then you can go to Scratch and use what the computer has learned to make a game!

If the computer is getting too many things wrong, you might want to go back to the Train page and collect some more examples

Once you've done that, click on the button below to train a new machine learning model and see what difference the extra examples will make!

Machine Learning for Kids

Try putting in some text to see how it is recognised based on your training.

Happy

Test

Recognised as **Yellow**
with 100% confidence

Try putting in some text to see how it is recognised based on your training.

I am angry

Test

Recognised as **Red**
with 94% confidence

About Teacher Projects Worksheets News Help Log Out Language

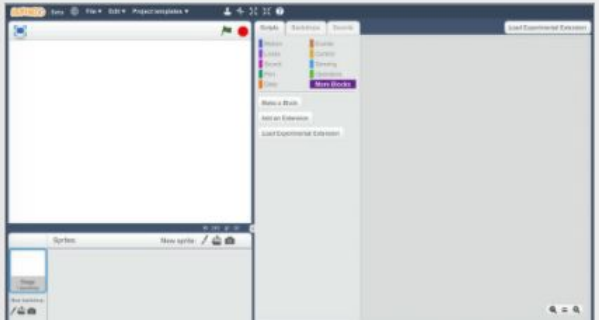
Make something with your machine learning model

Back to project

Scratch

Make a project in the old version of Scratch

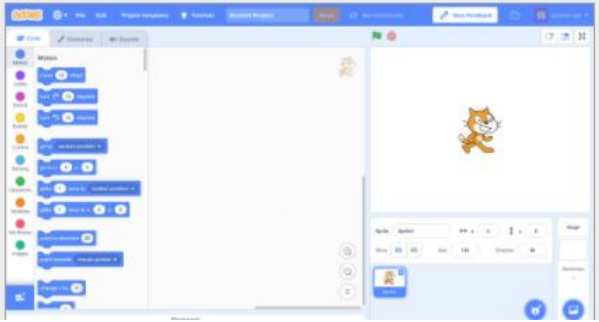
Scratch



Scratch 3

Use the new version of Scratch

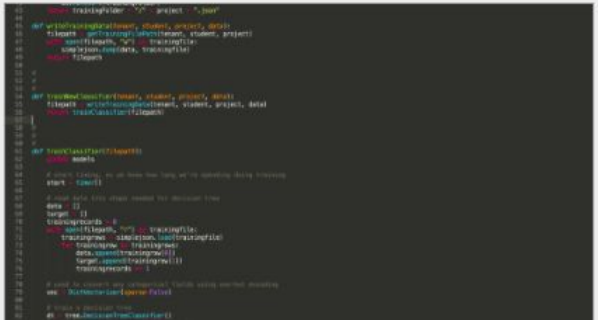
Scratch 3



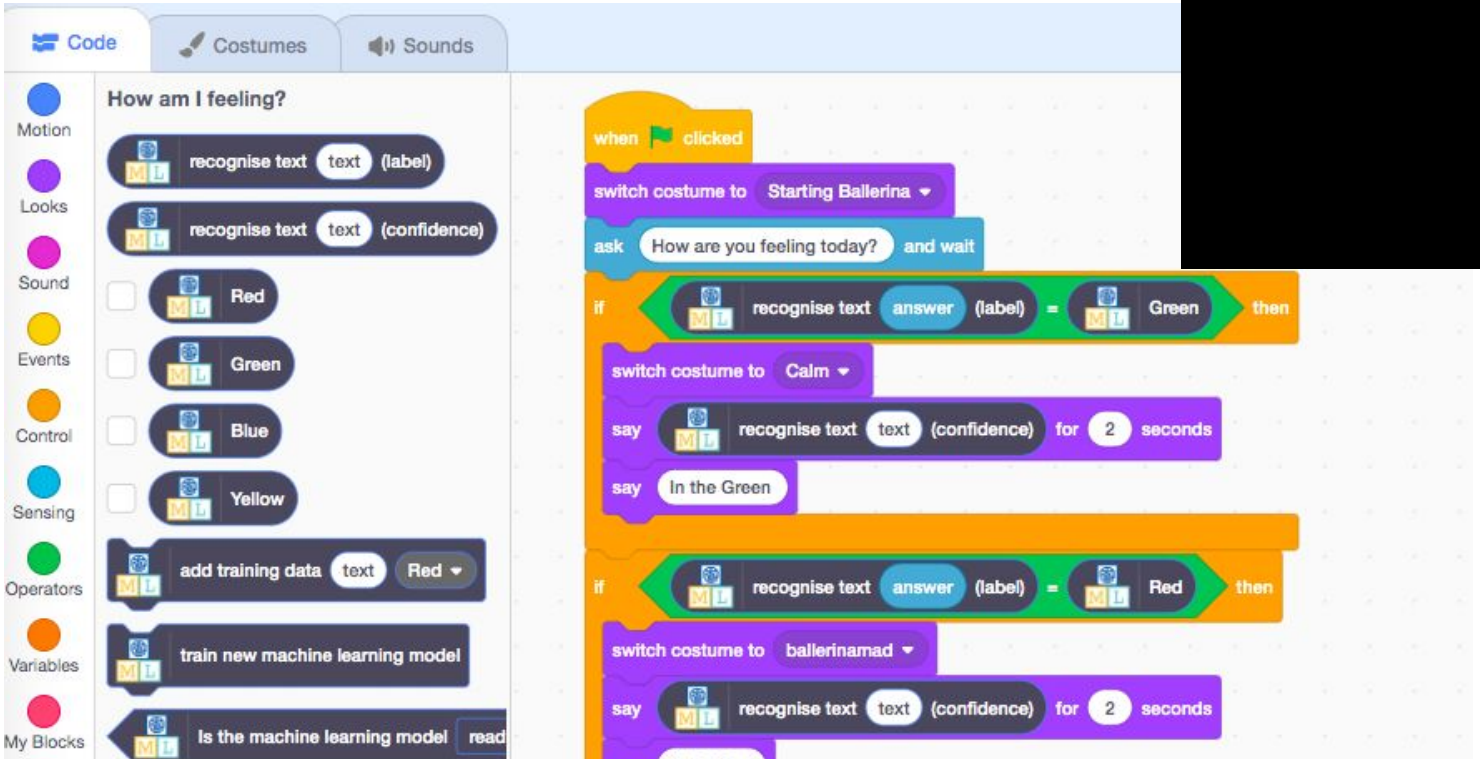
Python

Write Python code to use your machine learning model

Python



Using the Model in Scratch



Teaching AI in 6-8

Charlotte Dungan
AI Program Architect
North Carolina School of Science and Mathematics
Durham, NC

Charlotte Dungan: Teaching AI in 6-8

Exploring the Ethics of Artificial Intelligence with Middle School Students

Unplugged: Guess Who redesign with algorithms

Guess Who?

Investigate hidden bias in data
and explore strategies to create ethical AI

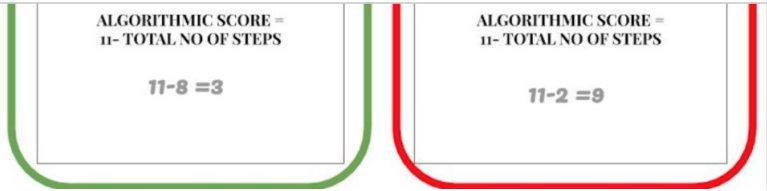
Grade Level: Suitable for Grade 6-8
Suggested Time: 1-2 classroom sessions

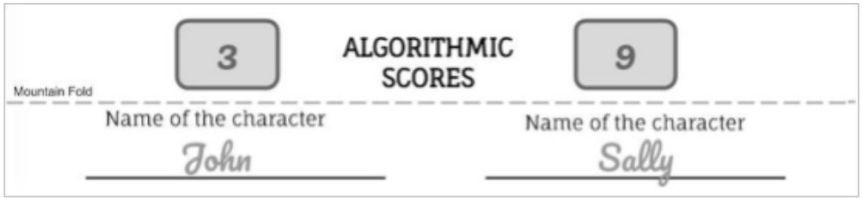
Overview

In this session, students will explore AI ethics through the critical lens of biases in machine learning. They will play '*Guess Who?*' a character guessing board game to gain an understanding of how data can be deceptive and impose bias for some people who may be at a disadvantage. Using this analogy, they will explore real-world examples of machine learning online applications that are known to be biased such as image recognition and online advertising. Along with attaining awareness around the importance of ethics in AI, students will also investigate strategies to solve the problem of algorithmic biases.

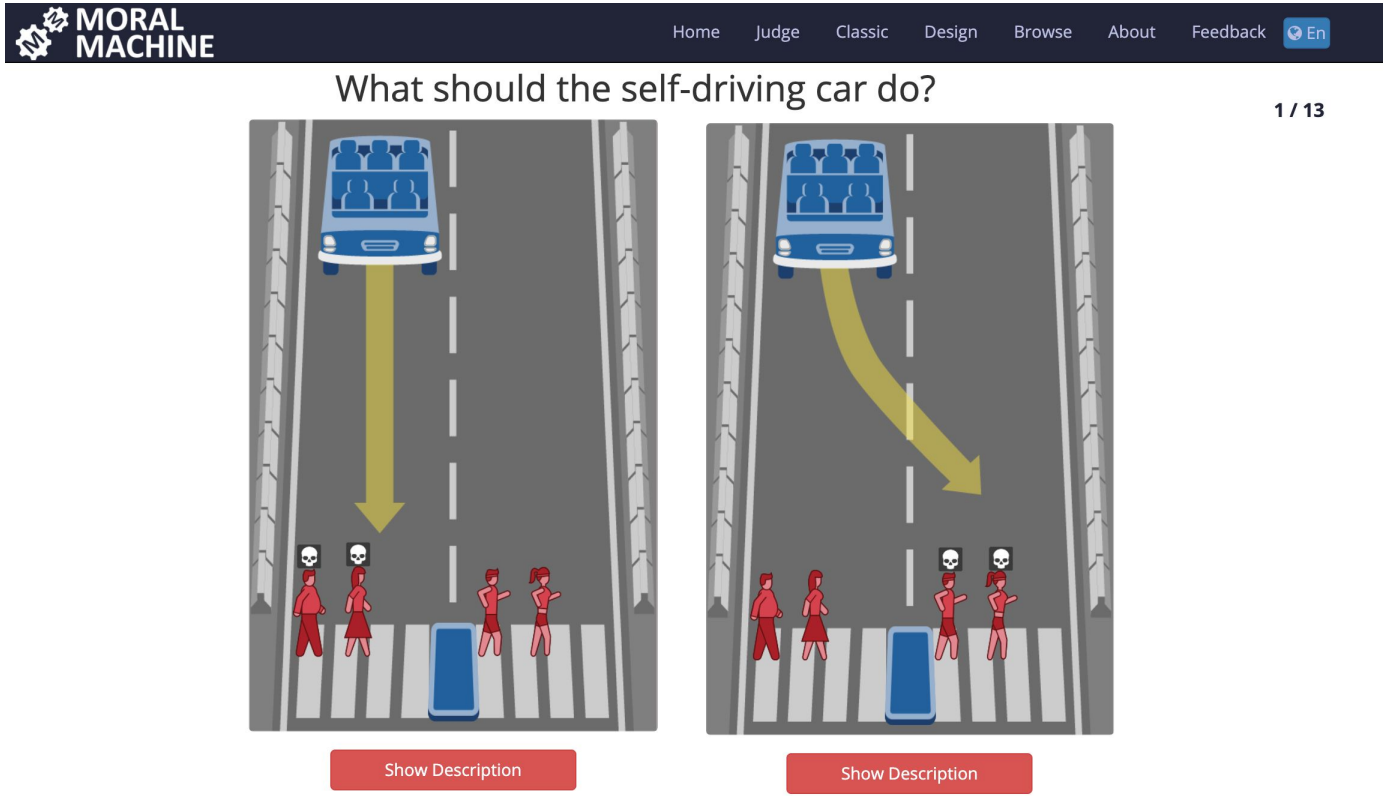
Fig1: A critical dialogue about data ethics

- Generate scores for these characters using the given formula

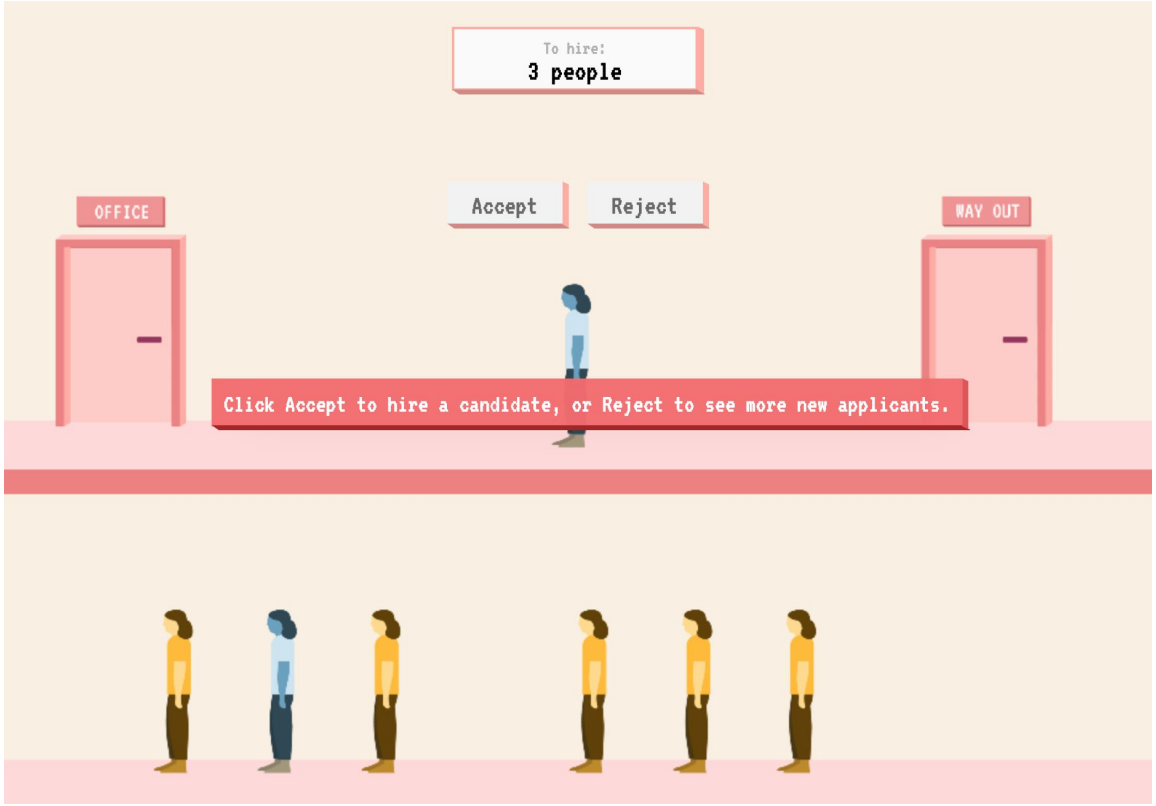




Moral Machine - Programming in our devices?



Survival of the Best Fit - What else is being sorted?



NATIONAL HIGH SCHOOL ETHICS BOWL

Frameworks of Analysis (Unplugged)

Cynthia Wood-Smythe, a 75-year-old widow, lives alone in a comfortable farmhouse in northern England where she has resided for the past 45 years. Her only child, Charles, lives in London but frequently travels overseas. He is employed by an international firm that is in the forefront of the field of robotics. The company is based in Japan, where robots are being used increasingly to provide care and as "companions" for elderly people. Research is well along in programming robots to emulate some human emotions.

Though in fairly good health, Mrs. Wood-Smythe takes several medications a day which effectively control her diabetes and arthritis. Her nearest neighbors are two miles away. She drives but deliberately limits her driving to do her marketing in the village some four miles away.

Charles speaks to his mother daily by telephone and has taught her to use face-time in order to better gauge her mood and health. However, she sometimes forgets how to use the application and Charles has detected signs of forgetfulness in his mother regarding other tasks. On the whole, he believes she is safe and comfortable, but he is considering ways to better monitor her behavior and personal safety.

Charles's firm has just begun to produce a robot called Cara which will be sold to care for the elderly and children. Cara is designed to help reduce stress, stimulate cognitive activities, and provide reminders about medications. However, as committed as he is to his firm's products, Charles is aware that ethicists have raised questions about whether the use of such a robot might replace human contact with negative consequences. Would providing Cara for his mother's use have such consequences? Would she strongly resist using such a device and be upset by it? Would she feel that he was substituting a machine for his own personal attention and affection? Would its use by his mother in a rural area cause a stir and call attention to his mother that would be unwanted and bothersome, if not downright disturbing? If Charles is unsure about providing Cara to his mother, are his commitments to his job, his firm, and its products in question?

Teaching AI in 9-12

Jared Amalong
Sacramento, CA
Sacramento County Office of Education
Computer Science Coordinator


An AI Pathway

Three Tiers of AI4K12 in High School

AI User	CSforAll … AI4All	Voice assistants, recommendations engines, facial recognition- we are all users of AI. Students may learn about the basic principles of AI technologies and the impacts of those technologies on society.
AI Manager	APCP/APCSA	As students learn CS, they may create projects and applications that incorporate AI technologies. In our careers, many of us will “manage” AI too
AI Developer	Capstone Experiences	Students develop and train AI models using industry tools and practices. This experience is likely accompanied with a 4+ year math pathway.


5:00
English
Spanish
English
Where is the train station?
Spanish
¿Dónde está la estación de tren?

Three Tiers in Action - A Demo with Google Translate

AI User	Google Translate in a World Languages Course	Students might compare and contrast the accuracy of the output of human and AI-powered translators. They might also use an AI-powered translator to hold a real-time conversation with a speaker of another language.
AI Manager	Scratch and Python with Google Translate	Students might incorporate an AI tool like Google Translate into a project using a web-based API. Scratch and Google Translate Google Translate API and Documentation for Python
AI Developer	AutoML Translation with Google Cloud	Students might train a machine learning model using the Google Cloud and the Google Translate API.

Exploring Computer Science

Artificial Intelligence

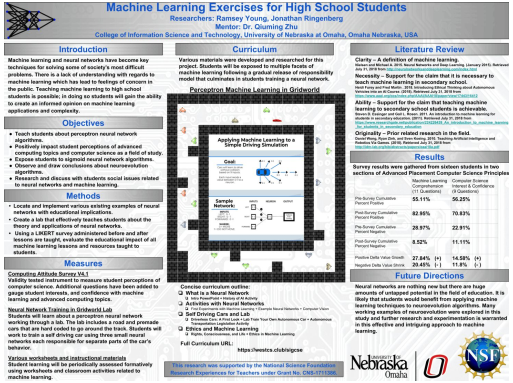
Alternate Curriculum Unit

BOOTSTRAP DATA SCIENCE

IDS

Introduction to Data Science

How to Implement AI in High School?



Machine Learning Exercises for High School Students

Researchers: Ramsey Young, Jonathan Ringenberg

Mentor: Dr. Qiuming Zhu

College of Information Science and Technology, University of Nebraska at Omaha, Omaha Nebraska, USA

Introduction

Machine learning and neural networks have become key techniques for solving some of society's most difficult problems. There is a lack of understanding with regards to machine learning which has lead to feelings of concern in the public. Teaching machine learning to high school students is possible; in doing so students will gain the ability to create an informed opinion on machine learning applications and complexity.

Objectives

- Teach students about perceptron neural network algorithms.
- Positively impact student perceptions of advanced computing topics and computer science as a field of study.
- Expose students to sigmoid neural network algorithms.
- Observe and draw conclusions about neuroevolution algorithms.
- Research and discuss with students social issues related to neural networks and machine learning.

Methods

- Locate and implement various existing examples of neural networks with educational implications.
- Create a lab that effectively teaches students about the theory and applications of neural networks.
- Using a LIKERT survey administered before and after lessons are taught, evaluate the educational impact of all machine learning lessons and resources taught to students.

Measures

Computing Attitude Survey V4.1

Validity tested instrument to measure student perceptions of computer science. Additional questions have been added to gauge student interests, and confidence with machine learning and advanced computing topics.

Neural Network Training in Gridworld Lab

Students will learn about a perceptron neural network working through a lab. The lab includes a road and premade cars that are hard coded to go around the track. Students will work to train a self driving car using three small neural networks each responsible for separate parts of the car's behavior.

Various worksheets and instructional materials

Student learning will be periodically assessed formatively using worksheets and classroom activities related to machine learning.

Curriculum

Various materials were developed and researched for this project. Students will be exposed to multiple facets of machine learning following a gradual release of responsibility model that culminates in students training a neural network.

Perceptron Machine Learning in Gridworld

Applying Machine Learning to a Simple Driving Simulation

Goal:

Sample Network:

INPUTS NEURON OUTPUT

Concise curriculum outline:

- What is a Neural Network
  - Intro PowerPoint + History of AI Activity
- Activities with Neural Networks
  - First Experiments with Machine Learning + Example Neural Networks + Computer Vision
- Self Driving Cars and Lab
  - Driverless Cars: A First Look + Lab Train Your Own Autonomous Car + Autonomous Transportation Legislation Activity
- Ethics and Machine Learning
  - Rights, Consciousness, and Life + Ethics in Machine Learning

Full Curriculum URL:

https://westcs.club/sigcse

This research was supported by the National Science Foundation Research Experiences for Teachers under Grant No. CNS-1711386.

Literature Review

Clarity – A definition of machine learning.

Nielsen and Michael A. 2015. Neural Networks and Deep Learning. (January 2015). Retrieved July 31, 2018 from http://neuralnetworksanddeeplearning.com/index.html

Necessity – Support for the claim that it is necessary to teach machine learning in secondary school.

Heidi Furey and Fred Martin . 2018. Introducing Ethical Thinking about Autonomous Vehicles into an AI Course. (2018). Retrieved July 31, 2018 from https://www.aaai.org/ocs/index.php/AAAI/AAAI18/paper/view/17443/16412

Ability – Support for the claim that teaching machine learning to secondary school students is achievable.

Steven D. Essinger and Gail L. Rosen. 2011. An introduction to machine learning for students in secondary education. (2011). Retrieved July 31, 2018 from https://www.researchgate.net/publication/224226439_An_introduction_to_machine_learning_for_students_in_secondary_education

Originality – Prior related research in the field.

Daniel Wong, Ryan Zink, and Sven Koeing. 2010. Teaching Artificial Intelligence and Robotics Via Games. (2010). Retrieved July 31, 2018 from http://idm-lab.org/bib/abstracts/papers/eaai10a.pdf

Results

Survey results were gathered from sixteen students in two sections of Advanced Placement Computer Science Principles

	Machine Learning Comprehension (11 Questions)	Computer Science Interest & Confidence (9 Questions)
Pre-Survey Cumulative Percent Positive	55.11%	56.25%
Post-Survey Cumulative Percent Positive	82.95%	70.83%
Pre-Survey Cumulative Percent Negative	28.97%	22.91%
Post-Survey Cumulative Percent Negative	8.52%	11.11%
Positive Delta Value Growth	27.84% (+)	14.58% (+)
Negative Delta Value Shrink	20.45% (-)	11.8% (-)

Future Directions

Neural networks are nothing new but there are huge amounts of untapped potential in the field of education. It is likely that students would benefit from applying machine learning techniques to neuroevolution algorithms. Many working examples of neuroevolution were explored in this study and further research and experimentation is warranted in this effective and intriguing approach to machine learning.

University of Nebraska Omaha

NSF

ISTE®

Examples of AI Implementation Across The Three Tiers

AI User	Academic Integration, Introductory CS, Data Science	Bootstrap UCLA CenterX Introduction to Data Science Exploring Computer Science AI Unit
AI Manager	AP CS Principles Content, Support for Create and Explore (RIP) PT	CS Principles Unit ISTE AI Project Guides (Coming Soon!)
AI Developer	Capstone Course Experience	Machine Learning Crash Course

Teaching AI in 9-12: A Look Into The Future

- Expanded resources to integrate and teach modular AI units within existing courses.
- Curriculum and Professional Learning Support for AI/ML courses
- Post-secondary articulation and matriculation opportunities for students

Teaching AI: How to get started?

- Join our mailing list
  - To join the AI4K12 mailing list, use the signup link on the AI4K12.org web site.
- Explore the Resource Directory
  - There are lots of materials in our resource directory on the AI4K12.org web site.
- Pursue professional development opportunities
  - Take advantage of PD opportunities from ISTE, ReadyAI, and others.

Questions for the Panel