



# K-12 AI Education & Outreach

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Slides

<http://bit.do/AI4K12stars>



#AI4K12

# Outline

1. Why is this the right time to begin teaching AI in K-12?
2. Overview of the AI4K12 Initiative
3. Exploring the “Big Ideas” in AI
4. Resources for teaching the big ideas in K-12
5. Discussion and Q&A

# Why is this the right time to be teaching AI in K-12?

1. AI is playing an increasingly prominent role in society:
  - Intelligent assistants
  - Self-driving cars
  - Autonomous robots in the workplace (and someday the home)
2. Informed citizens need to understand the basics of AI as our society faces important public policy decisions surrounding AI technologies.
3. AI technologies will cause job loss in some areas, and gains in other areas.
4. There is a growing need for AI-literate workers. Students should be encouraged from a young age to consider STEM careers.

# K-12 Computing Education

Worldwide, we are making progress on integrating **computing** into K-12:

- **Israel** started working on National standards in 1995
- **United Kingdom:**
  - Computing At School
  - **First country in the European Union to mandate computer science classes for all children** between the ages of 5 and 16.
- **18 European Countries**  
France, Spain, Switzerland, Slovakia, Finland, Poland, Portugal, Scandinavia, Italy, Estonia, Bulgaria, Cyprus, Czech Republic, Denmark, Greece, Ireland, Lithuania
- In progress: **US, India, China, Japan, Australia**
  - In the US: CSTA Computing Standards, CSForAll, Code.org

# K-12 AI Education

- We are not as far along when it comes to AI, but many countries are trying China, Finland, Canada, UK, Korea, Portugal, Turkey, Argentina
- 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)



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



## 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



# Steering Committee



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Carnegie Mellon  
AI for K-12 Working Group  
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Christina Gardner-McCune  
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## Grades 9-12

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Dr. Smadar Bergman  
Kate Lockwood



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MIT



Cynthia Breazeal  
MIT



Matt Dawson  
Google



Emily Reid  
AI4ALL



Matthijs Spaan  
TU Delft  
AAAI



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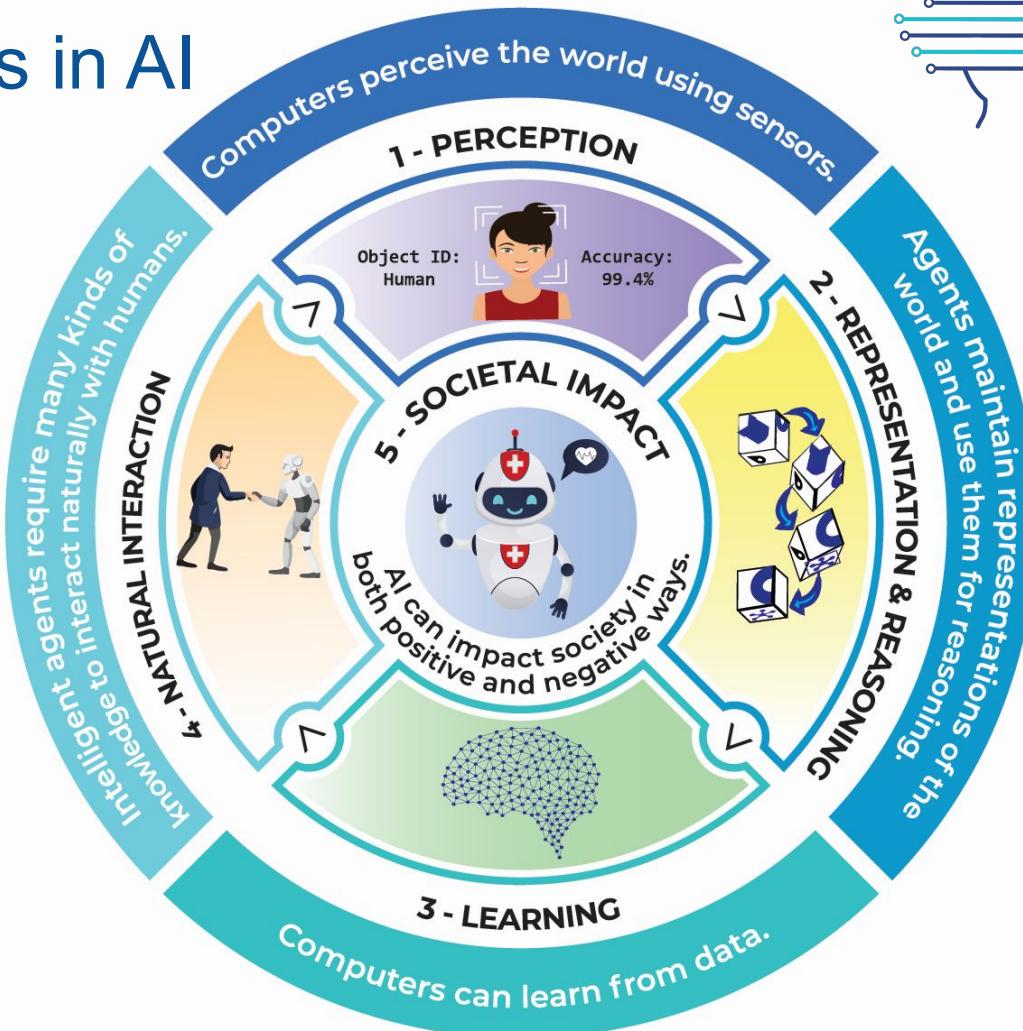
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# Five Big Ideas in AI



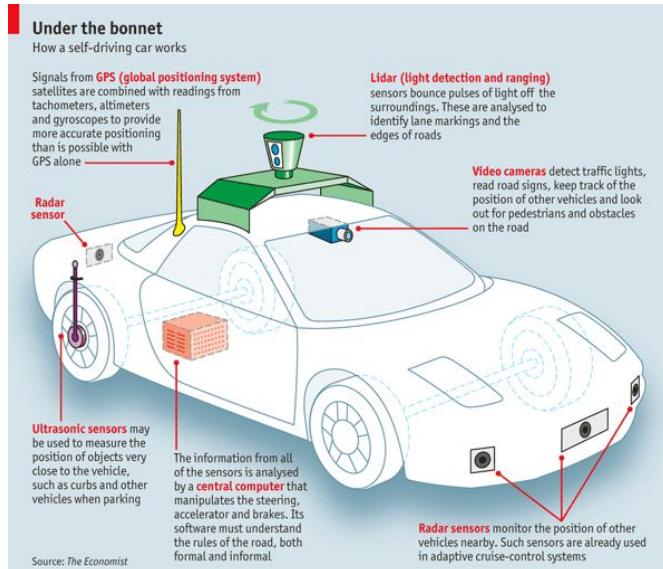
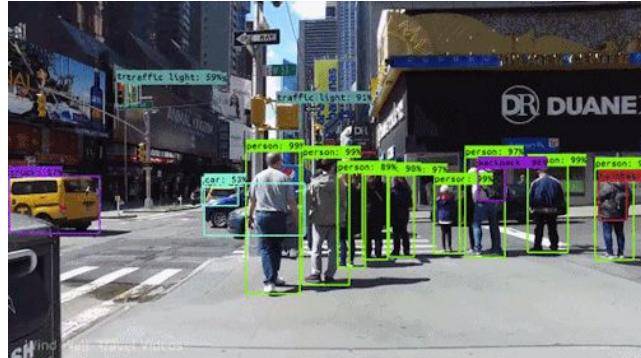
# Big Idea #1: Perception

*Computers perceive the world using sensors.*

**Perception is the extraction of meaning from sensory signals.**

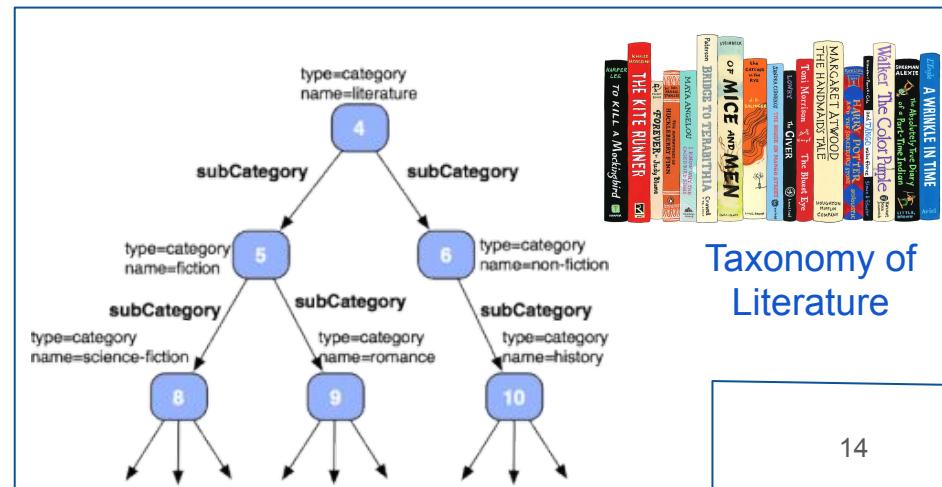
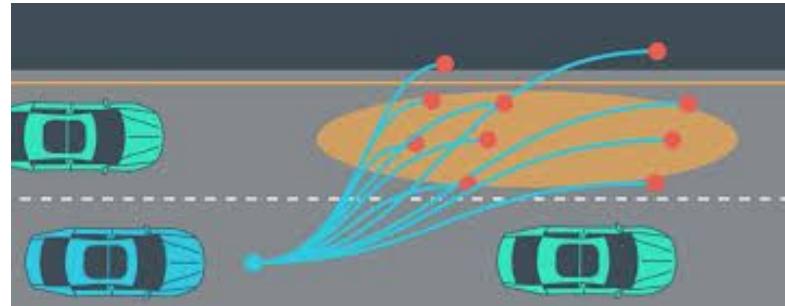
## Examples

- Speech recognition
- Computer vision:
  - object recognition
  - face recognition
  - license plate readers
  - scene understanding
- Other forms of perception e.g., music recognition, or interpreting sonar, radar, or LIDAR data



# Big Idea #2: Representation and Reasoning

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



# Big Idea #3: Learning

*Computers can learn from data.*

**Personal experience:**

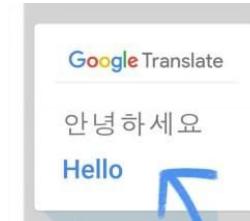


## Industrial applications:

- Training a **speech recognition** system.



- Training a **machine translation** system

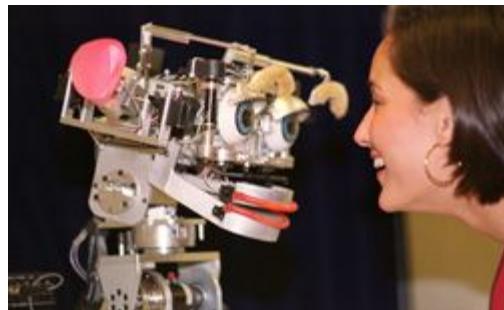


- **Image search**

training a classifier to recognize pictures of people, animals, vehicles, etc.

# Big Idea #4: Natural Interaction

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

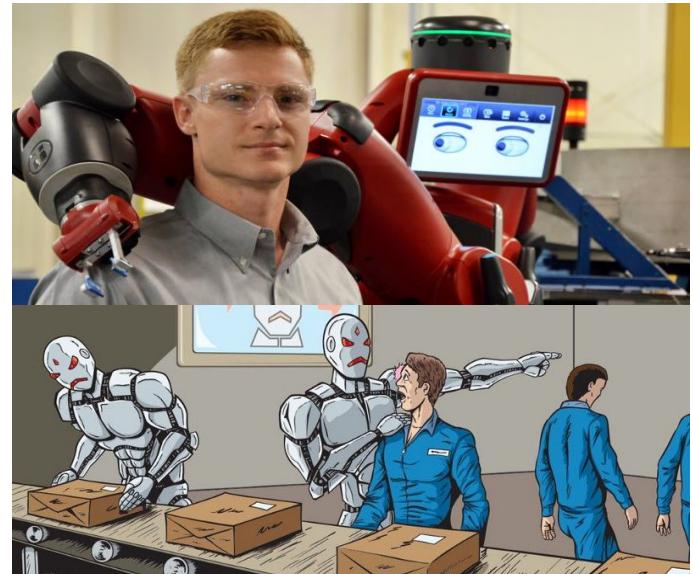


**Pressing questions about the capabilities of AI for natural interaction:**

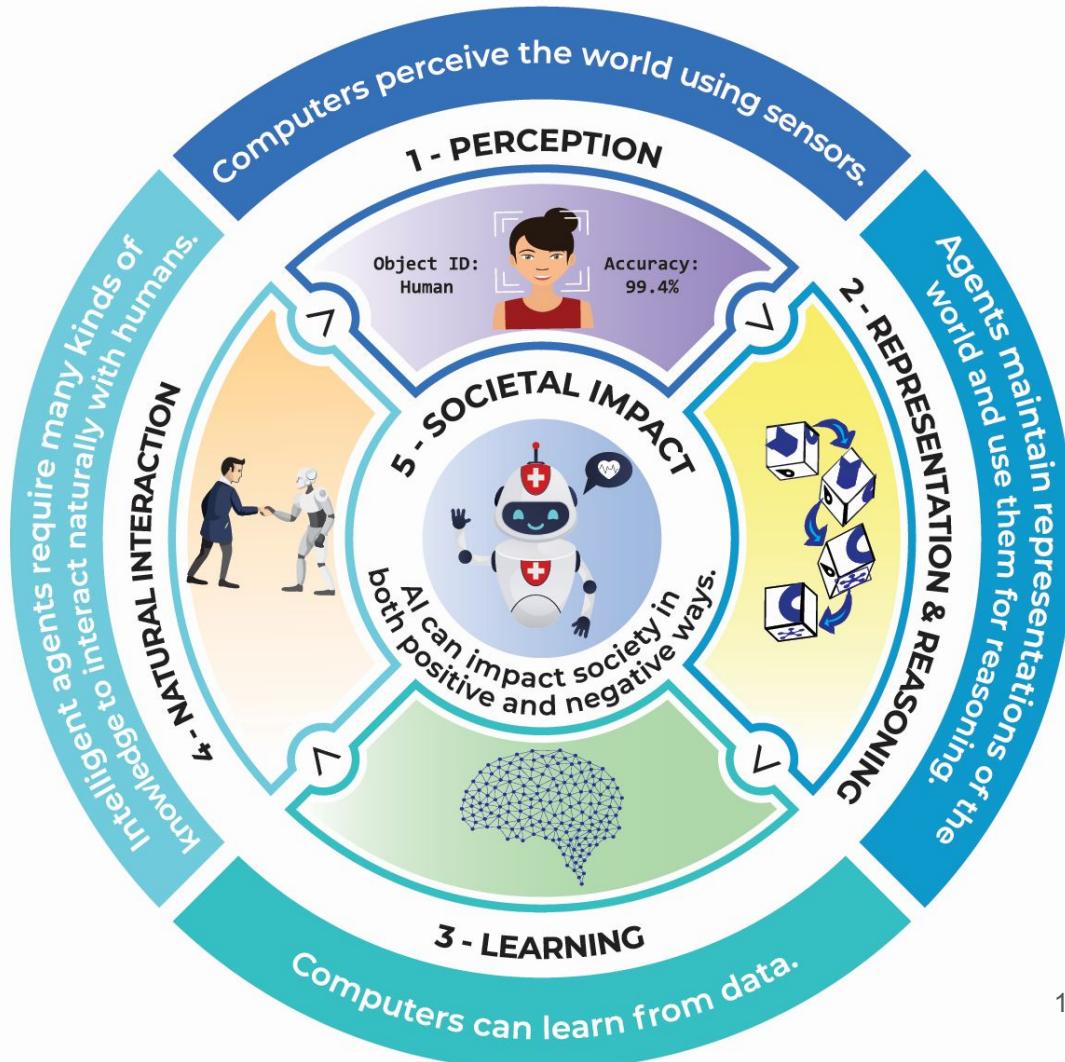
- Can computers exhibit common sense reasoning comparable to people?
- Can a computer ever be conscious or self-aware?

# Big Idea #5: Societal Impact

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



# Five Big Ideas in AI

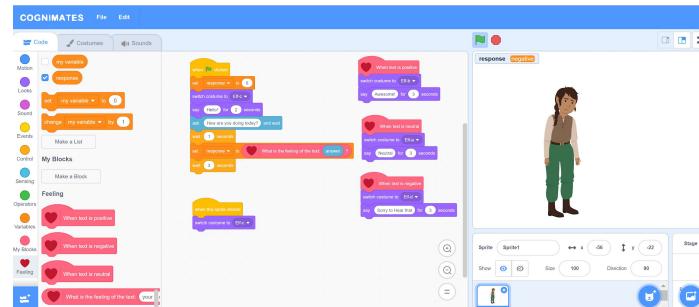
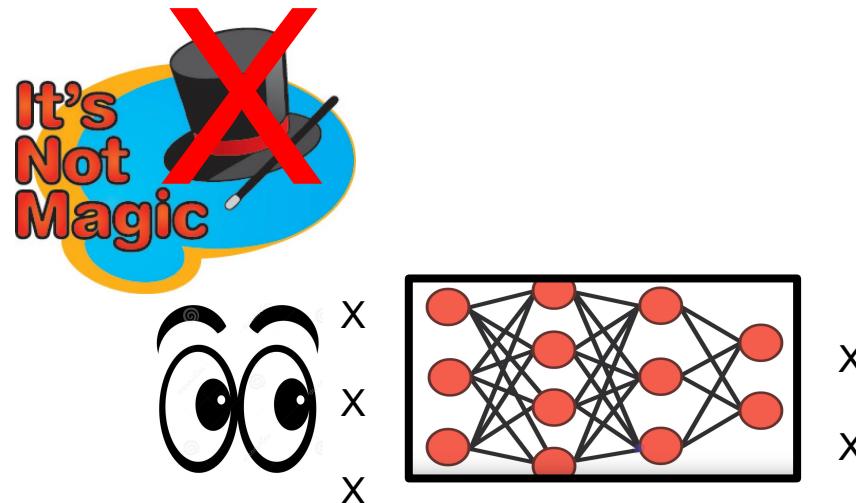




## Teaching AI in K-12 Classrooms

# Guidelines for supporting K-12 students

1. **Use transparent AI demonstrations that help students see what is going on inside the black box: it's not magic!**
2. **Help students build mental models of what is happening under the hood in AI applications.**
3. **Encourage students to develop AI applications using AI services.**

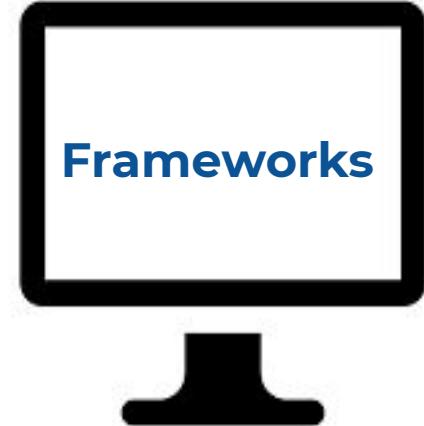


# Student Activity Considerations

- **Experiment with AI agents** to investigate their behavior
- **Hand simulate** AI algorithms
- Encourage students to **build their own AI applications**
- **Explore case studies of AI-related societal issues** from multiple perspectives

These activities promote 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



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

*Visit our resource directory at*



## 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**

combining verbal explanations with visualizations of AI algorithms can be very effective.

### **Hardware**

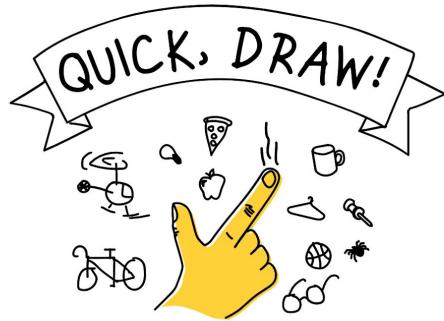
resources include vision-based mobile robots.

### **Formal curricula**



# 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!

How does it work? -

<https://www.bustle.com/articles/196717-how-does-google-quick-draw-work-this-game-makes-learning-about-artificial-intelligence-fun>

You were asked to draw snake

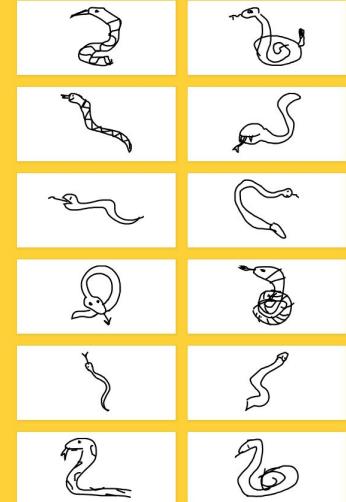
You drew this, and the neural net recognized it.



It also thought your drawing looked like these:



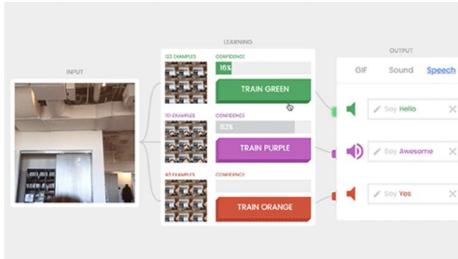
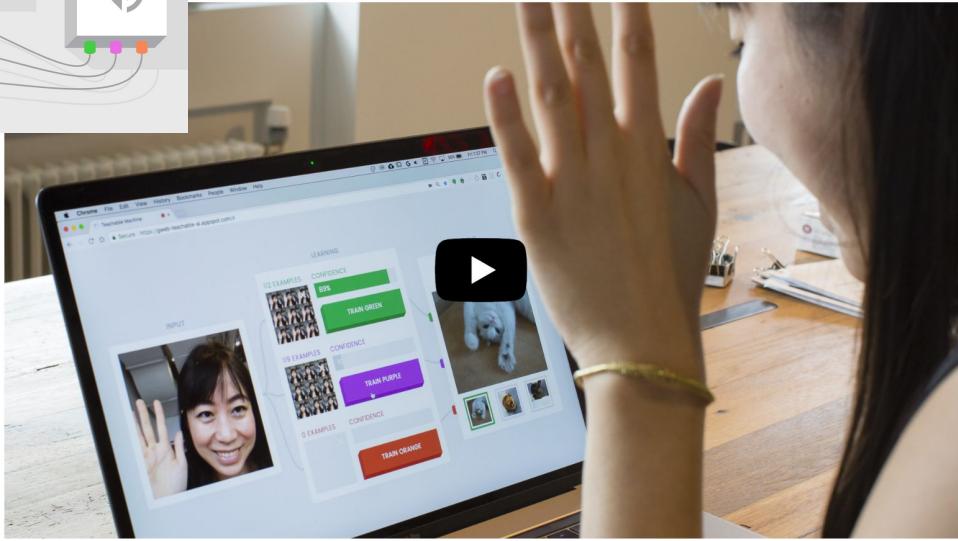
How does it know what snake looks like?  
It learned by looking at these examples drawn by other people.





Built with TensorFlow

- Teach a machine using your camera.
- Live, in the browser.
- No coding required.



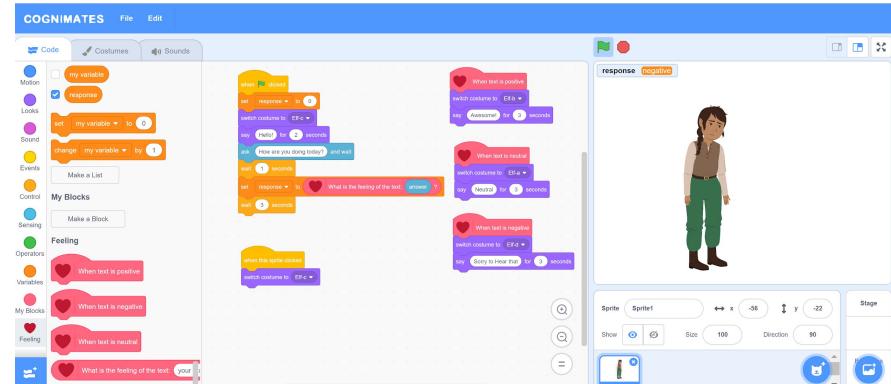
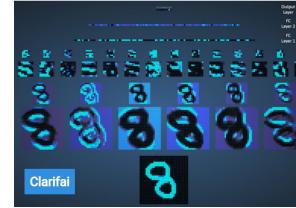
<https://experiments.withgoogle.com/teachable-machine>



<http://cognimates.me>

Cognimates offers AI extensions for Scratch, such as:

- speech recognition
- sentiment analysis
- visual pattern detection
- robot control





<http://cognimates.me>

# AI Services



Vision  
Training



Twitter



Text Training



Feelings



Speech to  
Text



Text to  
Speech



Translate

# Activity:



## AI Programming Framework for Kids

# cognimates.me

COGNIMATES

Get Started

Projects

Tutorials

Events

Research

Blog

Team

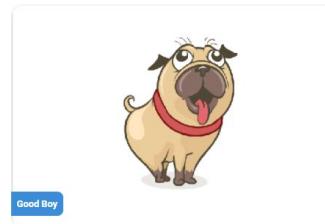
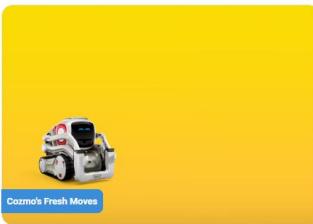


An AI education platform for building games,  
programming robots & training AI models

Train Models

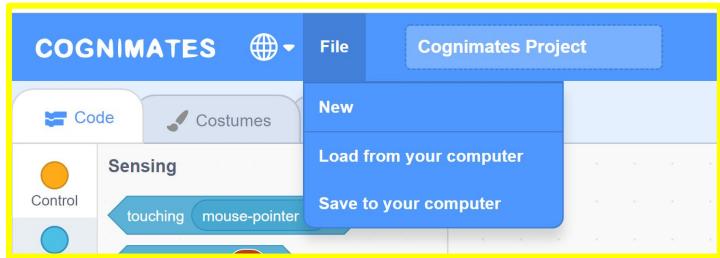
Code & Play

# Starter Projects



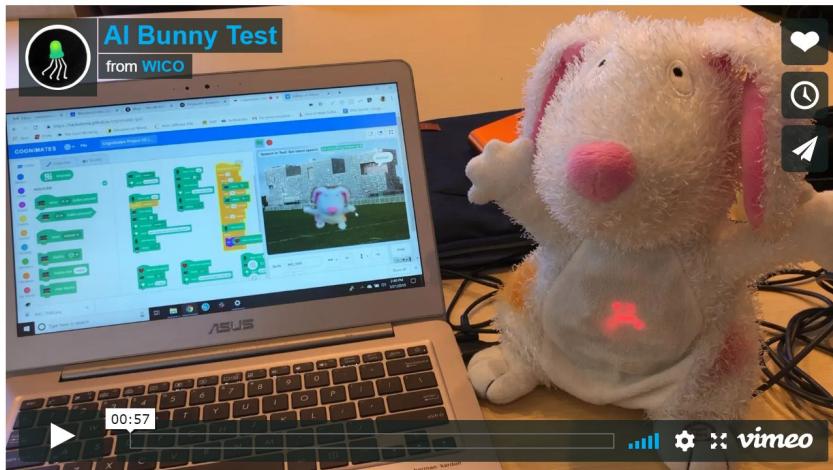
# Choose a Project

- Download the project code
- Launch Codelab
- Upload project from your computer



## AI Toy

Dissect a toy and learn how to remix it with machine learning.

[Download Project](#)[Launch Codelab](#)

# Speech Recognition & Text-to-Speech Generation

COGNIMATES    File    WICOToyHack

Code    Costumes    Sounds

Motion    Looks    Sound    Events    Control    Sensing    Operators    Variables    My Blocks    Vision Training

When I hear [stop] say [that feels funny]

When I hear [stop] say [goodbye]

6. end the session with the bunny

Speech to Text: Get latest speech

Sprite: IMG\_7652 (x: 16, y: -26)

Show: (circle) (square) Size: 100 Direction: 90

Backpack: (empty)

Stage: (empty)

Backgrounds: (empty)

The image shows a Scratch-like programming environment titled "WICOToyHack". On the left, there's a sidebar with categories: Motion, Looks, Sound, Events, Control, Sensing, Operators, Variables, My Blocks, Vision Training, and a plus sign icon. Below these are tabs for "Code", "Costumes", and "Sounds". The main workspace contains several script blocks. One block, "when B button pressed", has two speech bubbles: one saying "that feels funny" and another saying "goodbye". Another block, "When I hear [stop]", also has two speech bubbles with the same messages. A yellow note block contains the text "6. end the session with the bunny". To the right, a video player displays a white, fluffy toy rabbit on a green field in front of a modern building. The video player has controls for volume, play/pause, and a magnifying glass. Below the video are sprite settings: "Sprite: IMG\_7652 (x: 16, y: -26)", "Show: (circle) (square) Size: 100 Direction: 90", and a "Backpack" section which is currently empty. At the bottom, there are tabs for "Stage" and "Backgrounds".

# Train Models

COGNIMATES

Get Started

Projects

Tutorials

Events

Research

Blog

Team

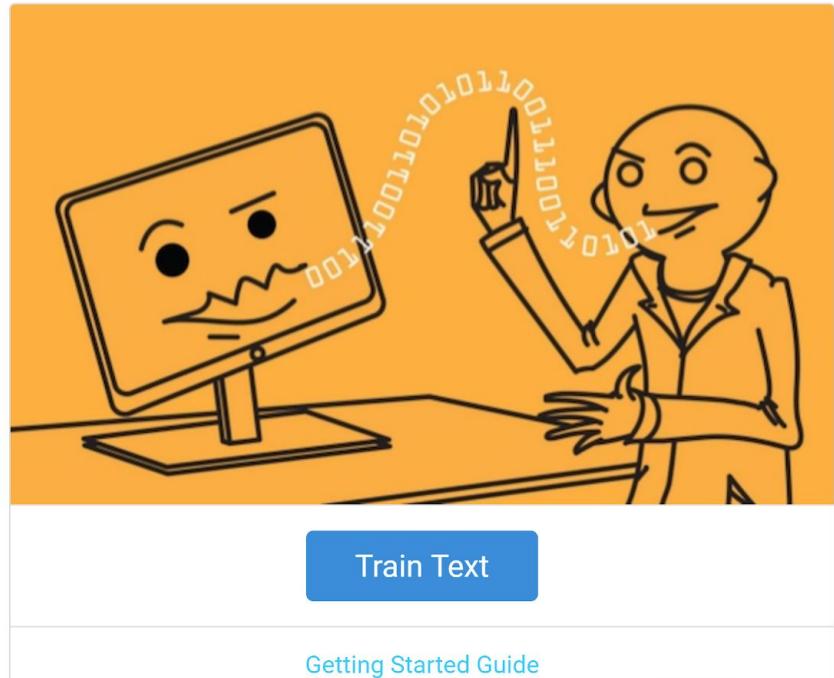
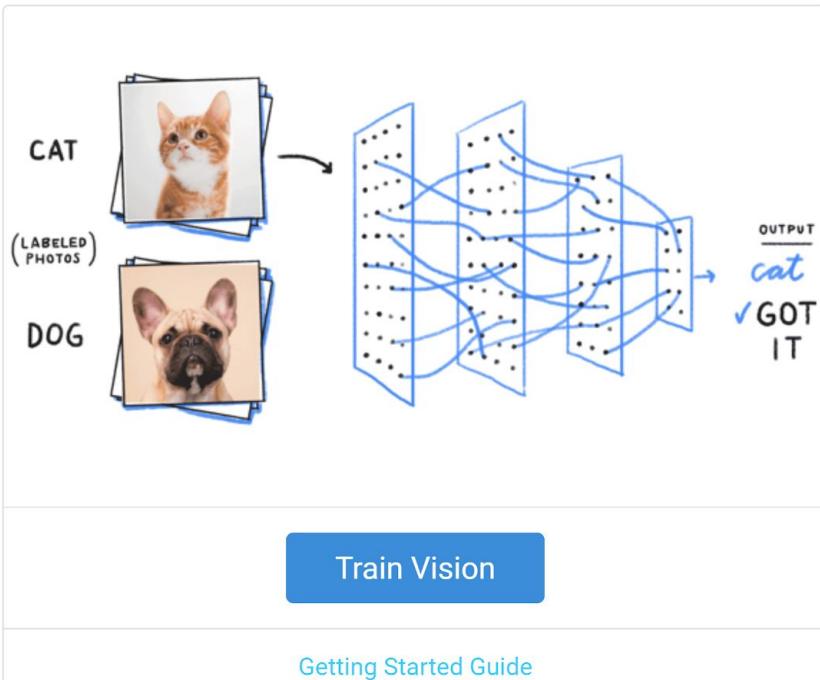


An AI education platform for building games,  
programming robots & training AI models

Train Models

Code & Play

## Cognimates Studio



# Code & Play

COGNIMATES

Get Started

Projects

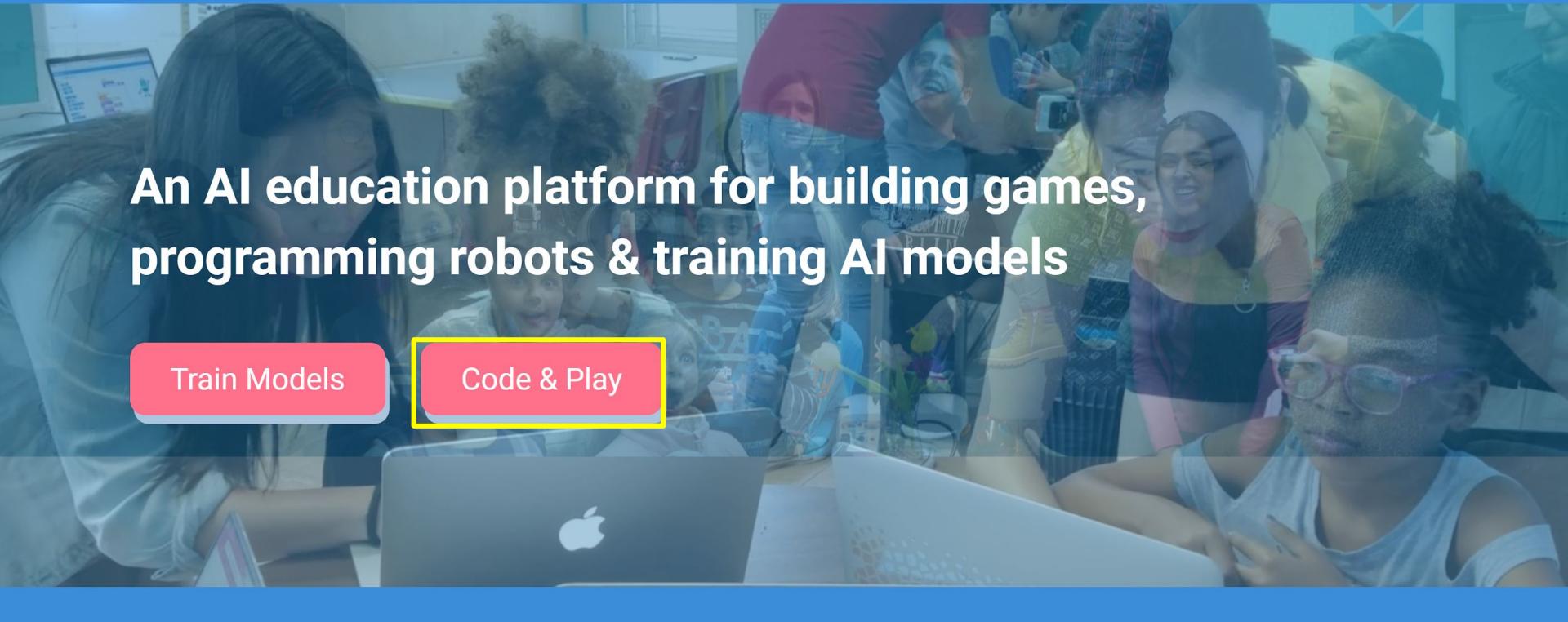
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# Launch Cognimates' Code Lab - Scratch Environment

The image shows the Scratch environment interface with a yellow box highlighting the left sidebar.

**Sidebar Categories:**

- Code
- Costumes
- Sounds
- Motion
- Looks
- Sound
- Events
- Control
- Sensing
- Operators
- Variables
- My Blocks
- Vision Training
- (plus sign icon)

**Stage Area:**

- Two sprites are present: a small boat-like sprite and a larger robot-like sprite.

**Script Editor (Scratch Script Area):**

- Scripts for the boat sprite include:
  - move (10) steps
  - turn (15) degrees
  - turn (15) degrees
  - go to [random position v.]
  - go to x: (0) y: (0)
  - glide (1) secs to [random position v.]
  - glide (1) secs to x: (0) y: (0)
  - point in direction (90)
  - point towards mouse-pointer

**Bottom Right Panel:**

- Sprite panel: Sprite1, x: 0, y: 0, Size: 100, Direction: 90.
- Show controls: Eye icon, Flag icon.
- Stage panel: Backdrops.

# AI API Plugins

COGNIMATES    File    Cognimates Project

Code    Costumes    Sounds

Operators

Vision Training

- Variables
- My Blocks
- Vision Training
- Text Training
- Feelings
- Twitter
- Speech to Text
- Text to Speech
- Translate

Code blocks for Vision Training:

- turn video on
- Set API key to [key]
- Choose image model: [model id]
- Choose pre-trained model
- Take photo from webcam
- Search image using link [add link here]
- What do you see in the photo?
- Search prediction for your photo
- How sure are you the photo is a [add c]



## Vision Training



## Text Training



## Feelings



## Twitter



## Translate



## Speech to Text



## Text to Speech



Sprite    Sprite1     x 0     y 0

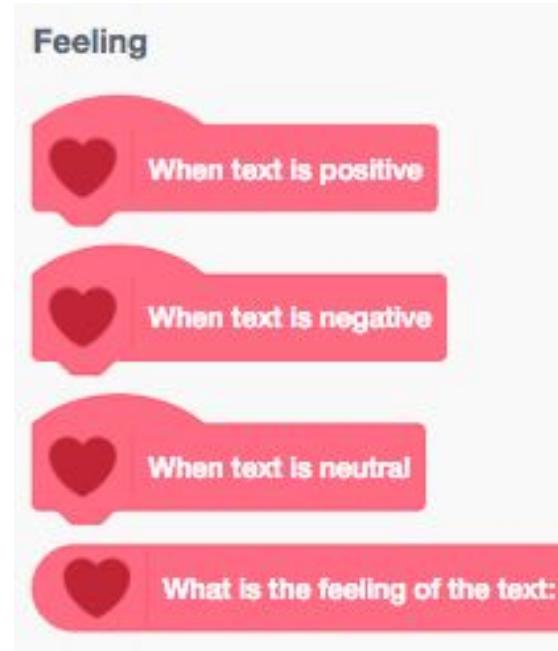
Show         Size 100    Direction 90

Backdrops



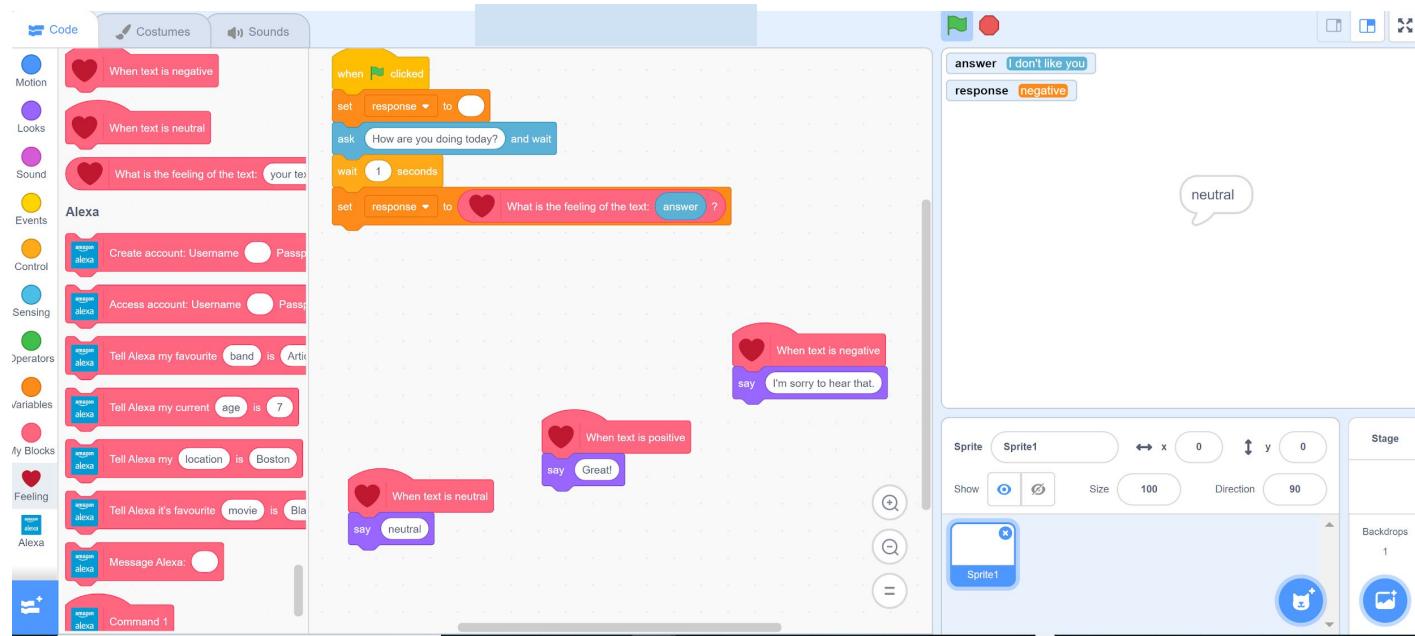
# Cognimates Feelings Extension

The **Feelings extension** is analysing if a text is positive or negative. This extension is using the Sentiment Analysis public pre-trained library.



# Sample Project

Create a program that will detect the emotions in message that are typed into the program.



# Customized Project

This image shows a user interface for a 'Customized Project' featuring two panels.

**Left Panel:** A character with brown hair in a braid, wearing a brown vest over a light-colored shirt and green pants, stands on the left. A speech bubble above them says "Hello!". The top bar includes icons for a blue flag and a red octagon, and a "response 0" counter. The bottom right corner has a blue checkmark icon inside a rounded rectangle.

**Right Panel:** A character with dark hair in a braid, wearing a brown vest over a light-colored shirt and green pants, stands on the right. A speech bubble above them says "How are you doing today?". The top bar includes a "response 0" counter. The bottom right corner has a blue checkmark icon inside a rounded rectangle.

# Responses & Sprite Costumes

response positive



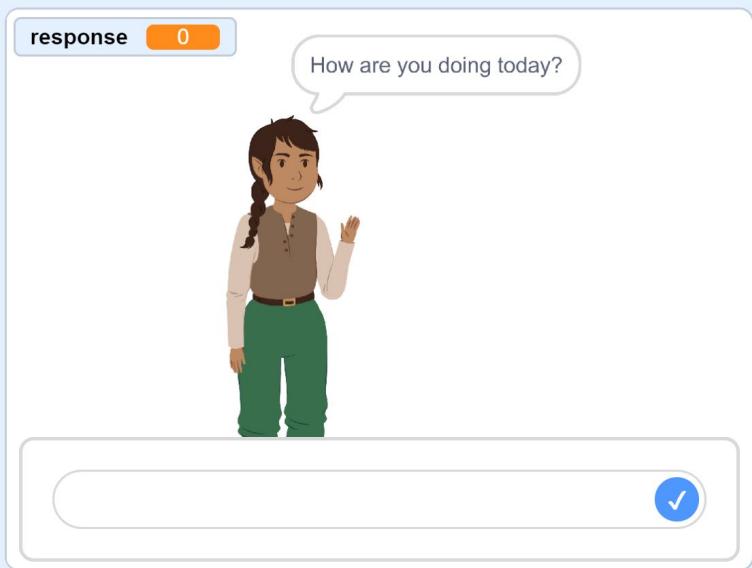
response neutral



response negative



# Code



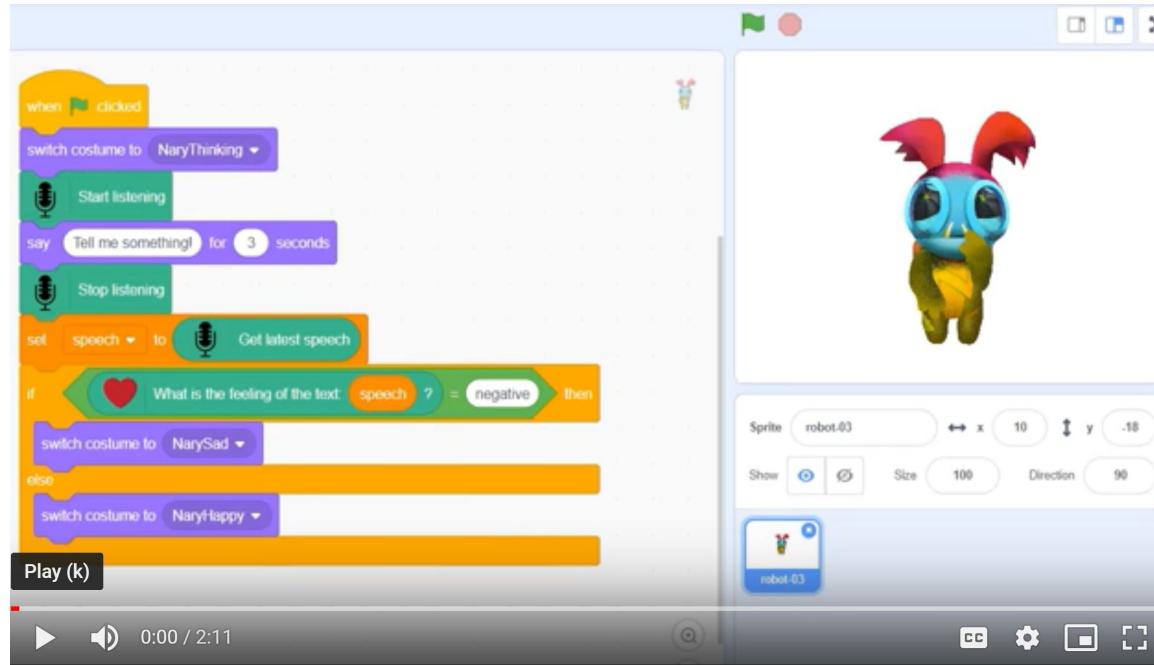
The script consists of three main sections:

- when green flag clicked:**
  - set response to 0
  - switch costume to Elf-c
  - say Hello! for 2 seconds
  - ask How are you doing today? and wait
  - wait 1 seconds
  - set response to [heart icon] What is the feeling of the text: answer ?
  - wait 3 seconds
- when this sprite clicked:**
  - switch costume to Elf-c
- When text is positive:**
  - switch costume to Elf-b
  - say Awesome! for 3 seconds
- When text is neutral:**
  - switch costume to Elf-a
  - say Neutral for 3 seconds
- When text is negative:**
  - switch costume to Elf-d
  - say Sorry to Hear that for 3 seconds

# Other Resources

# Video of How to use Cognimates with K-2

## By Vicki Sedwick

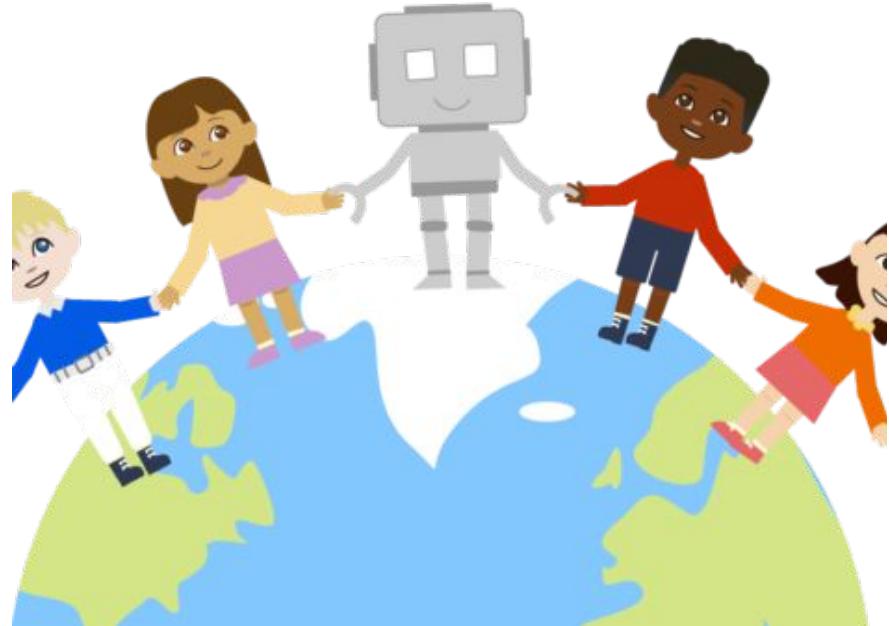


# AI + ME (AI and Me)

[edu.readyai.org/courses/aime/](http://edu.readyai.org/courses/aime/)

“AI+ME” is an online experience intended to provide young learners with the basics of AI. The lesson takes about one hour to complete. This is the first publicly available course introducing students to the “Five Big Ideas in AI” as defined by the AI4K12 Initiative.

*Target Audience: Elementary School*



# AI & Ethics Curriculum

- Middle School Curriculum
- Plugged & Unplugged Activities
- Teachable Machines
- Socratic Discussion

## An Ethics of Artificial Intelligence Curriculum for Middle School Students

Blakeley H. Payne, blakeley@mit.edu

MIT Media Lab

Personal Robots Group directed by Cynthia Breazeal

August 2019



A student shows off her paper prototype for her redesign of YouTube.

Please consider giving us feedback at:  
[https://mit.co1.qualtrics.com/jfe/form/SV\\_6X5UWiD7p58BnNz](https://mit.co1.qualtrics.com/jfe/form/SV_6X5UWiD7p58BnNz)



# 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](#)

About Teacher Projects Worksheets News Help Log Out

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

: Back to project

+ 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

# TensorFlow Playground

<https://playground.tensorflow.org>

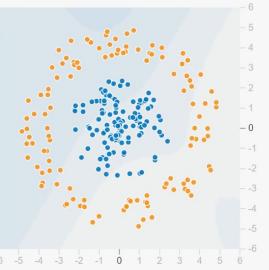
Tinker With a **Neural Network** Right Here in Your Browser.  
Don't Worry, You Can't Break It. We Promise.

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?  
 $x_1$     $x_2$     $x_1^2$     $x_2^2$     $x_1x_2$     $\sin(x_1)$     $\sin(x_2)$

**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.  
-1 0 1  
Show test data   Discretize output

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

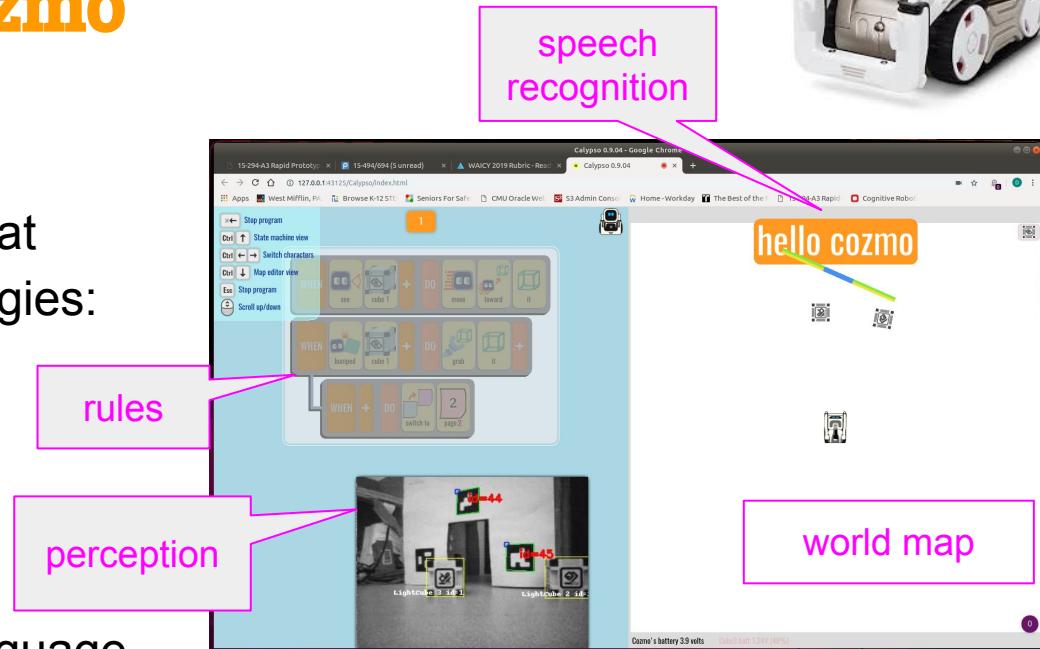


# Calypso for Cozmo



- A robot intelligence framework that Incorporates multiple AI technologies:

- Computer vision; face recognition
- Speech recognition and generation
- Landmark-based navigation
- Path planning
- Object manipulation

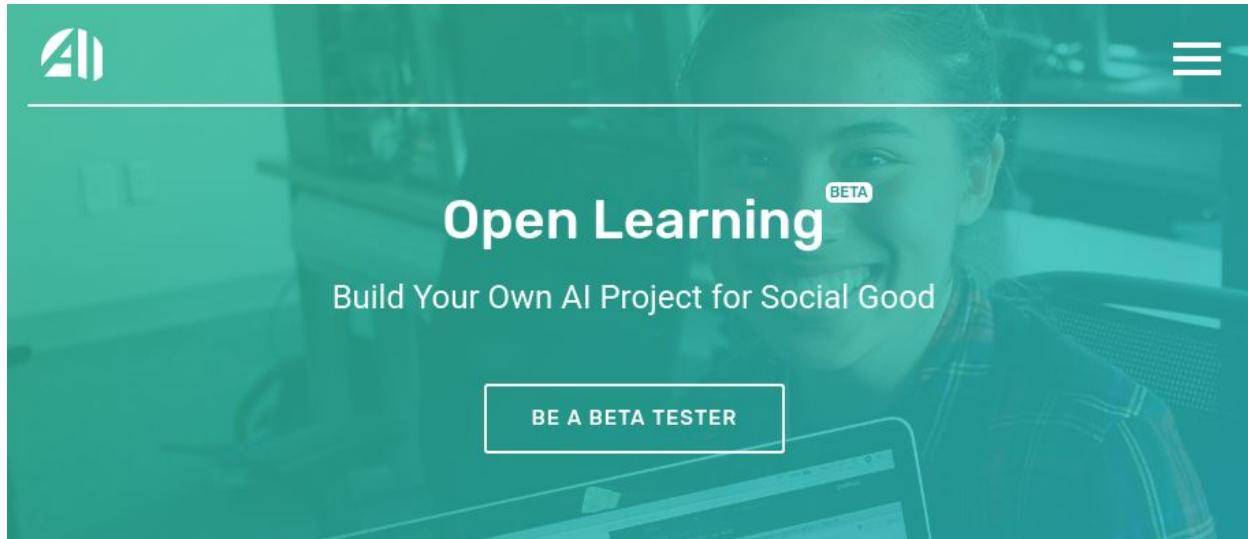


- Rule-based pattern matching language inspired by Microsoft's Kodu Game Lab
- Teaches computational thinking: “Laws of Calypso”, idioms, etc.
- Web site: <https://Calypso.software>

# AI4All: Online Student Portal

<http://ai-4-all.org/open-learning>

The AI4All Open Learning platform will offer a series of online AI courses for high school students. As of summer 2019, the first course is in beta test. This course focuses on the basics of machine learning.





# WAICY: World Artificial Intelligence Competition For Youth

2018 WAICY Stats:

**5+** Time zones

**200+** Students

**50** Teams

(**20+** remote participation)

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

- 50/50 Rubric
- Winning Project



**East to West**  
Energy Transportation  
Median Age: 8



**AI Ninja**  
Home Assistant  
Median Age: 7



**Earthquake**  
Search and Rescue  
Median Age: 12



# Professional Development Course

## Artificial Intelligence Explorations and Their Practical Use in Schools

[www.iste.org/learn/iste-u/artificial-intelligence](http://www.iste.org/learn/iste-u/artificial-intelligence)

### Course Dates:

Summer 2019 Session: June 3 - September 13

*Enrollment period: Now until July 12\**

[ENROLL NOW](#)

[ENROLL A GROUP](#)

Fall 2019 Session: October 14, 2019 - January 27, 2020

*Enrollment period: Now until October 28\**

### Course Details:

- Grade Level: 6-12
- Course Length: 30 hours
- Cost: \$224 Member / \$299 Non-member
- Course Style: asynchronous with instructor

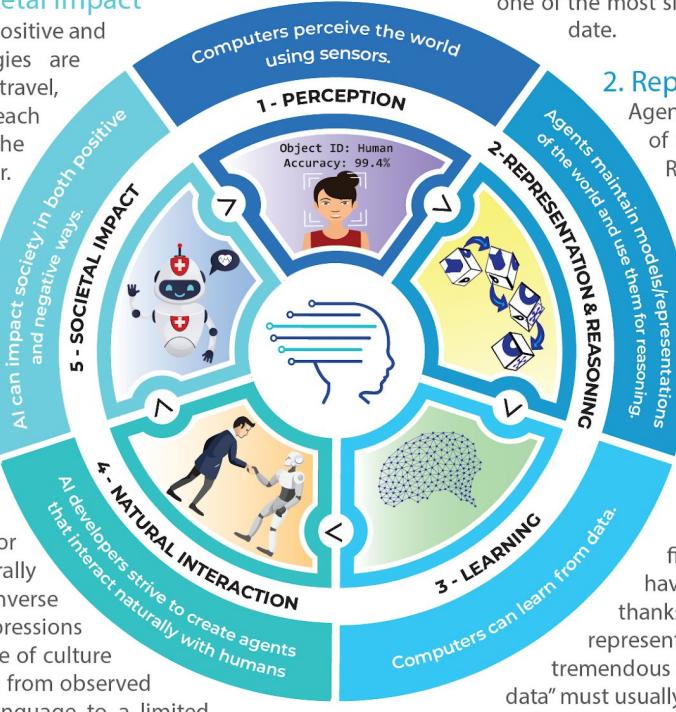
# Five Big Ideas in Artificial Intelligence

## 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.

## 4. Natural Interaction

AI developers strive to create agents that interact naturally with humans. Humans are among the hardest things for AI agents to understand. 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. Today's AI systems can use language to a limited extent, but lack the general reasoning and conversational capabilities of even a child.



## 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 models or 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.



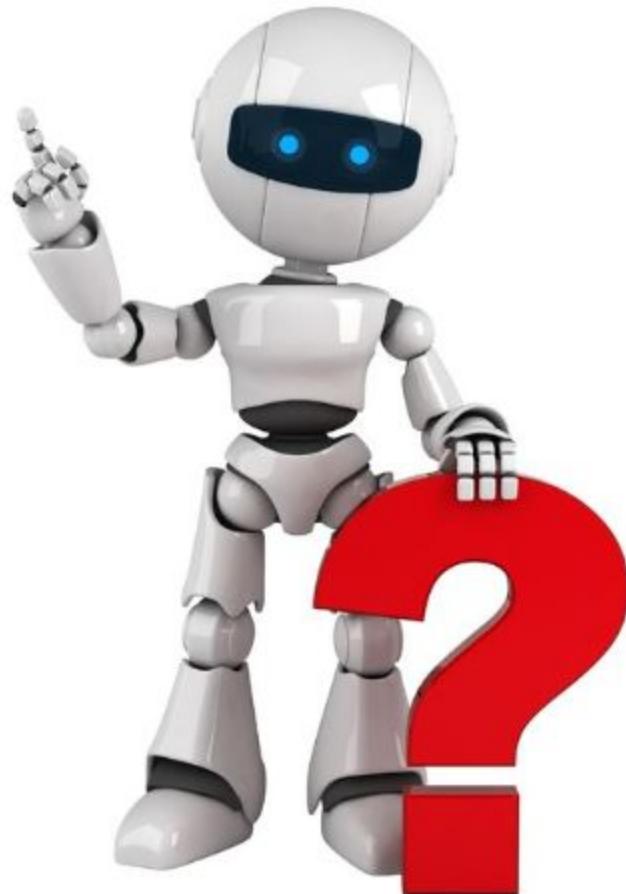


invites you to join us at the  
**2nd Annual AI for K-12 Symposium:**  
Teaching AI in K-12

**November 8-9th, 2019**  
**Westin Arlington Gateway**  
**Arlington, VA**

*Part of the AAAI 2019 Fall Symposium Series*

# Questions?



# 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](mailto:ai4k12@aaai.org)

