Northeastern University
College of Engineering

Weekly STEM Newsletter - Week 21 (10.16.2020)

Artificial Intelligence and Robotics

Introduction

Have you ever wondered how Siri is able to understand what we say and can respond? This is an example of AI. AI stands for Artificial Intelligence and is the construction of systems that have human-like intelligence. Traditionally, machines do exactly what you tell them to do, with every single possibility planned out through a program. AI allows machines to start learning, to build on the existing knowledge and keep expanding -- not everything is explicitly programmed. AI uses machine learning to do so. There are different ways a machine can learn: unsupervised learning, supervised learning, or reinforcement learning.

Supervised learning is providing the machine the input as well as the expected output to learn from. The training data is labeled and once it is trained, it should be able to label unlabelled data. For example, you can teach an AI model to identify cats and dogs and differentiate between the two. To train it, you give it several examples of cats with the label 'cat', and do the same with dogs. To test your model, give it an unlabelled cat or dog example to identify -- one that it has not seen before. Unsupervised learning is the opposite of supervised learning, where the training data fed to the model is not labeled. The machine would then be expected to group the data based on the similarities it observes. An example would be providing your AI model different sounds that are not labelled or tagged, and have the machine sort the sounds. Reinforcement learning is when the machine is given a task to achieve, and learns and improves based on rewards. It will learn from its own mistakes and make progress.

There are different fields of AI such as Computer Vision, Natural Language Processing, and Robotics. Computer vision is the interpretation of the visual world. It allows machines to "see" and understand what they are seeing. Natural Language Processing is when machines process human language, understand it, and extract useful information from it, just like our first example: Siri. Robotics is the design, construction, and application of robots. Robots are machines that can be programmed to execute a series of actions.

All robots have a mechanical component, the frame, the gears, the form, etc. Then you have the internal electrical components with circuits, wires, and a power source that moves the mechanical parts. The last aspect is the programming. There are three different types of robotic programs: remote control, artificial intelligence, and hybrid. Remote control is when a robot is

programmed with a set of commands and awaits a signal to be activated. Artificial intelligence, as we learned, is when the robot has some human-like intelligence. A hybrid is a mix of the two. Robots have many applications including healthcare, education, factories, agriculture, and even in our own homes.

Northeastern Connections

Faculty Connection

Northeastern has an Institute for Experiential Robotics where they create artificial intelligence that learns from humans in order to build robots that can bridge the gap between humans and machines. Professor Hanumant Singh, Associate Professor Taskin Padir, and Assistant Professor Peter Whitney are highly involved, and hope to advance the capabilities of autonomous robots to be able to perform daily tasks with humans. They study research problems including: machine learning, human-robot interaction, autonomous systems, the ethics of robots, and the socioeconomic impact of robots on humans.

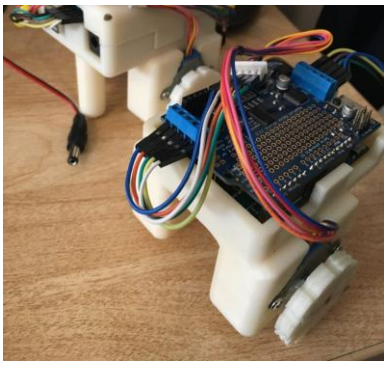
On Northeastern's Boston campus, the university is also launching an Institute for Experiential Artificial Intelligence, a research hub with experts in law, machine learning, security, health, and sustainability will work together to find solutions to the world's challenges. "This new institute, the first of its kind, will focus on enabling artificial intelligence and humans to collaborate interactively around solving problems in health, security, and sustainability. We believe that the true promise of AI lies not in its ability to replace humans, but to optimize what humans do best." - Northeastern President Joseph E. Aoun.

Last month (Sep 2020), Northeastern opened its most recent campus, the Roux Institute in Portland, Maine, with a focus on AI and machine learning in digital and life sciences. This institute is dedicated to both research and learning and offers Master's, Certificate, PhD, and Post-doc programs in a variety of fields.

Student Connection

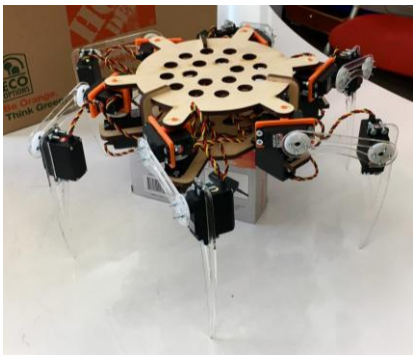
The NU Robotics Club is a student organization that maintains several different robotics projects. They aim to help students learn robotics and hope to encourage a love for learning. This is a club that helps students get into robotics, even if they are inexperienced.

Here are some of their projects:



Swarm Robotics: NU Robotics is designing and creating 10 identical robots that will communicate with each other to complete a task. They are learning more about robot-to-robot communication to be able to successfully make these robots.

Hexapod: The aim for this project is to develop an autonomous robot that can walk on its six legs using data from the sensors that are attached to it. The mechanical aspect of the robot is complete, and NU Robotics just needs to complete the programming aspect.



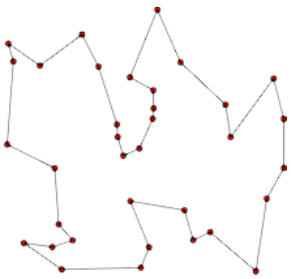
Another robotics-focused Northeastern student group is NUTRONs, also known as FIRST Robotics Team 125. As part of this club, Northeastern students serve as mentors to high school students competing in the FIRST robotics league, as well as participating in a variety of outreach events such as University Day and Latino STEM Alliance's low-cost robotics competitions.

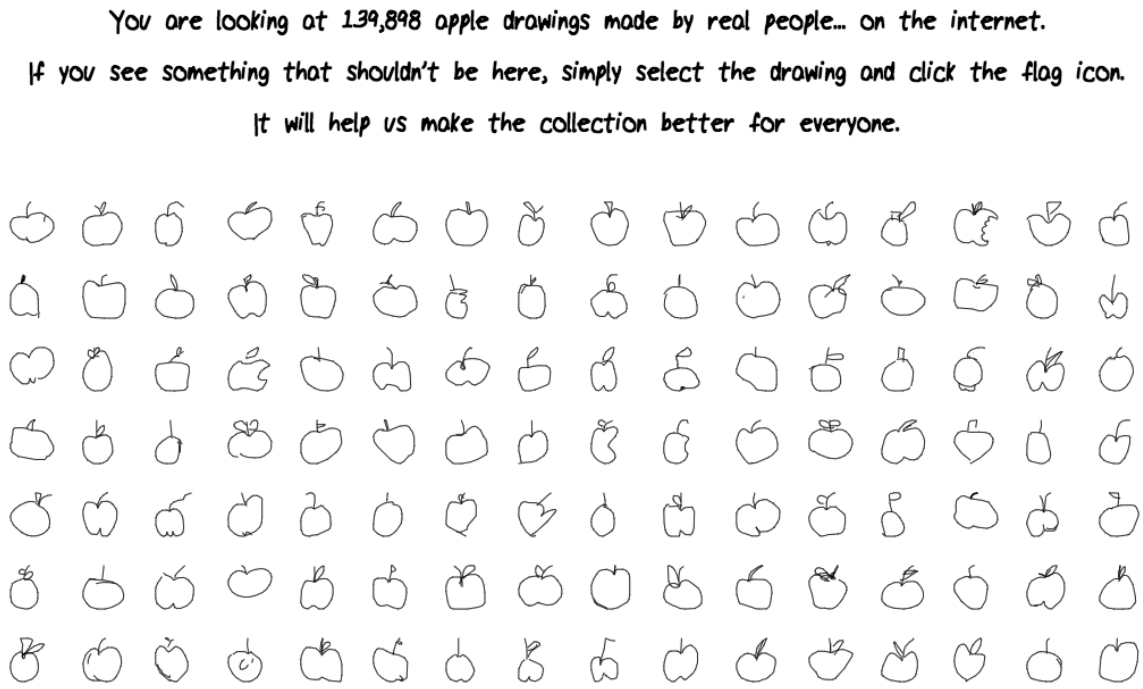
Do Now

Google AI Experiments

https://quickdraw.withgoogle.com/

Click on the link above. The machine gives you a prompt to draw, and because of AI, it can guess what you're drawing. It has learned how to identify drawings through supervised learning (type of machine learning). There were previous drawings submitted by people for each prompt, and the machine learned to identify the characteristics: meaning that it was able to predict your drawing.





It learns from human examples and you can even remove the "bad apples" to help it learn from drawings that most represent what an apple drawing looks like.

Activity

Every robot needs a programmer, why not be both?

Source: https://curriculum.code.org/csf-18/coursee/6/

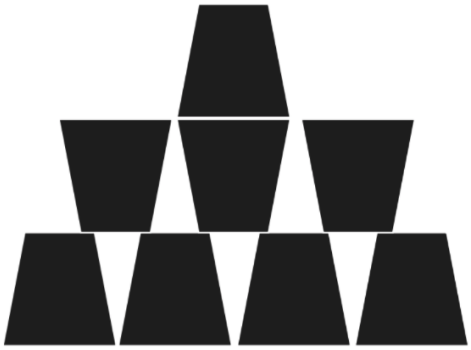
Materials Needed:

You can use any materials you want but here are some suggestions:

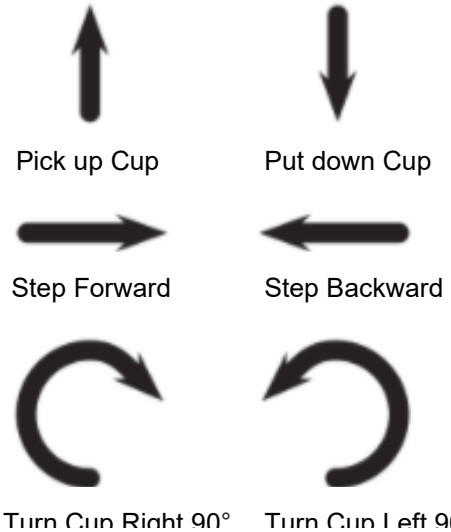
- Paper
- Pen or Pencil
- Paper cups

Steps:

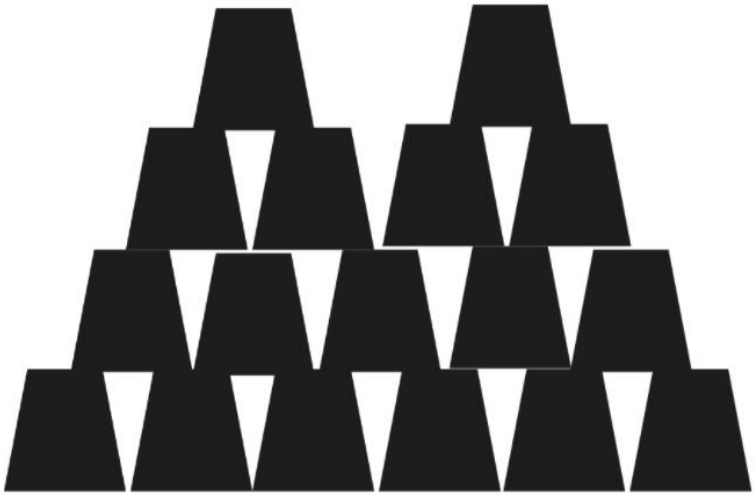
1. You will play the role of a programmer and a robot
2. You will need to write instructions to set up a tower of cups, such as the one in this image:



3. As a programmer, write a series of commands, using these symbols:



4. You can use numbers to symbolize the number of times a step should be repeated, or just draw the symbol out that number of times
5. Now that your code is ready, you are the robot now! Execute the instructions, follow what you wrote down accurately.
6. After trying it out as the robot, switch back to being the programmer. Did the robot build the tower correctly? If not, change parts of the code and let the robot try it again.
7. Once you master the first tower, try this one:



Discussion Questions:

- What is a loop?
- What type of machine learning would you use to teach a robot to build it on its own? Why?
- What was the most difficult part of the task?

Share Your Results

We'd love to know how the activity and/or the "do now" turned out! What worked and what didn't work? Please share with us something you learned and/or send us pictures! Email us at stem@northeastern.edu.

Related links/Extensions

- How Engineering Robots Works: Crash Course
- Important Inventions in Robotics
- Machine Learning Bias Game
- Machine Learning for Kids
- Unplugged Activities
- Google AI Experiments
- STEM.org AI Resources
- AI4All Open Learning
- Video on AI Learning (language warning)