K-12 AI Education in 2020

EAAI 2020

Panelists

Dave Touretzky
Carnegie Mellon
AI for K-12 Working Group
Chair

Christina Gardner-McCune
University of Florida
AI For K-12 Working Group
Co-Chair

Cynthia Breazeal
MIT

Rooz Aliabadi
ReadyAI

Emily Reid
AI4ALL

Initiative Update

David S. Touretzky & Christina Gardner-McCune

Supported by NSF DRL-1846073.

#AI4K12

K-12 AI Education (Circa May 2018)

- CS K-12 Education is exploding in the US and abroad.
- We are not as far along when it comes to AI, but many countries are trying China, UK, Thailand, Korea, and EU Countries

- The 2017 CSTA Computing Standards contain just two sentences about AI.
  - Both are for the 11-12 grade band. Nothing for younger students.

3B-AP-08	11-12	Describe how artificial intelligence drives many software and physical systems.	Algorithms & Programming	Algorithms	Communicating
3B-AP-09	11-12	Implement an artificial intelligence algorithm to play a game against a human opponent or solve a problem.	Algorithms & Programming	Algorithms	Creating

The AI4K12 Initiative, a joint project of:

AAAI (Association for the Advancement of Artificial Intelligence)

CSTA (Computer Science Teachers Association)

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

Carnegie Mellon University
School of Computer Science

AI4K12.org Initiative 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 K-12 AI Education Research and Practice Community & Resource Developers

Steering Committee

Dave Touretzky
Carnegie Mellon
AI for K-12 Working Group Chair

Christina Gardner-McCune
University of Florida
AI For K-12 Working Group Co-Chair

Fred Martin
UMass Lowell
CSTA Chair of Board of Directors

Deborah Seehorn
Co-Chair of CSTA Standards Committee

K-12 Teacher Working Group Members

Grades K-2
Vicky Sedgwick (Lead)
Susan Amsler-Akacem
Dr. April DeGennaro
Melissa Unger (New)

Grades 3-5
Kelly Powers (Lead)
Dr. Marlo Barnett
Dr. Phillip Eaglin
Alexis Cobo (New)

Grades 6-8
Sheena Vaidyanathan (Lead)
Padmaja Bandaru
Josh Caldwell
Charlotte Dungan
Rachael Smith (New)

Grades 9-12
Jared Amalong (Lead)
Dr. Smadar Bergman
Kate Lockwood
John Chapin (New)

Year 1 Alumni: Brian Stamford, Minsoo Park, Juan Palomares, Vincent Gregorio, Dianne O'Grady-Cunniff

Academia/Industry Working Group Members

Hal Abelson
MIT

Cynthia Breazeal
MIT

Emily Reid
AI4ALL

Matthijs Spaan
TU Delft
AAAI

AI4K12.org Advisory Board

Miles Berry, Roehampton University, UK

Amy Eguchi, UC San Diego, CA

Laura Schmidt, Milwaukee School of Engineering University, WI

Maitreyee Joshi, Microsoft, Seattle, WA

Irene Lee, MIT, Cambridge, MA

Dahua Lin, Chinese University of Hong Kong, China

Hari Raghavan, IBM, New York, NY

Joseph South, ISTE, Portland, OR

Tom Vander Ark, Getting Smart, Federal Way, WA

Joyce D. Williams, National Geospatial-Intelligence Agency, VA

Wells Santo, Oakland, CA

Structure of Working Group & Responsibilities

Goal: Increase familiarity with AI concepts and leverage knowledge of students capabilities in CS and other disciplines and interests to scope expectations for student learning about AI for their grade band

Monthly

Large Working Group Meeting

AI Bootstrapping

- Introduce the concepts in one of the big ideas (demos, activities, explanations)
- Provide key concepts and Enduring Understandings we want all students to know by they time they graduate from high school

Gradebands Share out Progress

Weekly or Bi-Monthly

Small Working Group Meetings

- **Review & Discuss** key concepts introduced on the call
- **Identify** existing student knowledge, skills, and connections to other disciplines
- **Redefine** concepts from Big Group presentations
- **Scope** to grade band

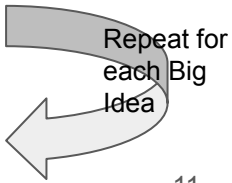
Individual Work

Read

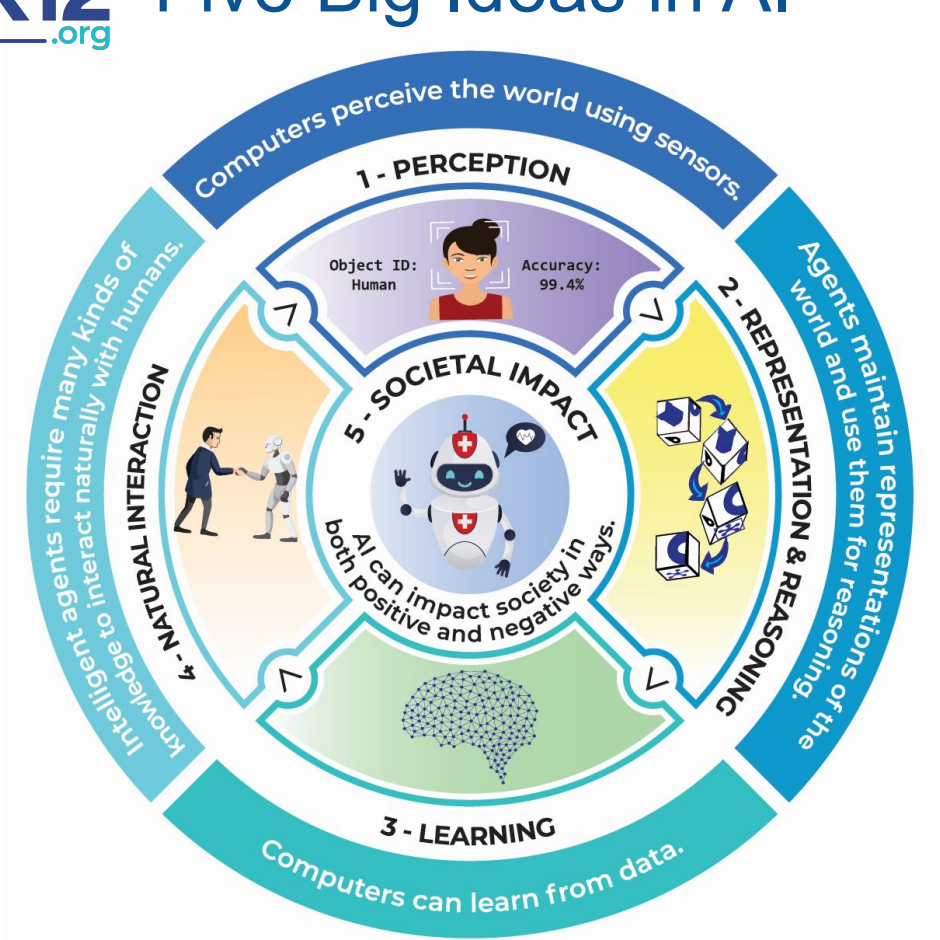
- Scholarly Articles
- Explanatory Articles about AI Concepts
- Research & concepts, activities, and tools

Face-to-Face Meetings

Face-to-Face Meetings



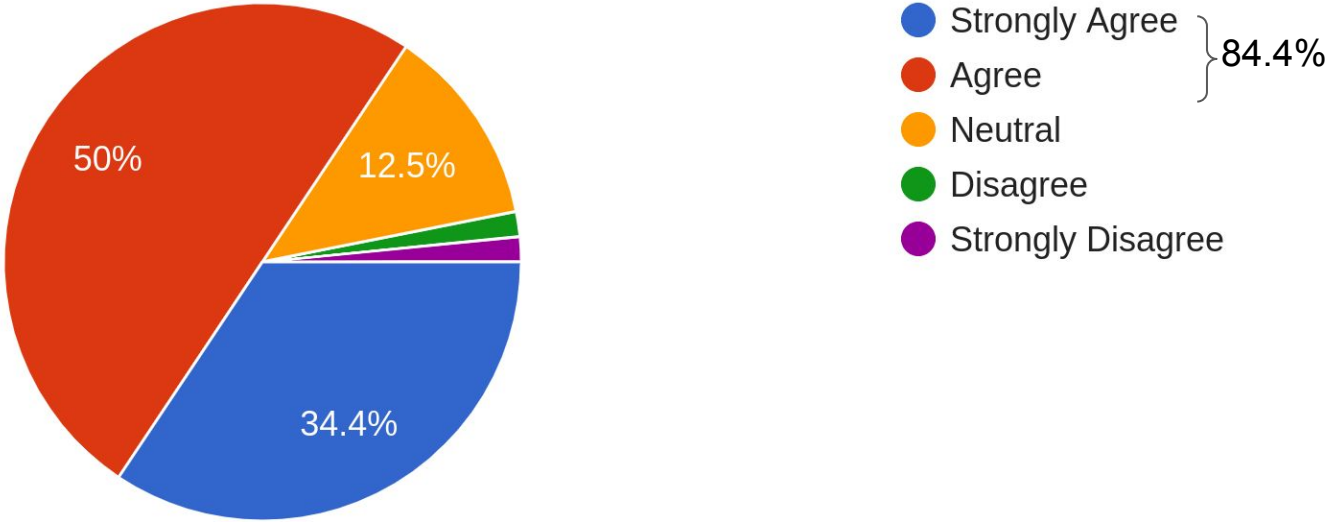
Five Big Ideas in AI



Results of AAAI Members Survey

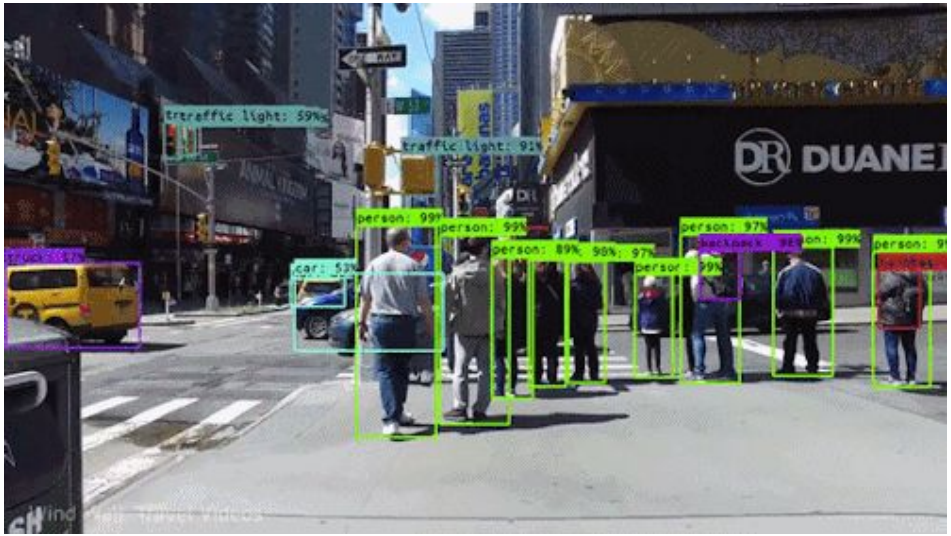
The "5 Big Ideas in AI" capture the essence of AI.

64 responses



Big Idea #1: Perception

Computers perceive the world using sensors.
Perception is the extraction of *meaning* from sensory signals.



- 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

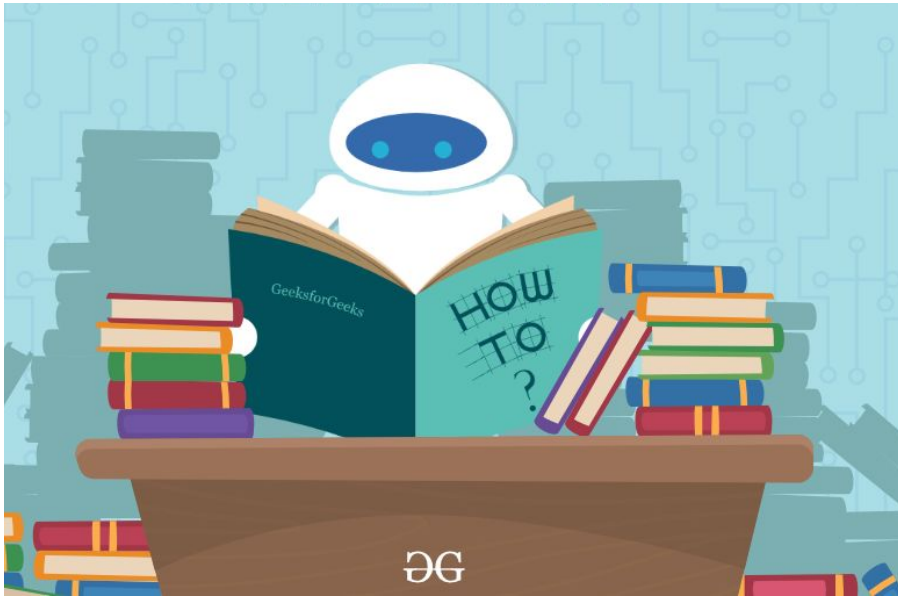
Example Guidelines

- 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 & interaction (e.g. with robots, or speech agents)
- 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.

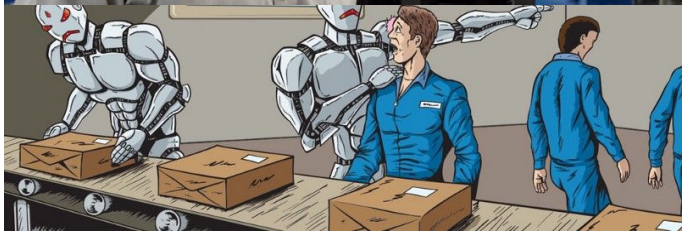
Big Idea #5: Societal Impact

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

- Ethics of AI making decisions about people
- AI & Culture
- Economic impact of AI

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



Principles for Refinement & Scoping of Guidelines

Guidelines need to have real-world relevance to enable students to

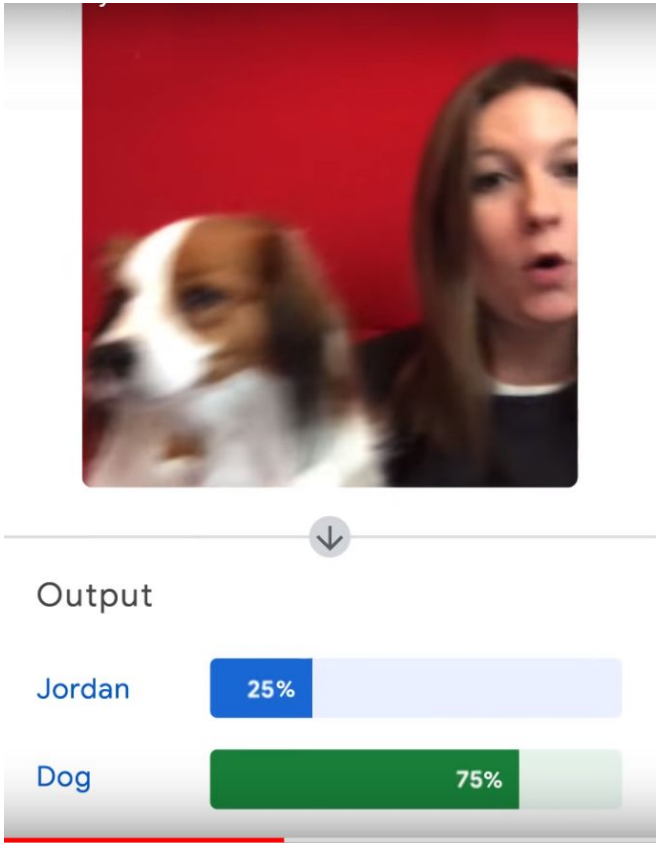
- explain how a self-driving car works and the types AI systems or subsystems involved in decision making
- explain the process by which ML models are developed, from data collection to types of training and sources of bias etc
- use, modify, and create AI systems using developmentally appropriate tools
- understand the implications of AI for real world issues

Recent Developments in Tools for K-12 AI Education

TEACHABLE MACHINE

Built with TensorFlow

- Version 2 (new)
- Teach a machine using your camera.
- Live, in the browser.
- No coding required.
- Export a trained model to JavaScript



https://experiments.withgoogle.com/teachable-machine

AI WITH APP INVENTOR

https://appinventor.mit.edu/explore/ai-with-mit-app-inventor

Introduction to Machine Learning: Image Classification

Difficulty: beginner

Resource Type: curriculum unit

Subject: computer science

Grade Level:

- 6-8
- 9-12

Students will learn about the basics of machine learning and create their own apps that implement these concepts through image classification. The students will take photos with their mobile devices and the apps will identify objects within those photos. Each classification comes with a confidence level, a value of how... More Details

Use a pre-trained image classifier

Personal Image Classifier

Difficulty: beginner

Resource Type: curriculum unit

Subject: computer science

Grade Level:

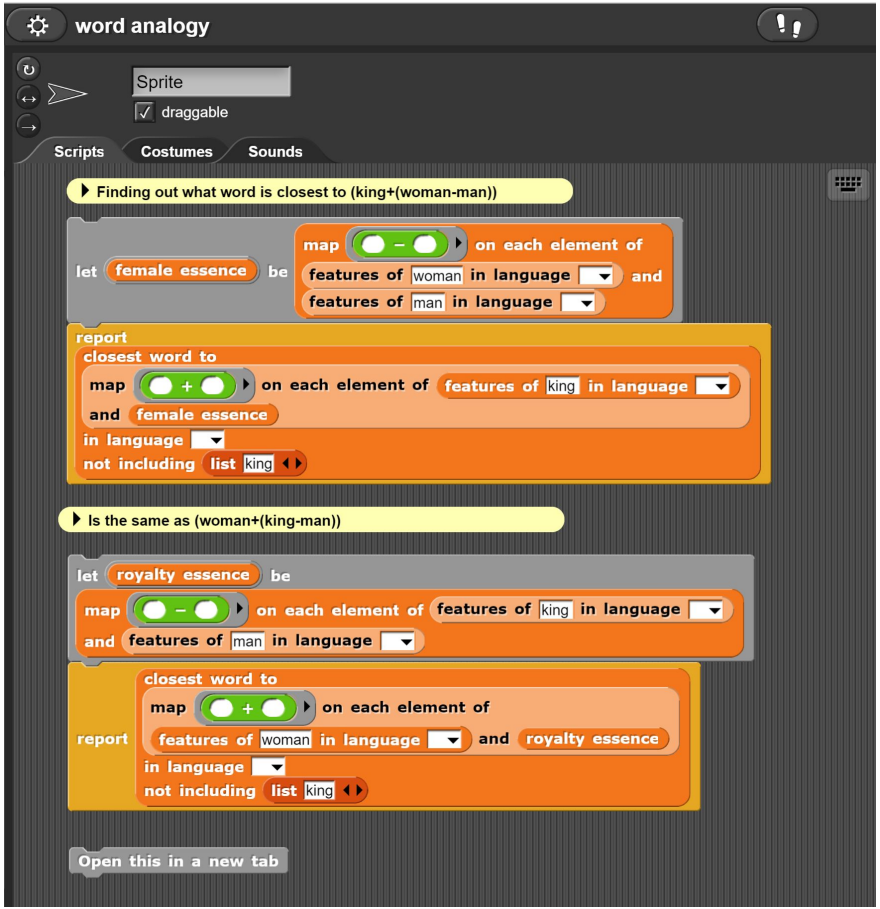
- 6-8
- 9-12

This AI unit is broken into three parts. In part 1, students learn how to create and train their own image classification model to identify and classify images. In part 2, students use their model in an app using MIT App Inventor to see how their model performs. In part... More Details

Train your own image classifier

eCraft2Learn - Ken Kahn

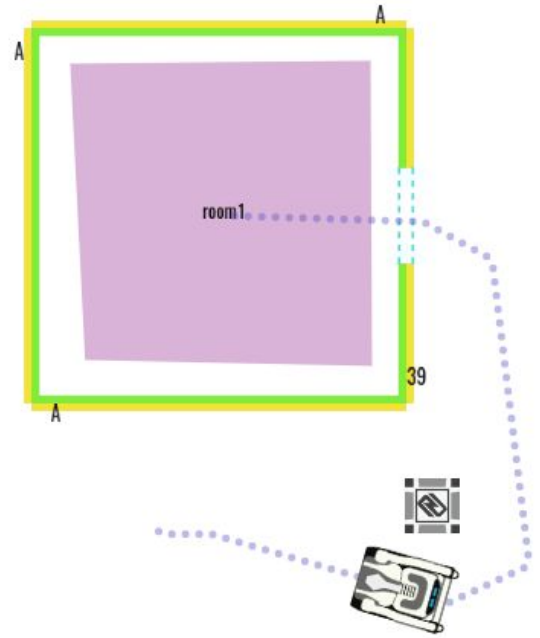
- Exploring word2Vec
- Snap! extension that supports 20,000 words in 15 languages
- Teacher Guide
  https://ecraft2learn.github.io/ai/AI-Teacher-Guide/chapter-5.html



Source:
https://ecraft2learn.github.io/ai/snap/snap-no-logging.html?project=word%20analogy&noRun&editMode

Calypso for Cozmo: New Path Planner

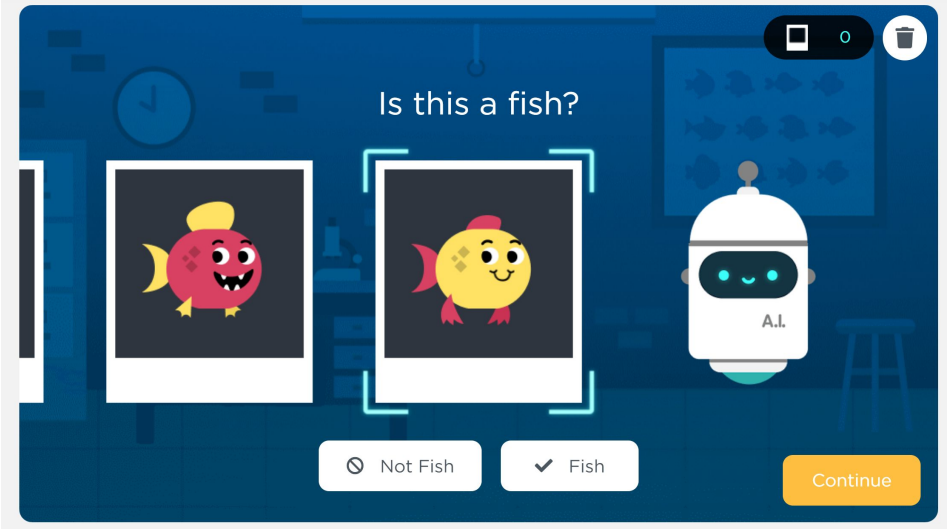
- Hybrid wavefront/RRT path planner
- It draws the planned path in the world map, or indicates if planning has failed (goal unreachable).
- The Cozmo robot is coming back!



Hour of Code: AI for Oceans

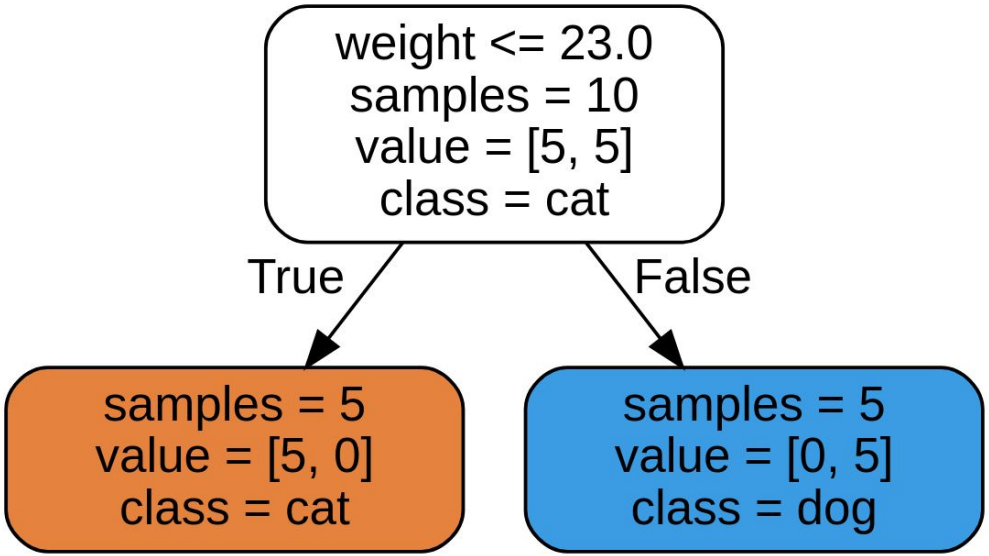
https://code.org/oceans

- Introduction to Machine Learning
- Train a classifier to distinguish categories of cartoon marine life



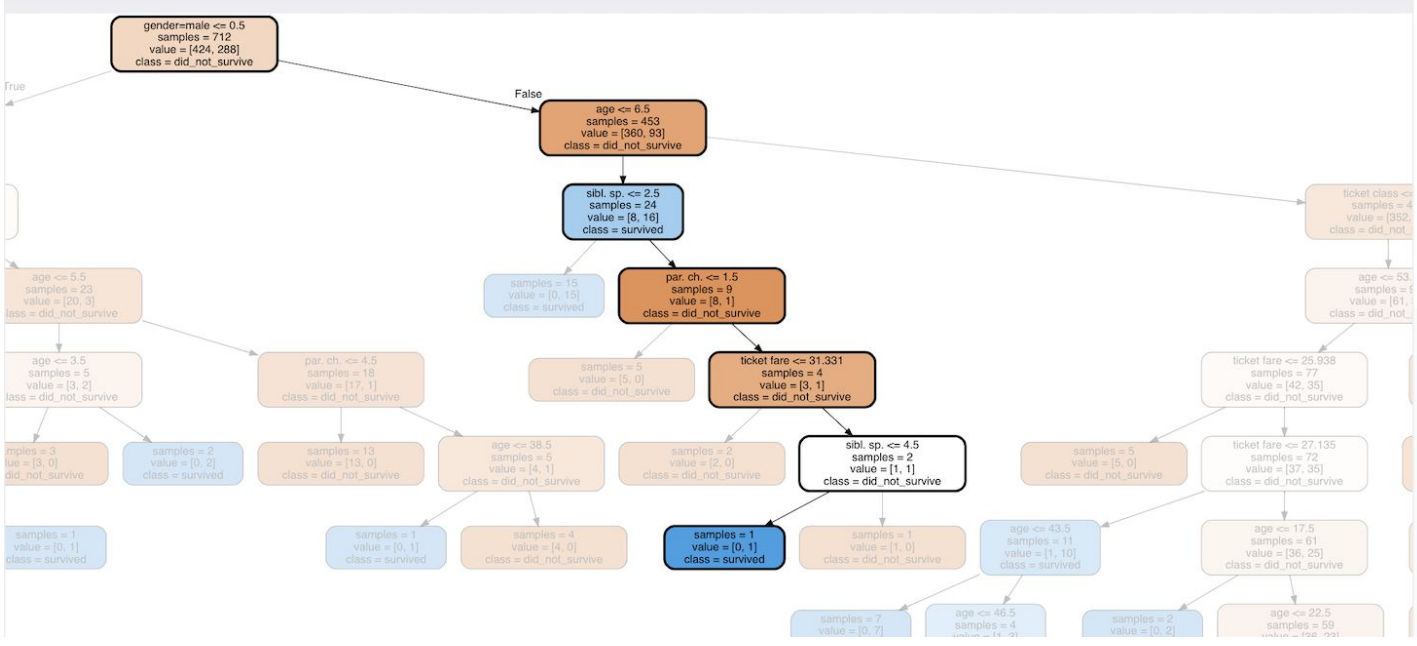
Machine Learning for Kids

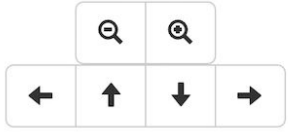
- Added a decision tree visualizer
- Can also show you how a particular input gets classified by the tree.



Machine Learning for Kids

Trees can be very complex! This display shows the path that led to classification of the instance at right as class blue (“survivor”).





Try out your machine learning model to see how it uses the decision tree to make predictions

ticket class	1
gender	male
age	6
sibl. sp.	3
par. ch.	2
ticket fare	80
embarked	Southampt

Test Reset

Tools & Activities Can Facilitate

- **Experiments with AI agents** to investigate their behavior
- **Hand simulations of** AI algorithms
- **Building their own AI applications**
- **Exploring case studies of AI-related societal issues** from multiple perspectives

The goal is to promote students' understanding of:

- How AI works
- Limitations of AI
- Systems thinking (AI systems are built from smaller components)
- Sources of bias in AI
- Societal impacts of AI systems

Types of AI Teaching Resources for K-12

Black box demos
provide hands-on experience with AI applications but don't reveal what's going on under the hood.

Glass box demos
expose the workings of an AI algorithm and invite the user to play with its parameters.

AI programming frameworks
allow students to develop their own applications by extending a familiar programming language with new AI primitives

Unplugged activities
guide students to explore AI by hand-simulating learning or reasoning algorithms.

Videos
combinomg verbal explanations with visualizations of AI algorithms can be very effective

Hardware
resources include vision-based mobile robots

Formal curricula

K-12 AI Education Community Update

K-12 AI Education Community Growth

- AI for K-12 Symposium (2018) & Teaching AI in K-12 (2019)
  AAAI Fall Symposia, Arlington, VA
- 560+ K-12 Teachers completed ISTE AI Teacher PD Course
- AI4K12 Interest Group List-serv - Over 250 people
  moved to ai4k12@lists.aaai.org
- K12 AI Education workshop (AIED conference, Chicago, May 2019)
- ISTE - 16 AI Talks, Events, and Workshops
- CSTA - 3 AI Breakout Sessions; 2 AI Workshops
- Workshop on Education in Artificial Intelligence K-12 (EduAI)
  IJCAI, Macau, China, Aug. 11, 2019
- 7 NSF Funded K-12 AI Education Projects

K-12 AI Curricula & Professional Development

- ISTE PD - Over 560+ Educators Completed the Course (Sept. 2019)
- ReadyAI: Free AI+ME tutorial for K-5
- 2019 WAICY Competition
- Exploring Computer Science (ECS) AI Curriculum Unit
- AI4ALL Open Learning Platform
- AI + Ethics (MIT) Curriculum & Standards
- Teaching AI book - Michelle Zimmerman

Grow the Community

Develop
Video, Web-based Demo,
& Tool frameworks

- **Your research**
- **Basic AI concepts**
- **How AI works** through the lens of everyday technologies

Develop for all grade bands: K-2, 3-5, 6-8, and 9-12 & work with teachers & students

Start thinking of
AI K-12 Demo ideas for
EAAI 2021

AI outreach in your local community

Align your curricula, PD, activities to the Five Big Ideas in AI

Feedback on guidelines

Join us in Sparking AI Curiosity

Visit us:

http://AI4K12.org

Join the mailing list

https://aaai.org/Organization/mailing-lists.php

OUR MISSION:

Increase Diversity & Inclusion in AI Development, Education, Policy, & Research.

The AI4ALL Solution: 3 Core Initiatives

AI4ALL Open Learning

Enabling AI projects for good at high schools

Summer Programs

Hosted at AI-focused Universities

University of Maryland · Stanford University · SFU Simon Fraser University · Princeton University · UCSF · Columbia University in the City of New York · Carnegie Mellon University · Arizona State University · Boston University · Berkeley University of California · Michigan Engineering University of Michigan

Changemakers in AI

Supporting careers for AI4ALL alumni

Core Educational Approach

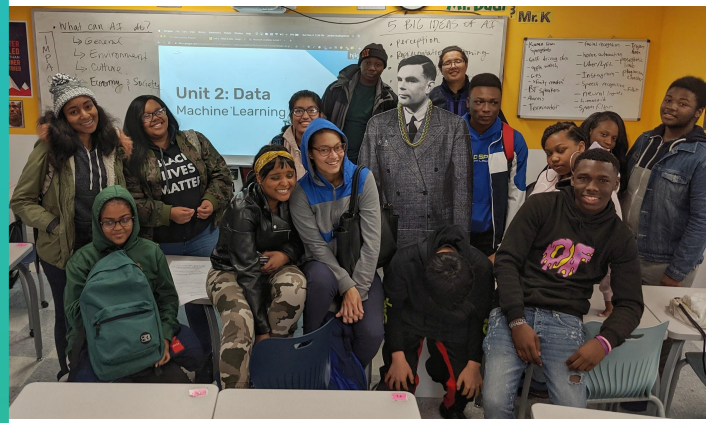
Project-based
skill building

Social impact +
ethics of AI

Diverse applications +
role models

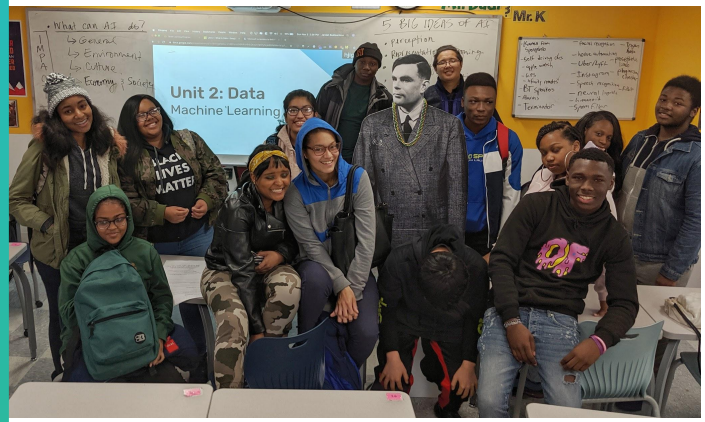
Data
literacy

What is AI4ALL Open Learning? Who is it for?



- AI curriculum that empowers teachers and community members to bring AI education into their community
- Free, modular, and delivered online
- Not a MOOC; meant to be run in classroom settings
- Can be embedded in workshops, after-school, and in-school programs
- Made for high school students

ExploreAI Audience



- Offers 10, 20, and 30 hour models
- NO background necessary--focus on AI literacy
  - NO computer programs
  - NO math
  - NO programming needed for this course
  - Still rigorous - gives a technical understanding of how machine learning works, how computers use data, algorithmic bias.

ExploreAI's Model of Inclusion

Meaningful Projects

- How can you bring AI to your community

Role Models

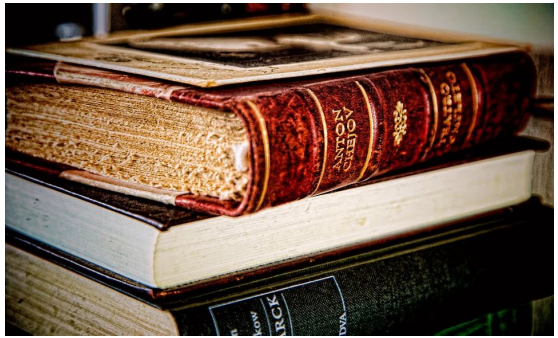
- Examples of AI
- Career Paths

Student Voice and Choice

- Projects based on student interests
- Discussion strategies that empower multiple voices

ExploreAI in Non-CS Subjects

English Language Arts



- Discussions
- Close readings of articles
- Research processes

Social Studies

- Policy around the world
- Ethics
- Civic participation

Career & Tech Ed

- Exploration of several different career paths in AI

To learn more:

olp.ai-4-all.org

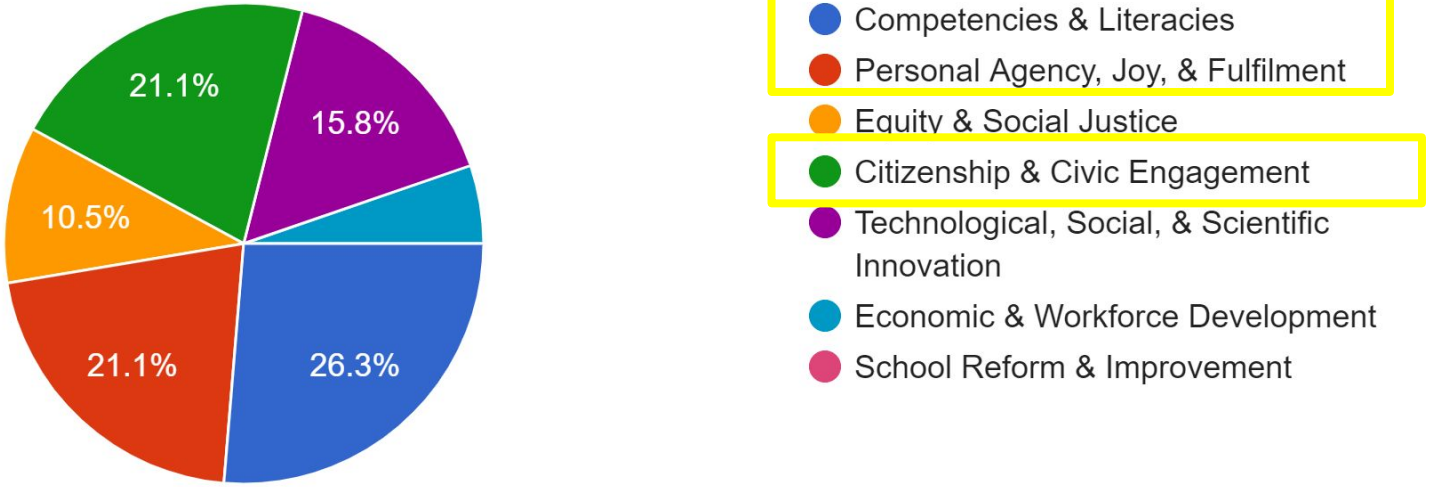
Interested in partnering?
bit.ly/OpenLearningPartners

2018 - 2019 Accomplishments Summary

Snapshot:
AI For K-12 Working Group Perspective on the Guidelines

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

19 responses



Five Big Ideas in Artificial Intelligence

1. Perception

Computers perceive the world using sensors. Perception is the process of extracting meaning from sensory signals. Making computers "see" and "hear" well enough for practical use is one of the most significant achievements of AI to date.

2. Representation & Reasoning

Agents maintain representations of the world and use them for reasoning. Representation is one of the fundamental problems of intelligence, both natural and artificial. Computers construct representations using data structures, and these representations support reasoning algorithms that derive new information from what is already known. While AI agents can reason about very complex problems, they do not think the way a human does.

3. Learning

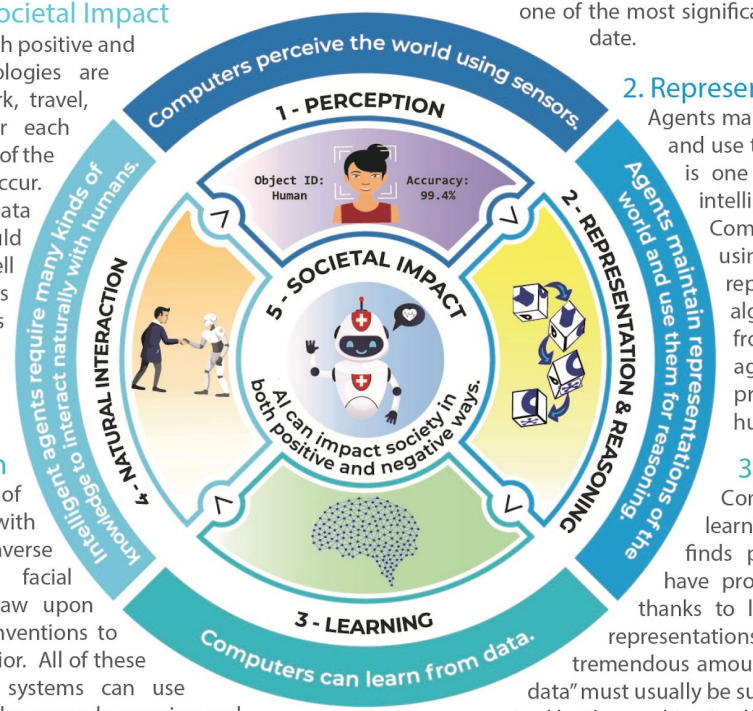
Computers can learn from data. Machine learning is a kind of statistical inference that finds patterns in data. Many areas of AI have progressed significantly in recent years thanks to learning algorithms that create new representations. For the approach to succeed, tremendous amounts of data are required. This "training data" must usually be supplied by people, but is sometimes acquired by the machine itself.

4. Natural Interaction

Intelligent agents require many kinds of knowlege to interact naturally with humans. Agents must be able to converse in human languages, recognize facial expressions and emotions, and draw upon knowledge of culture and social conventions to infer intentions from observed behavior. All of these are difficult problems. Today's AI systems can use language to a limited extent, but lack the general reasoning and conversational capabilities of even a child.

5. Societal Impact

AI can impact society in both positive and negative ways. AI technologies are changing the ways we work, travel, communicate, and care for each other. But we must be mindful of the harms that can potentially occur. For example, biases in the data used to train an AI system could lead to some people being less well served than others. Thus, it is important to discuss the impacts that AI is having on our society and develop criteria for the ethical design and deployment of AI-based systems.



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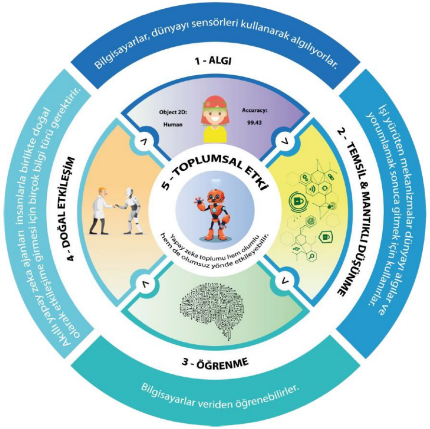
AI4K12.org

11x14 Poster available for free download at AI4K12.org

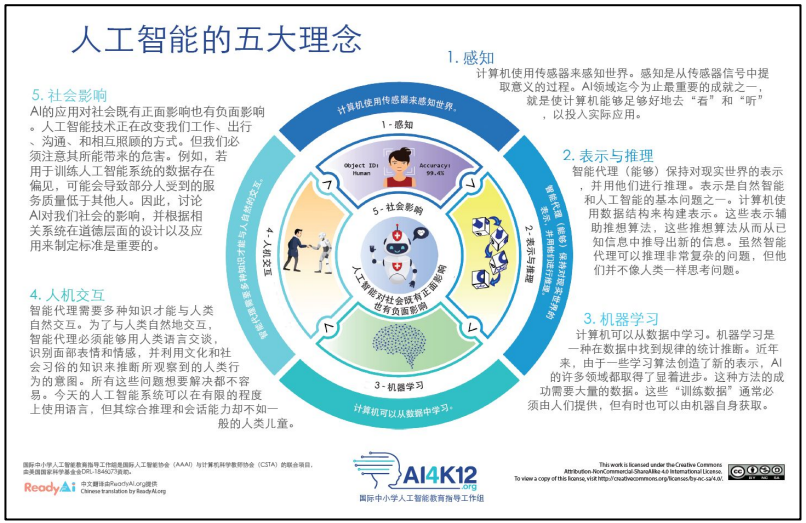
Adoption of the Big Ideas

- Now being adopted by curriculum developers in the US and elsewhere.
- Translations available in Chinese, Korean, and Turkish.

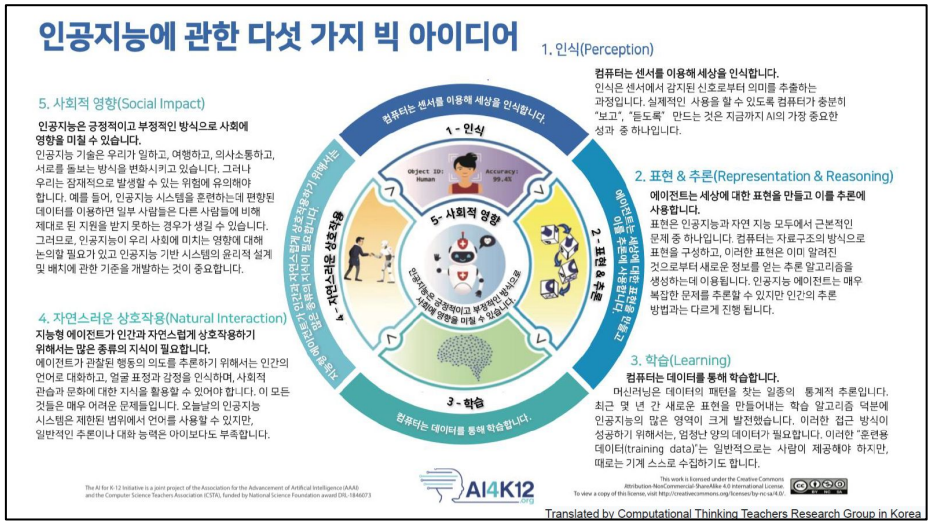
Turkish



Chinese



Korean



2019 Teaching AI in K-12 Program Overview

2 Keynotes

16 Presentations

1 Panel

6 AI Playground Demos

7 Lightning Talks

1 Participatory Activity

11 Teacher Scholarship

75

AAAI **2019**
Fall Symposium Series
Largest Symposium