K-12 AI Playground

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and Jason Huang

Supported by NSF DRL-1846073.

Overview

- Introductions
- AI4K12 and Five Big Ideas in AI
- ReadyAI Curricula & WAICY Competition
- Part I: Interactive Browser-Based AI demos
- Part II: Unplugged Activities
- Break
- Part III: Cognimates / Machine Learning for Kids
- Break
- Part IV: Cozmo + Calypso
- Additional Resources and Next Steps

Your Workshop Presenters

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Please Introduce Yourselves

- Who teaches K-2?
- Who teaches 3-5?
- Who teaches 6-8?
- Who teaches 9-12?
- Who doesn’t fit these categories?

- Please introduce yourselves to the other people at your table.

The AI for K-12 Initiative

- Developing national guidelines for teaching AI in K-12
  - Modeled after the CSTA standards for computing education.
  - Organizing framework for the guidelines: “Five Big Ideas in AI”
  - Four grade bands: K-2, 3-5, 6-8, and 9-12
  - What should students know?
  - What should students be able to do?
- Developing a curated AI resource directory for K-12 teachers.
- Fostering a community of AI resource developers.
- Web site: http://AI4K12.org

The AI4K12 Initiative is a joint project of:

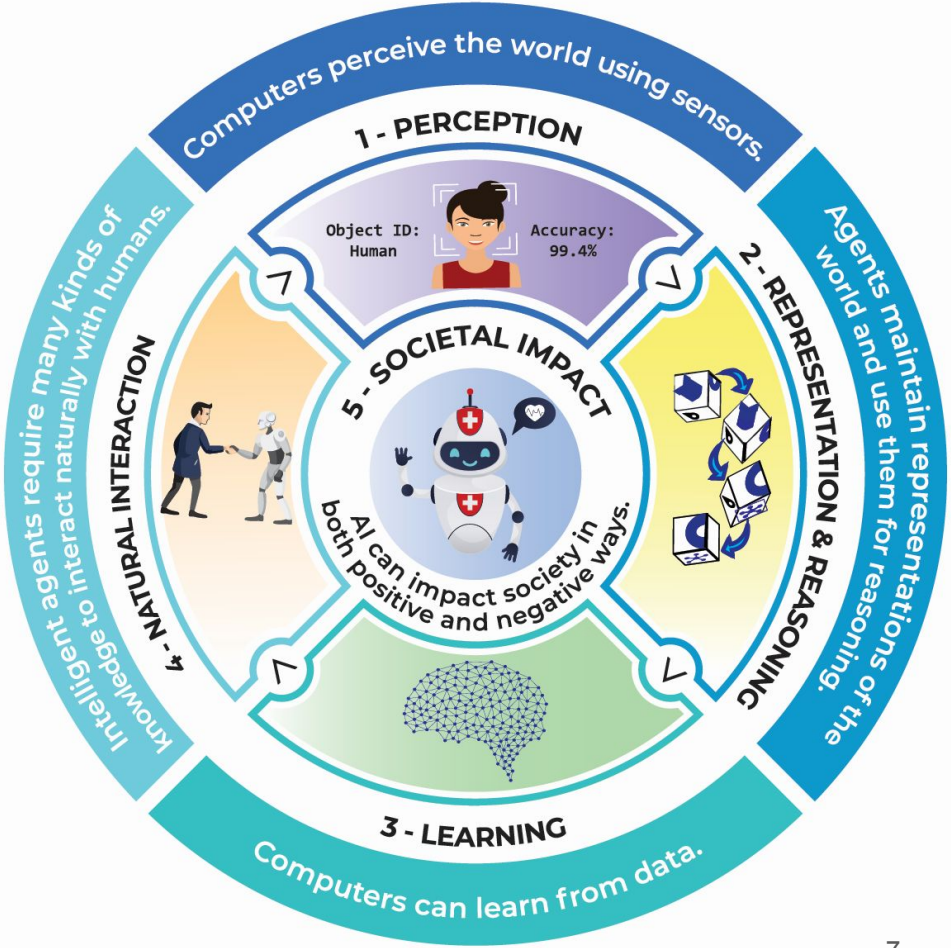
AAAI (Association for the Advancement of Artificial Intelligence)

CSTA (Computer Science Teachers Association)

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

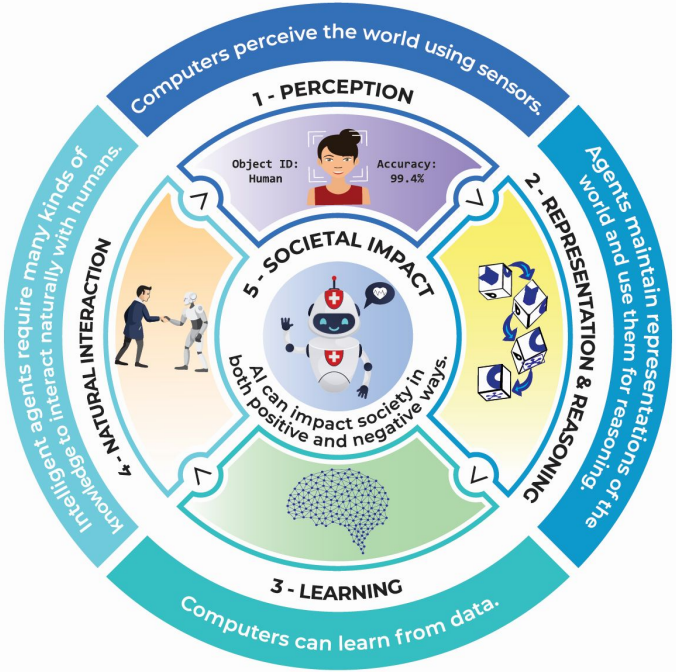
Carnegie Mellon University
School of Computer Science

Five Big Ideas in Artificial Intelligence



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 knowledge to interact naturally with humans.
5. **Societal Impact:** AI can have both positive and negative impacts on society.



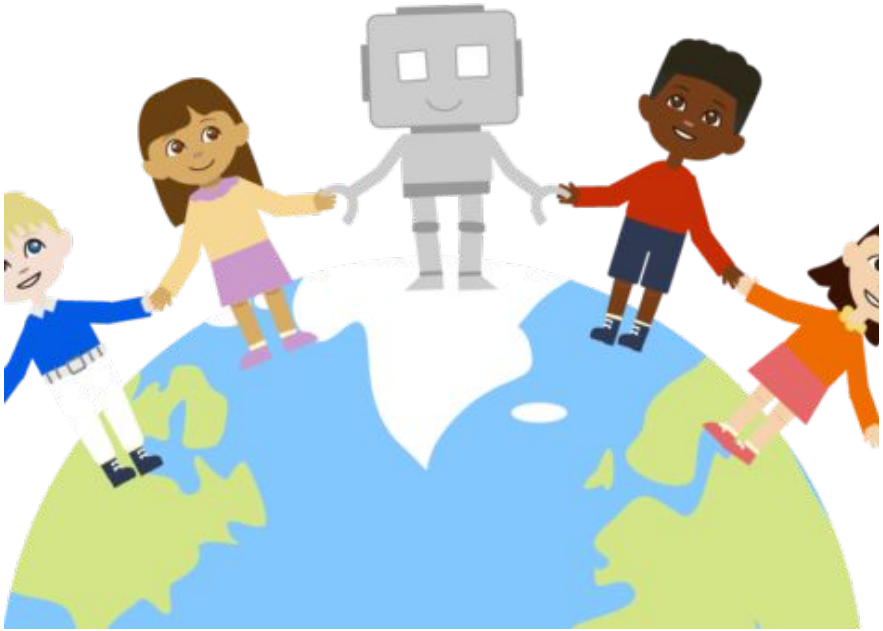
- ReadyAI is a Pittsburgh-based company that is developing AI curriculum and professional development materials for K-12 teachers.
- Makers of AI-IN-A-BOX: a turn-key solution that gives students a hands-on introduction to AI-enabled robotics using Calypso and the Cozmo robot.
- AI+ME: free online intro to AI for K-5 students.
- Sponsors of WAICY: the World Artificial Intelligence Competition for Youth.
- Visit https://ReadyAI.org to learn more.

AI + ME (AI and Me)

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



Curriculum

AI-IN-A-BOX™

- 3 sets serving 3-15 students at a time.
- Color-labeled devices for best student experience.
- Fun and innovative teaching tools for your classroom.

K-12 Curriculum

- 8-12 hours of instruction
- Introductory, project-based courses
- Lesson plans, handouts, online courses.
- Suitable for every skill level
- No STEM teaching experience required
- PD available

First WAICY – July 2018 at CMU

5 Time zones

200+ Students

50+ Teams

(**20+** remote participation)

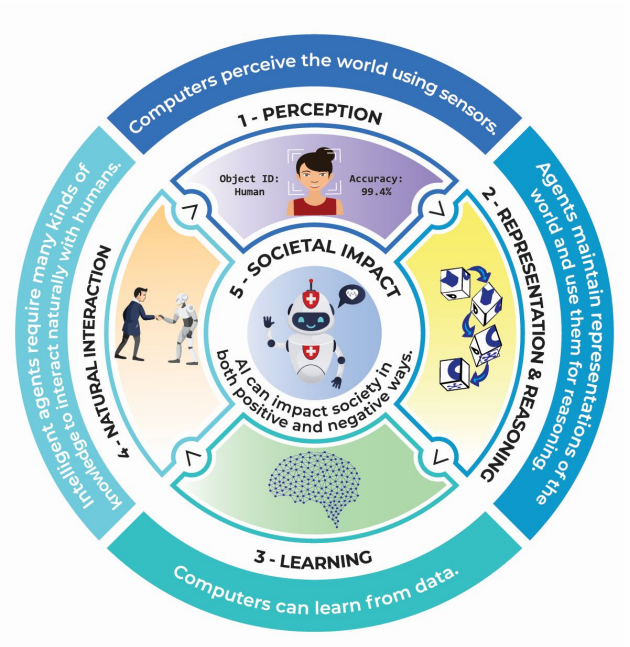
"S.T.E.A.M.-Powered A.I."
- 50/50 Rubric
- Winning Project


STUDENTS DEVELOPED DEMONSTRATIONS OF
HOW THEY THINK AI CAN CHANGE THE WORLD

WAICY 2019: S.T.E.A.M-Powered A.I.

July 27. 2019 at Nova Place in Pittsburgh, PA

AI Criteria



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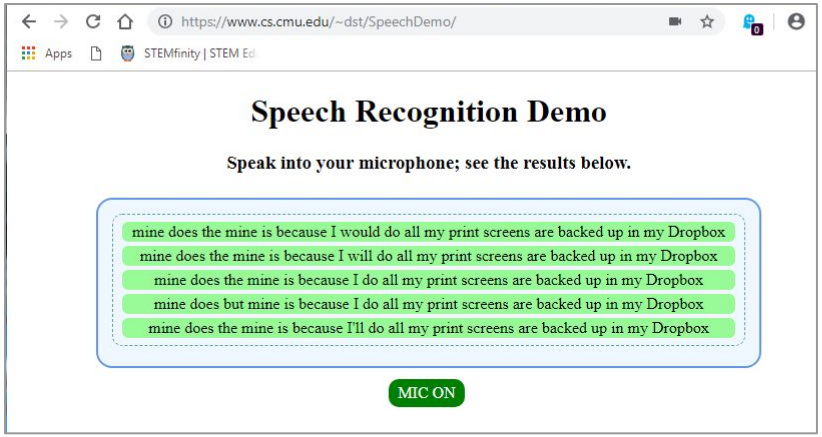
Multimedia Criteria

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

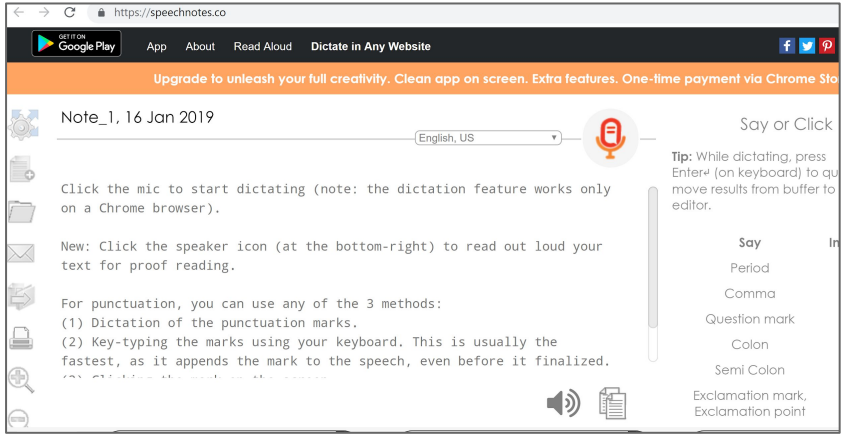
Part I:
Interactive Browser-Based AI demos

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/



AI & Creativity

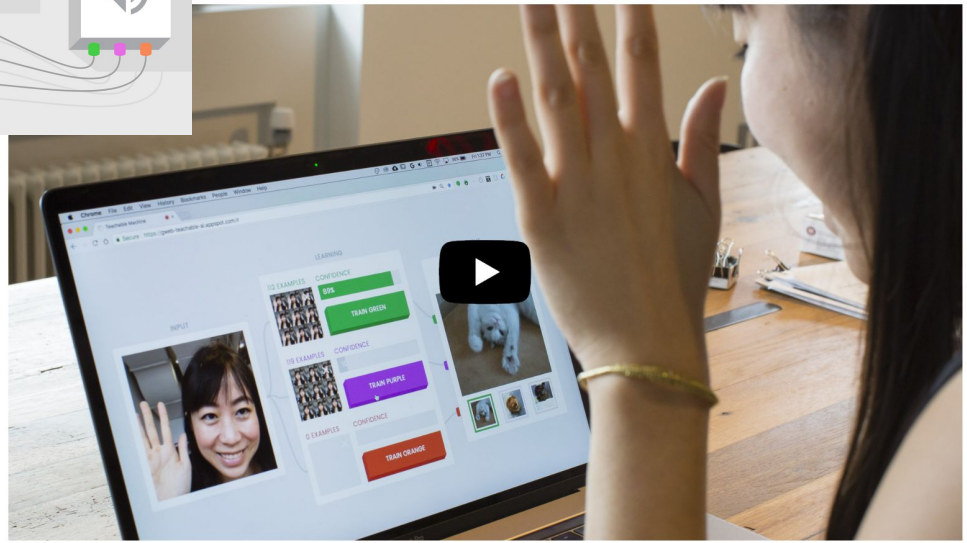
https://experiments.withgoogle.com/mixlab

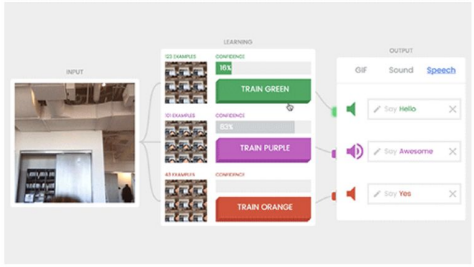
Input & *Output*

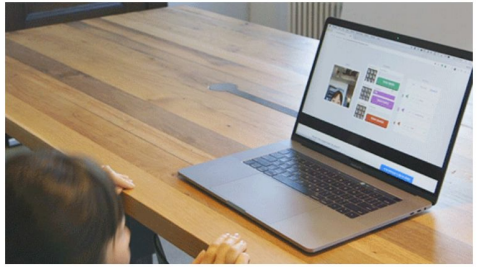
TEACHABLE MACHINE

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!

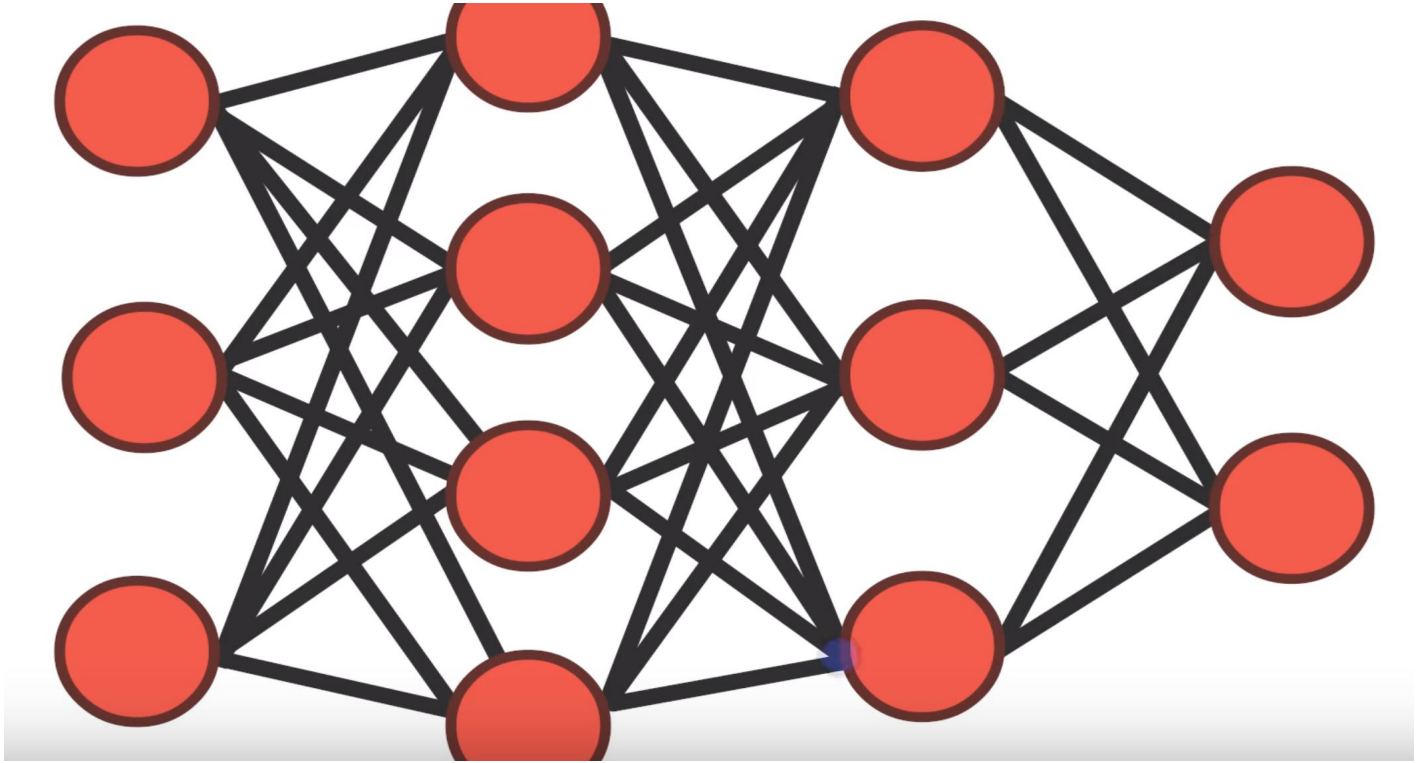
https://quickdraw.withgoogle.com/

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!

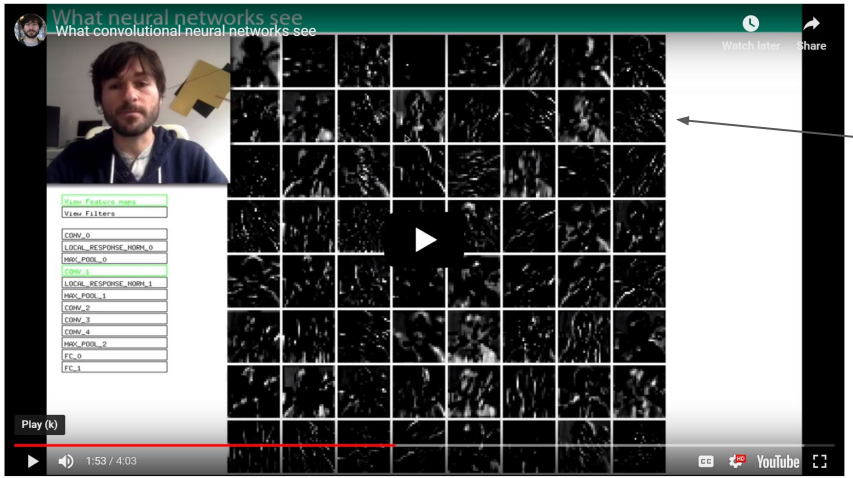
Neural Networks in a minute



Structure of a Neural Net - https://www.youtube.com/watch?v=rEDzUT3ymw4

Deep Convolutional Neural Nets

Web Camera Input



Activation Map

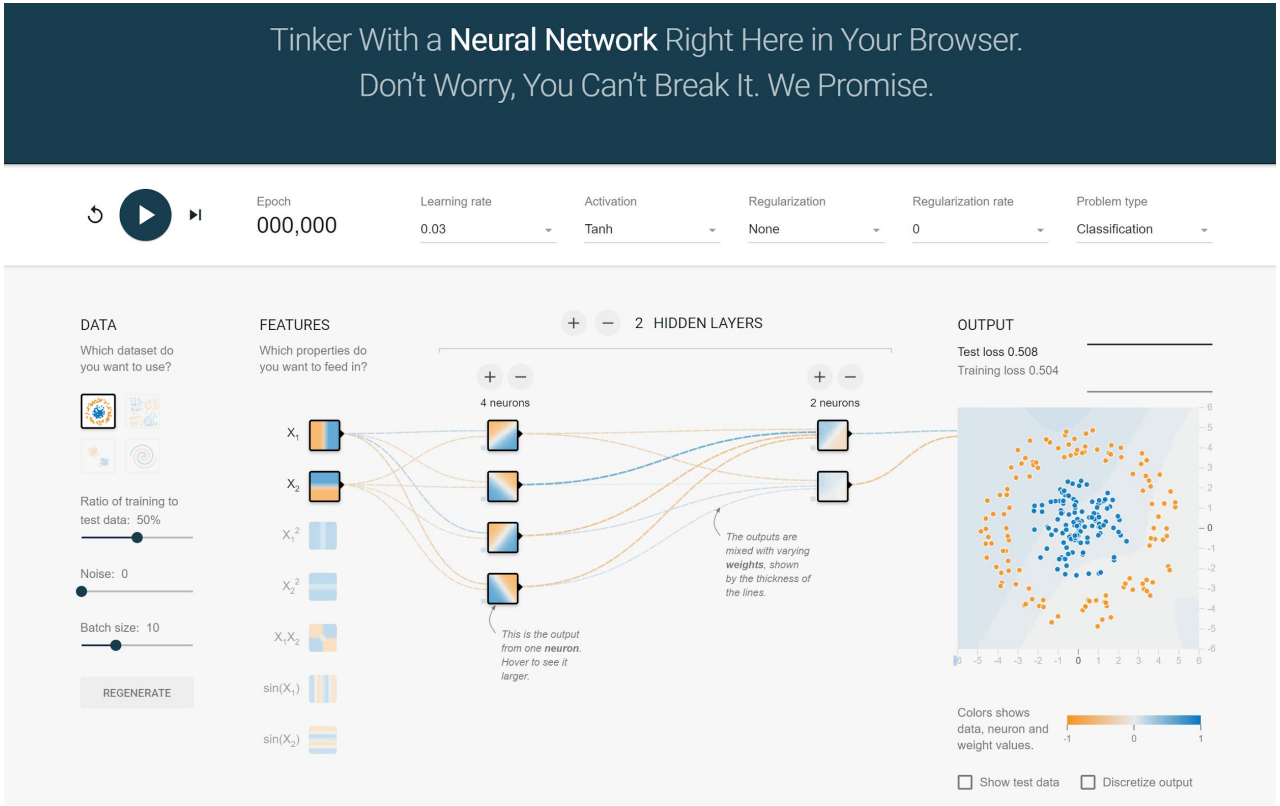
Feature detection - geometric shapes

Guesses of what is in the video feed

https://experiments.withgoogle.com/what-neural-nets-see

TensorFlow Playground

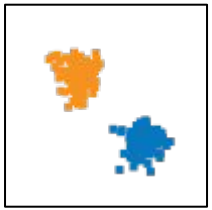
https://playground.tensorflow.org



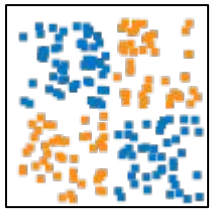
Tutorial: https://cloud.google.com/blog/products/gcp/understanding-neural-networks-with-tensorflow-playground

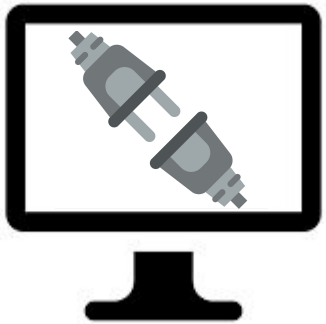
TensorFlow Exercise

1. Set problem to two gaussians:
2. Set # hidden layers to zero.
3. Turn on “discretize output”.
4. Train.



5. Set problem to four-region XOR:
6. Train with 0 hidden layers.
7. Train with 1 hidden layer.
8. Train with 2 hidden layers. Try several times.
9. Increase hidden layer 1 to 4 units and train again.





Part II:
AI Unplugged Activities

How do you help your students get a feel for representation and reasoning?

- Unplugged exercises for students
  - Build your own taxonomy
  - Generate a search tree
- Experiments with smartphones, Alexa, Cozmo, etc.
- Online demos that display representations (e.g., sample parses)
- Animations of search algorithms

Graphs and Trees:Unplugged activities

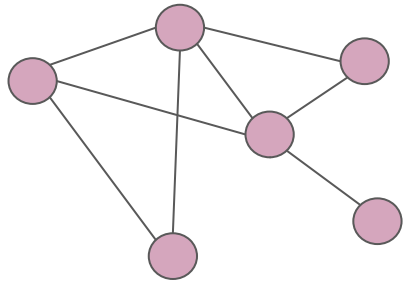
Graphs and Tree are the Heart of Symbolic AI Representations

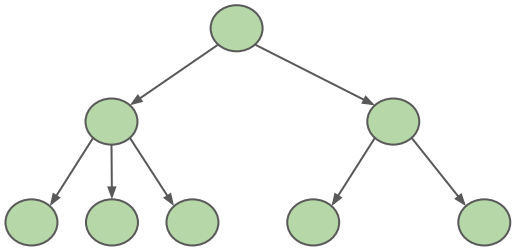
Cross-cutting connections:

(1) Computer science: data structures

(2) Mathematics: graph theory

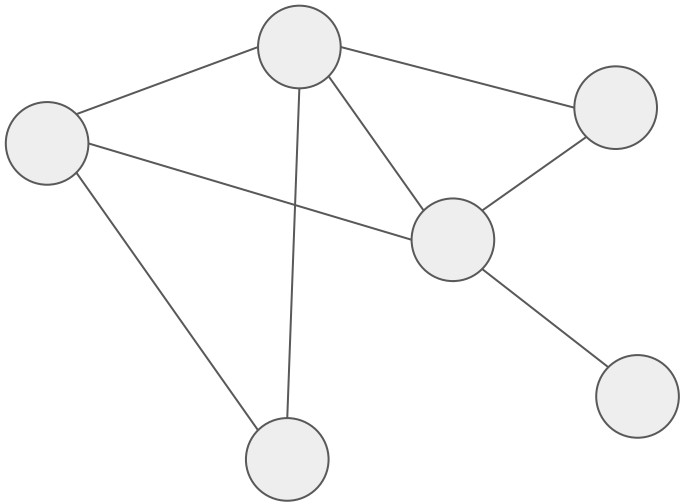
Graphs and trees are implemented in programming languages using lists, arrays, or dictionaries.





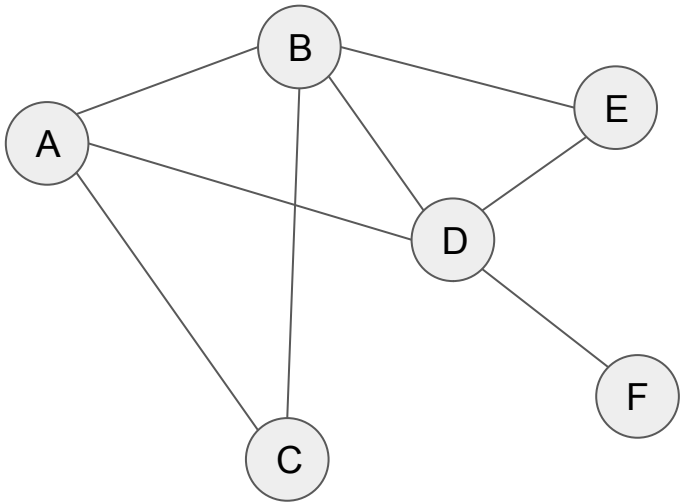
Graphs are Central to Symbolic AI Representations

In symbolic AI, the most common type of representation is the **graph**. (Trees are a special kind of graph.) Graphs are composed of **nodes** and **links**.



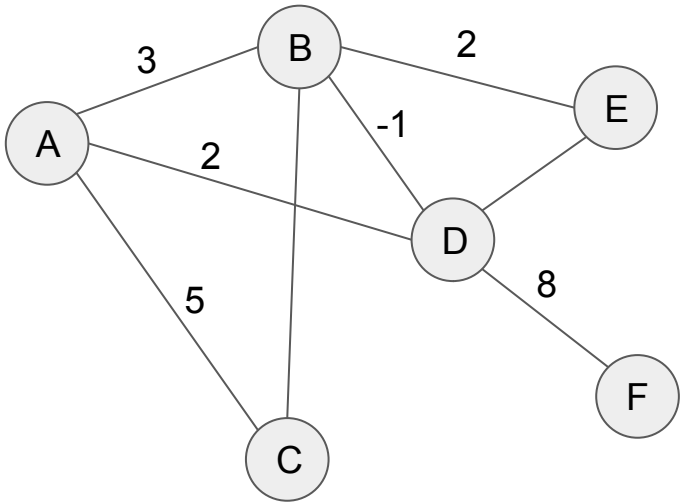
Labeled Graphs

The nodes of a graph may be “labeled”, i.e., they hold information.



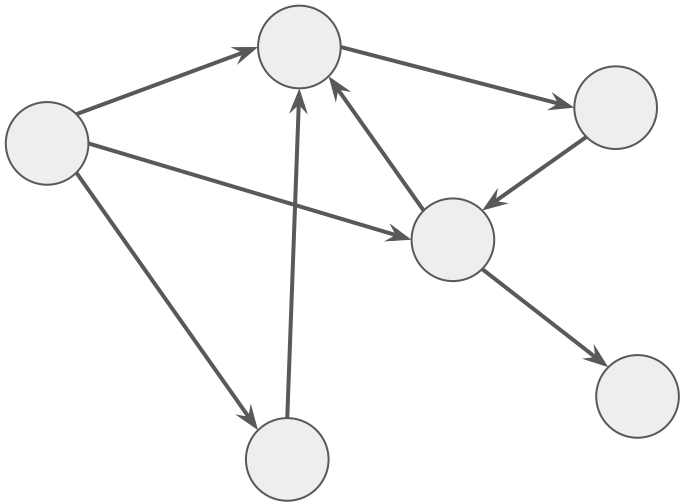
Labeled Graphs

The links may also be labeled.



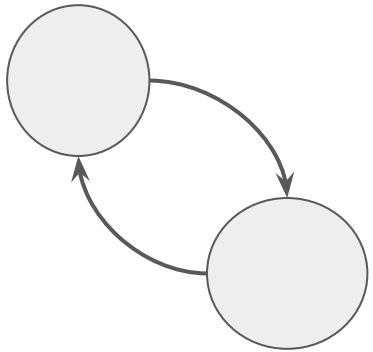
Directed Graphs

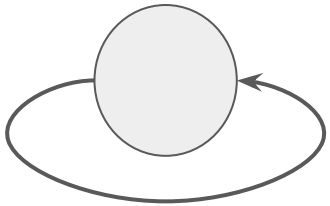
In a **directed** graph, each link has a direction, shown by an arrowhead: 



Directed Graphs

Cycles and self-links may be permitted.

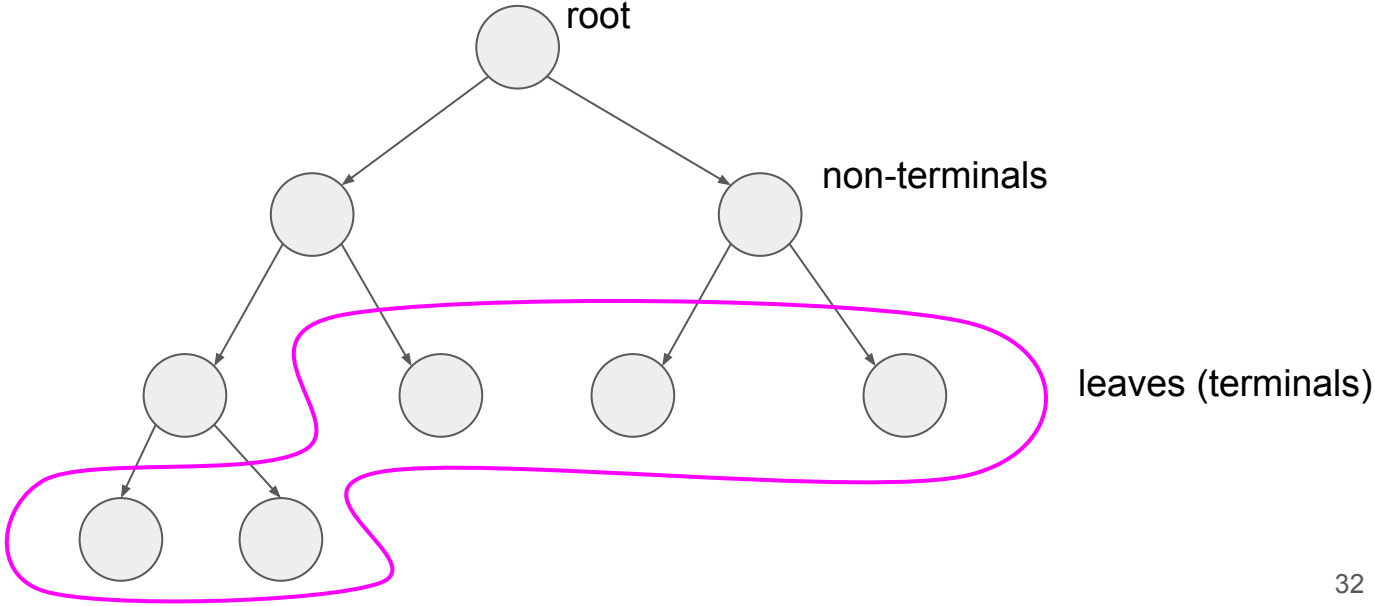




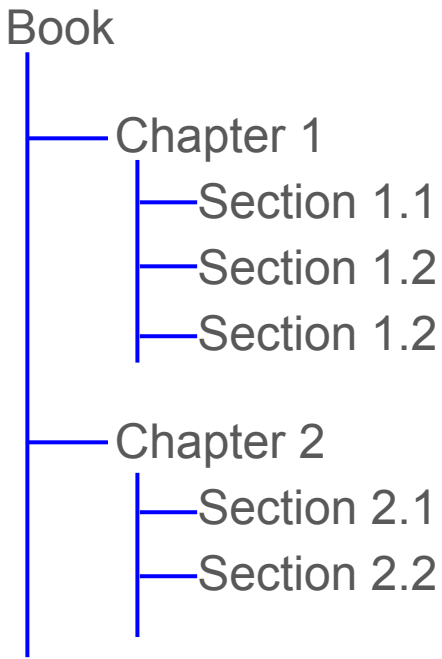
Trees

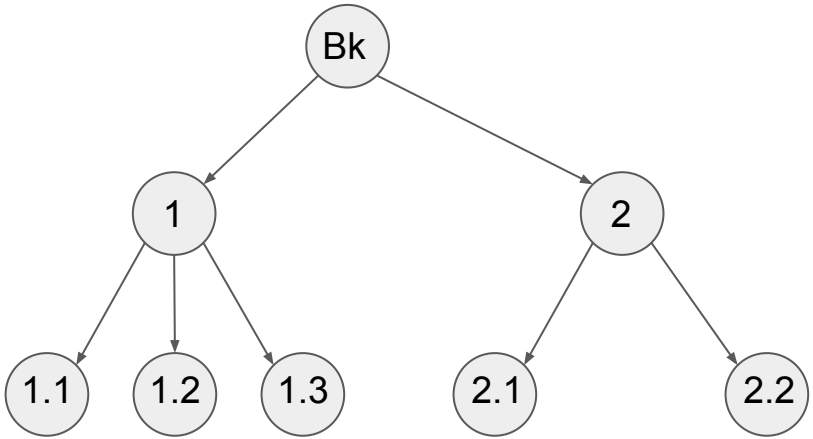
Trees are a special kind of graph.

Each node has exactly one **parent**, except for the **root node**, which has none.
Nodes without **children** are called **leaves**, or **terminal nodes**.



Trees in real life: a book's table of contents





Trees in real life: an organizational chart

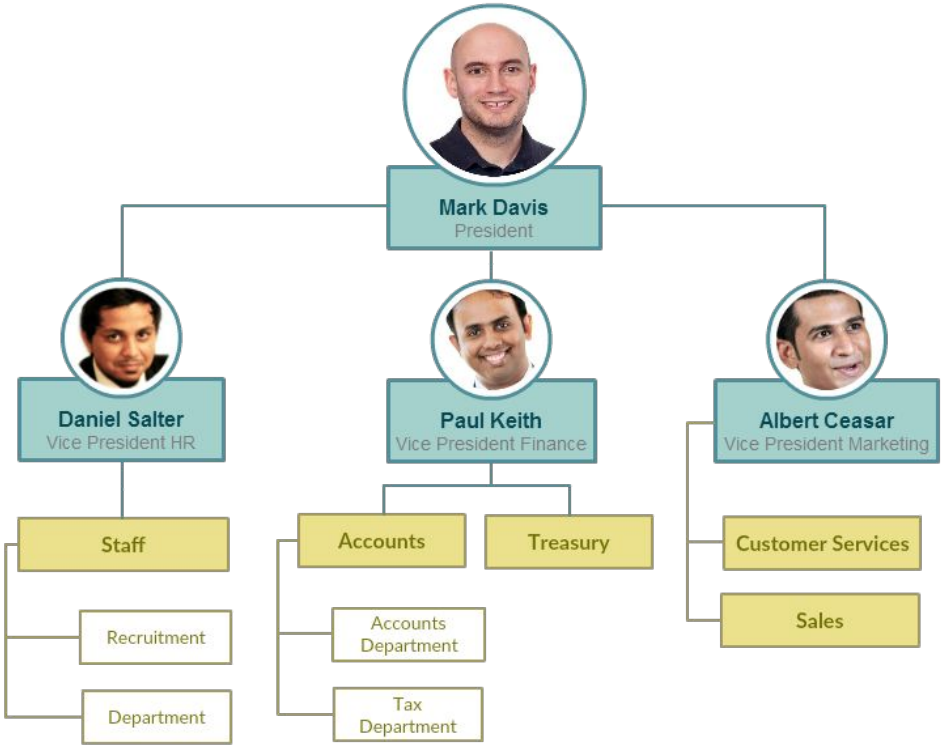


Image source: https://creately.com/blog/examples/organizational-chart-templates/

Trees in real life: taxonomic hierarchy

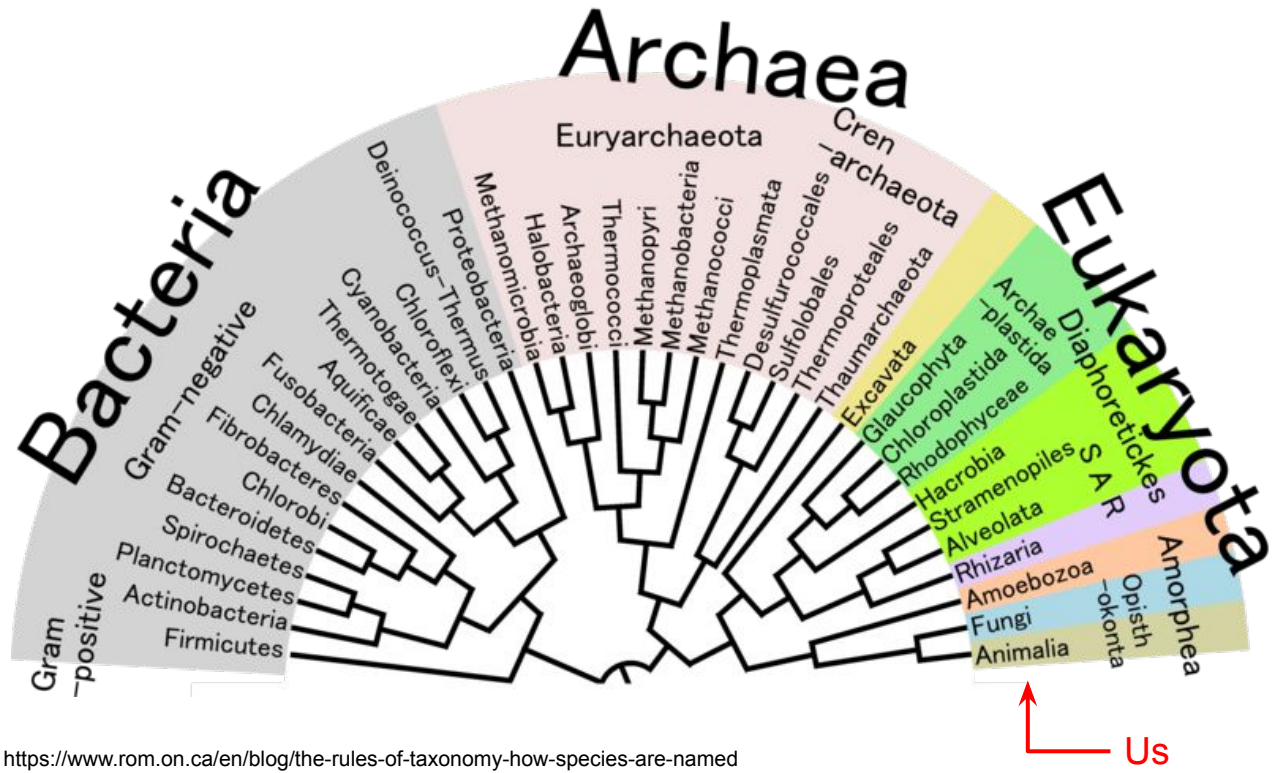
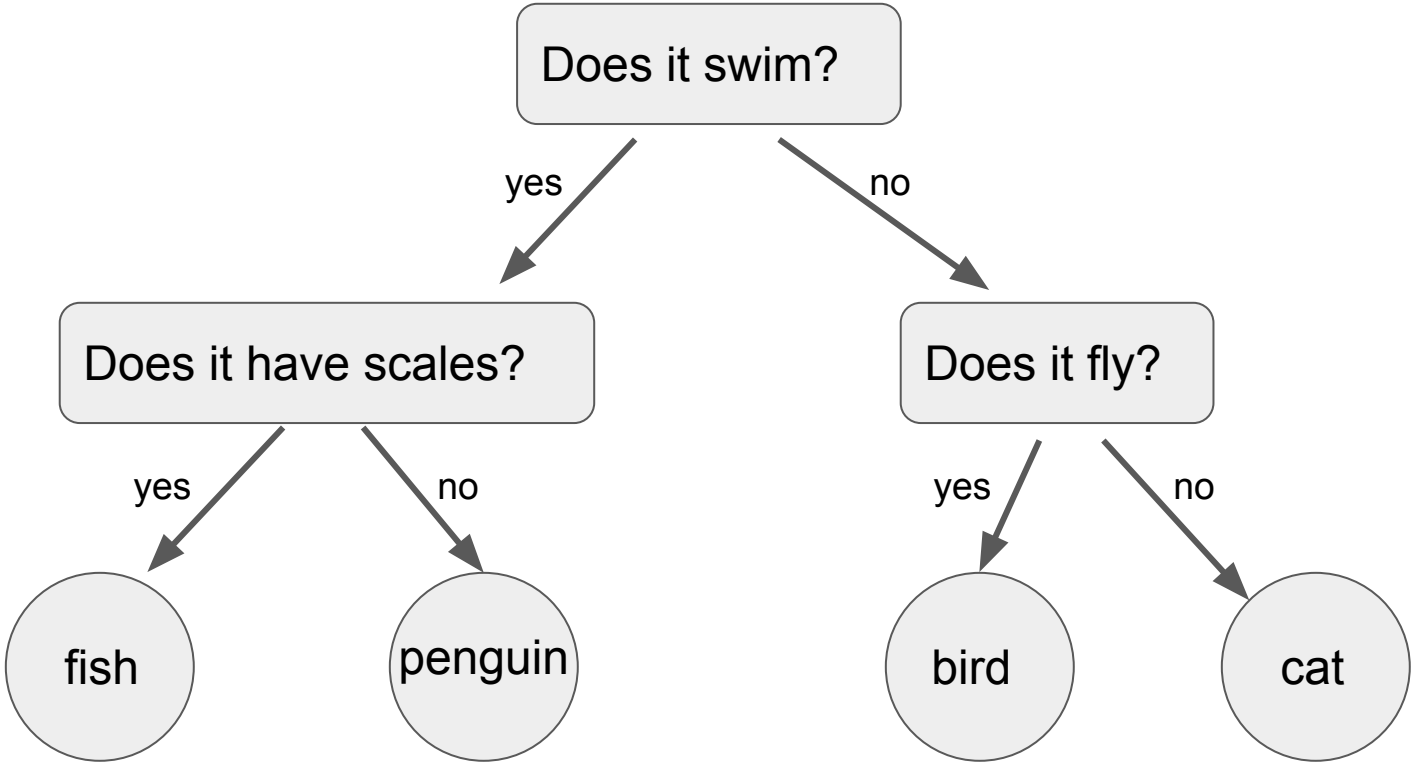


Image source: https://www.rom.on.ca/en/blog/the-rules-of-taxonomy-how-species-are-named

Unplugged Reasoning Exercise: Discrimination Net

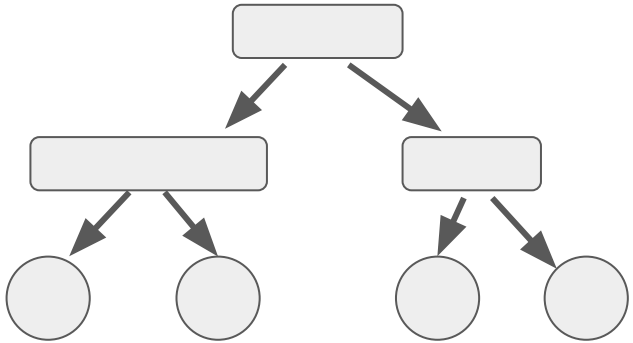
Discrimination Net: Guess the Animal



Discrimination Net: Guess the Animal

What is the **representation**?

- Tree structure
- Non-terminal nodes are questions
- Terminal nodes are animals



What is the **reasoning** algorithm?

- Start at the root node
- At a non-terminal node, ask the question.
- Use the answer to choose which node to visit next.
- At a terminal node, report that animal as your guess.

Growing the Discrimination Net

Computer: Does it have scales?

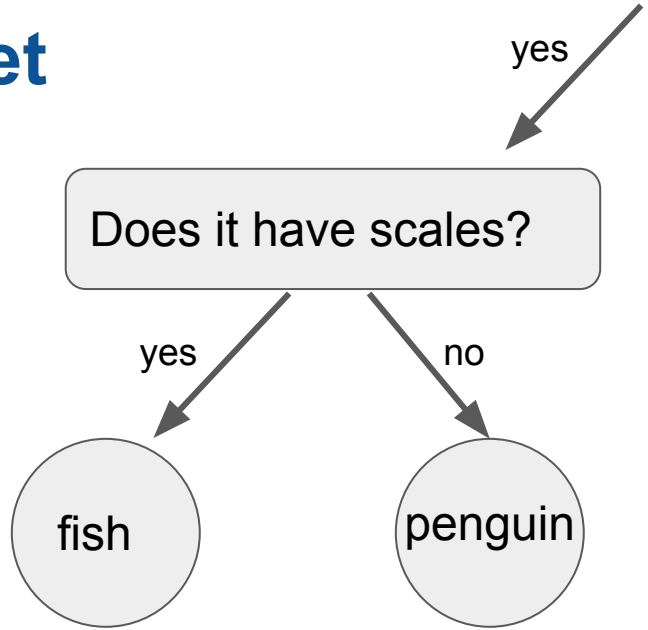
Human: no

Computer: I guess “penguin”. Is this correct?

Human: no

Computer: What was your animal?

Human: octopus



Growing the Discrimination Net

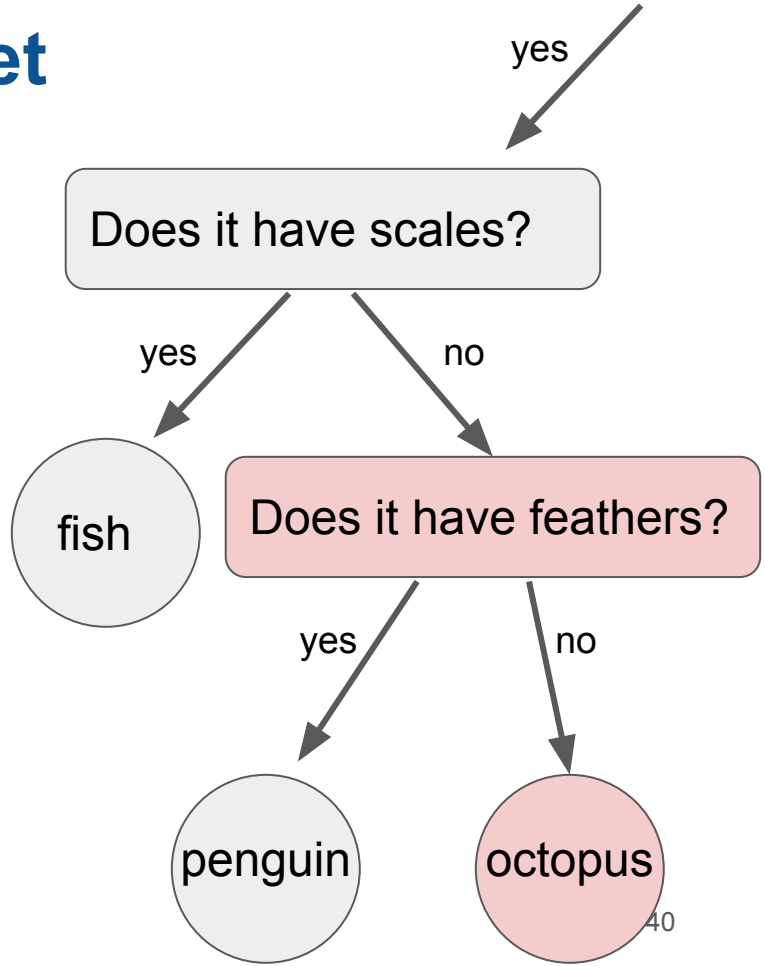
Computer: what question distinguishes between a penguin and an octopus?

Human: “Does it have feathers?”

Computer: What is the answer for octopus?

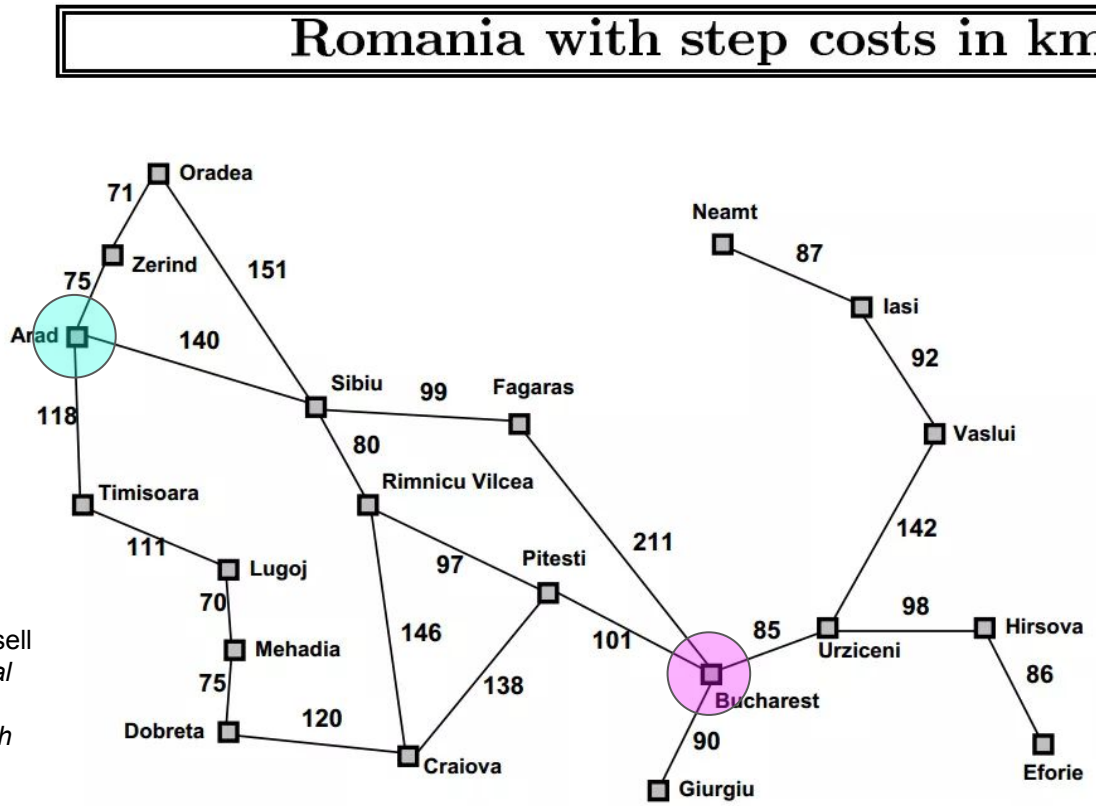
Human: “no”.

Computer: I’ll remember that.



Unplugged Reasoning Exercise: Route Finding

Finding a route from Arad to Bucharest



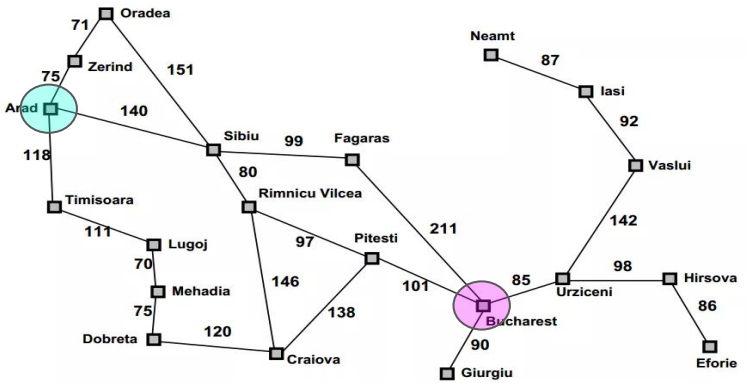
Straight–line distance to Bucharest

Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	178
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	98
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Figure from Russell & Norvig, *Artificial Intelligence: A Modern Approach*

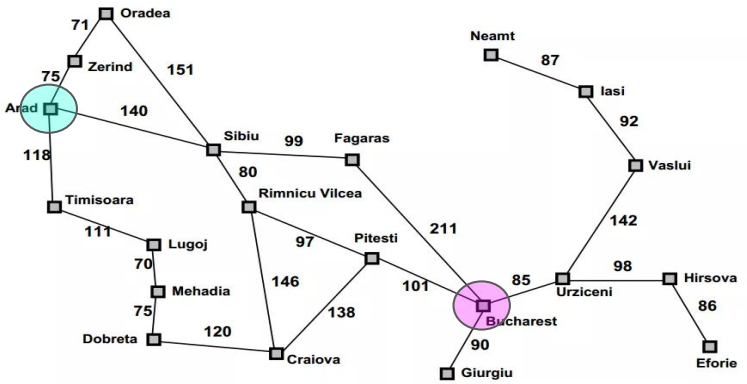
Continue on the next slide

Simple route-finding algorithm



1. **Start** at Arad on line 1.
2. Write down every city you can reach directly from Arad on line 2.
3. Write down every city you can reach from there on line 3. Skip any city you've reached on any previous line.
4. Repeat until you reach Bucharest.
5. Trace backward from Bucharest to find the route to Arad.

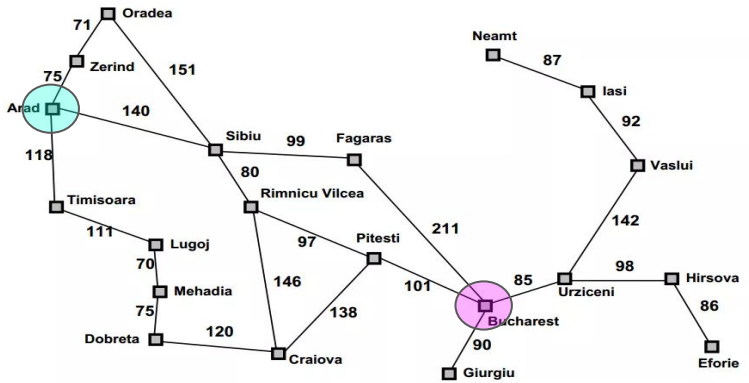
Drawing the search tree

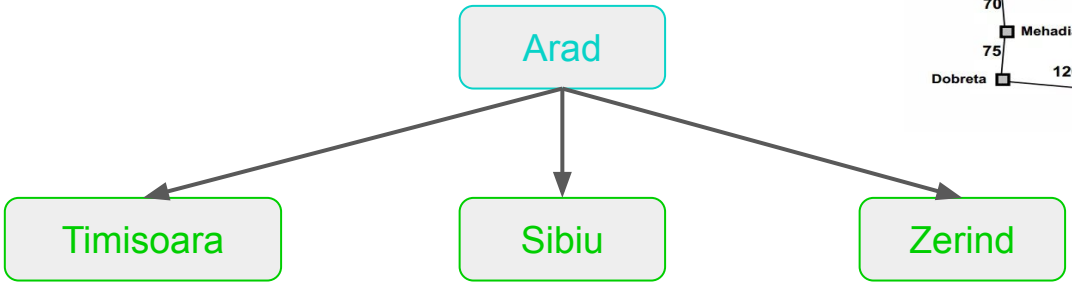


Arad

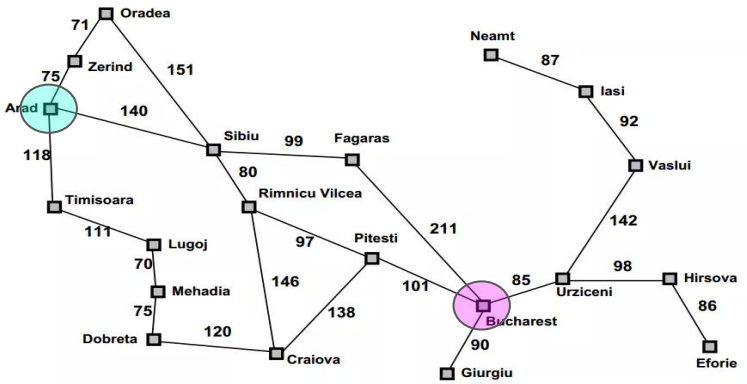
Draw this on your paper.

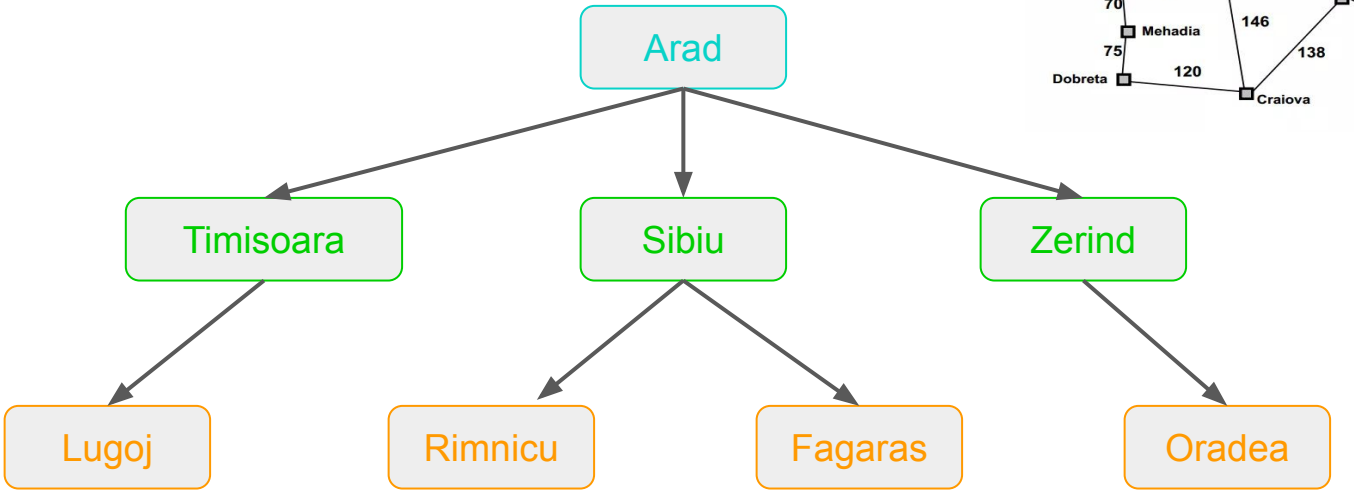
Drawing the search tree



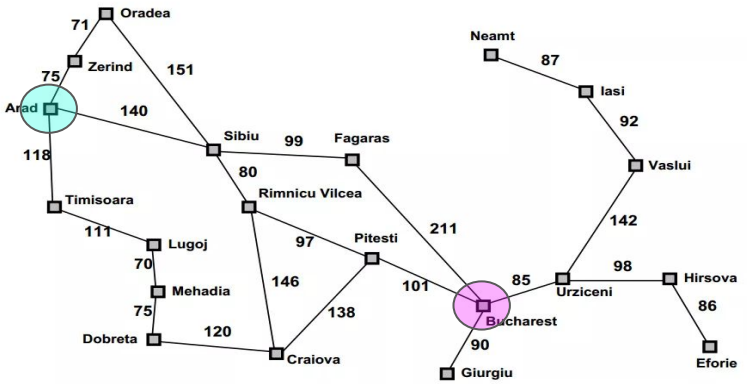


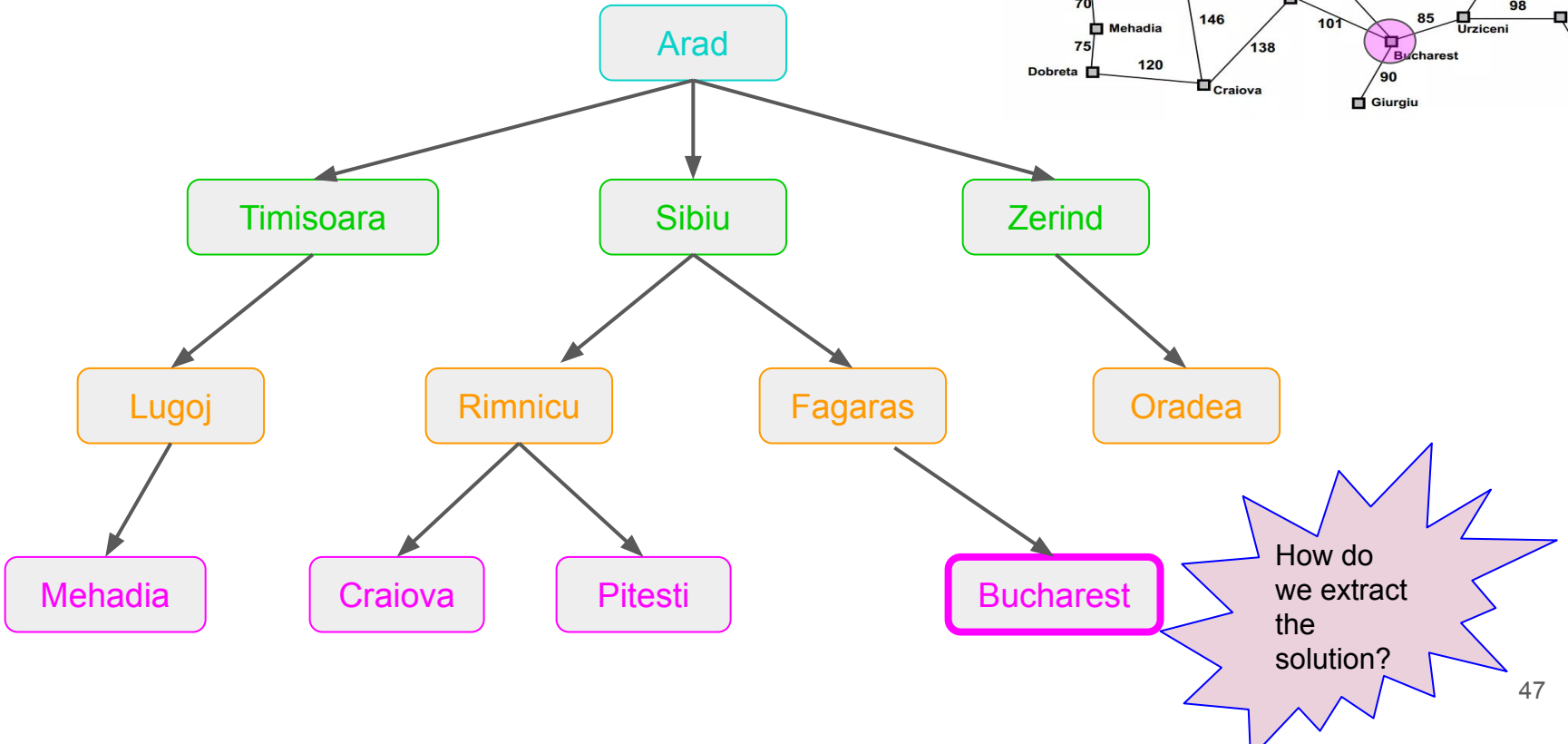
Drawing the search tree



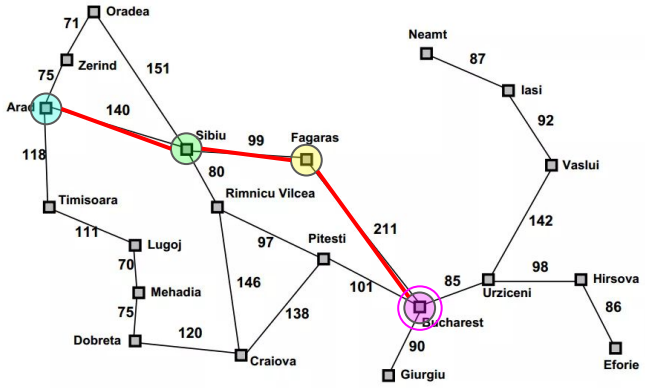


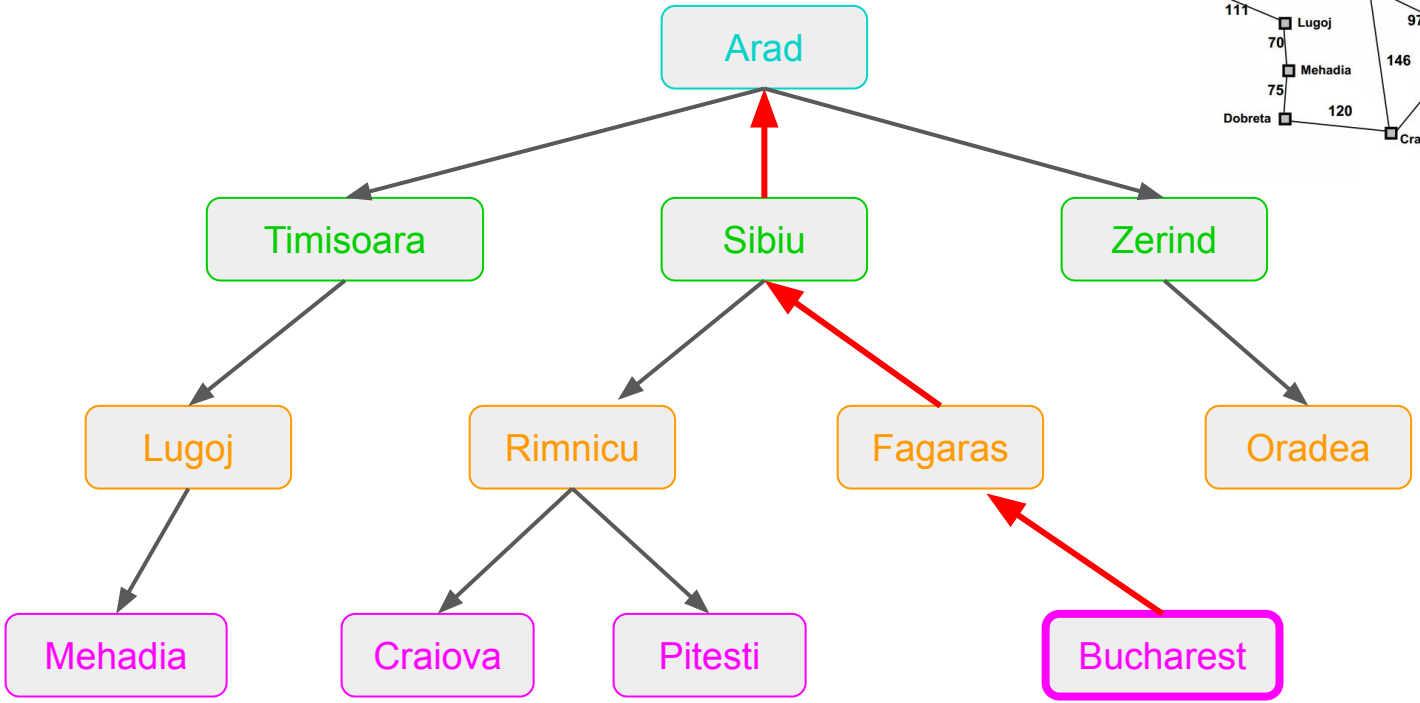
Drawing the search tree





To extract the solution path, follow the parent links to the root.





Solving Route Finding Problems

Data structure/representation:

- The input was a labeled, undirected **graph** (like a map for a self-driving car)
- The reasoning algorithm constructed a **tree** as it searched for the answer.
- The output was a **path** (a sequence of nodes) through the graph

Algorithm/reasoning process:

- Find a route as quickly as possible: Breadth First Search (what we used)
- Find the shortest route? Best First Search (a little trickier)

Part IV:
AI Programming Frameworks for Kids

Machine Learning for Kids

COGNIMATES

Calypso

Machine Learning for Kids
https://machinelearningforkids.co.uk

Organize the School Library

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

Built with IBM Watson AI

Link to Supplemental Slides

Classifier

A **classifier's** job is to sort things into categories

Spam Filters:
Spam, or not-spam?

Loan Applications:
Low risk, Mid-risk, High-risk

Ad or movie recommender:
Sports fan? Romantic? Horror fan? History buff?

Training a Classifier

A **classifier's** job is to sort things into categories

How it Works:

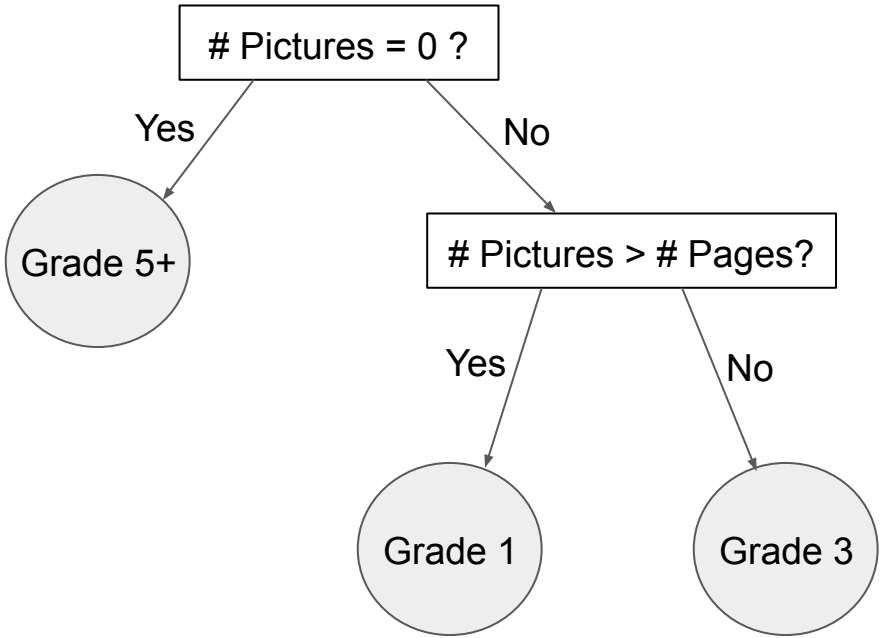
Our Role:
We choose the categories & provide examples of each one.

Algorithms:
We let the machine learning algorithm figure out how to classify the examples the way we wanted them classified. Then we can test it on new data.

One machine learning method that can be used to do the classification is called a **decision tree**.

Decision tree - a collection of nested if-then statements that classify data.

Decision tree classifier: book reading level



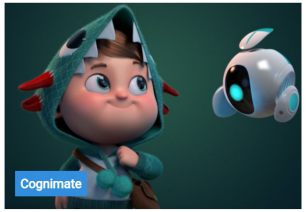
We won't see the decision tree. But if we did it might look like this.

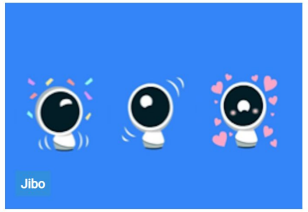
COGNIMATES

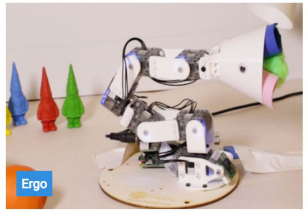
http://cognimates.me

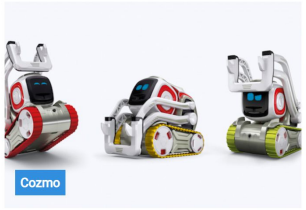
AI extensions for Scratch.

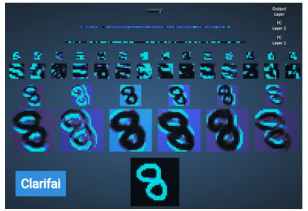
Project creator Stefania Druga
The project was supported by the Personal Robots Group at MIT Media Lab, directed by Cynthia Breazeal, Associate Professor of Media Arts and Sciences.







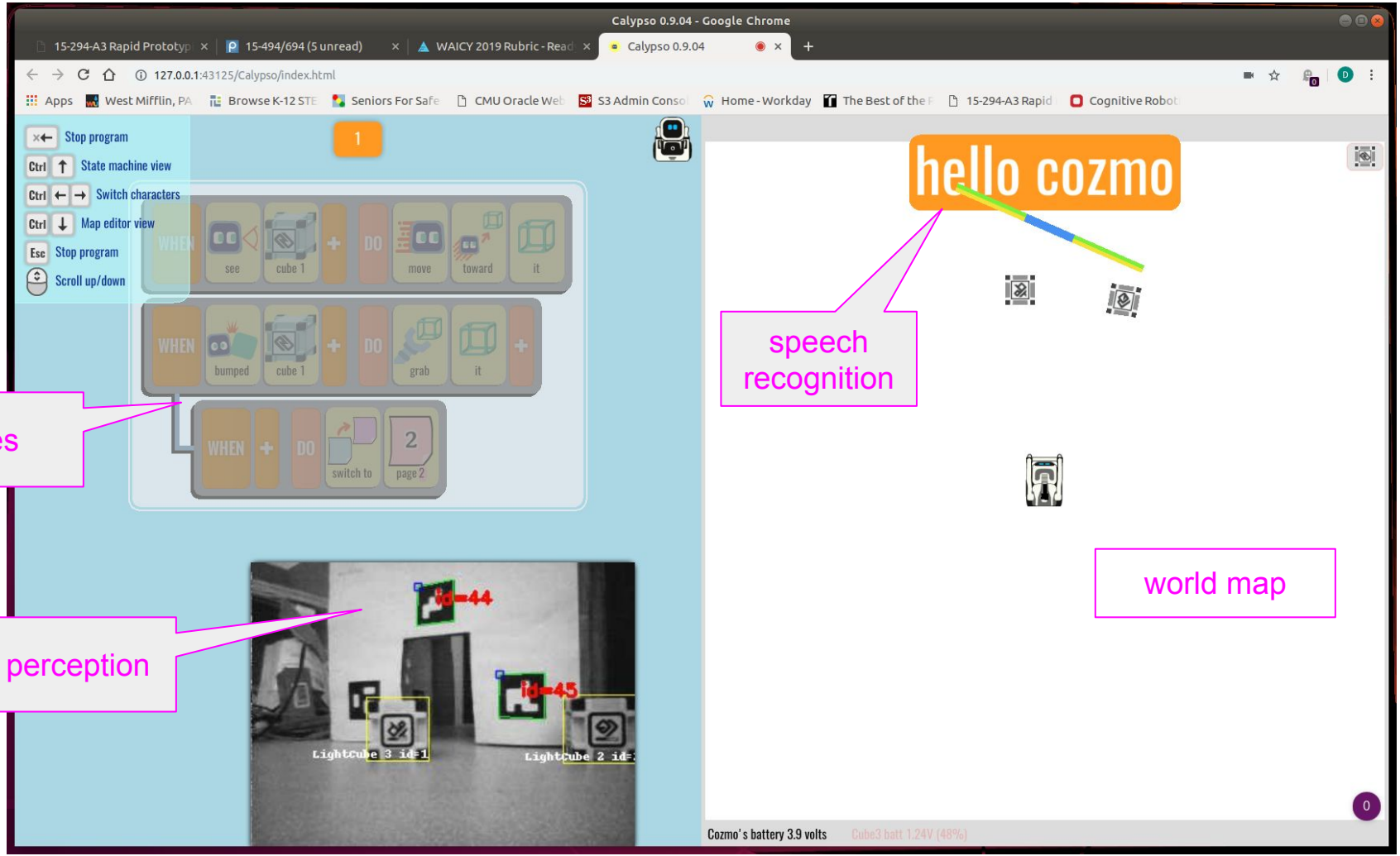




Link to Supplemental Slides

Calypso for Cozmo

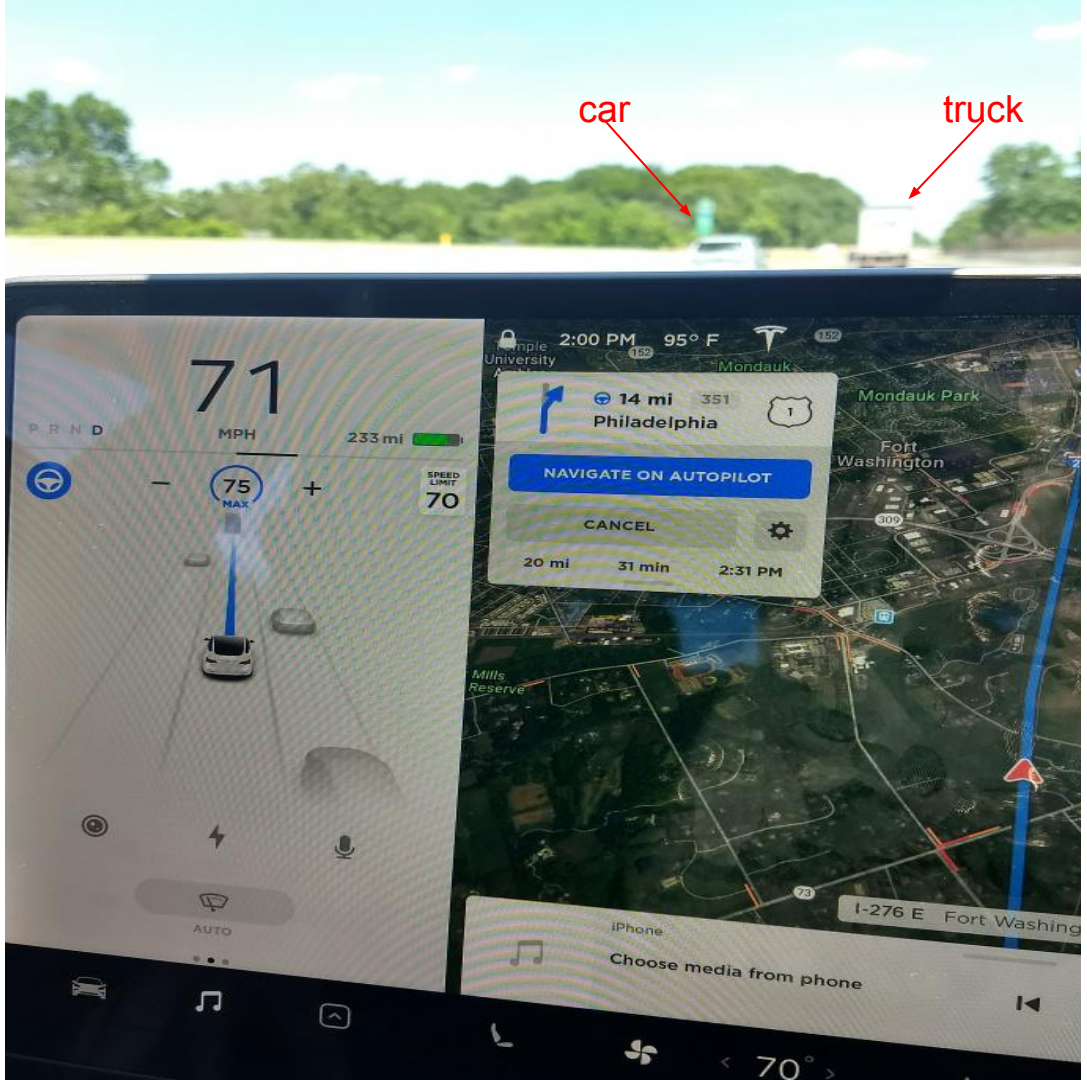
- A robot intelligence framework that combines multiple types of AI:
  - Computer vision
  - Speech recognition
  - Landmark-based navigation
  - Path planning
  - Object manipulation
- Rule-based language inspired by Microsoft's Kodu Game Lab
- Teaches computational thinking
- Web site: https://Calypso.software


Calypso 0.9.04 - Google Chrome
15-294-A3 Rapid Prototyp
15-494/694 (5 unread)
WAICY 2019 Rubric - Read
Calypso 0.9.04
127.0.0.1:43125/Calypso/index.html
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

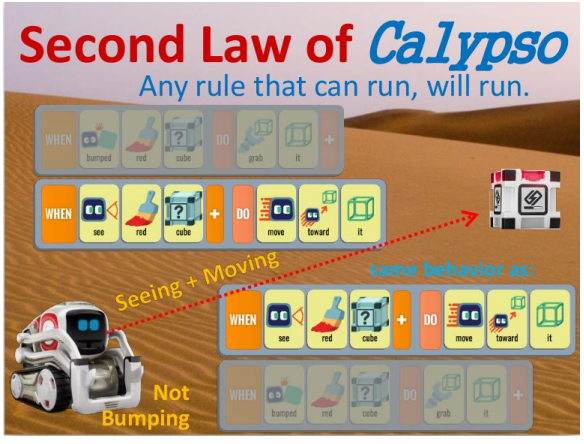
Tesla's World Map

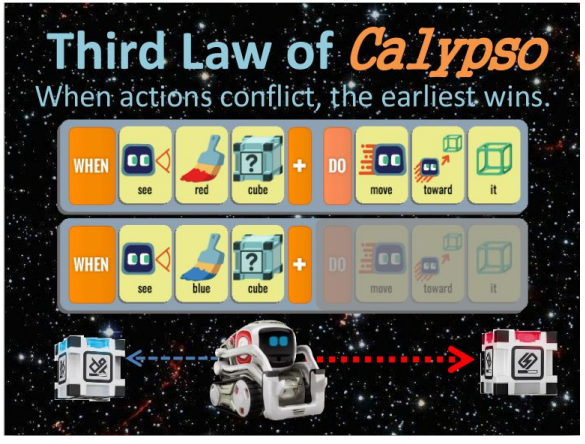
Cozmo can be considered "a self-driving car in the palm of your hand."

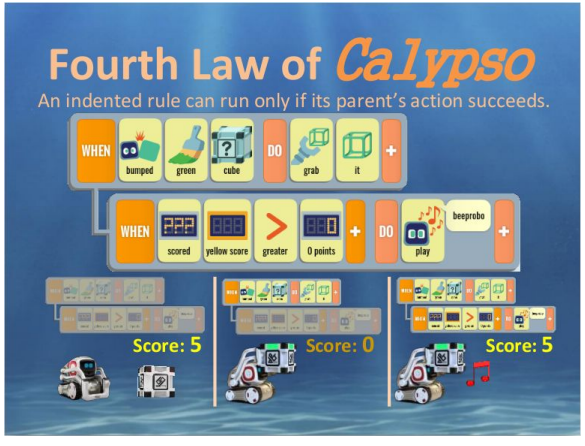
At right is an image from a real self-driving car, a Tesla, showing the road and other nearby vehicles on its world map.

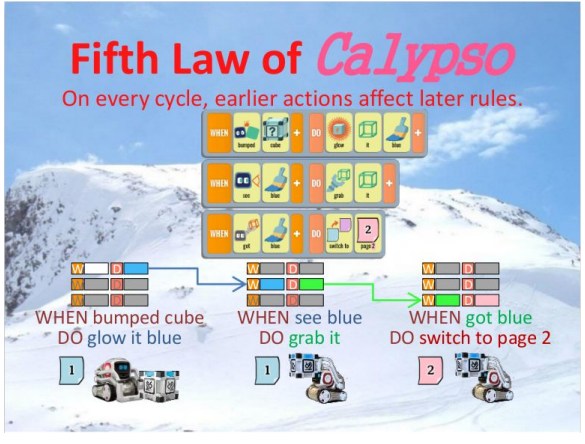


Laws of Calypso

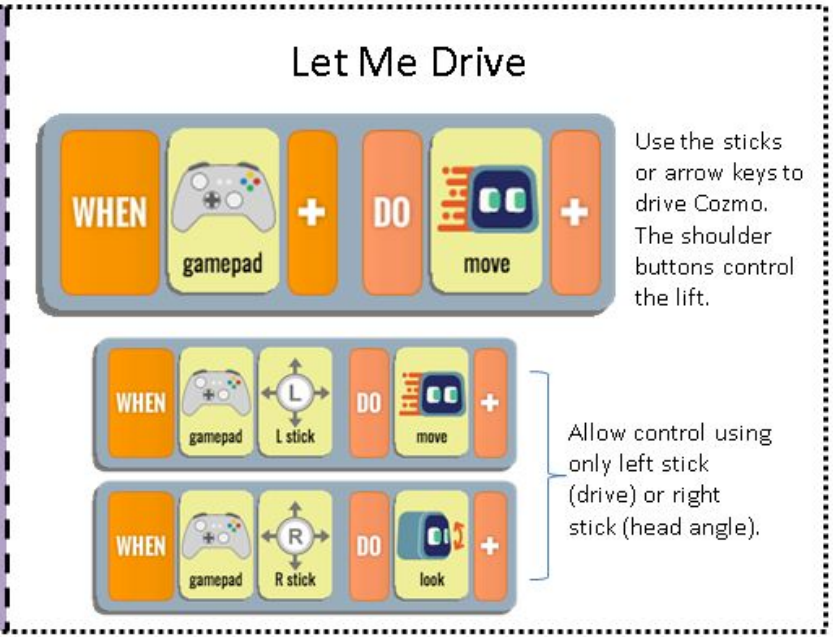








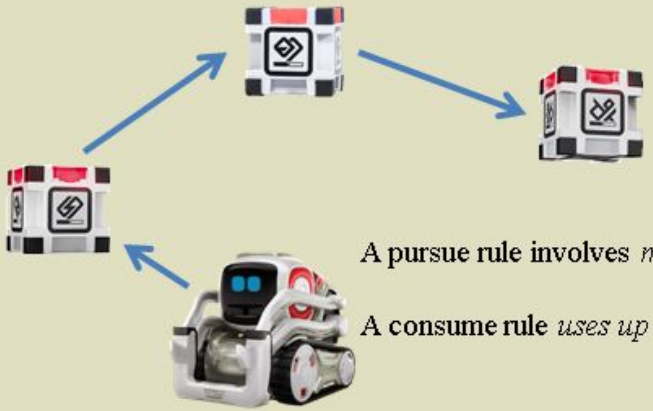
Calypso Idiom Catalog



Calypso Idiom Catalog

Pursue and Consume

Make Cozmo extinguish all the red cubes.

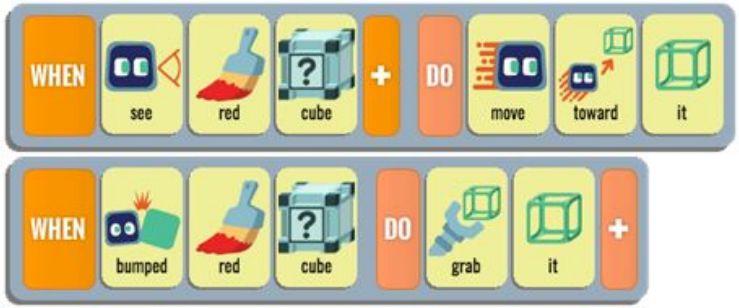


A pursue rule involves *motion*.

A consume rule *uses up* the object.

Pursue and Consume

Pursue rule



Consume rule

General Form:

WHEN see *thing* DO move toward it

WHEN bumped *thing* DO *consume* it

Calypso Curriculum

1. Carnegie Mellon Curriculum
   - Click on the “Curriculum” link at https://Calypso.software to visit the main curriculum page
   - 12 modules explain the features of Calypso and how to use them
   - Designed primarily to help teachers learn Calypso

2. New Brighton Curriculum
   - Click on the “New Brighton” link from the main curriculum page
   - Project-based approach designed for classroom implementation
   - Work in progress; more material will be available in July 2019

3. ReadyAI AI-IN-A-BOX Tutorials
   - Instructional videos available on ReadyAI’s YouTube channel
   - Click on the “ReadyAI” link on the main curriculum page

Other Resources & Next Steps

- AI4K12.org Resources Directory
- Join the AI4K12 mailing list: send mail to ai4k12@aaai.org and ask to be placed on the list.
- “Teaching AI in K-12” Symposium, Nov. 8-9, 2019 in Arlington, VA (AAAI Fall Symposium Series).
- Hour of Code Build an Alexa Skill (1hr 5 mins) https://learn.amazonfutureengineer.com/alexa/fact-skill/

Let’s continue this conversation

in our **session tomorrow, July 9 @ 10am**

How to Teach AI Across K-12

Location: West 212C

Questions?