



2019 Annual Conference



How to Teach AI Across K-12

Vicky Sedgwick

Kelly Powers

Padmaja Bandaru

Dr. Marlo Barnett

Dianne O'Grady-Cunniff

Deborah Seehorn



DRL-1846073

CSTA Annual Conference - Breakout Session - July 9, 2019



#AI4K12

AI for K-12 Initiative



Association for the
Advancement of Artificial Intelligence



Carnegie Mellon University
School of Computer Science





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 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



Academia/Industry Working Group Members



Hal Abelson
MIT



Cynthia Breazeal
MIT



Matt Dawson
Google



Emily Reid
AI4ALL



Matthijs Spaan
TU Delft
AAAI



K-12 Teacher Working Group Members

Grades K-2

Vicky Sedgwick (Lead)

Susan Amsler-Akacem

Dr. April DeGennaro

Charlotte Dungan

Grades 3-5

Kelly Powers (Lead)

Dr. Marlo Barnett

Dr. Phillip Eaglin

Brian Stamford

Grades 6-8

Padmaja Bandaru (Lead)

Minsoo Park

Juan Palomares

Josh Caldwell

Sheena Vaidyanathan

Grades 9-12

Dianne O'Grady-Cunniff (Lead)

Jared Amalong

Dr. Smadar Bergman

Kate Lockwood



Advisory Group

Miles Berry, Roehampton University, UK

Amy Eguchi, Bloomfield College, Bloomfield, NJ

Laura Hintzman Schmidt, Milwaukee School of Engineering

Irene Lee, MIT, Cambridge, MA

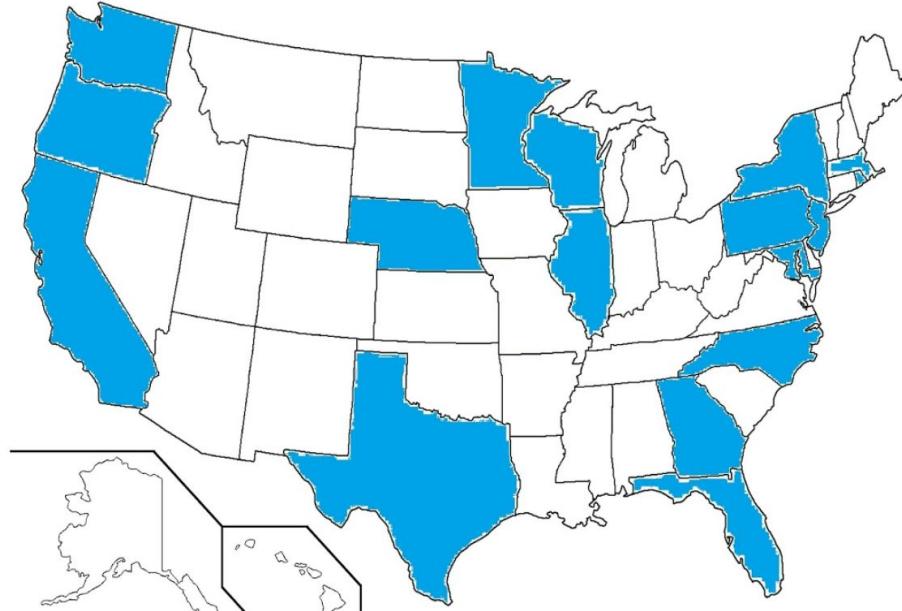
Dahua Lin, Chinese University of Hong Kong, China

Joseph South, ISTE, Portland, OR

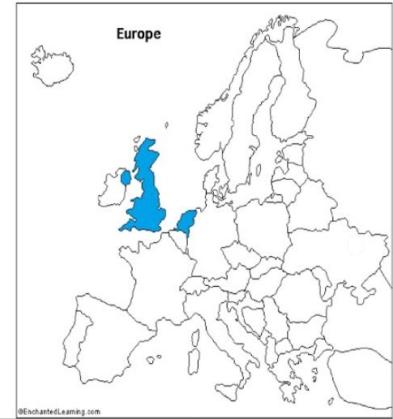
Tom Vander Ark, Getting Smart, Federal Way, WA

Joyce D. Williams, Defense Acquisitions University, Ft. Belvoir, VA

Across the three groups that make up the AI for K-12 Initiative, we have 33 individuals: 18 women and 15 men. We have representation from 17 US states, the UK, Europe, and Asia. Ethnic diversity: African American (5), Indian & Asian (5), Latino/a (2), and White (21).



AI For K-12 Geographic Distribution





Timeline

May 2018 - AAAI & CSTA collaboration formed & press release

June 2018 - Interim Wiki launched -
<https://gitub.com/touretzkyds/ai4k12/wiki> =>
<http://AI4K12.org>

June 2018 - Steering Committee formed

July 2018 - Interest Group formed -
ai4k12-list@aaai.org

July 2018 - CSTA Breakfast -- 120 attendees!

August 2018 - Working Group formed

August 2018 - Working Group Kick-Off Meeting

September 2018 - 1st Monthly Working Group Meeting - Big Ideas Discussion

October 2018 - AI for K-12 Symposium (AAAI Fall Symposia) - 50 Invited Participants!!!

November - January 2019 - Big Idea #1 Development (Perception)

January - March 2019 - Big Idea #2 Development (Representation & Reasoning)

March -April 2019 -Big Idea #3 Development (Machine Learning)

April - May 2019 -Big Idea #4 Development (Natural Interaction)

May - June 2019 -Big Idea #5 Development (Societal Impacts)



Public Activities



AI for K-12 Breakfast @ #csta2018

sponsored by Carnegie Mellon AI and The Robotics Hub
July 2018

AI for K-12 Symposium

@AAAI Fall Symposium, Washington, DC
October 2018

AAAI 2019 Conference, Hawaii Jan. 2018

AAAI Workshop K-12 Teacher Workshop
EAAI Panel

Senior Member - Blue Sky Talk)

Envisioning AI for K-12:
What should every child know about AI?

SIGCSE 2019 (February, Minneapolis)

- SIGCSE 2019 - *Special Session: AI For K-12 Initiative February 2019*
- SIGCSE 2019 - *Birds of a Feather*
AI for K-12: Making Room for AI in the K-12 CS Curriculum

ISTE 2019

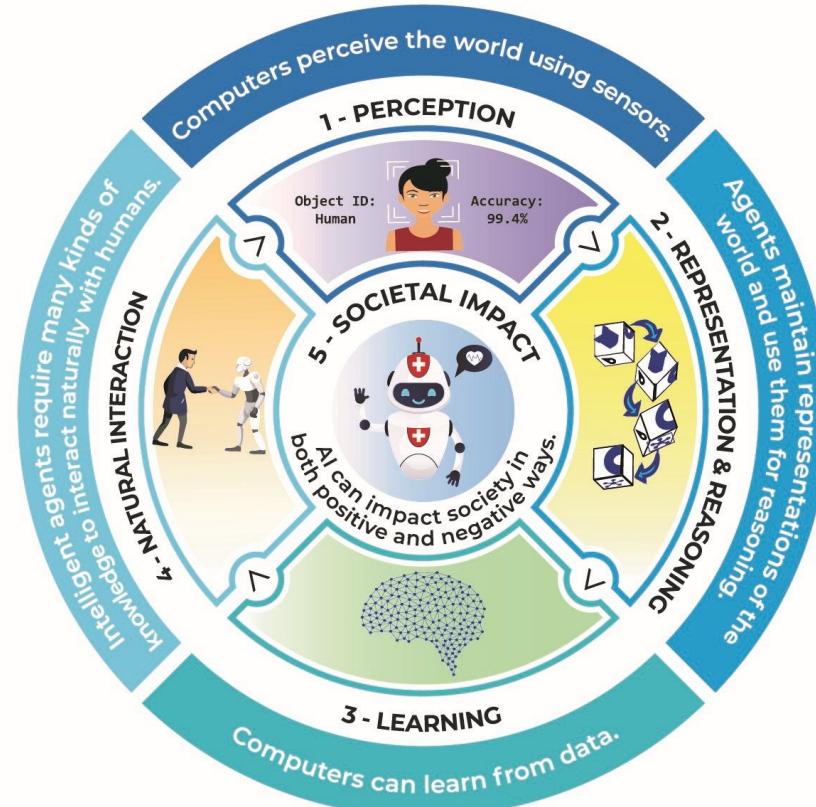
- ISTE 2019 (June 23, Philadelphia)
K-12 Guidelines for Artificial Intelligence: What Students & Teachers Should Know

Upcoming events

- AAAI 2019 Fall Symposium (November
Arlington, VA)

Five Big Ideas in AI

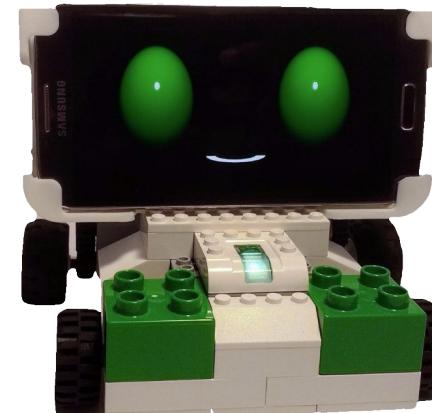
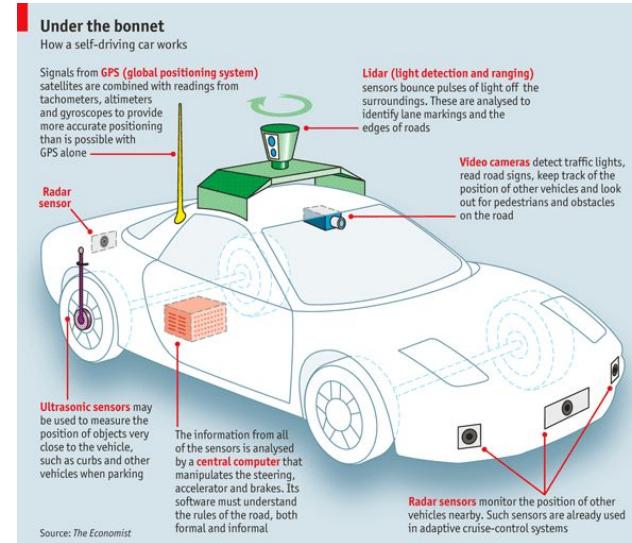
- Organizing framework for the K-12 guidelines.
- 5 big ideas are enough to cover the richness of the field, but small enough to be manageable by teachers
- CSTA experience shows 5 is a good number.
- Not necessarily the way AI practitioners view their field, but appropriate for the needs of the K-12 audience



Big Idea #1: Perception

“Computers perceive the world using sensors.”

- Speech recognition
- Computer vision, object recognition, scene understanding
- Face recognition
- Other forms of perception (e.g., sonar, LIDAR, music recognition)



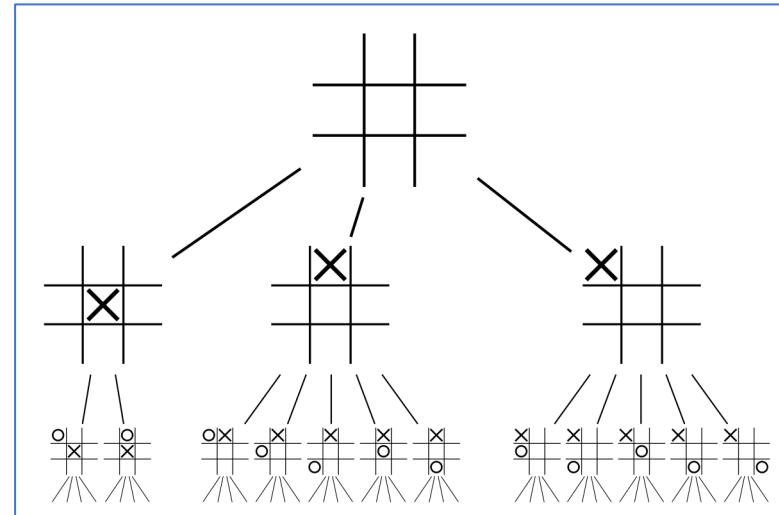
PopBots:
robot
perception
for K-2

Students should be able to identify types of sensors and their limitations.

Big Idea #2: Representation and Reasoning

“Agents maintain representations (and models) of the world, and use them for reasoning.”

- Knowledge representation
- Semantic web
- Search (and heuristic search)
- Inference algorithms:
 - Theorem proving
 - Rule-based reasoning
 - Constraint satisfaction
 - Optimization
 - Etc.



Students in grades 6+ should be able to draw a search tree.

Big Idea #3: Learning

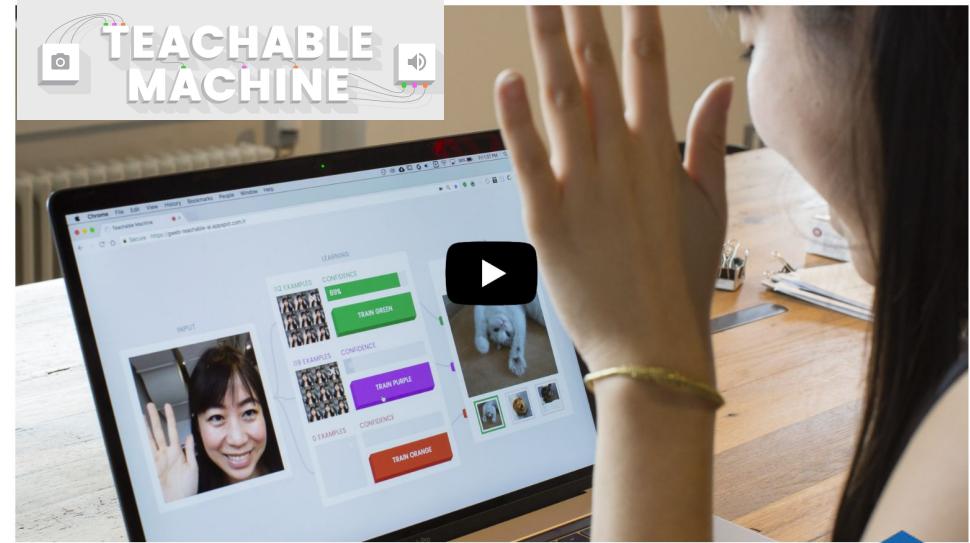
“Computers can learn from data.”

- Machine learning
 - Classifiers
 - Function approximators
 - Data science
 - Training sets and sources of bias
- Neural networks

Students should be able to train a classifier:

Grades K-2: train a gesture discriminator..

Grades 6-8: define a feature set and train a decision tree classifier.

A screenshot of the "Machine Learning for Kids" website. At the top, it says "Machine Learning for Kids" and "Recognising numbers as beginner, Intermediate or advanced". Below this, there are three mobile device icons representing different skill levels:

- beginner**: Shows examples like "pages 10 lines 10 pictures 10".
- Intermediate**: Shows more complex examples like "pages 20 lines 40 pictures 10" and "pages 60 lines 70 pictures 8".
- advanced**: Shows the highest complexity like "pages 150 lines 1200 pictures 0".

Each device icon has a "+ Add example" button at the bottom right. The number "6" is visible in the bottom right corner of each device icon.

Big Idea #4: Natural Interaction

“AI developers strive to create agents that interact naturally with humans.”

- Natural language understanding
- Dialog management
- Affective computing
- Human-Robot Interaction
- Artificial general intelligence (AGI)

Grades K-2: students should be able to converse with an agent like Alexa.

Grades 6-8: students should be able to construct a simple chatbot.

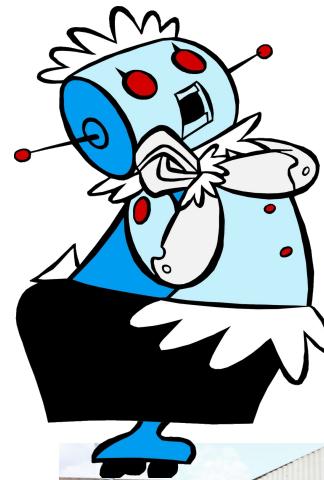


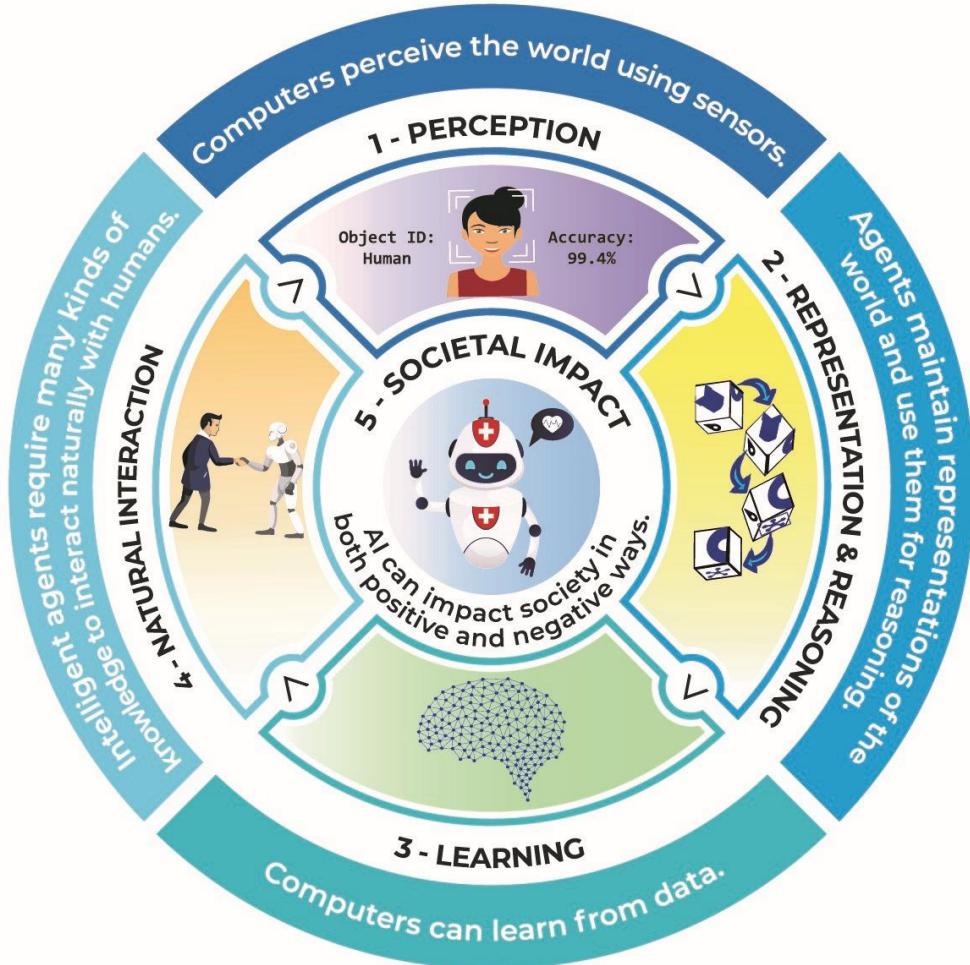
Big Idea #5: Societal Impact

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

- Ethics: what sorts of applications are desirable/permissible?
 - Transparency and accountability of AI systems
 - Values tradeoffs, e.g., privacy vs. security; who should own your data?
- Effects: what are the likely impacts of AI technology on society?
 - Robot servants, rescuers, and companions
 - Economic disruption; changes in the nature of work
 - Effects of unintended biases

Grades 6+: Students should be able to identify ethical issues raised by AI applications.







Supporting AI in K-12 Classrooms: What Teachers and Students Need

Guidelines for supporting K-12 students & teachers

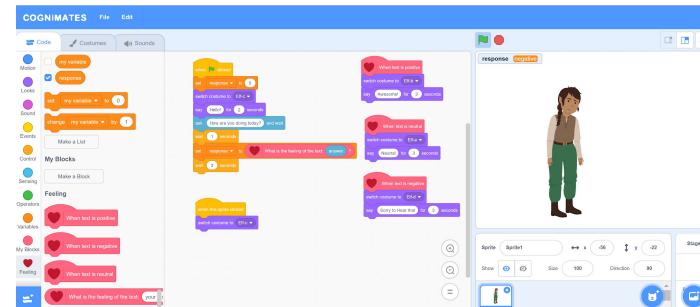
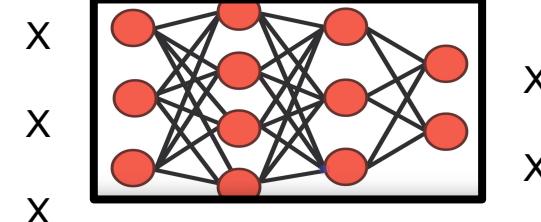
1. Transparency

help students see what is going on inside the black box and glass box



2. Help students build models of what is happening under the hood of AI applications

3. Allow students to use AI services to develop AI applications



Student Activity Considerations

- AI Experiments
 - e.g., *science experiments*
- Hands-on simulations of AI algorithms
- Projects that allow students to build AI applications
- Case studies of ethical issues
 - that explore multiple perspectives*

- Projects and activities that promote*** understanding of
- how AI works
 - limits of AI
 - AI systems that are built using smaller AI components
 - sources of bias in AI
 - results of AI systems

Types of Instructional Resources

Self-contained resource

Allows students to interact with AI concepts and run experiments

e.g., Tensorflow playground - neural net

Plugin to existing frameworks

Allows students to build AI applications

- a. Scratch
- b. Snap!
- c. Python libraries (with accompanying K-12 resource guide)

Demonstration (not a tool)

*Provides insight into how AI works,
e.g.,*

Demos:

- speech recognition demo
- parser demonstrations that display the parse tree

Video Explanations:

- “How Snapchat’s filters work”
- “What neural networks see”
- AI Careers & Research
- Ethical issues

Classroom Support Considerations

Provide

- Terminology and definitions
- Sample projects
- Sample activities & experiments
- Troubleshooting guide
- Videos
- Student contests and competitions

Design for

- Diverse learners
- Awareness, engagement, deep learning

By End of Grade 5, Students Should Know Terms, in 3-5 Language

Be Able To Use appropriate vocabulary including these key terms:

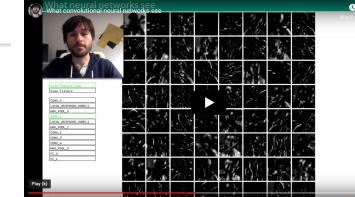
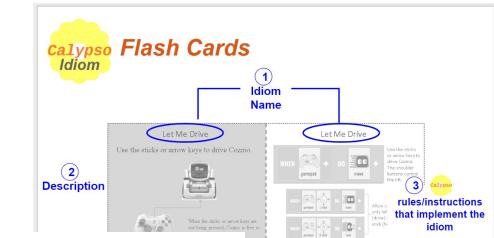
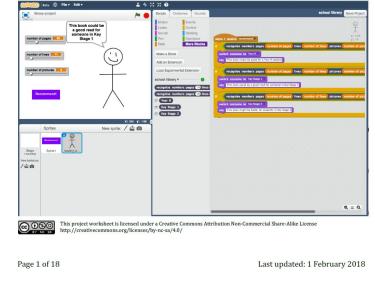
- **Algorithm** - A precise sequence of instructions for processes that are executed by a computer
- **Autonomous** - Something that can run by itself
- **Agents** - Machines like computers, robots, smartphones, smart speakers and software such as computer programs and apps including things like typing, and spell check
- **Computation** - Solving a problem step-by-step with a computer
- **Sensor** - A device that relates to senses
- **Sensing** - Collecting information using sensors
- **Perception** (and the distinction between perception and sensing) - the information collected from sensors

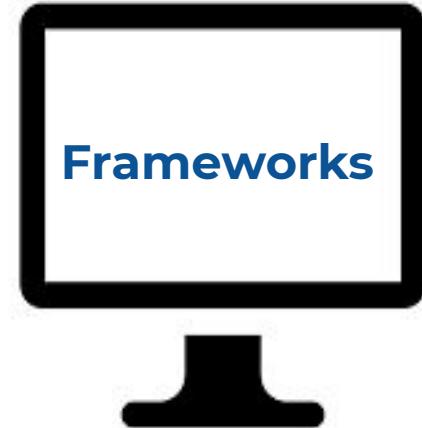
School Library

In this project you will make a school librarian character that can make reading book recommendations.

If you describe a book to it, it will try to predict who that book might be suitable for.

You will teach the computer to recognise fiction books of different reading levels by giving it examples of each.





Overview of the Resource Library: AI Tools & Resources for K-12

3-5 Grade Band

3rd grade is one of the pivot points in education for students. Teachers expect 3rd-5th grade students to take more responsibility for their education, asking questions when they don't understand something and devising strategies for learning that work best for them. Therefore, AI in 3-5th grade will continue to uncover the “Magic” concept and build on the basic foundational skills from K-2. Students will continue with a deeper understanding about AI and engage in more hands on activities.

3-5 what should students know and be able to do

Know:

Big Idea 1:

Big Idea 2:

Big Idea 3:

Able to do:

Big Idea 1:

Big Idea 2:

Big idea 3:

3-5 what should students know and be able to do

Know:

Big Idea 4:

Big Idea 5

Able to do:

Big Idea 4:

Big Idea 5:

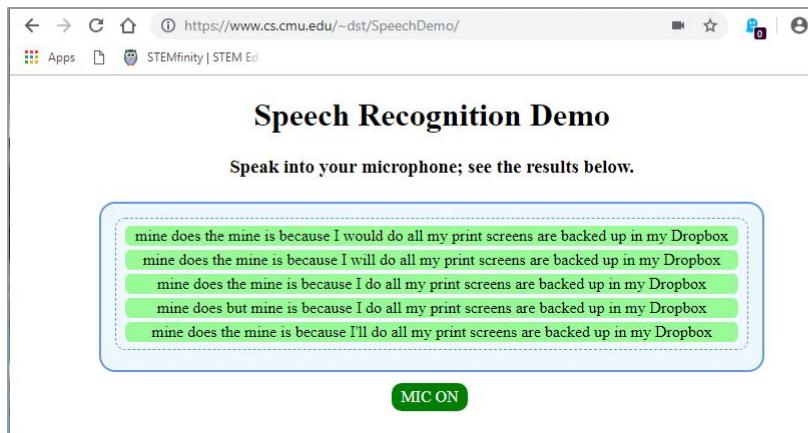


Free web-based AI demos

Speech Recognition: Speech to Text Demos



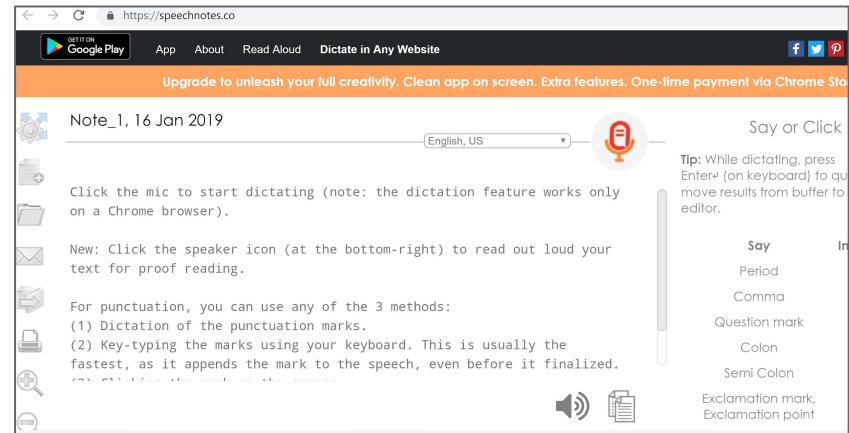
1. Demo shows alternative parses
<https://www.cs.cmu.edu/~dst/SpeechDemo/>



The screenshot shows a web browser window with the URL <https://www.cs.cmu.edu/~dst/SpeechDemo/>. The page title is "Speech Recognition Demo". Below it, a instruction says "Speak into your microphone; see the results below." A blue speech-to-text interface displays five green rectangular boxes containing the same text: "mine does the mine is because I would do all my print screens are backed up in my Dropbox". At the bottom is a green button labeled "MIC ON".



2. Demo speaks back what it heard
<https://speechnotes.co/>



The screenshot shows a web browser window with the URL <https://speechnotes.co/>. The page title is "SpeechNotes". It features a sidebar with icons for Apps, STEMfinity, and STEM Ed. The main content area shows a note titled "Note_1, 16 Jan 2019" with the text "Click the mic to start dictating (note: the dictation feature works only on a Chrome browser)." Below it, instructions for reading text aloud are provided. On the right, there's a "Say or Click" section with a microphone icon and a list of punctuation marks: Say, Period, Comma, Question mark, Colon, Semi Colon, Exclamation mark, and Exclamation point. A vertical scroll bar is visible on the right side of the content area.

AI & Creativity



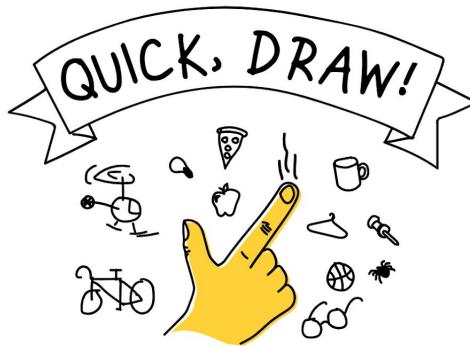
<https://experiments.withgoogle.com/mixlab>





Google's Quick, Draw!

<https://quickdraw.withgoogle.com/>



Can a neural network learn to recognize doodling?

Help teach it by adding your drawings to the [world's largest doodling data set](#), shared publicly to help with machine learning research.

Let's Draw!

You were asked to draw snake

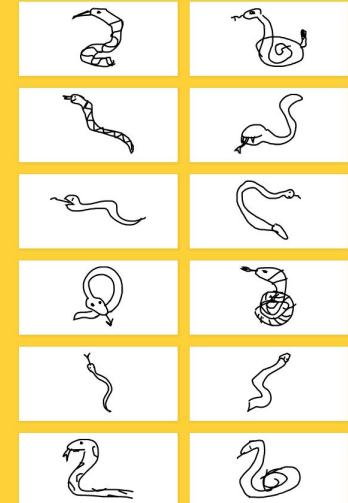
You drew this, and the neural net recognized it.



It also thought your drawing looked like these:



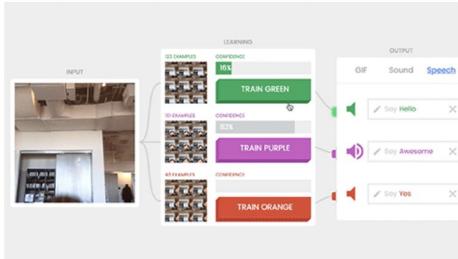
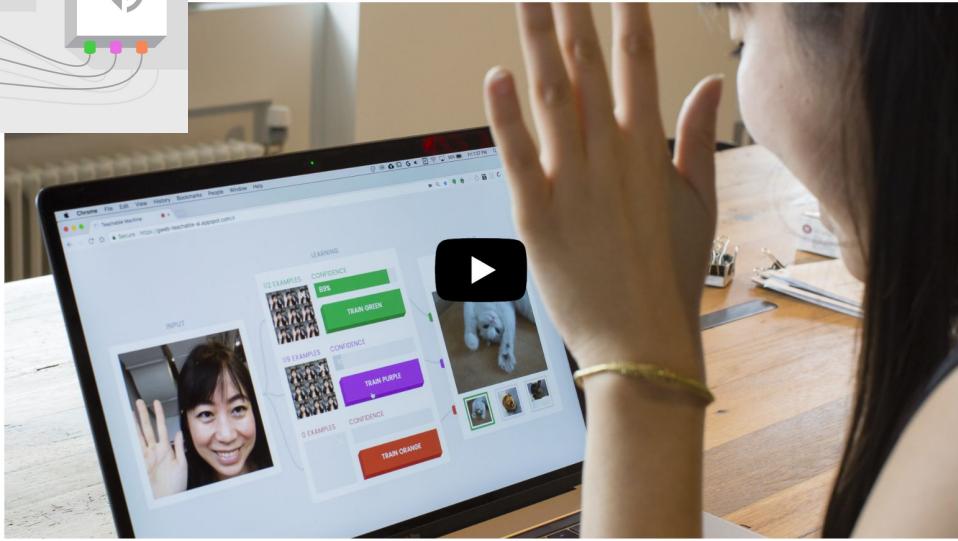
How does it know what snake looks like?
It learned by looking at these examples drawn by other people.





Built with TensorFlow

- Teach a machine using your camera,
- live in the browser
- no coding required.



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

TensorFlow Playground

<https://playground.tensorflow.org>

Tinker With a **Neural Network** Right Here in Your Browser.
Don't Worry, You Can't Break It. We Promise.

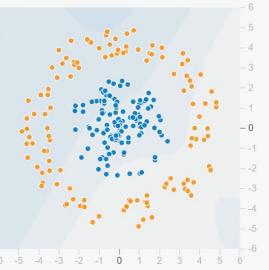
Epoch 000,000 Learning rate 0.03 Activation Tanh Regularization None Regularization rate 0 Problem type Classification

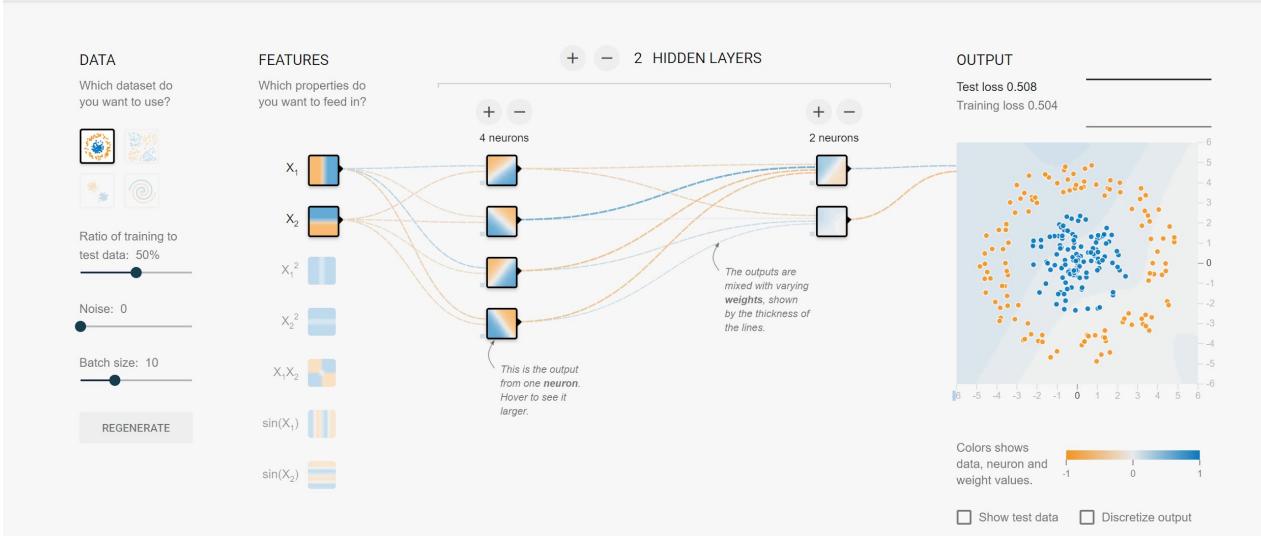
DATA
Which dataset do you want to use?

Ratio of training to test data: 50%
Noise: 0
Batch size: 10
REGENERATE

FEATURES
Which properties do you want to feed in?
 x_1 x_2 x_1^2 x_2^2 $x_1 x_2$ $\sin(x_1)$ $\sin(x_2)$

HIDDEN LAYERS
+ - 2 HIDDEN LAYERS
+ - 4 neurons + - 2 neurons
This is the output from one neuron. Hover to see it larger.
The outputs are mixed with varying weights, shown by the thickness of the lines.

OUTPUT
Test loss 0.508 Training loss 0.504

Colors show data, neuron and weight values.
 Show test data Discretize output



Tutorial: <https://cloud.google.com/blog/products/gcp/understanding-neural-networks-with-tensorflow-playground>



AI Programming Frameworks for Kids



Calypso



Machine Learning for Kids

<https://machinelearningforkids.co.uk>

- 1 Collect examples of things you want to be able to recognise
- 2 Use the examples to train a computer to be able to recognise them
- 3 Make a game in Scratch that uses the computer's ability to recognise them

School Library

Create a school librarian in Scratch that suggests who a reading book might be suitable for.

Teach a computer to make recommendations

Difficulty: Intermediate

Recognising: **numbers**

Tags: predictive model, recommendations, supervised learning

[Download](#)

Recognising **numbers** as **beginner, Intermediate or advanced**

+ Add new label

beginner

pages 10 lines 10 pictures 10	pages 5 lines 5 pictures 10	pages 10 lines 0 pictures 10
pages 8 lines 4 pictures 4	pages 20 lines 40 pictures 10	pages 40 lines 16 pictures 8

Intermediate

pages 20 lines 10 pictures 10	pages 50 lines 100 pictures 0	pages 80 lines 120 pictures 8
pages 30 lines 75 pictures 5	pages 60 lines 240 pictures 0	pages 70 lines 350 pictures 0

advanced

pages 150 lines 1200 pictures 0	pages 300 lines 6000 pictures 0	pages 180 lines 1980 pictures 18
pages 140 lines 2100 pictures 0	pages 200 lines 3000 pictures 0	pages 250 lines 3300 pictures 0

+ Add example

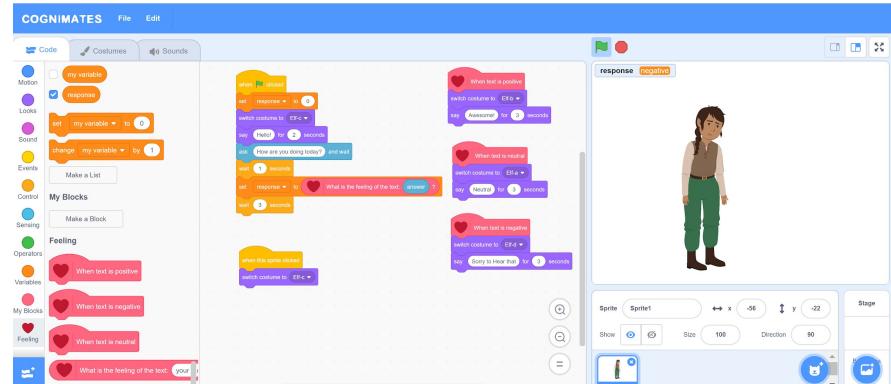
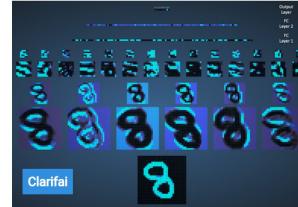
+ Add example

+ Add example



<http://cognimates.me>

Project creator [Stefania Druga](#)
The project was supported by the
[Personal Robots Group](#) at MIT
Media Lab, directed by [Cynthia
Breazeal](#), Associate Professor of
Media Arts and Sciences.





<https://ecraft2learn.github.io/ai/>

AI services have become ubiquitous. But

Designed for use by professional programmers.

The challenge - create child-friendly interfaces



Here's all the tags of what I see
person, man, indoor, sitting, table, front, looking, older, food, holding, eating, shirt, glasses, blue, old, wearing, standing, white, glass, plate, cake, kitchen, pizza, phone,

Microsoft

IBM Watson

I think I see hair, and facial hair, and glasses, and beard, and man, and person, and vision care, and chin, and nose, and moustache, and hairstyle, and forehead, and fun, and smile, and senior citizen, and human, and eyewear, and portrait, and selfie, and that's all.

Google

[Listen to a description of what is in front of the camera in response to you speaking](#)

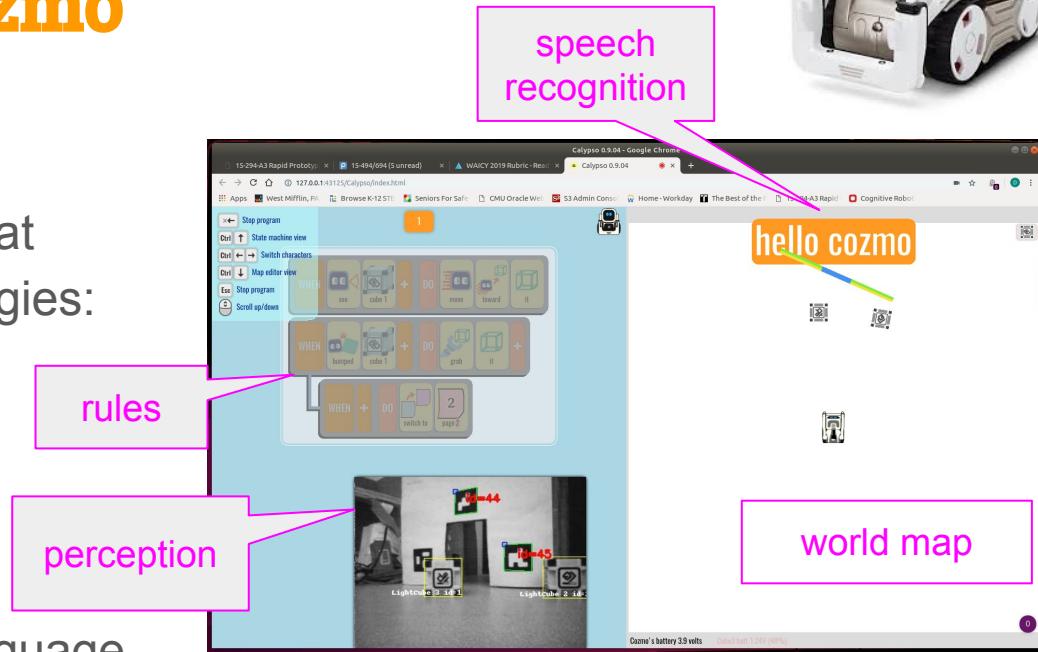
(requires microphone, speaker/headphones, webcam, and API key(s))



Calypso for Cozmo



- A robot intelligence framework that Incorporates multiple AI technologies:
 - Computer vision; face recognition
 - Speech recognition and generation
 - Landmark-based navigation
 - Path planning
 - Object manipulation
- Rule-based pattern matching language inspired by Microsoft's Kodu Game Lab
- Teaches computational thinking: “Laws of Calypso”, idioms, etc.
- Web site: <https://Calypso.software>



Google Machine Learning Crash Course



A self-study guide for aspiring machine learning practitioners

Machine Learning Crash Course features a series of lessons with video lectures, real-world case studies, and hands-on practice exercises.



#1: Intro to Artificial Intelligence



0 / 20 lessons completed

START LEARNING NOW

How would you rate this course?

What is Artificial Intelligence? 0 / 2 ▾

Landscape of AI 0 / 1 ▾

Overview of Machine Learning 0 / 8 ▾

Intro to Artificial Intelligence Conclusion Lesson

Intro to AI: Check your own understanding! Test



AI Unplugged Activities

Create a Discrimination Net: Guess the Animal

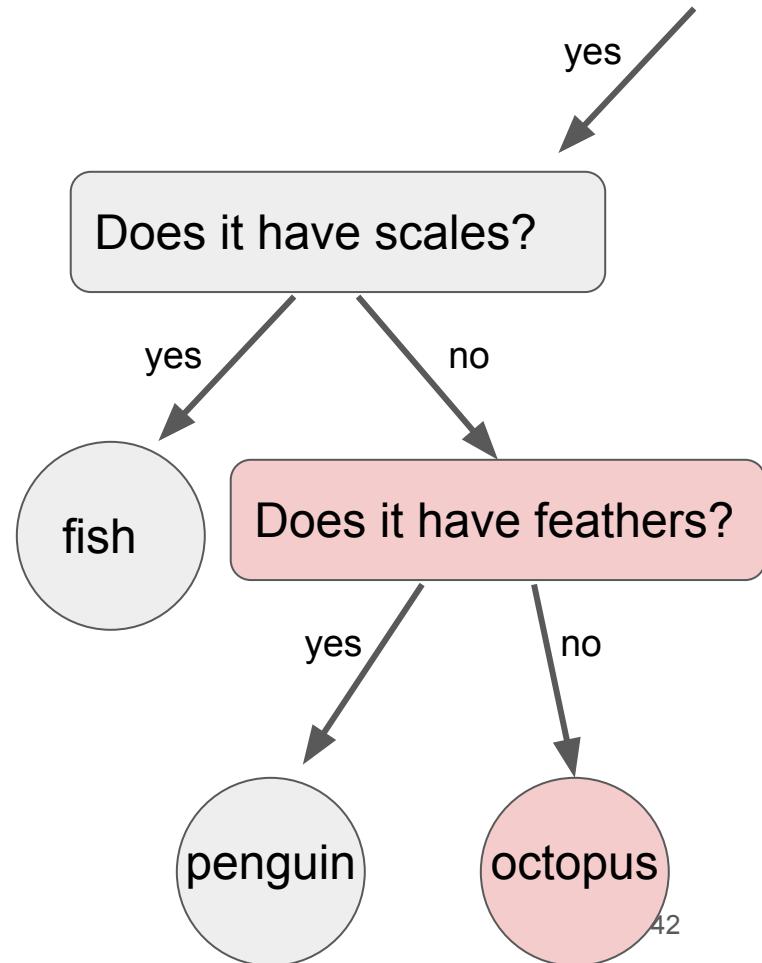
Computer: what question distinguishes between a penguin and an octopus?

Human: “Does it have feathers?”

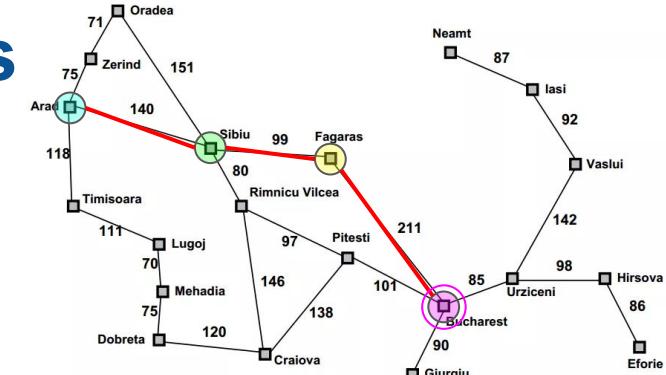
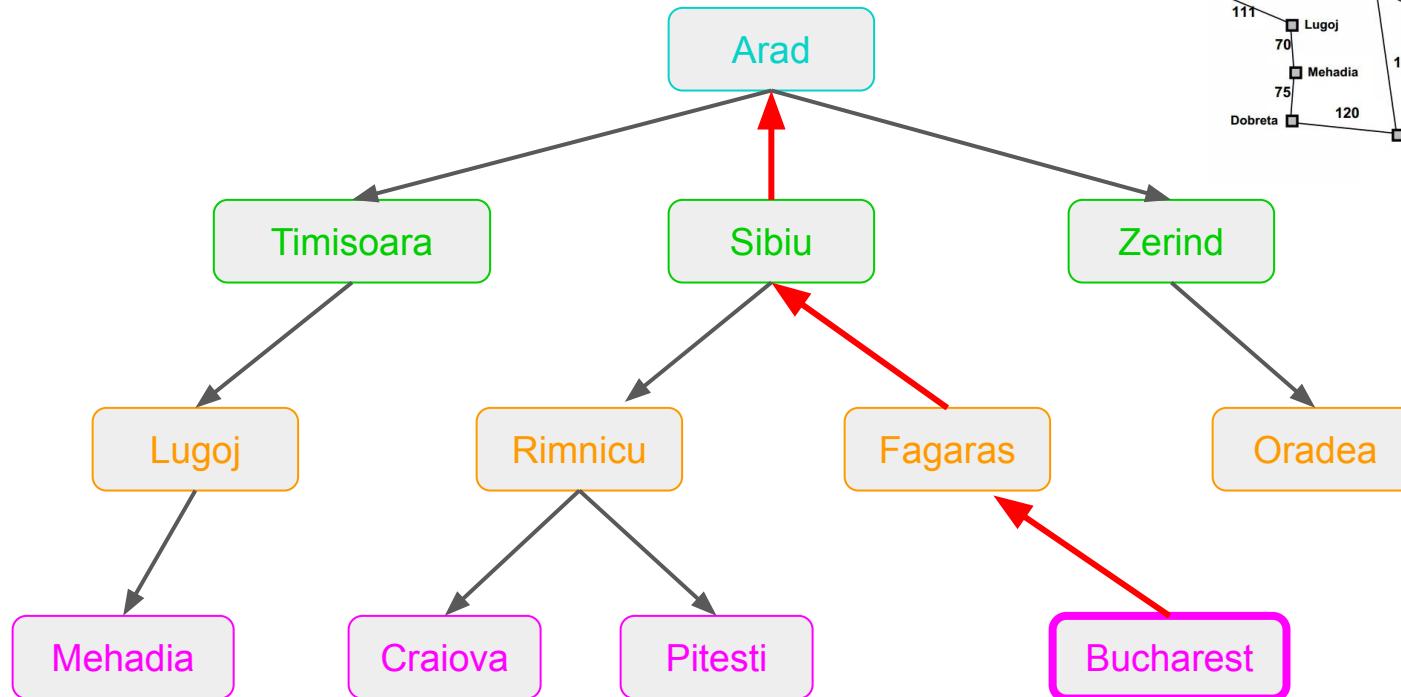
Computer: What is the answer for octopus?

Human: “no”.

Computer: I'll remember that.



Unplugged: Drawing Search Trees





AI Competitions for K-12



First WAICY - July 2018 at CMU



5 Time zones
200+ Students
50+ Teams
(20+ remote participation)

"S.T.E.A.M.-Powered A.I."
- 50/50 Rubric
- Winning Project





S.T.E.A.M-Powered A.I.

AI Criteria



Vision



Speech
Recognition



Face
Recognition



Landmark-based
Navigation



Speech
Generation



Object
Manipulation

Multimedia Criteria

- Story line
- Visual Design
- Audio Design
- Theme/Message
- Preparation/Delivery
- . . .



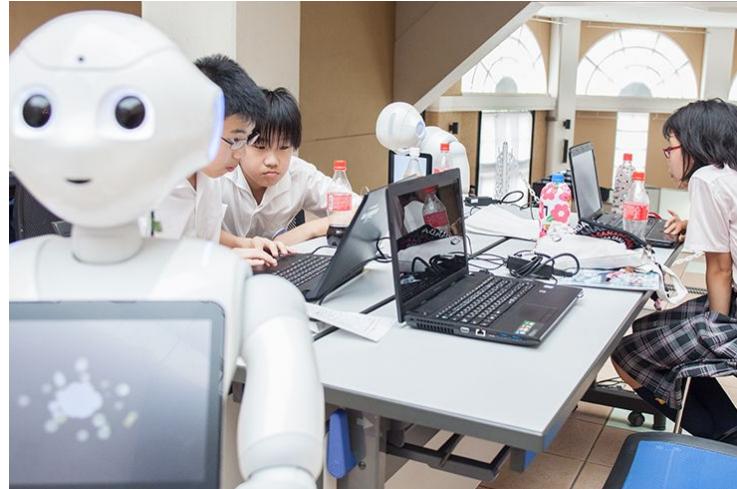
World Robot Summit

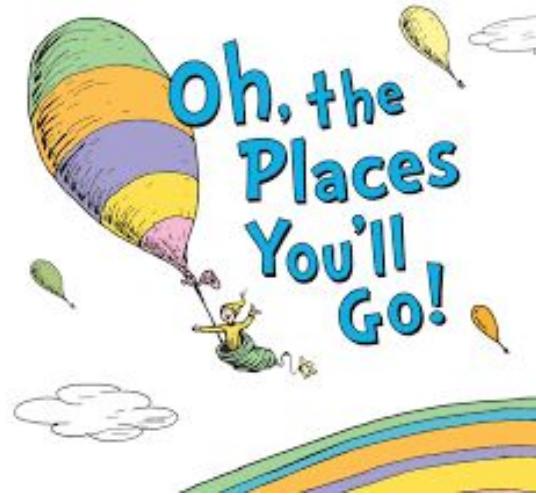
World Robot Challenge

Robotics for Happiness

Towards achieving a society where humans and robots cooperate and coexist.

World Robot Challenge (WRC), a robot competition in which teams from all over the world compete in 4 categories where use of robots is highly expected:
Industrial Robotics, Service Robotics,
Disaster Robotics, and Junior.





How Can You Contribute???

How to Contribute

Develop
Inspiring Assignments for AI
for K-12 classrooms

Try one of the AI tools
and
Begin incorporating AI into your
plans for teaching CS in K-12



Provide Feedback on guidelines

Join the mailing list:
 ai4k12@aaai.org

It's time for all of us to think about AI in K-12.

Visit us
<http://AI4K12.org>

Join the mailing list:
Send mail to ai4k12@aaai.org



Thank you!

Please visit our website <http://ai4k12.org>