Intro to AI for K-12 Educators

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RockCS
Rocky Mountain Computer Science Conference for P–12 Educators

What is AI?

Artificial Intelligence is a **branch of computer science** concerned with techniques that allow **computers** to do things that, when people do them, are considered evidence of **intelligence**.

We Use AI-Powered Technologies Every Day

- Speech recognition
  - Home assistants: “Alexa, please dim the lights.”
  - Automated video subtitles; automated transcription services (otter.ai, sonix.ai)
- Computer vision
  - Use your face to unlock your iPhone; play with Snapchat and Tiktok filters
  - Self-driving cars: Tesla autopilot; automated lane departure warnings; emergency braking
- Language understanding
  - Google search: “What does an alligator weigh?” “What’s the second largest city in Honduras?”
  - Google Translate: automatic translation among any of 100+ languages; translate menus
- Recommender systems
  - Netflix→movies; Amazon→products; Facebook→news stories; Google→ads
- Robotics
  - Roombas clean up; Kiva robots automate warehouses; drones follow you

AI Poses Challenges for Society

- Many types of work will become more highly automated.
  - Some people will **lose their jobs** -- including white collar jobs.
  - People will find that their **jobs have changed**; new skills are needed.
  - New **jobs will be created** around AI, robotics, and machine learning.

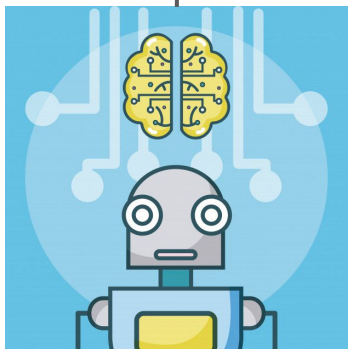
- Automated decision making systems can be opaque and biased.

- AI is powering the surveillance state:
  - Ubiquitous face recognition: loss of privacy
  - Automated monitoring of phone calls and social media

- Deep fakes: seeing is no longer believing; hard to know what to trust

AI is a Branch of Computer Science

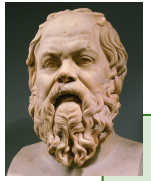
- Algorithms and complexity theory
- **Artificial intelligence**
- Computer systems (i.e., hardware)
- Databases
- Graphics
- Human-computer interaction
- Networking
- Operating Systems
- Programming Languages
- Security
- Software Engineering



AI's Relationships with Other Disciplines

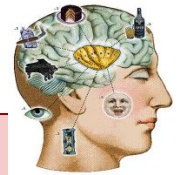
Statistics
Bayesian inference, regression

Operations Research
planning, optimization

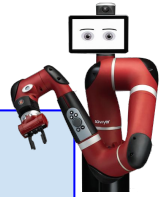


Philosophy
logic, ontology, theory of mind, consciousness

Artificial Intelligence



Cognitive Science
perception, memory, learning, reasoning



Robotics
artificial intelligence + mechanical engineering + electrical engineering

Specialties Within AI

- Computer vision
- Game playing (chess, go, poker, etc.)
- Knowledge representation
- **Machine learning**
- Machine translation
- Natural language understanding
- Neural networks
- Optimization
- Planning
- Search
- Speech recognition
- Theorem proving / automated reasoning

These are topics that would be covered in a university-level AI course.

Each topic might itself be a course in a graduate-level AI program.

Weak vs. Strong AI (or Narrow vs. Broad AI)

Weak AI is what we have now:

- Specialized algorithms for solving hard but narrowly-defined problems.
- When IBM's Deep Blue beat chess grandmaster Garry Kasparov in 1996-97, it had no idea who Kasparov was, or what a grandmaster was, or even what physical chess pieces look like.
- Google cannot tell you if an alligator weighs more than an ostrich.

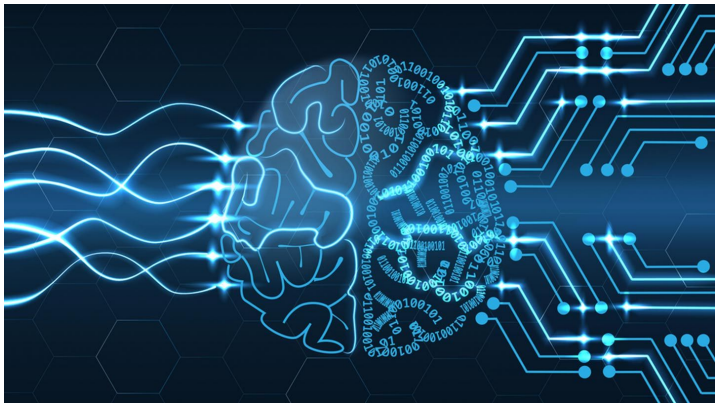
Strong AI or AGI (Artificial General Intelligence) is what we hope to achieve:

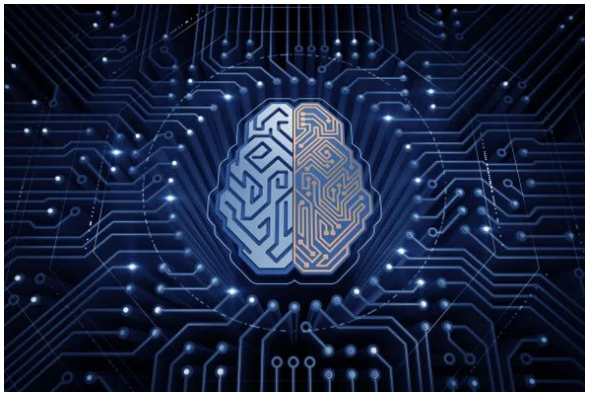
- General reasoning abilities with human-like breadth and flexibility
- Self-awareness, consciousness
- This is what is needed to create Commander Data or C3PO or Terminator
- Sadly, we have no idea how to achieve this

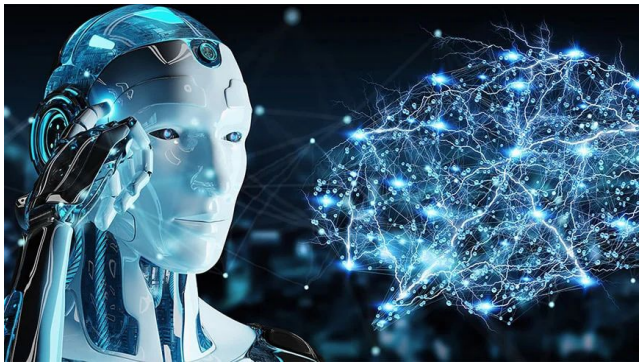
Hype vs. Reality

“Google, What Does AI Look Like?”

AI is Blue and Has Brains and Wires and Cyborgs







What AI Really Looks Like: Algorithms + Data Structures

```python
import tensorflow as tf

x = tf.placeholder(tf.float32)
W = tf.Variable(0 , dtype = tf.float32)
b = tf.Variable(0 , dtype = tf.float32)
y_ = tf.placeholder(tf.float32)

y = W * x + b

lost = tf.reduce_mean(tf.square(y_ - y))

optimizer = tf.train.GradientDescentOptimizer(0.01)
train_step = optimizer.minimize(lost)

sess = tf.Session()
init = tf.global_variables_initializer()
sess.run(init)

tf.summary.scalar('lost' , lost)
merged = tf.summary.merge_all()
writer = tf.summary.FileWriter("./logs", graph=tf.get_default_graph())

steps = 1000
for i in range(steps):
    xs = 1
    ys = 3
    feed = { x: xs, y_: ys }
    sess.run(train_step , feed_dict=feed)
    xs = 2
    ys = 5
    feed = { x: xs, y_: ys }

    _ , rs = sess.run([train_step , merged] , feed_dict=feed)
    writer.add_summary(rs, i)

print("W: %f" % sess.run(W))
print("b: %f" % sess.run(b))
```

the function of the code is

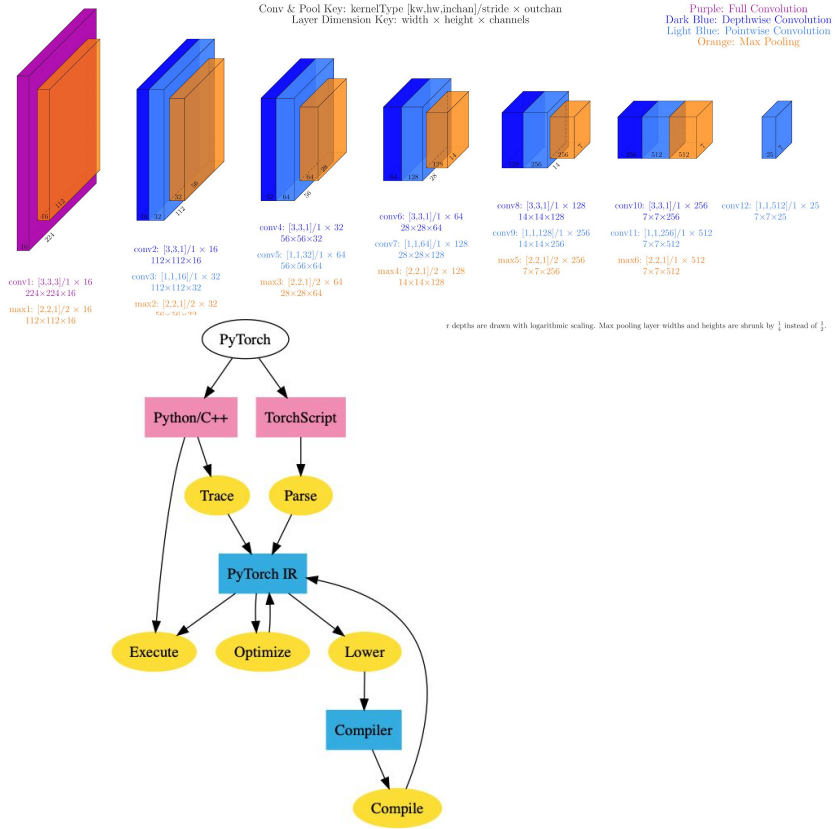
linear recurrence

$y = 2x + 1$

calculate the lost

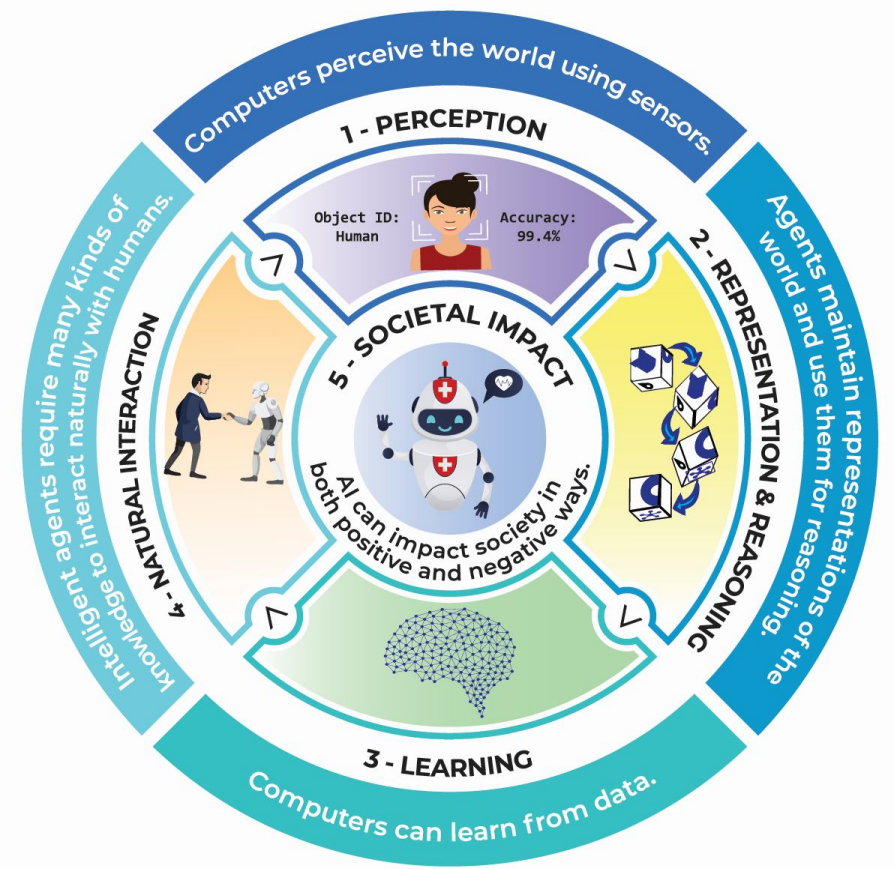
record the lost

update



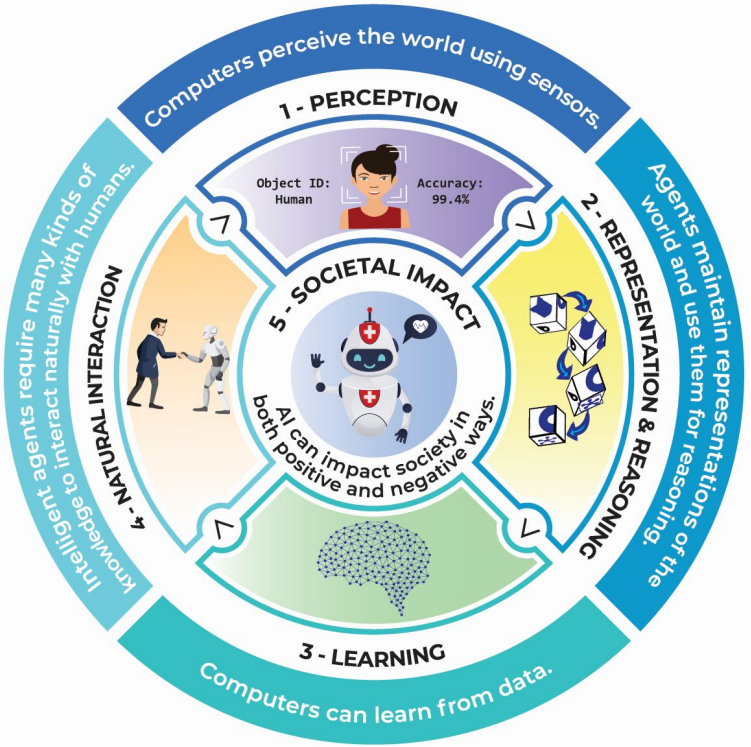
Five Big Ideas in AI

- Organizing framework for the K-12 guidelines, modeled after CSTA Computing Standards.
- 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.



Five Big Ideas in AI

1. **Perception:** Computers perceive the world using sensors.
2. **Representation and reasoning:** Agents maintain representations of the world and use them for reasoning.
3. **Learning:** Computers can learn from data.
4. **Natural interaction:** Intelligent agents require many kinds of information to interact naturally with humans.
5. **Societal impact:** AI can impact society in both positive and negative ways.

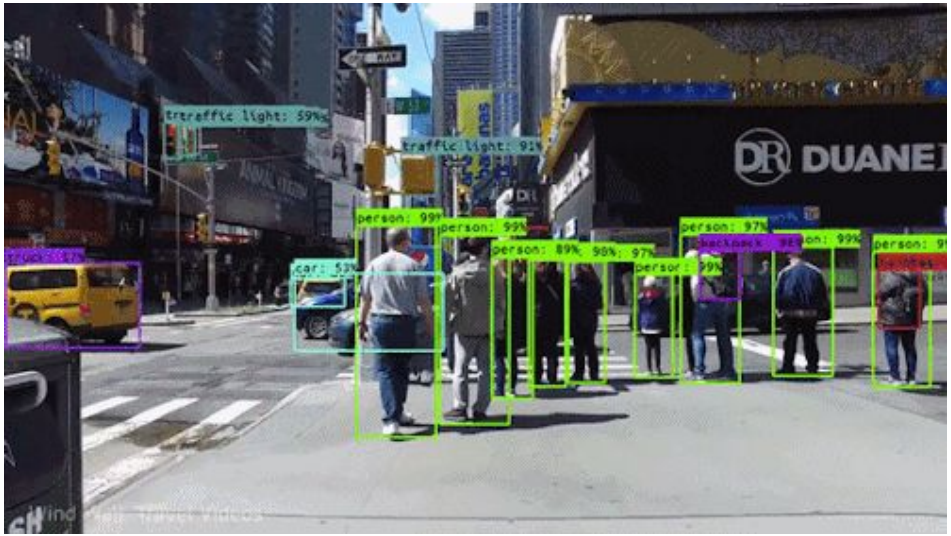


Big Idea #1: Perception

Computers perceive the world using sensors.

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

Are Supermarket Doors Intelligent?

This is what you get when your automatic doors have sensing but not perception.

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

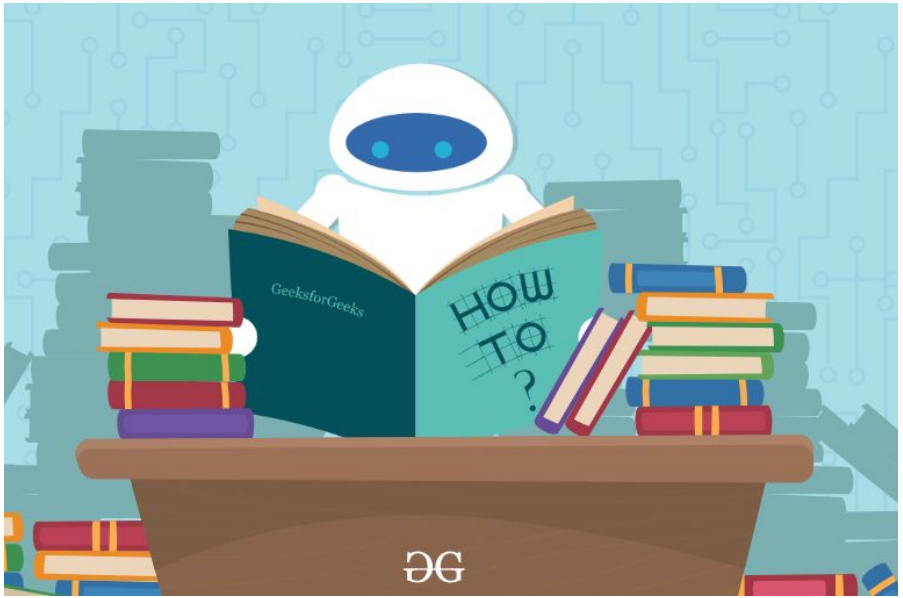
Example Guidelines

- 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.

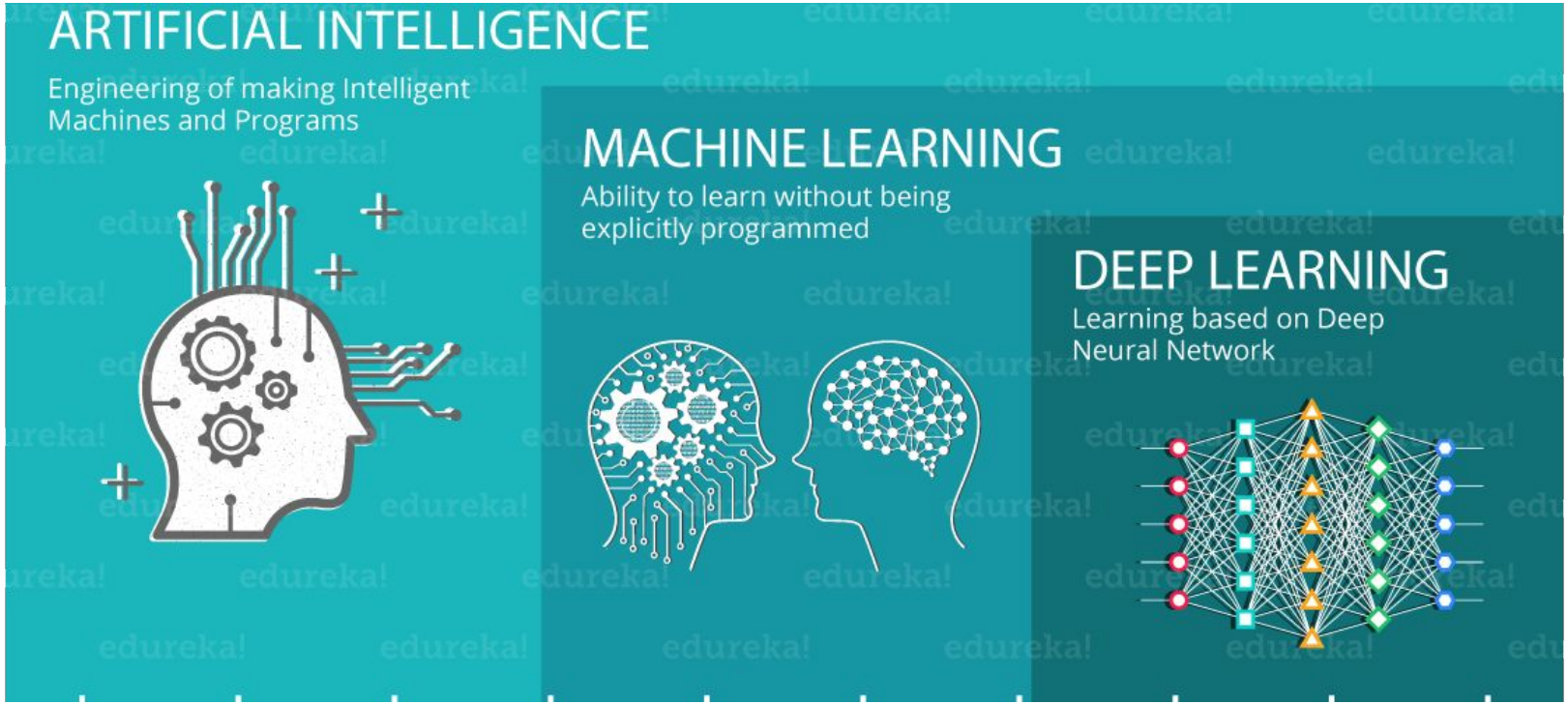
- Nature of learning
- Fundamentals of neural networks
- Data sets



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

AI and Machine Learning



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 (1 of 3)

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

- **Ethics of AI making decisions about people**
  - Fairness and bias
  - Transparency and explainability
  - Accountability

Example Guidelines

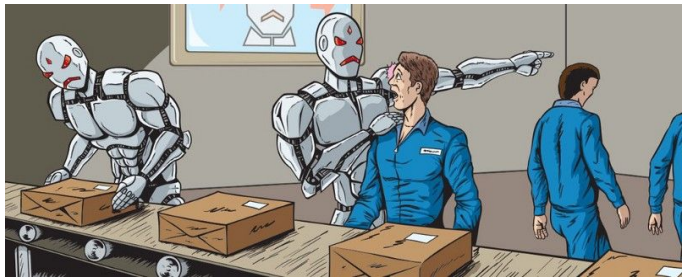
- Critically explore the positive and negative impacts of an AI system.
- Describe ways that AI systems can be designed for inclusivity.

Machine Bias: ProPublica.org

Big Idea #5: Societal Impact (2 of 3)

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

- **Economic impacts of AI**
  - Increased productivity
  - New types of services
  - Reduction in of some types of jobs
  - New career opportunities



Example Guidelines

- Design and explain how an AI system can be used to address a social issue.

- Understand tradeoffs in the design of AI systems and how decisions can have unintended consequences in the function of a system.

Big Idea #5: Societal Impact (3 of 3)

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

- **AI & Culture**
  - Living with intelligent assistants and robot companions.
  - Would you let your child travel unaccompanied in a self-driving car?
  - New YouTube genre: self-driving car mishaps.

Example Guidelines

- Critically explore the positive and negative impacts of an AI system.
- Describe the debate about whether people should be polite to agents and robots.

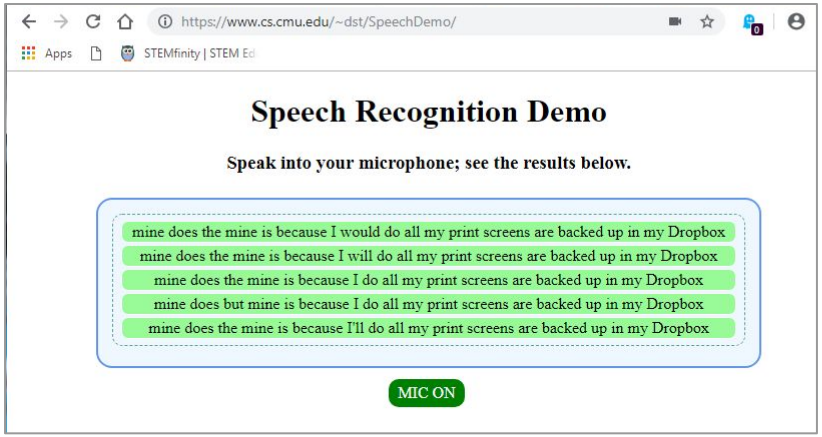
Demos

- SpeechDemo
- Facial Landmark Detection
- FaceDemo (Deep Neural Network)
- Teachable Machine
- QuickDraw
- Machine Learning for Kids: Titanic
- TensorFlow Playground
- Calypso

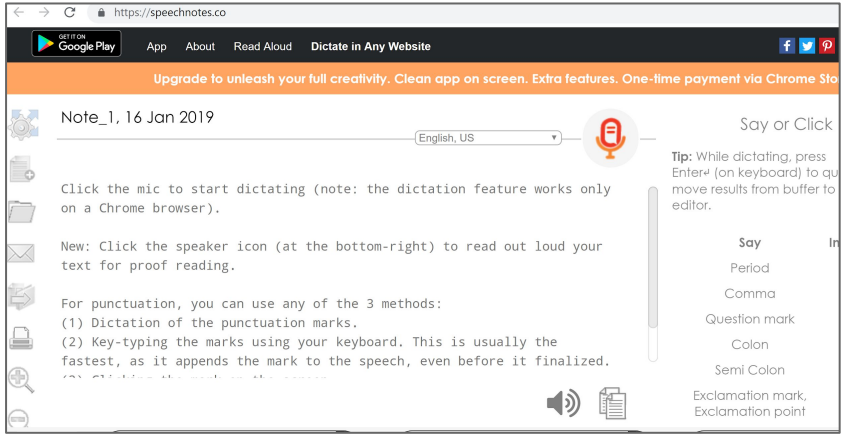
Find more great demos, videos, and curriculum resources at the AI4K12.org Resources Directory.

Speech Recognition: Speech to Text Demos

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



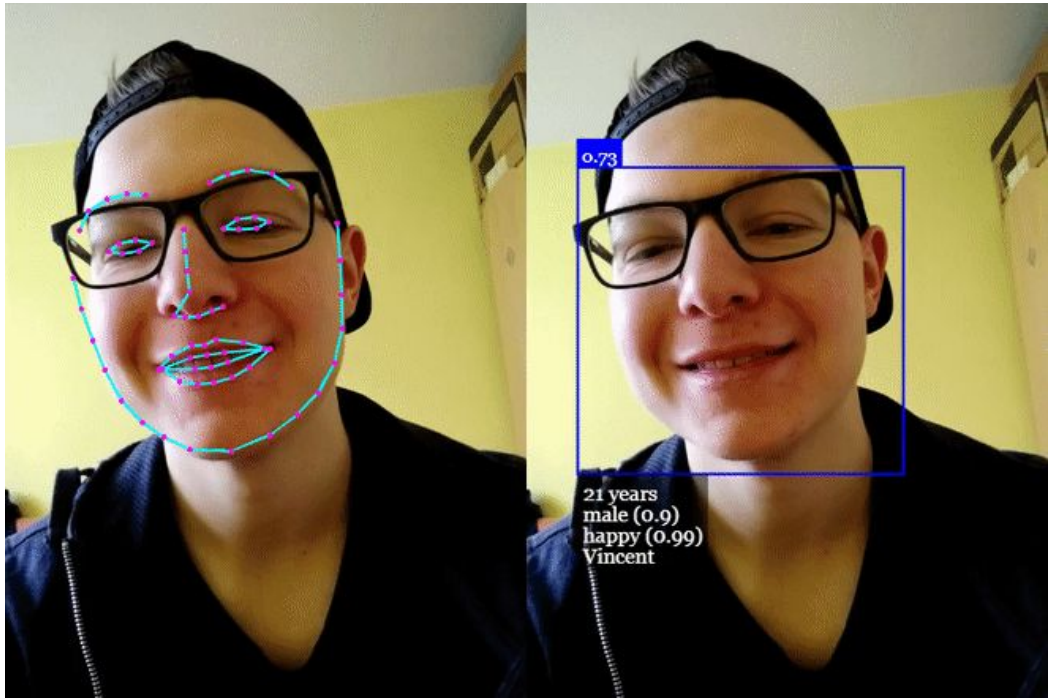
2. Demo speaks back what it heard
https://speechnotes.co/



Facial Landmark Recognition

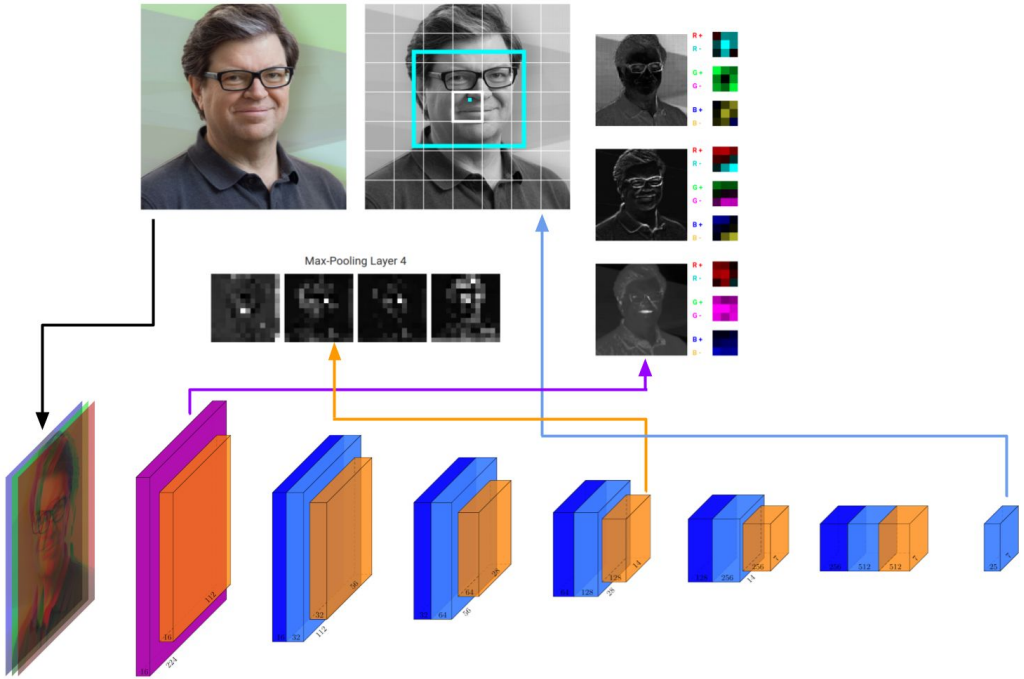
https://justadudewhohacks.github.io/face-api.js/webcam_face_tracking

Click the box for “Detect Face Landmarks”



Face Recognition With A Deep Neural Network

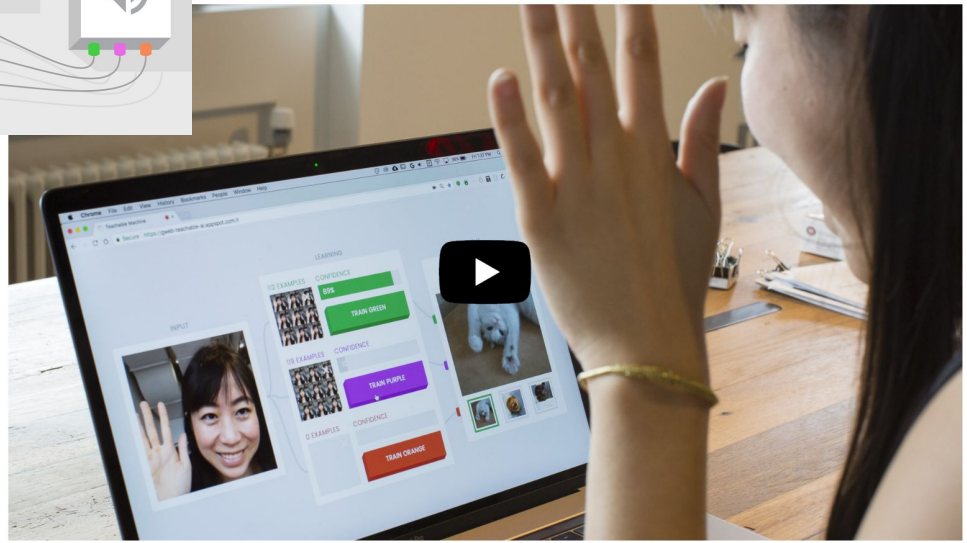
https://www.cs.cmu.edu/~dst/FaceDemo

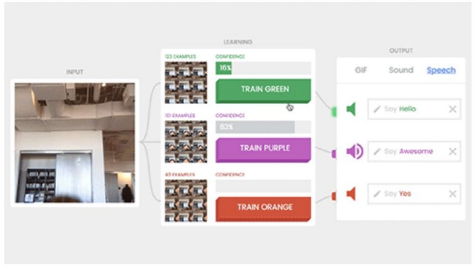


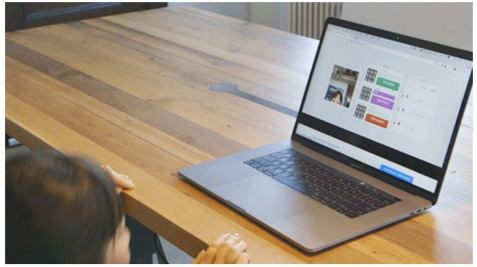
TEACHABLE MACHINE

Built with TensorFlow

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







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

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!

Machine Learning for Kids

https://machinelearningforkids.co.uk

Machine learning projects

These projects are downloadable step-by-step guides, with explanations and colour screenshots for students to follow.

Each project is a stand-alone activity, written to last for a single lesson, and will guide children to create a game or interactive project that demonstrates a real-world use of artificial intelligence and machine learning.

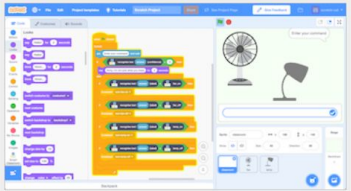
Suggestions for new worksheets, suggestions of improvements to any of the worksheets, or contributions of new project worksheets, are all very welcome.

All project types | All difficulties | All make types

Smart Classroom

Create a smart assistant in Scratch that lets you control virtual devices.

Teach a computer to recognise the meaning of your commands



Difficulty: Beginner Recognising: **text**

Tags: digital assistants, supervised learning

Download

Make me happy

Create a character in Scratch that smiles if you say nice things to it and cries if you say mean things to it.

Teach a computer to recognise compliments and insults

Difficulty: Beginner Recognising: **text**

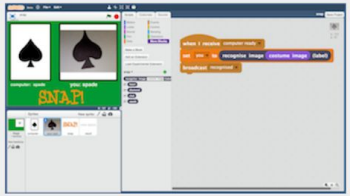
Tags: sentiment analysis, supervised learning

Download

Snap!

Make a card game in Scratch that learns to recognise pictures of your card.

Teach a computer to recognise what icons look like



Difficulty: Beginner Recognising: **images**

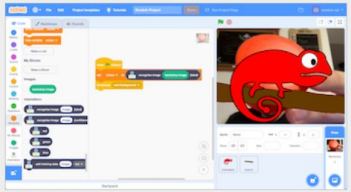
Tags: image classification, supervised learning

Download

Chameleon

Make a chameleon in Scratch that changes colour to match its background

Teach a computer to recognise colours



Difficulty: Beginner Recognising: **images**

Tags: image classification, supervised learning

Download

Titanic

Create a Python program that can predict who survived the sinking of the Titanic.

Teach a computer to predict outcomes

Difficulty: Beginner Recognising: **numbers**

Tags: predictive model, supervised learning

Download

Mailman Max

Make a postal sorting office in Scratch that can recognise handwritten postcodes on envelopes.

Teach a computer to recognise handwriting

Car or cup

Train the computer to be able to sort photos into groups.

Teach a computer to recognise pictures of objects

Face Lock

Make a phone in Scratch that unlocks if it recognises your face.

Teach a computer to recognise faces

Journey to school

Train the computer to be able to predict how you travel to school in the morning.

Teach a computer to make predictions

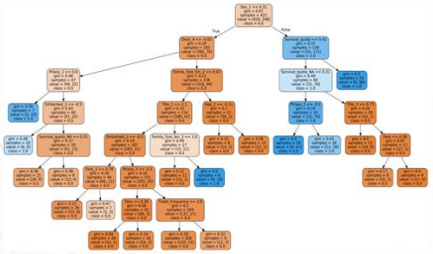
Shy Panda

Make a dancing panda that gets shy and stops dancing if it sees you looking.

Teach a computer to recognise pictures

Machine Learning with the Titanic Dataset

An end-to-end guide to predict the Survival of Titanic passenger



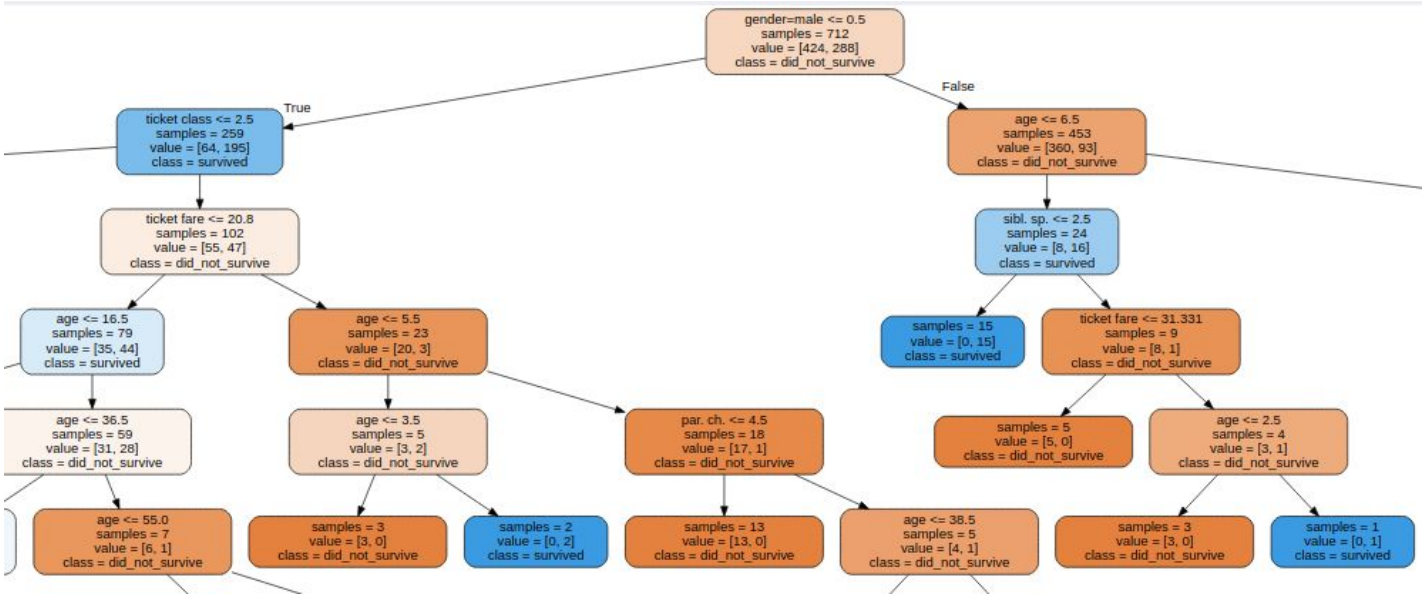
Is this test true?

samples = *how many training examples got here*

class = *prediction so far*

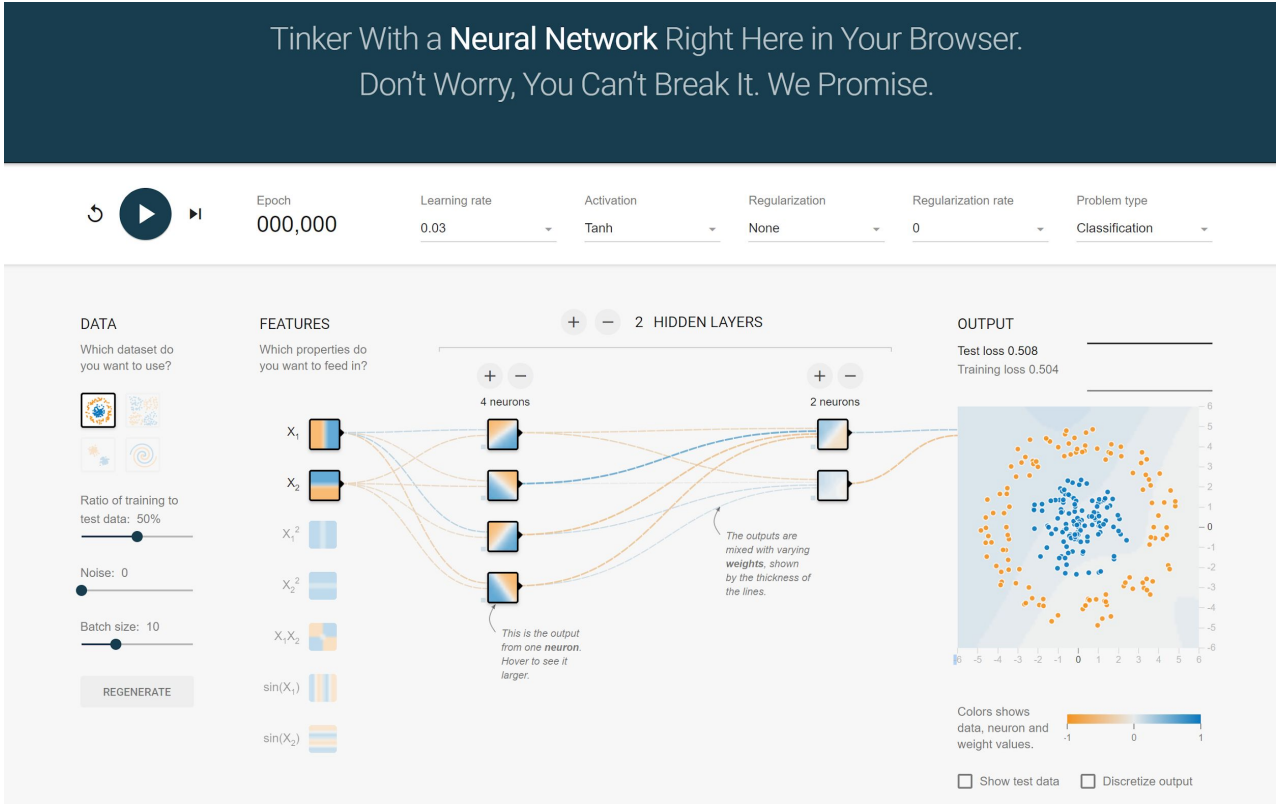
Go this way if the test is true

Go this way if the test is false



TensorFlow Playground

https://playground.tensorflow.org

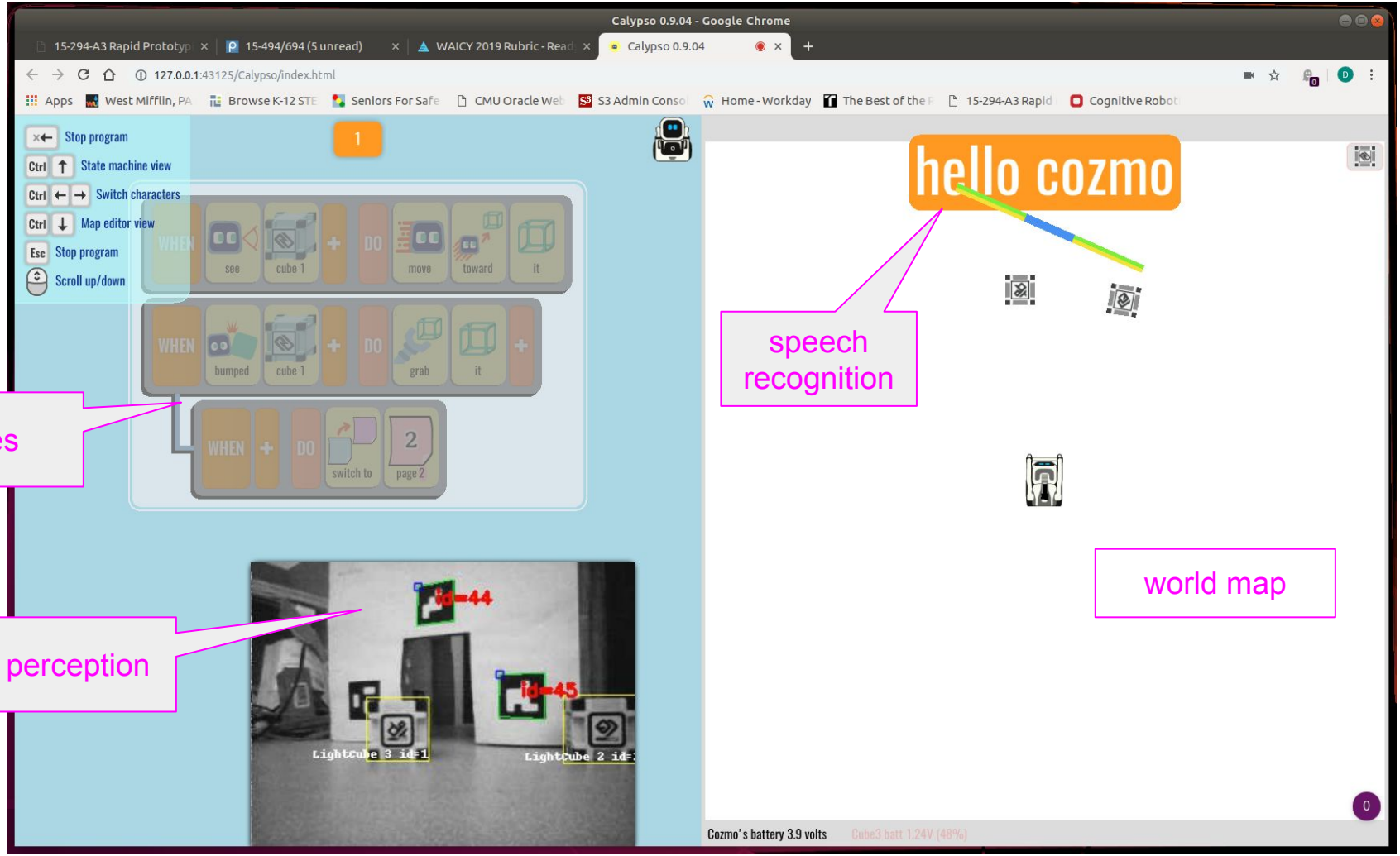


Tutorial: https://cloud.google.com/blog/products/gcp/understanding-neural-networks-with-tensorflow-playground

Calypso for Cozmo

- A robot intelligence framework that combines multiple types of AI:
  - Computer vision
  - Speech recognition
  - Landmark-based navigation
  - Path planning
  - Object manipulation

- Rule-based language inspired by Microsoft's Kodu Game Lab
- Teaches computational thinking
- Web sites:
  - https://Calypso.software (Cozmo robot version)
  - https://calypso-robotics.com (free simulator version runs in the browser)


Calypso 0.9.04 - Google Chrome
15-294-A3 Rapid Prototyp
15-494/694 (5 unread)
WAICY 2019 Rubric - Read
Calypso 0.9.04
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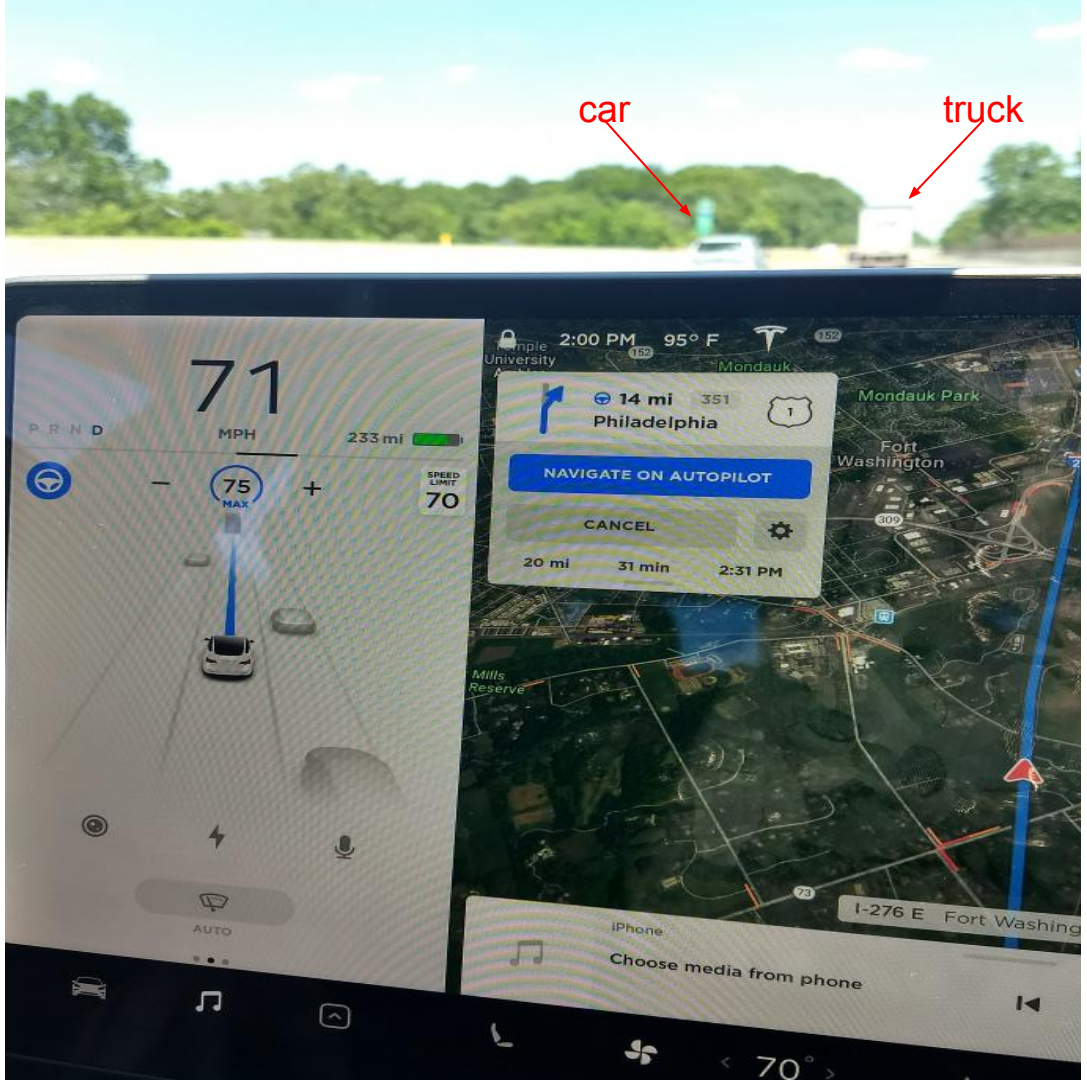
Apps
West Mifflin, PA
Browse K-12 STE
Seniors For Safe
CMU Oracle Web
S3 Admin Consol
Home - Workday
The Best of the F
15-294-A3 Rapid
Cognitive Robot
Stop program
State machine view
Switch characters
Map editor view
Stop program
Scroll up/down
1
WHEN
see
cube 1
DO
move
toward
it
WHEN
bumped
cube 1
DO
grab
it
WHEN
DO
switch to
2
page 2
hello cozmo
speech recognition
rules
perception
world map
id=44
id=45
LightCube 3 id=1
LightCube 2 id=
Cozmo's battery 3.9 volts
Cube3 batt 1.24V (48%)
0

Tesla's World Map

Cozmo can be considered "a self-driving car in the palm of your hand."

At right is an image from a real self-driving car, a Tesla, showing the road and other nearby vehicles on its world map.



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Questions?