MathDance Workshop

Introduction to AI (ML/DL) with Teachable Machine & Scratch

for the Roeper School

Jan 16, 2025

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https://en.wikipedia.org/wiki/Chan-Jin_Chung

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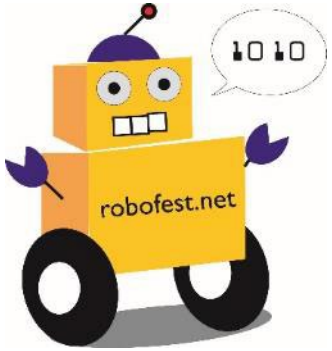


Pre Survey

- https://docs.google.com/forms/d/e/1FAIpQLSciHoCDB4GdrQfMzZgCXYAUOL9jdqAoeyWqfAnMh0w7kfzvgQ/viewform?usp=sharing

Goals of MathDance Workshops

1. Learn basic concept of ML/DL
2. Learn/Sharpening Scratch Programming Skills
3. Learn mathematical functions
4. Integrate Math, AI, and Scratch to develop a MathDance Game App
5. Advance Quality Education, one of the UN's Sustainable Development Goals

United Nations

This presentation file in PDF is available at

https://www.robofest.net/DL/ROEPER.pdf

Workshop Assistant

Devson Butani

Robotics Research Lab Manager

Agenda

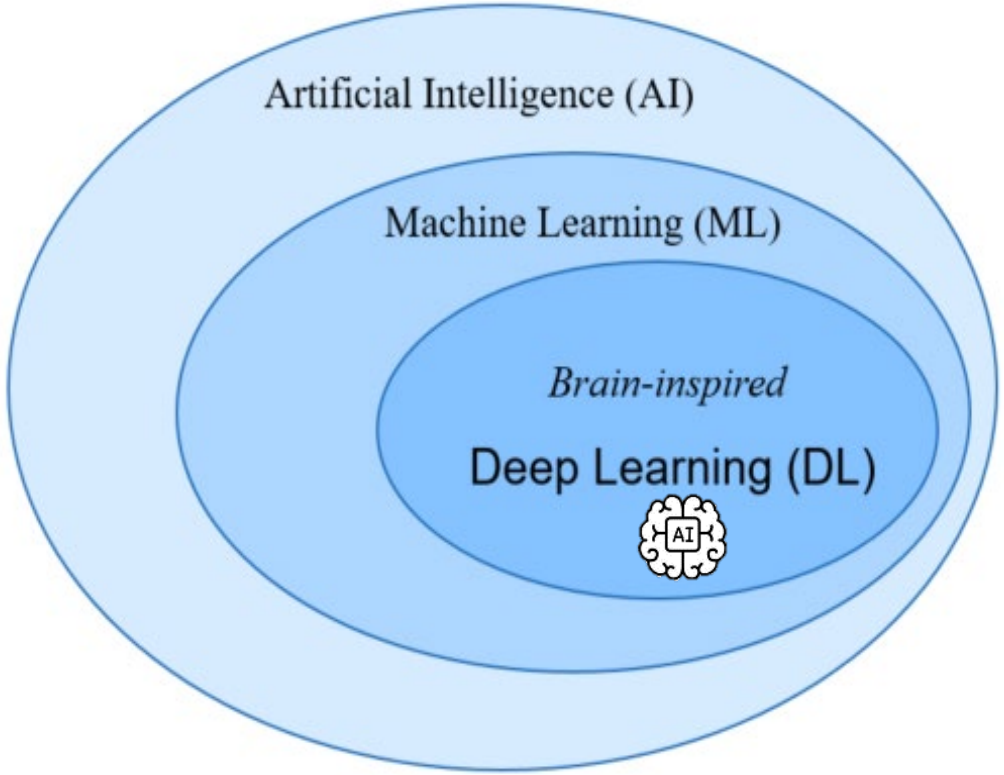
(1) Intro to Machine Learning (ML)

(2) Introduction to Teachable Machine (TM)

(3) Introduction to Scratch Coding

(4) Hand MathDance Game App Development

What is Machine Learning (ML) - A subfield of AI



AI mimics the intelligence of humans

ML?
makes machines (models*) learn from example-data**

DL?
makes machines learn from example data **using brain-inspired algorithms.**

Today, we will use only labeled sample data using "supervised learning method".

(*) The model learns the mapping between input and output
(**) labeled, unlabeled, or past experience.




…


label ➡

Cat Cat Cat Cat

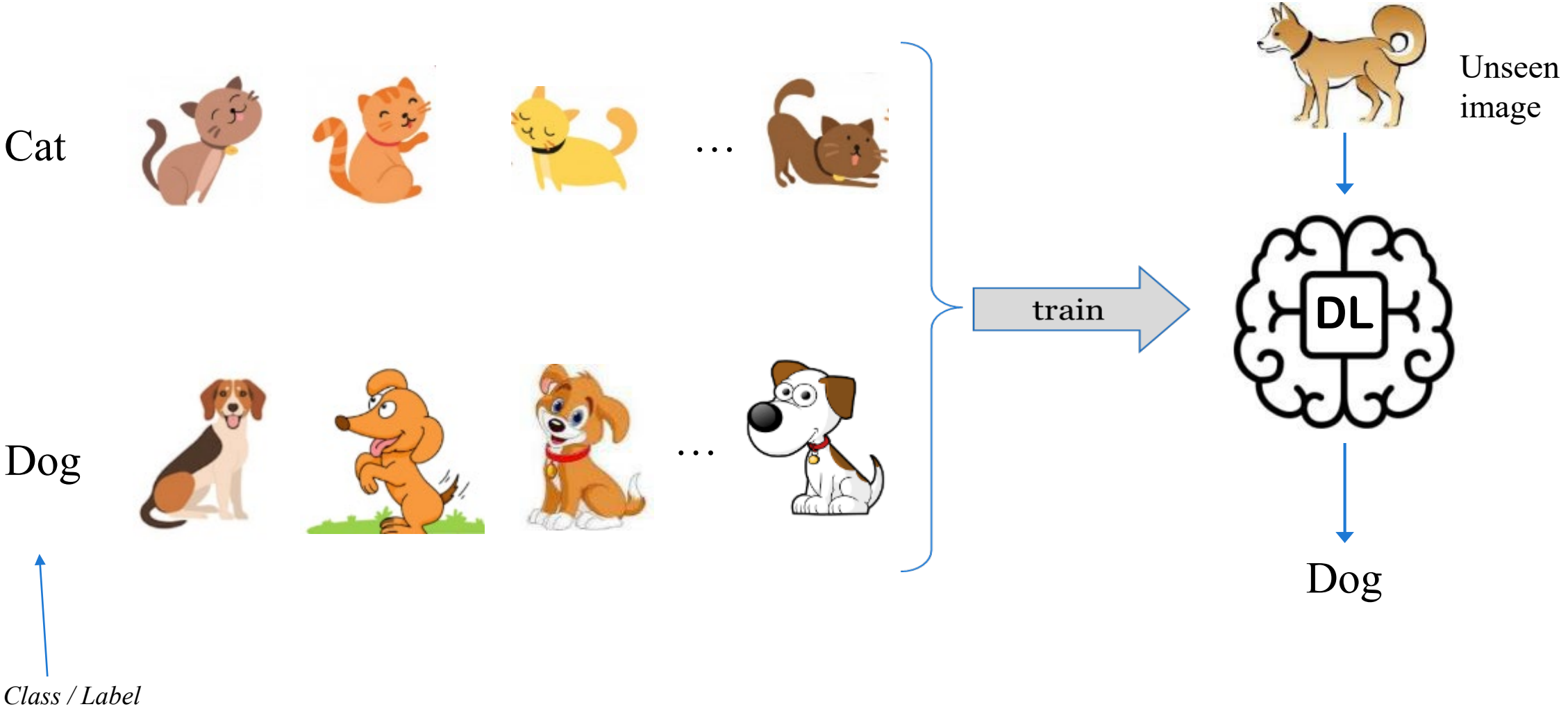



...


label ➡ Dog Dog Dog Dog

What's the label of this image?

Example of ML



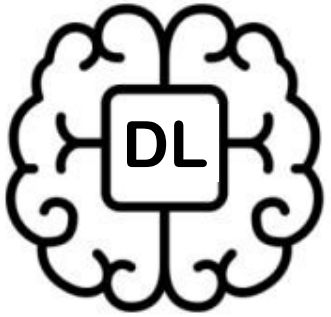
Example of ML: What is wrong?

Dog

Cat

Miss labeled

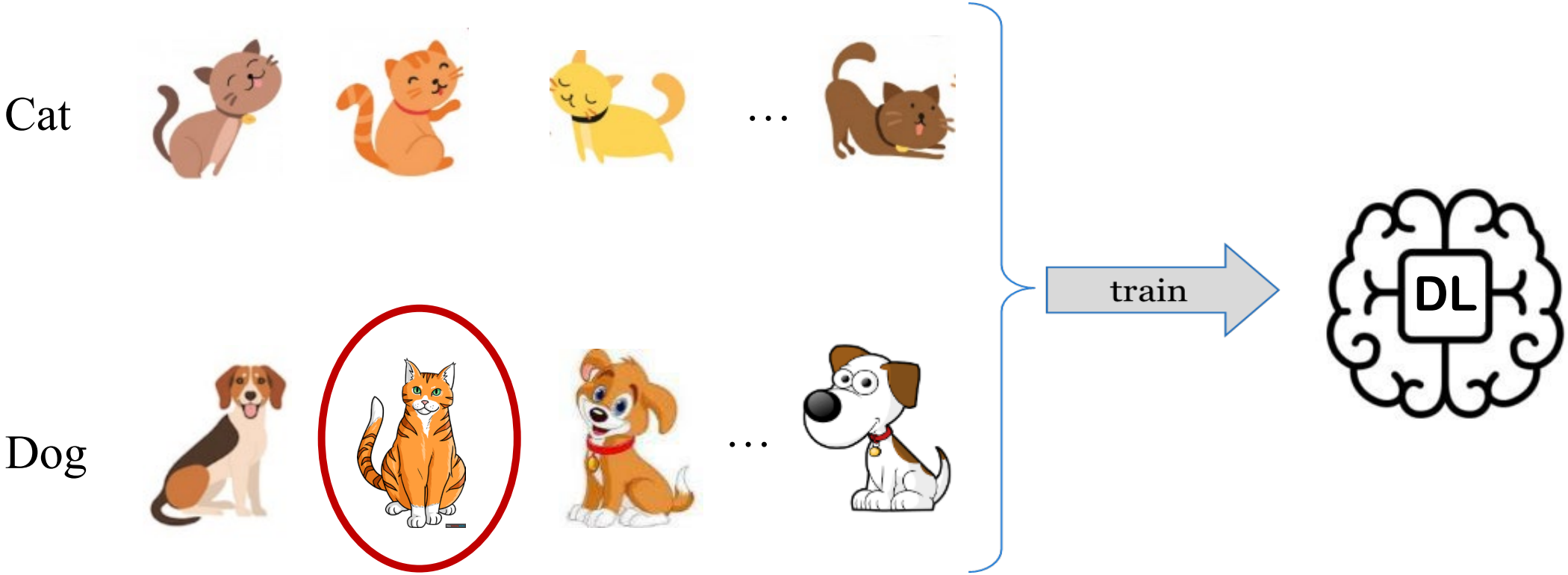
train



Unseen image

Cat

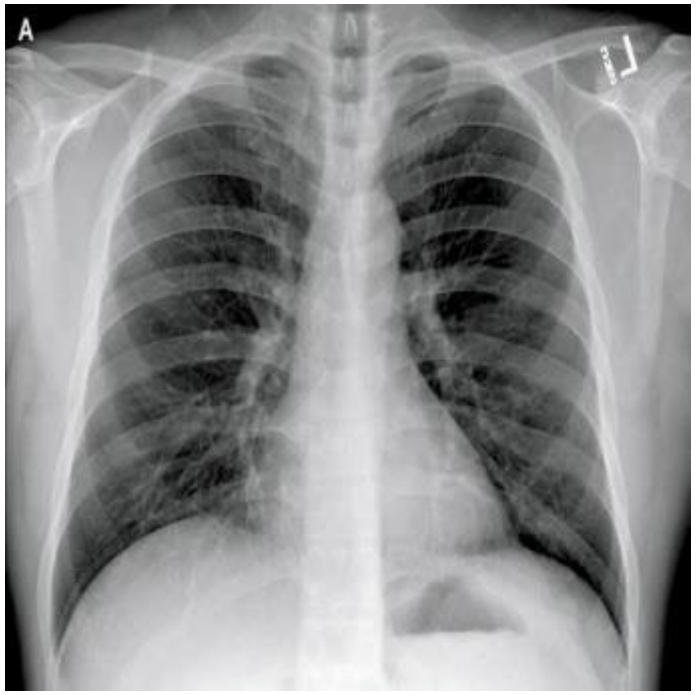
Example of ML: What is wrong??



Normal Chest X-rays

. . .

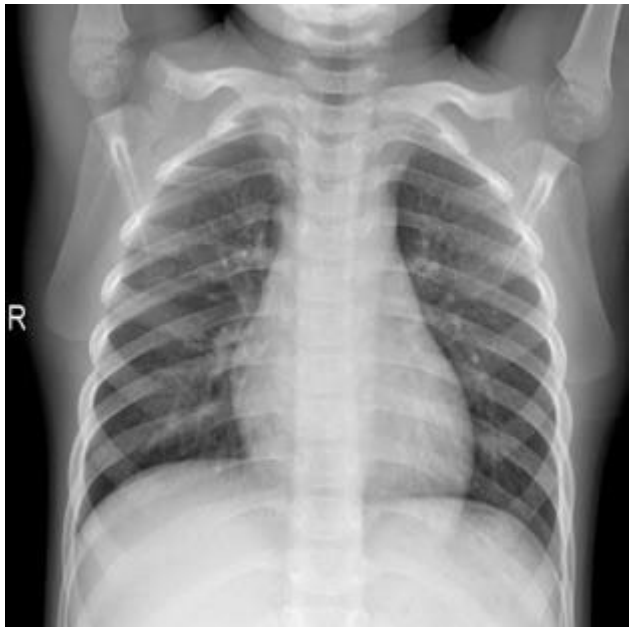
COVID 19 Chest X-Rays



• • •

Chest X-Rays for Pneumonia Viral Case

. . .



?

Normal



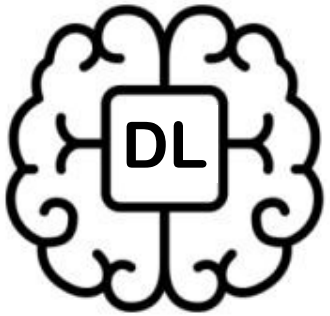
Covid19



Pneumonia
Viral

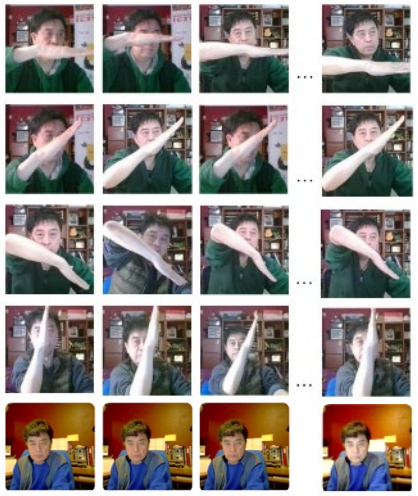


train

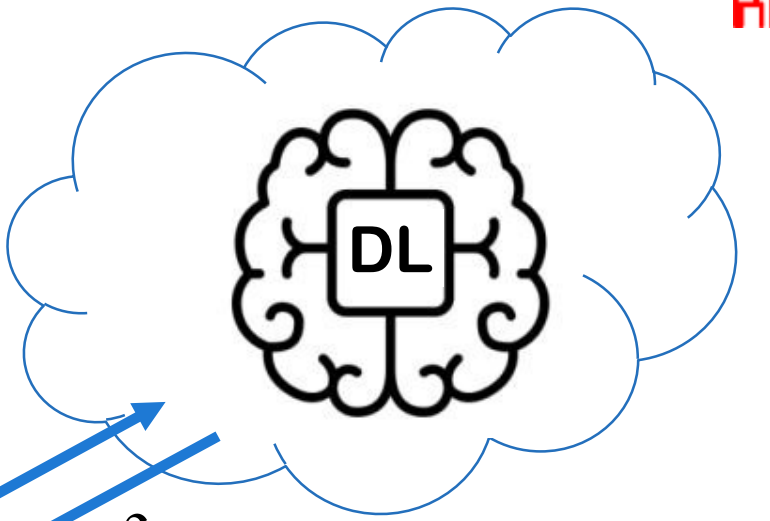


Unseen image

Normal



Teachable Machine



Webcam image
(unlabled)

Label, confidence

Inference

mathDance1

MathDance1

Day 1
Project

https://youtu.be/nhMvf34A4TI

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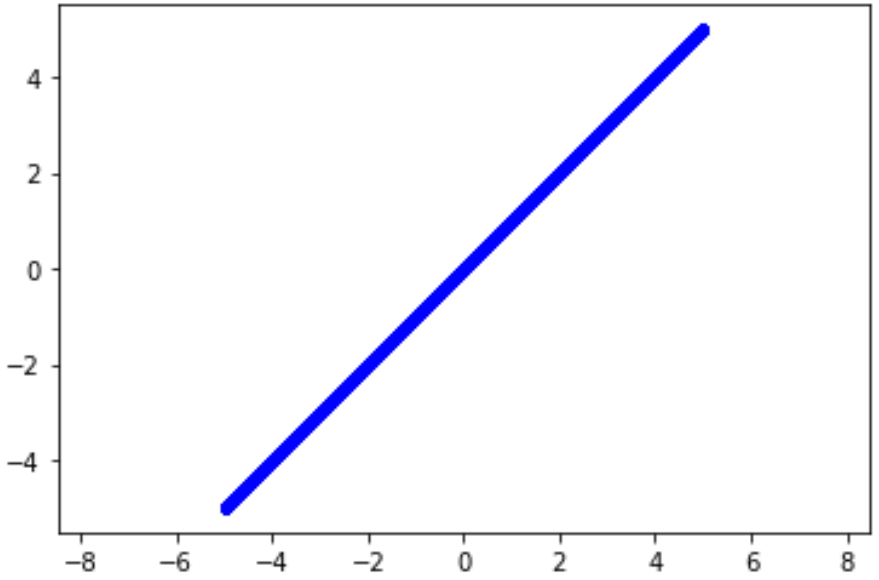
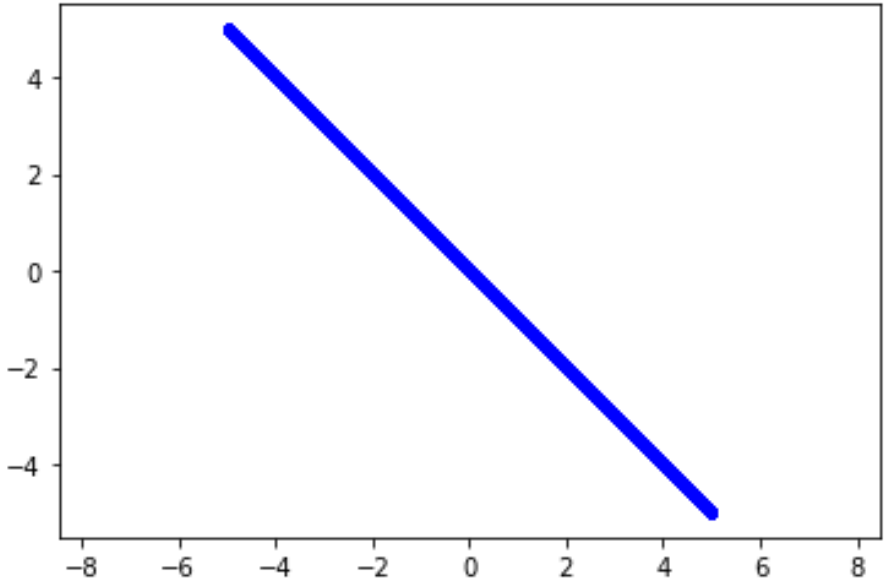
(3) Introduction to Scratch Coding

(4) Hand MathDance Game App Development

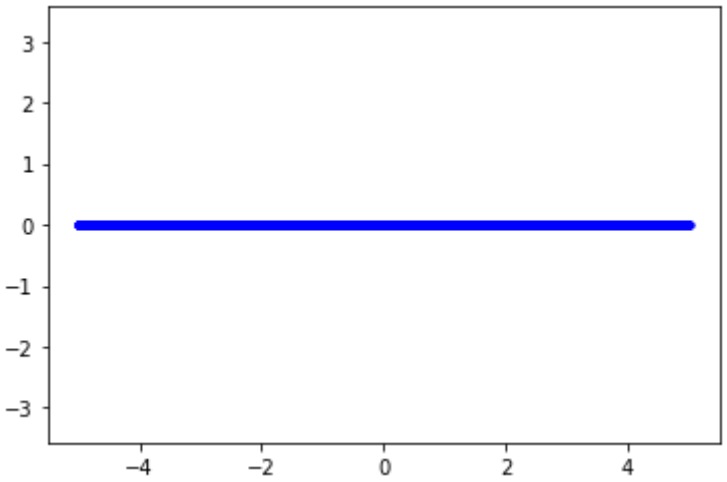


$y = x$

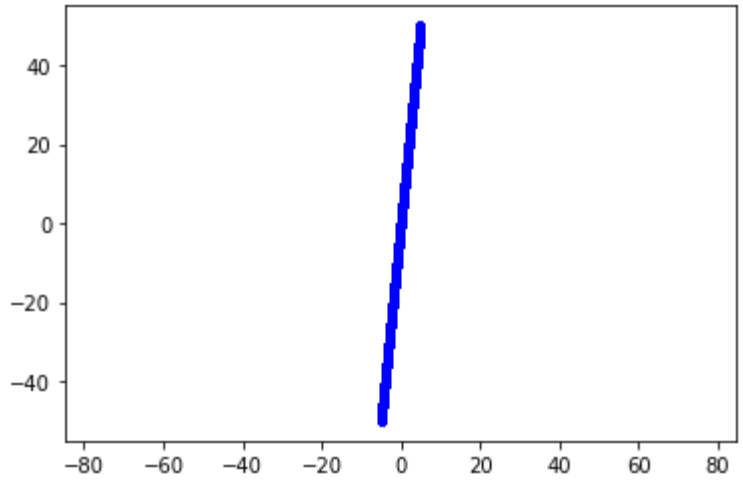


$y = -x$

Roll up your sleeves!



$y = 0$



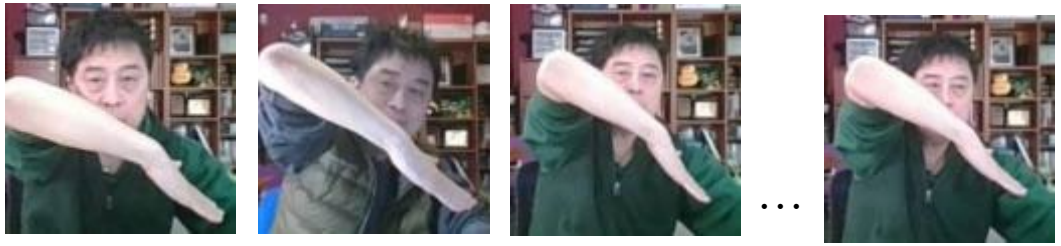
$y = 10x$

Roll up your sleeves!

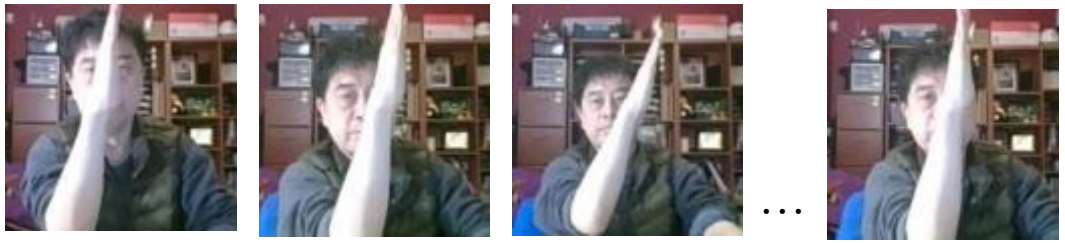
5 classes (one-hand gestures only)

$y = 0$

$y = x$



$y = -x$



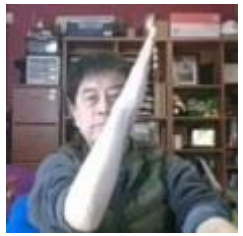
$y = 10x$

none

50+ samples

train

Scratch app

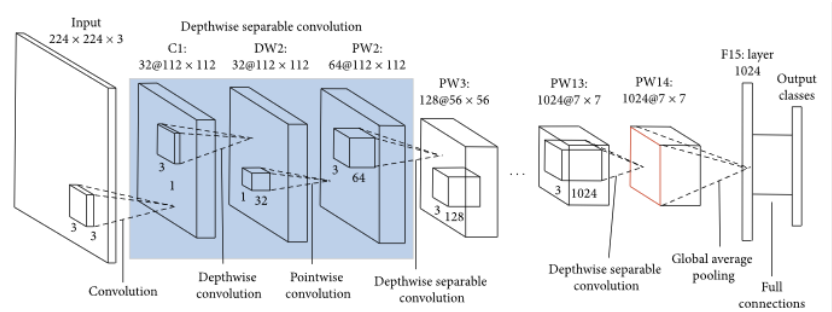


New image

Trained DL Model

$y = 10x$

Tools to use today



Teachable Machine (TM) - using Pretrained MobileNet

- https://teachablemachine.withgoogle.com/

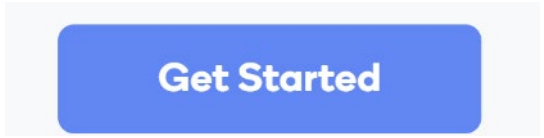
Machine Learning for Kids (ML4K)

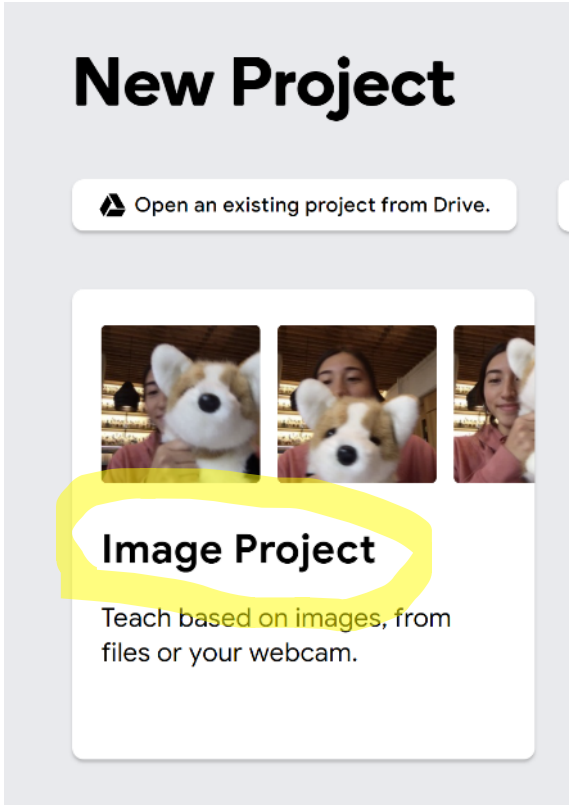
- https://machinelearningforkids.co.uk/#!/pretrained

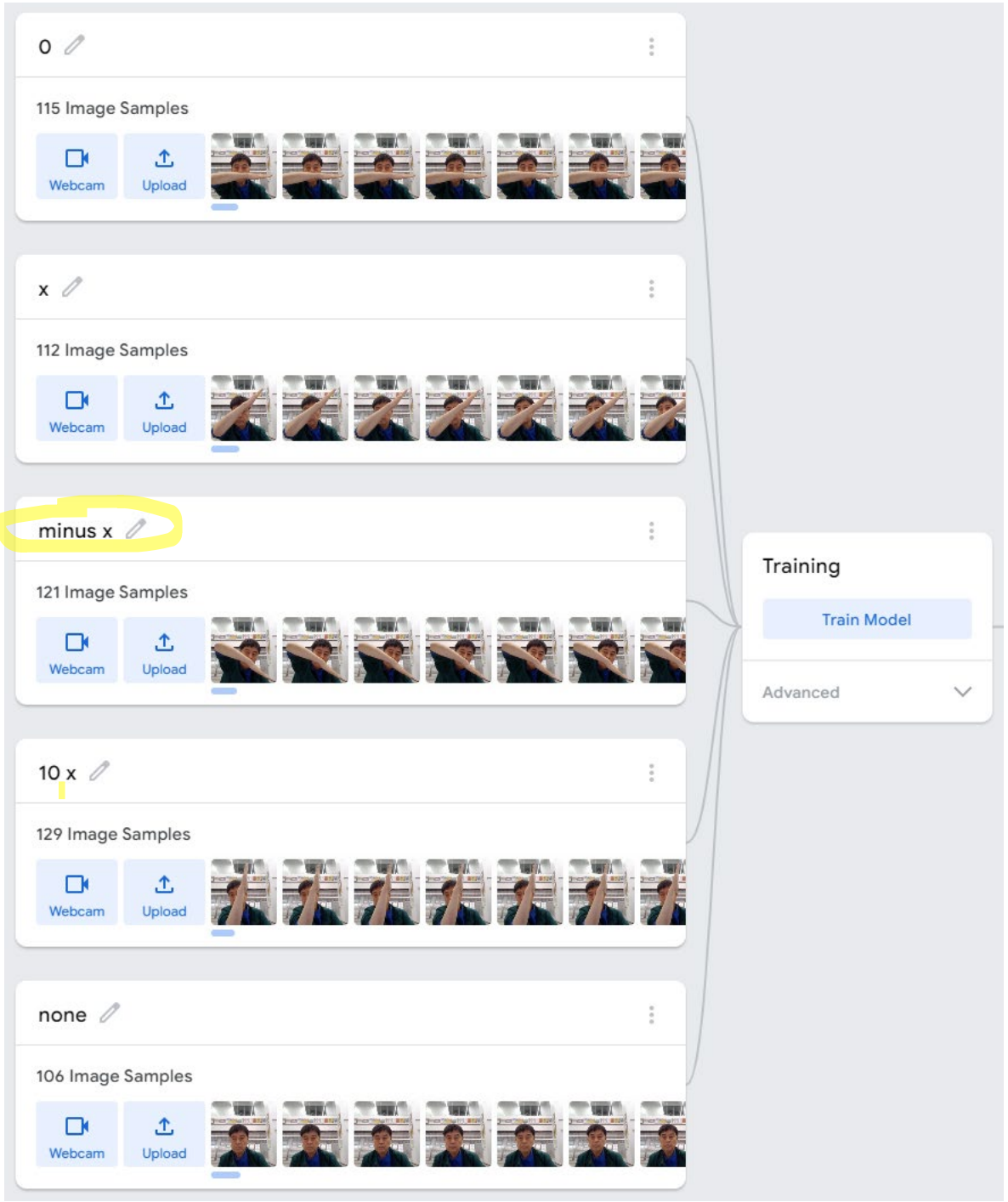
Please bookmark them!

Let's first train a model for 4 hand poses

(1) Go to https://teachablemachine.withgoogle.com







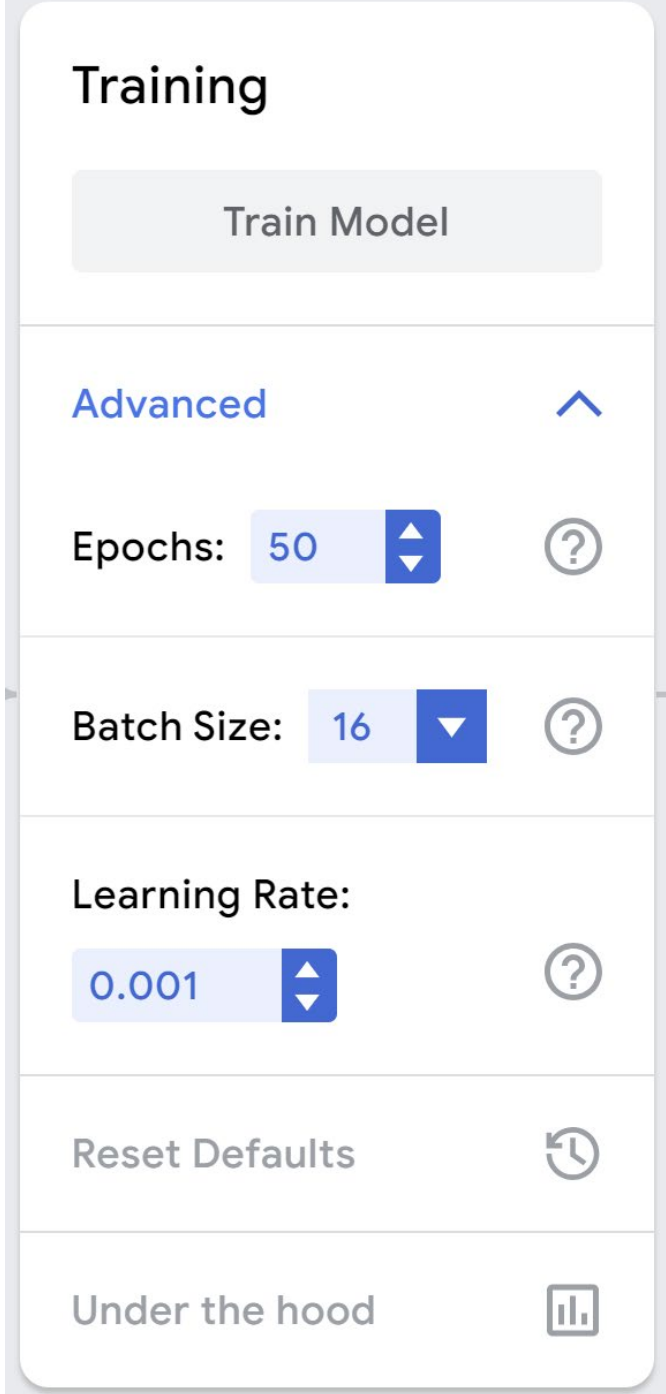
(2) Collect images for 5 classes

Use **"minus x"**, ***not*** **"-x"** due to Scratch Speech function.

(3) Train

Teachable Machine (TM) is using MobileNet

- A simple but efficient and not very computationally intensive convolutional neural networks (CNN)
- TM leverages the pre-trained knowledge of MobileNet, which has been trained on a large dataset like ImageNet, allowing you to train custom classifications with relatively few images
- Specifically designed to be lightweight and run well on mobile devices, making it a suitable choice for browser-based applications like TM
- While using the MobileNet backbone, TM allows you to add your own custom classification last layer to recognize the specific objects you want to identify



(4) Test thoroughly and Save as mathDance1 (Task1)

Teachable Machine

To save

mathDance1.tm

0

115 Image Samples

Webcam Upload

x

112 Image Samples

Webcam Upload

minus x

121 Image Samples

Webcam Upload

10 x

Training

Model Trained

Advanced

Preview Export Model

Input ON Webcam

Output

0 91%

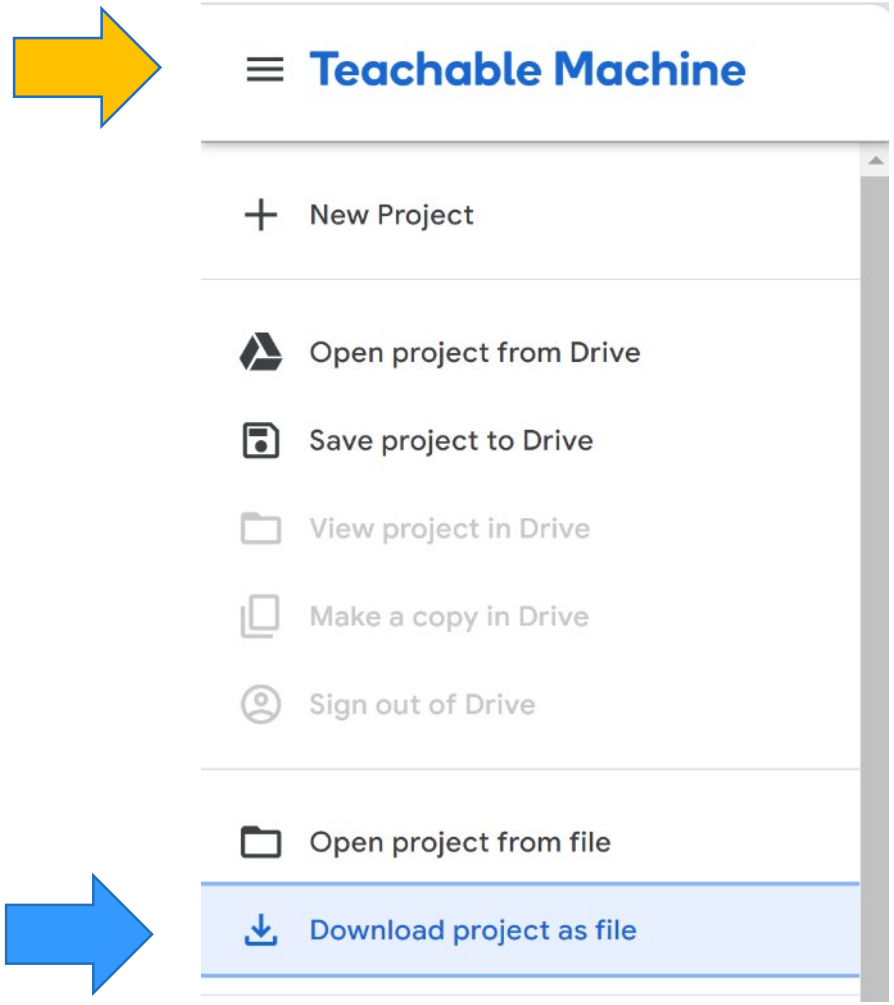
x

minus x

10 x

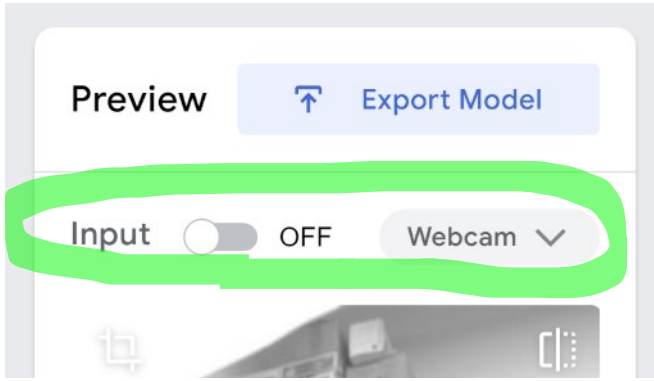
none

Saving the TM project



Rename as **mathDance1.tm** and save the file.
Remember the saved location

Release your Webcam and
Close your browser



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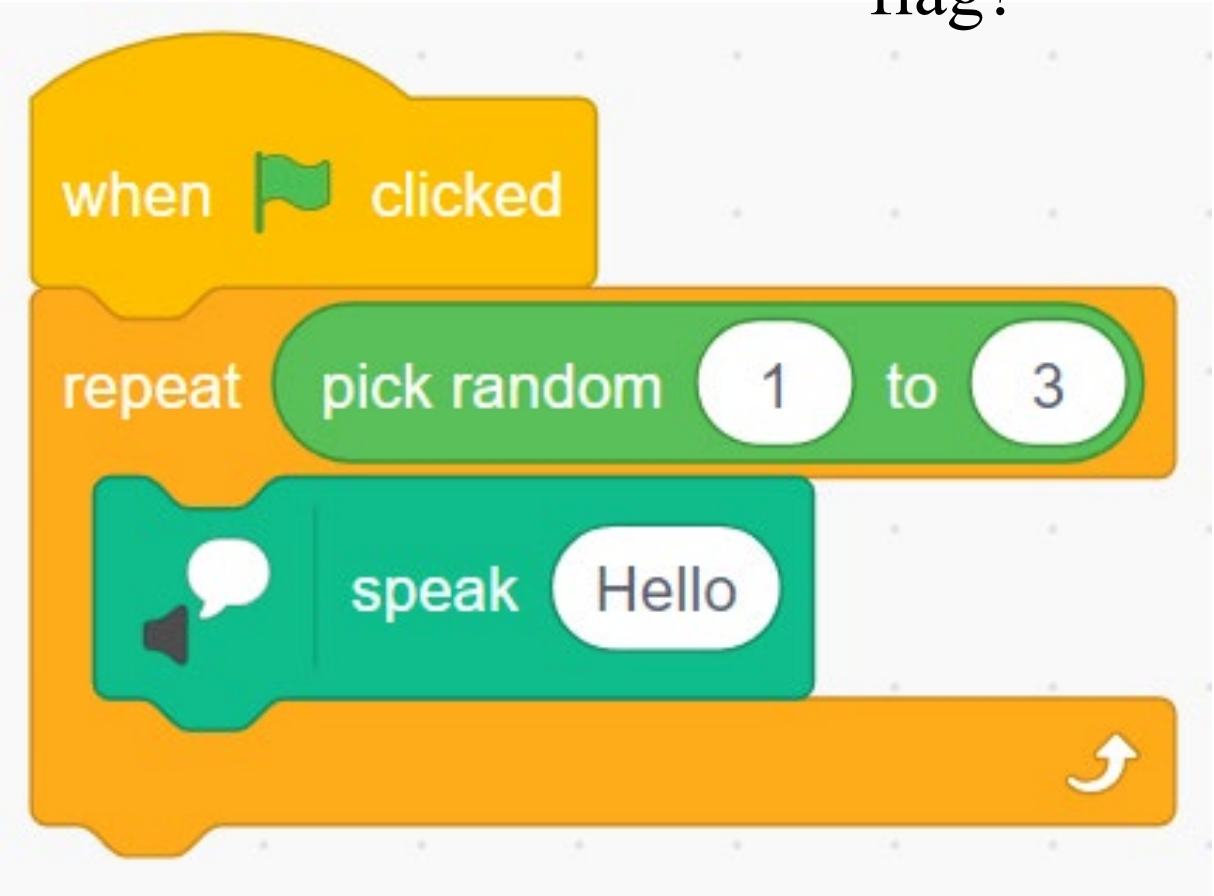
Why Scratch Coding? Great for youth for several reasons:

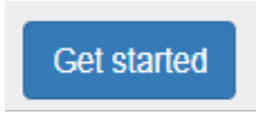
- Easy of learning – Visual programming (VP), drag-and-drop blocks, focus on concepts
- Multimedia (visual, sound) feedback
- Learn programming concepts
- Improve problem-solving skills
- Promote Creativity, Expression, and Imagination
- **Cross-Curricular benefits** – integrates math, science, art, robotics, AI, story telling, and physical activities

Q: Is VP such as Scratch for professional engineers too? YES! Simulink

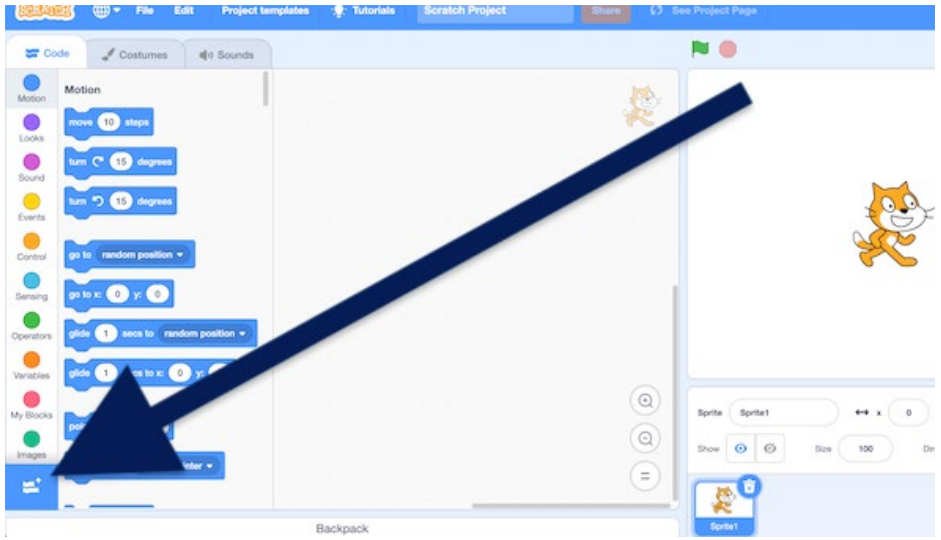
How many “Hellos” do you hear when you click the green flag?

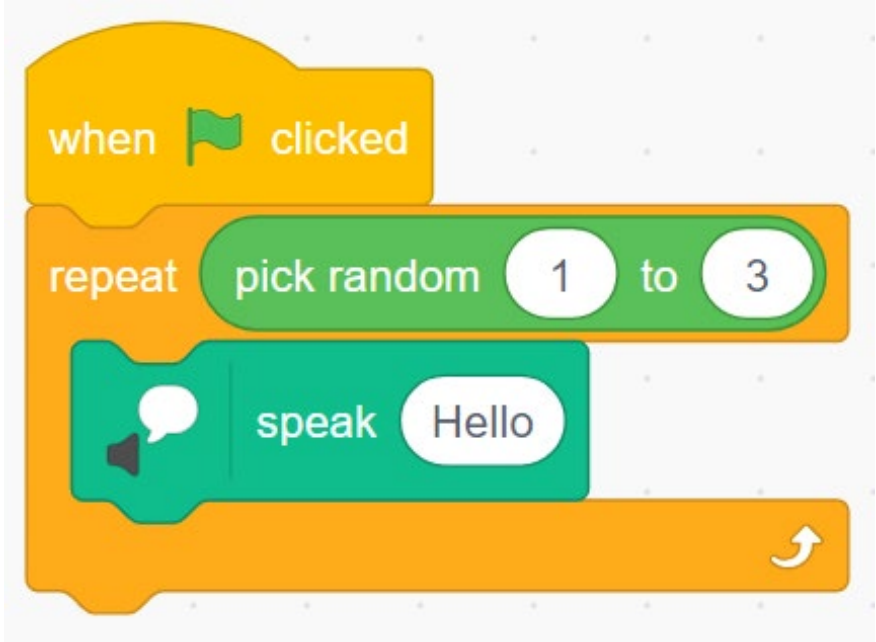


Let's test the code using ML4K using your browser **(Task2)**

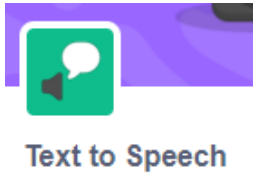
- Go to: https://machinelearningforkids.co.uk/#!/pretrained
- Click on 

button
- Click on Extensions button

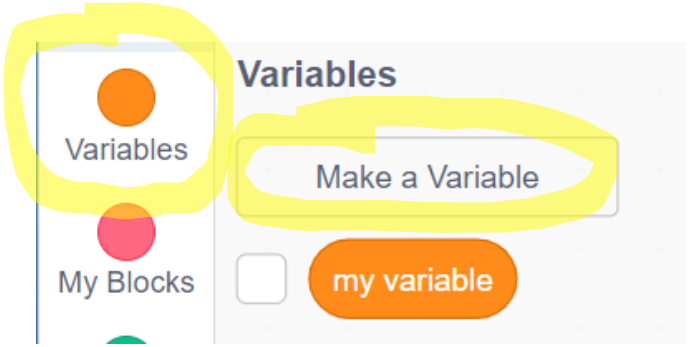


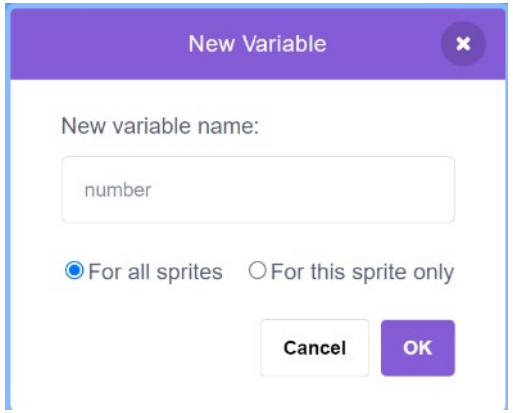


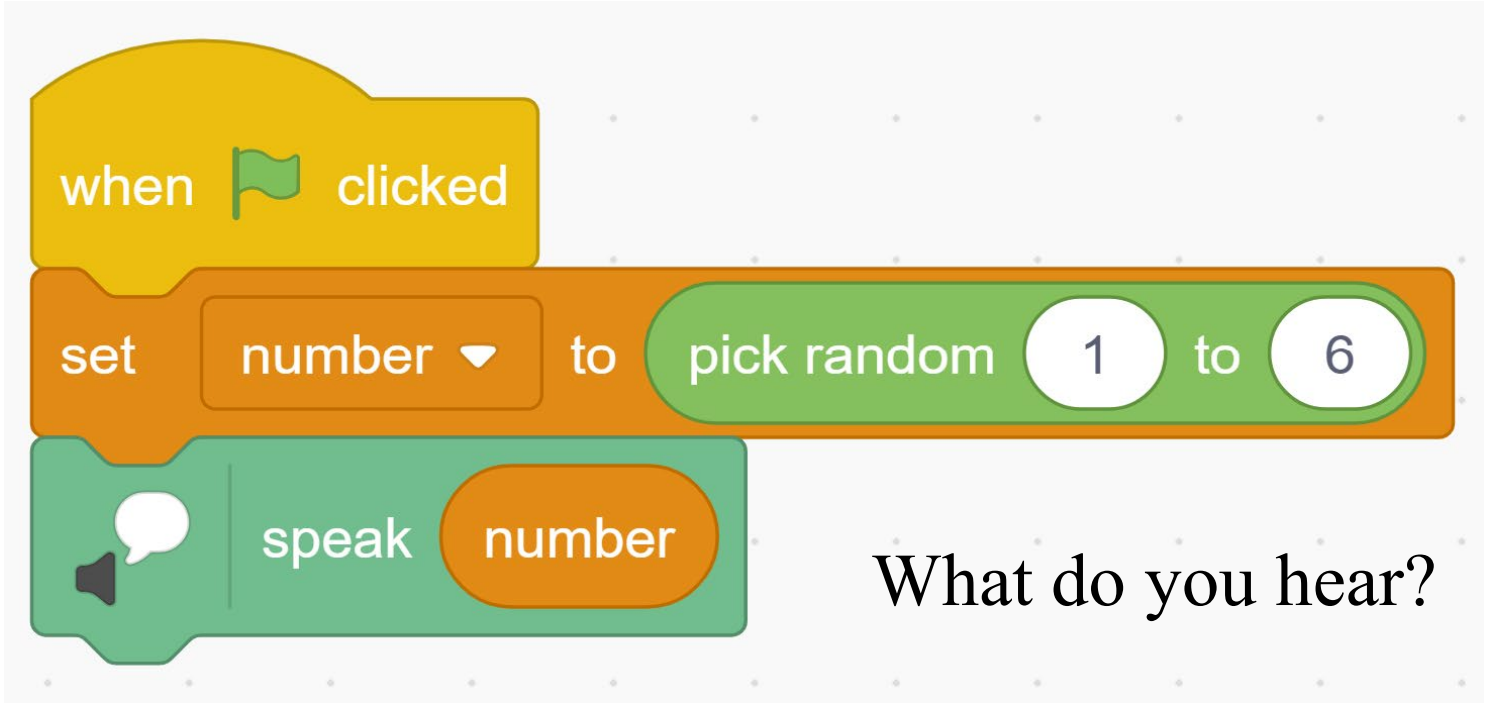
- Click on "Text to Speech" extension



Scratch **Variables** (Task3)







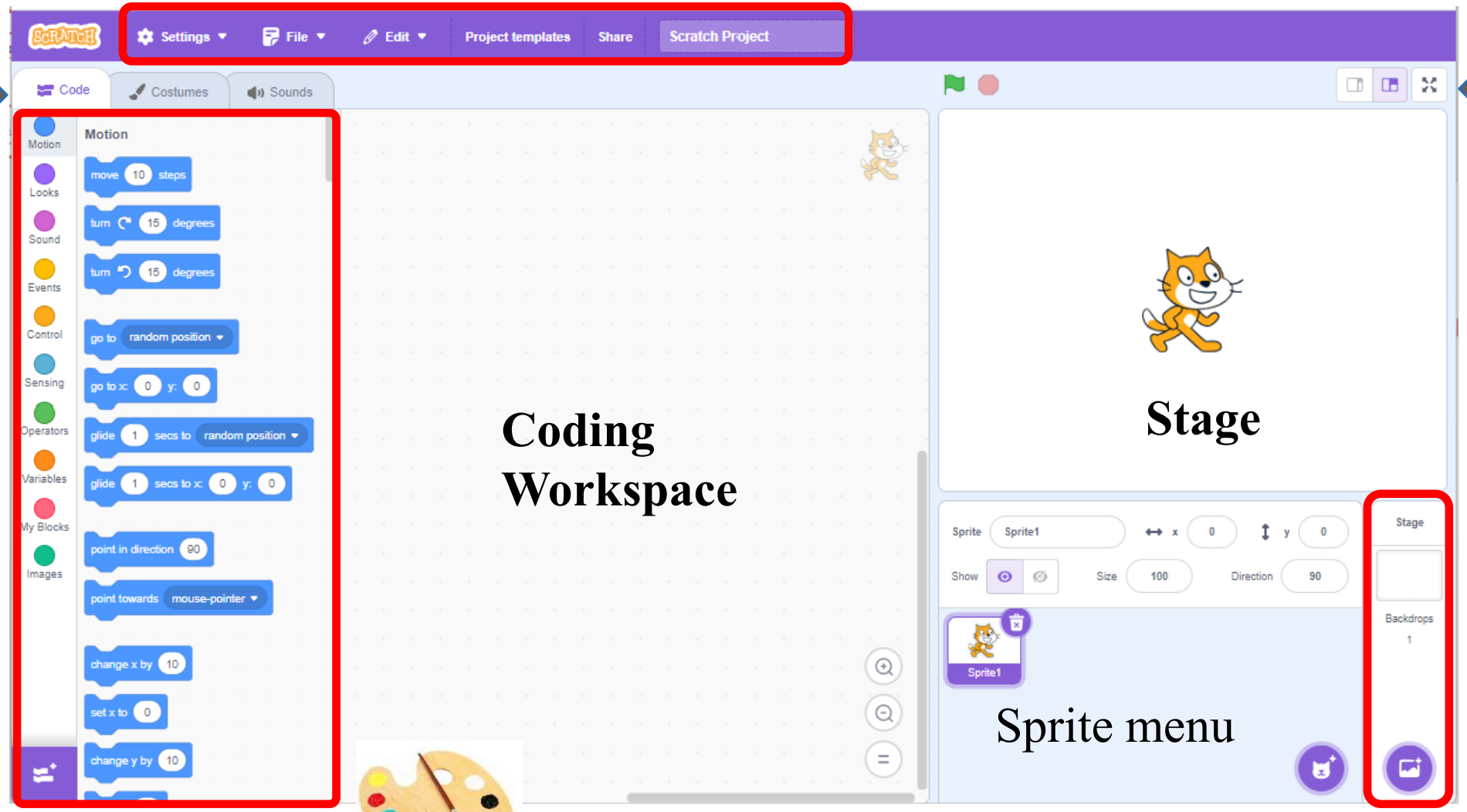
What do you hear?

ML4K Scratch Project Editor

Tool select tabs

Project options

View options



Coding Workspace

Stage

Sprite menu

Block Palette

Backdrop menu

Six Scratch Block Shapes

Hat blocks are the blocks that start every script.

C blocks loop the blocks *or* check if a condition is true.

Stack blocks perform commands.

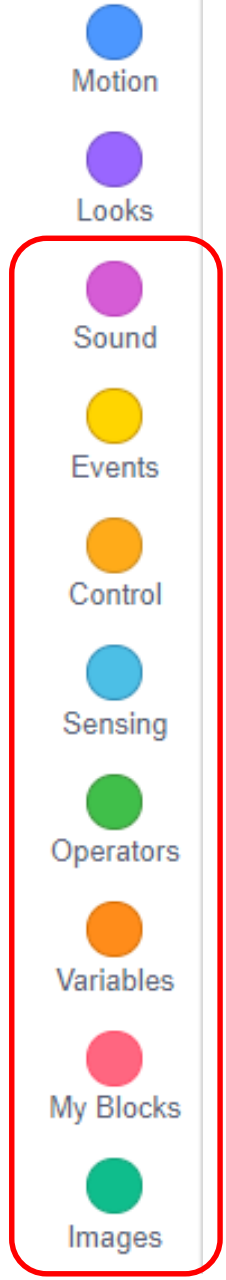
Reporter blocks can hold numbers and strings.

Boolean blocks are the conditions — they are either true or false.

Cap blocks are the blocks that end scripts.

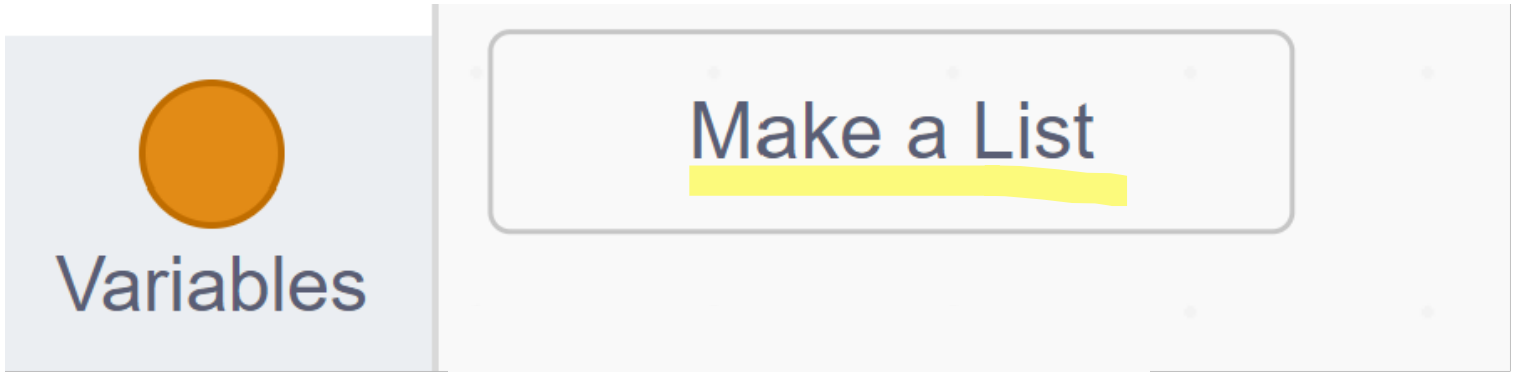
Scratch Block Categories

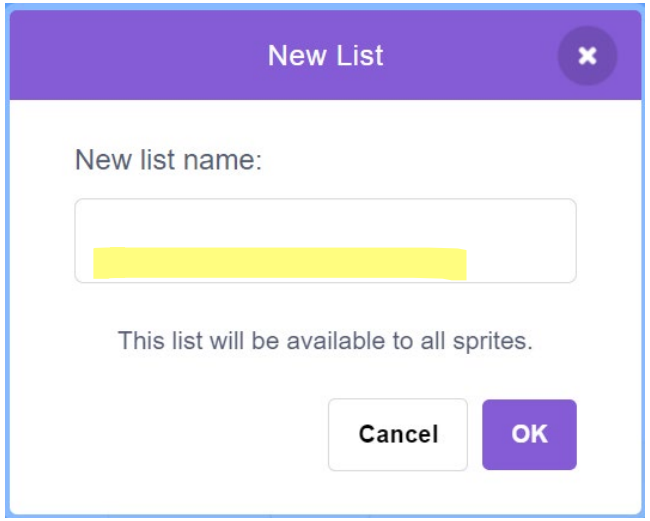
- **Motion** blocks deal with the movement of sprites. They relate mainly to the *x* and *y* position and direction of the sprite.
- **Looks** blocks are related to the appearance of sprites and the stage.
- **Sound** blocks control sound. (*)
- **Events** blocks are related to various triggers in a project, or when one part signals another to run. (*)
- **Control** blocks run the basic flow of a project in the desired fashion. (*)
- **Sensing** blocks associate with sprites and the stage detecting conditions. (*)
- **Operators** blocks deal with many mathematical functions. (*)
- **Variables** blocks are for storing and accessing data. (*)
- **My blocks** are blocks that hold custom procedures for a selected sprite. (*)
- **Images** blocks contain costume & backdrop image reporters (*)



(*) used in MathDance workshop

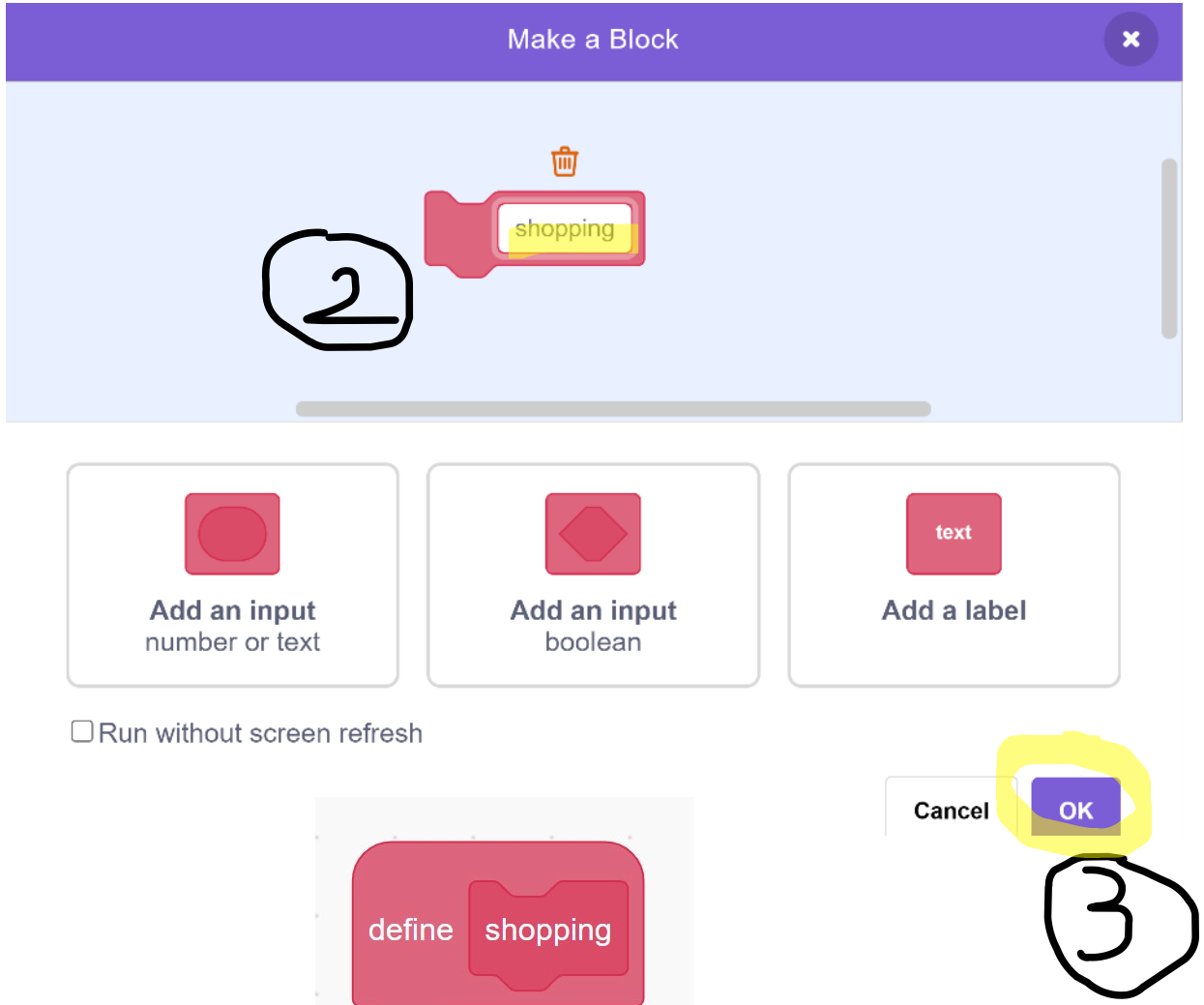
How to create a **List**?





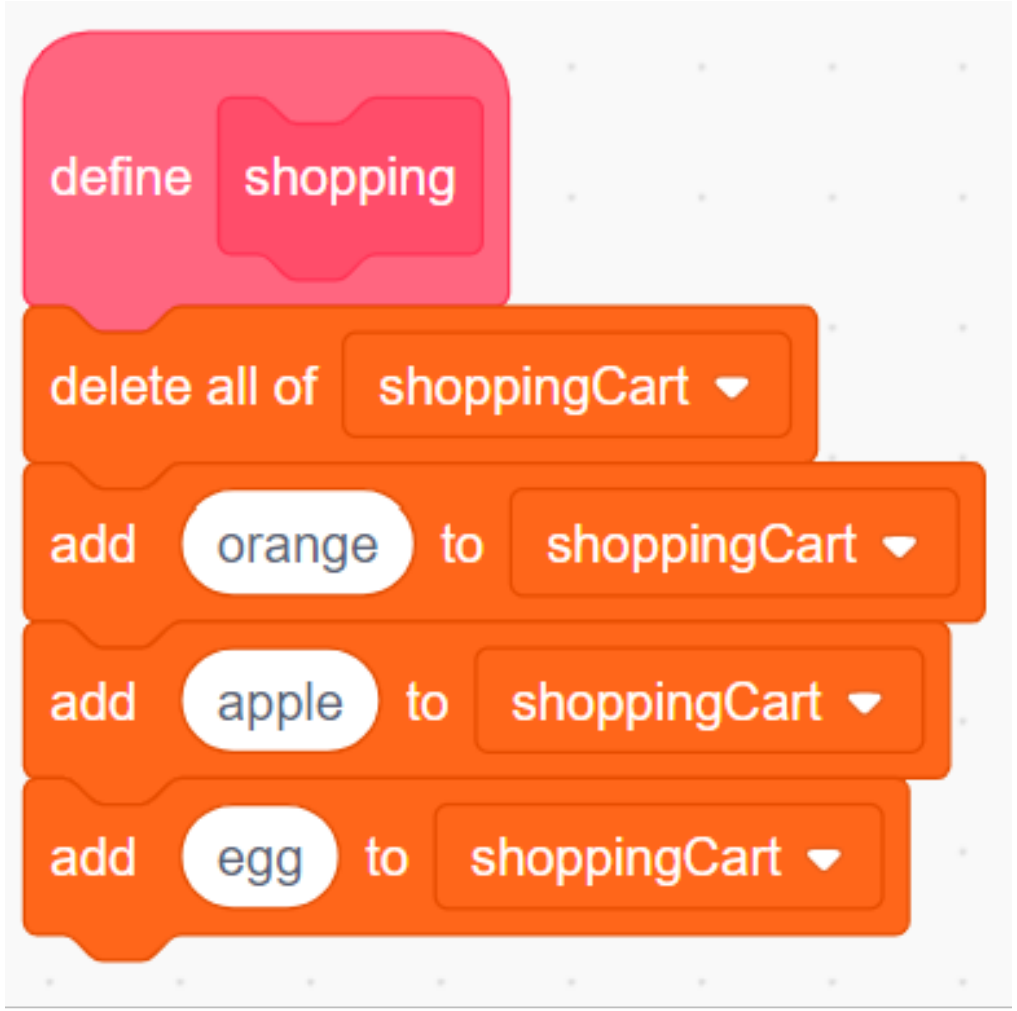
Create a list named "**shoppingCart**" that can have multiple items

How to create "**My Block**" to define my "shopping"

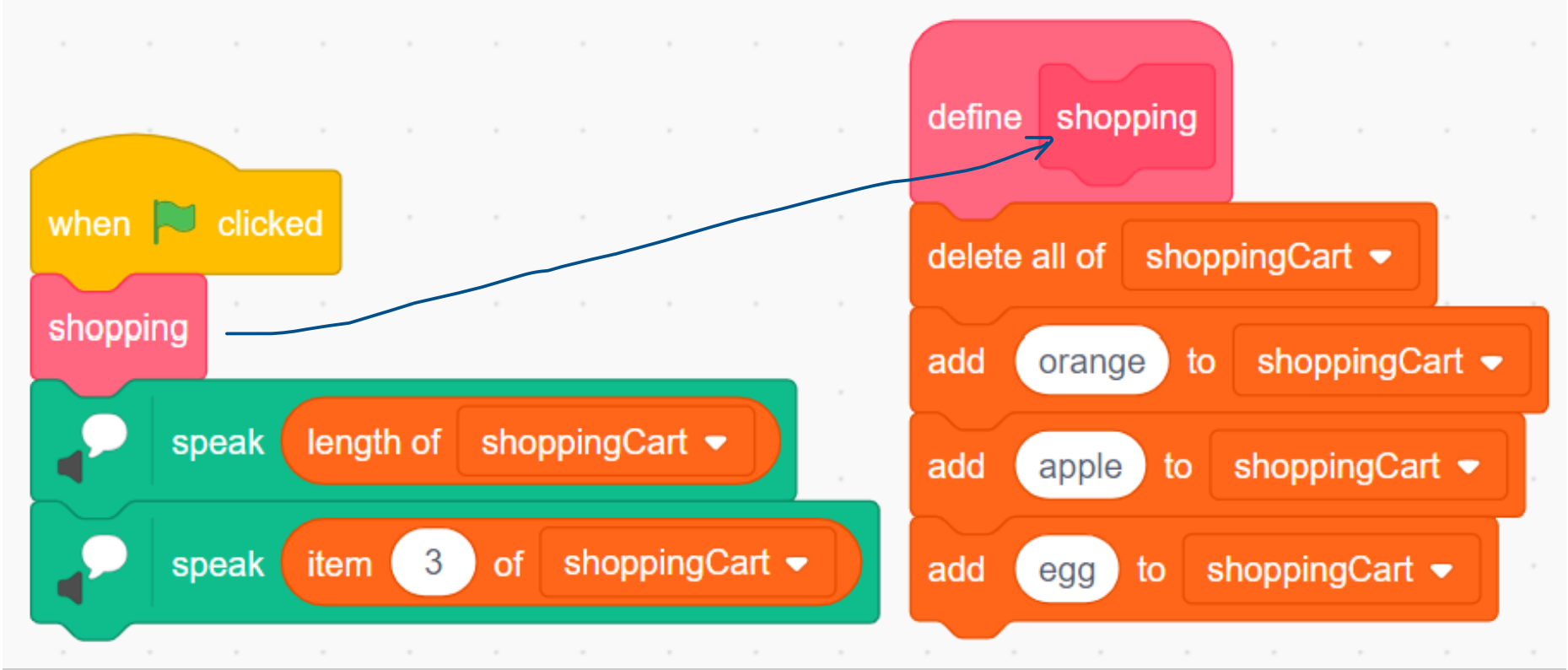


will appear on workspace

To define My Block – “shopping”



To use My Block and List **(Task4)**

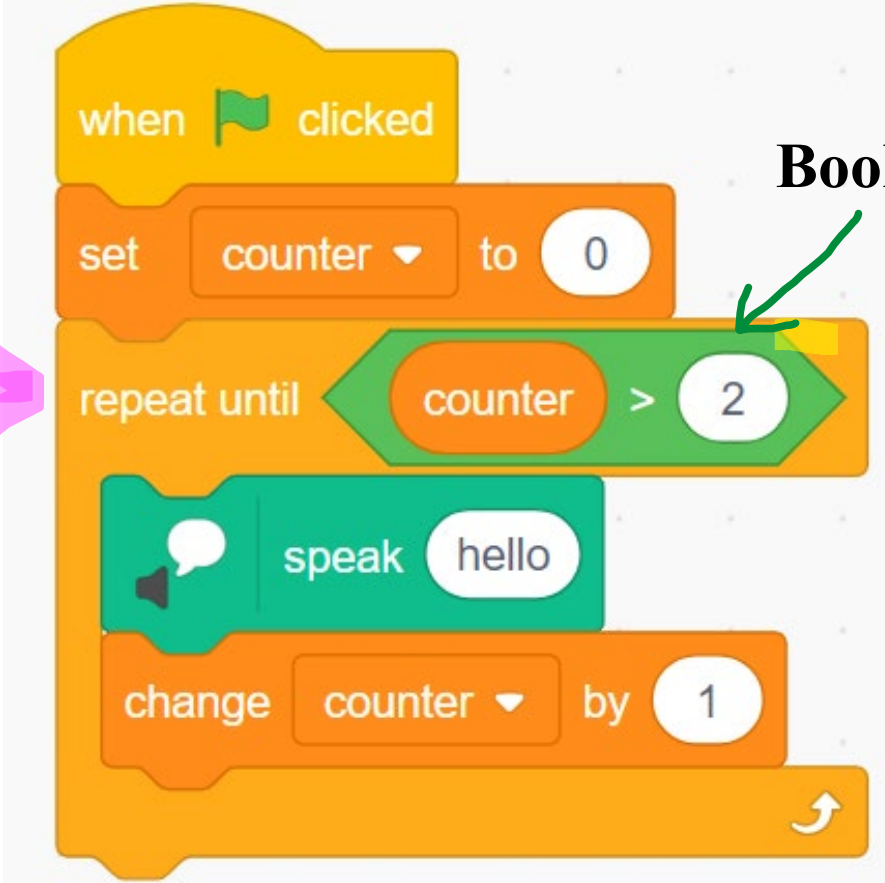


What will you hear?

repeat until <loop-Boolean-termination-condition>

(Task5)

How many hellos can you hear?



Boolean block - either true or false

0 > 2? No (hello)

1 > 2? No (hello)

2 > 2? No (hello)

3 > 2? Yes. End the loop

Lawrence Technological University

Q: What is the color of variable block in Scratch?

Q: What is the color of operator block?

Q: What is the color of “My Blocks”?

3 min stretch break

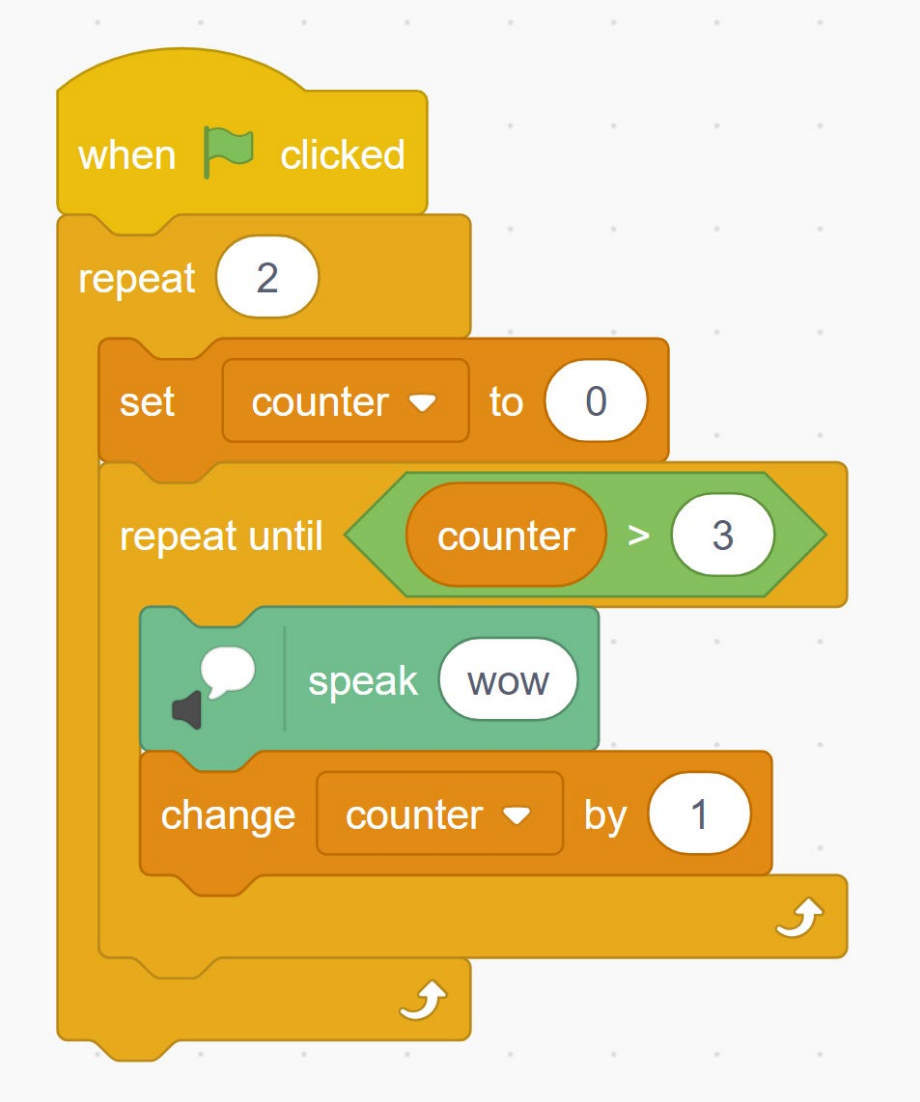
Stretch Break

with MathDance

https://youtu.be/3deuHdsdTLY

Nested Repeat with repeat until <*loop-Boolean-termination-condition*>

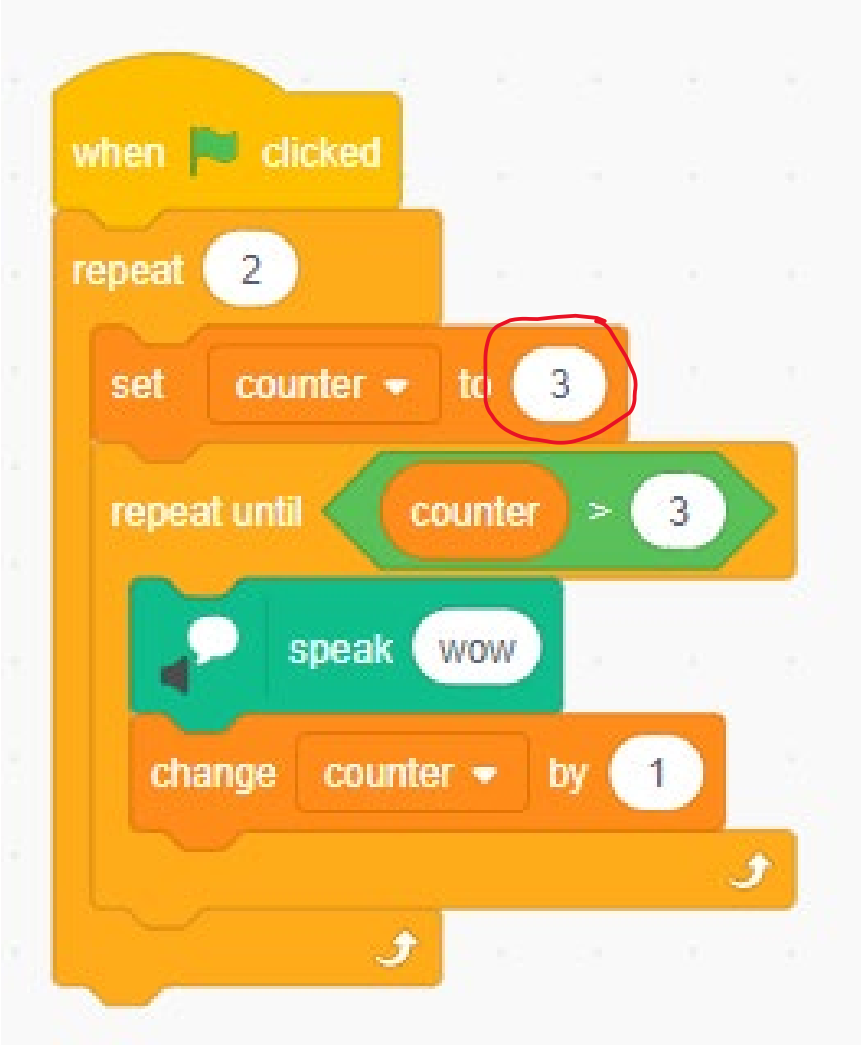
(Task6)



How many wows can you hear?

2 x 4

Review Q: How many Wows?



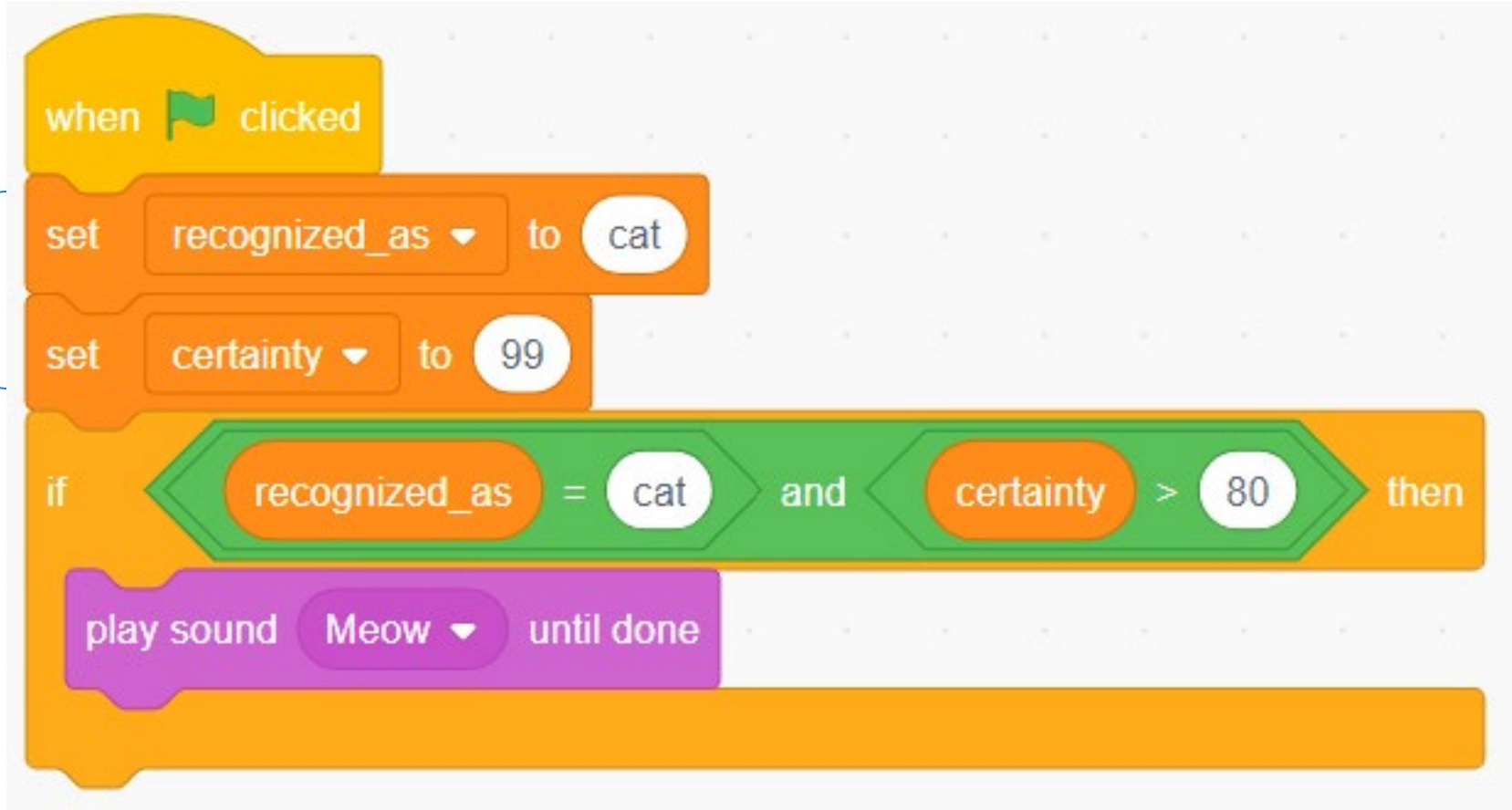
3 > 3 ? No (wow)

4 > 3 ? Yes. End of Repeat

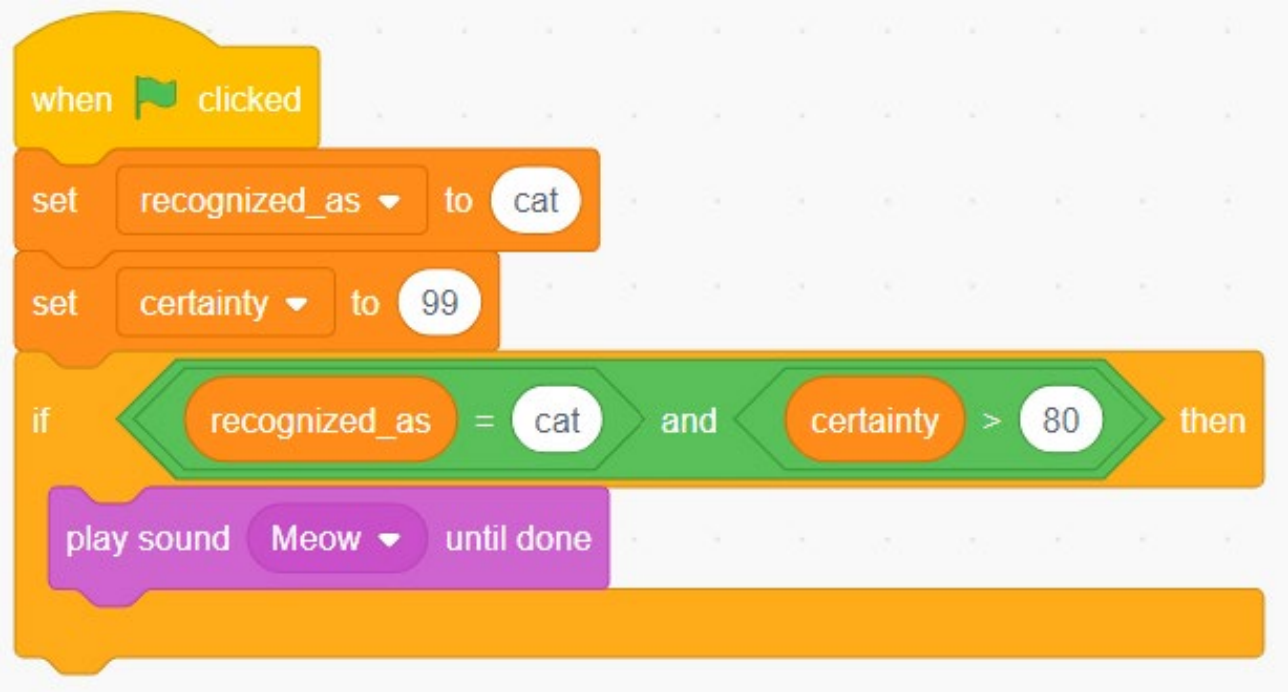
2 x 1

"If" with logical "and" operator (Task 7)

Two variables



“If” with logical “and” operator vs. Nested “if”s



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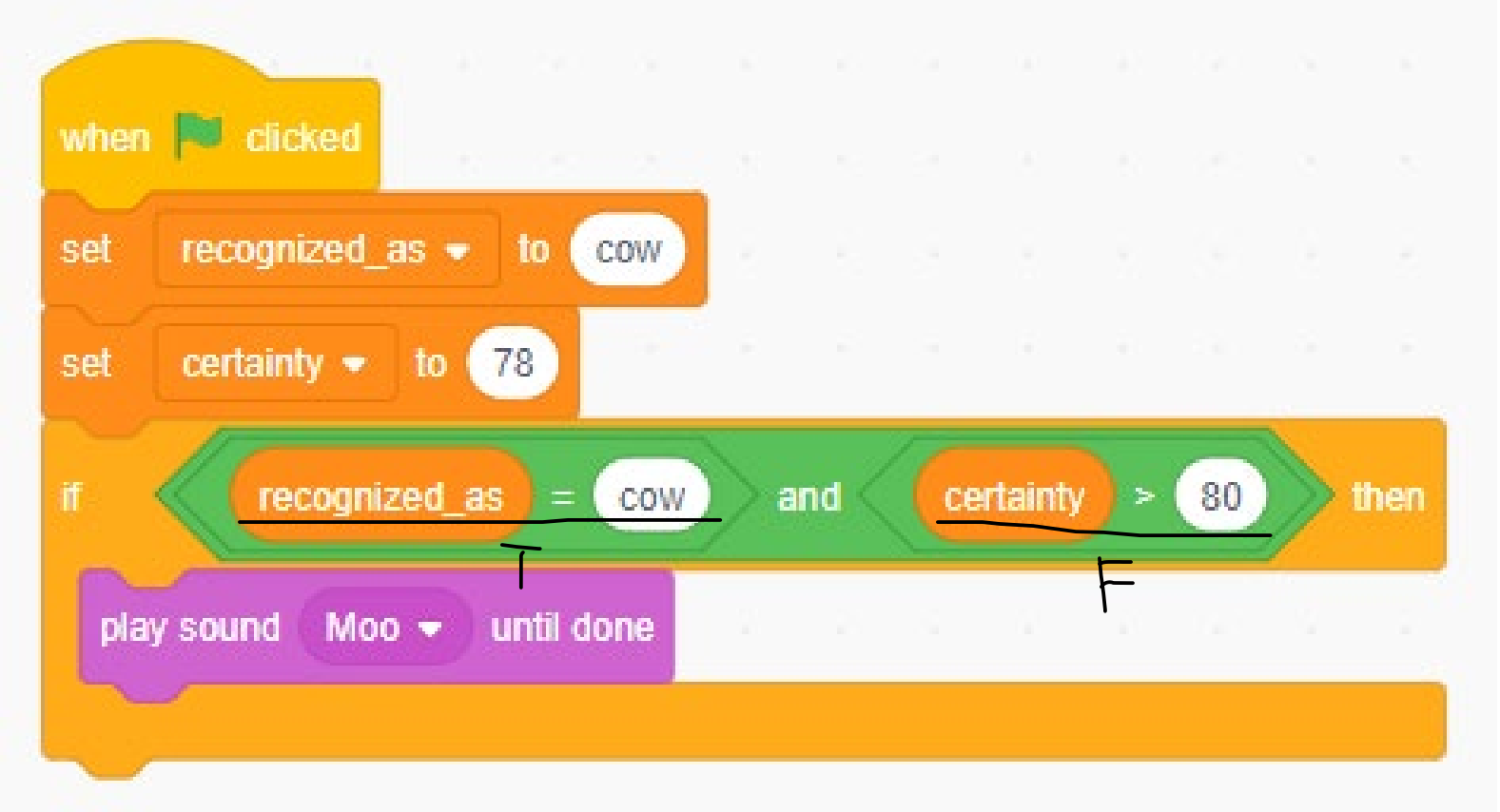
Review Q: What will you hear?



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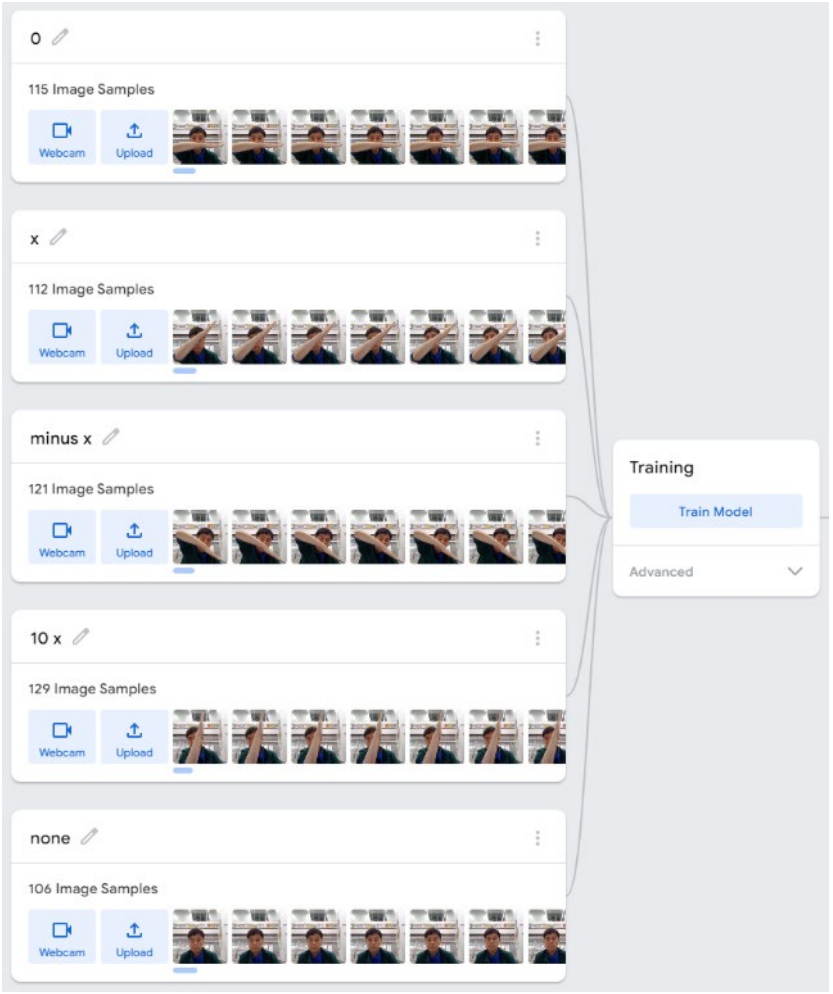
(2) Introduction to Teachable Machine (TM)

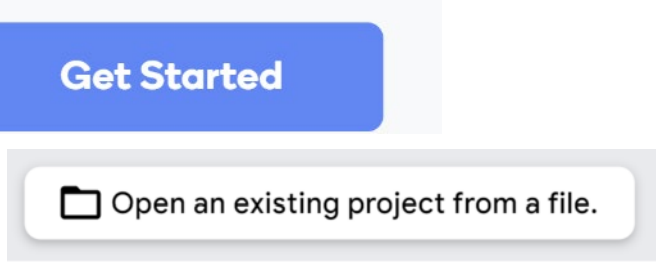
(3) Introduction to Scratch Coding

(4) Hand MathDance Game App Development

Steps to use your trained TM model in Scratch

(1) Go to https://teachablemachine.withgoogle.com





mathDance1.tm

(2) Train, Test and Collect more images, if needed

(3) ReTrain

(4) Check **all** the images, Test thoroughly, and re-save as mathDance1.tm

Teachable Machine

To save

0

115 Image Samples

Webcam Upload

x

112 Image Samples

Webcam Upload

minus x

121 Image Samples

Webcam Upload

10 x

Training

Model Trained

Advanced

Preview

Export Model

Input ON Webcam

Output

0 91%

x

minus x

10 x

none

(5) Export Model

Teachable Machine

0

115 Image Samples

Webcam Upload

x

112 Image Samples

Webcam Upload

minus x

121 Image Samples

Webcam Upload

10 x

Training

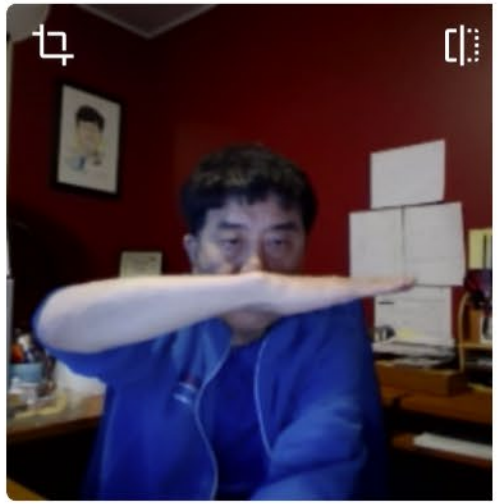
Model Trained

Advanced

Preview

Export Model

Input ON Webcam



Output

0 91%

x

minus x %

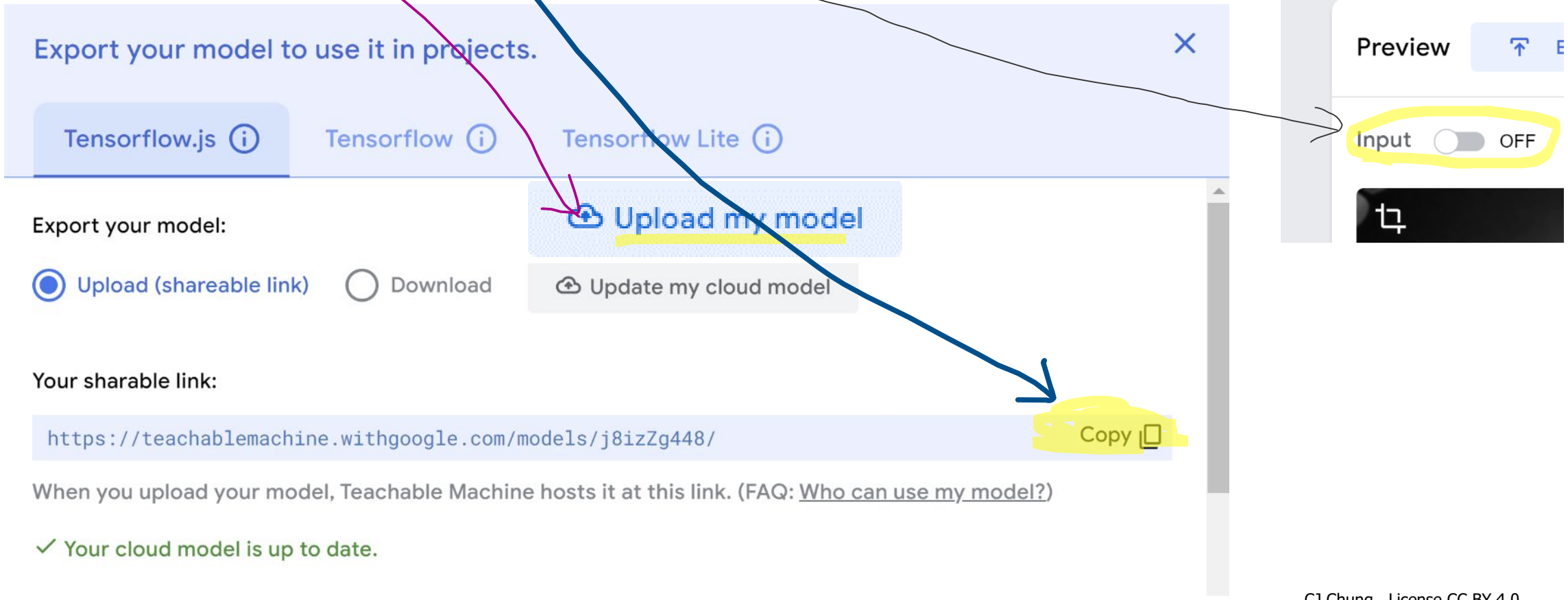
10 x

none

(6) “Upload my model” (takes time)

(7) Copy the URL, paste it to Notepad (*recommended*)

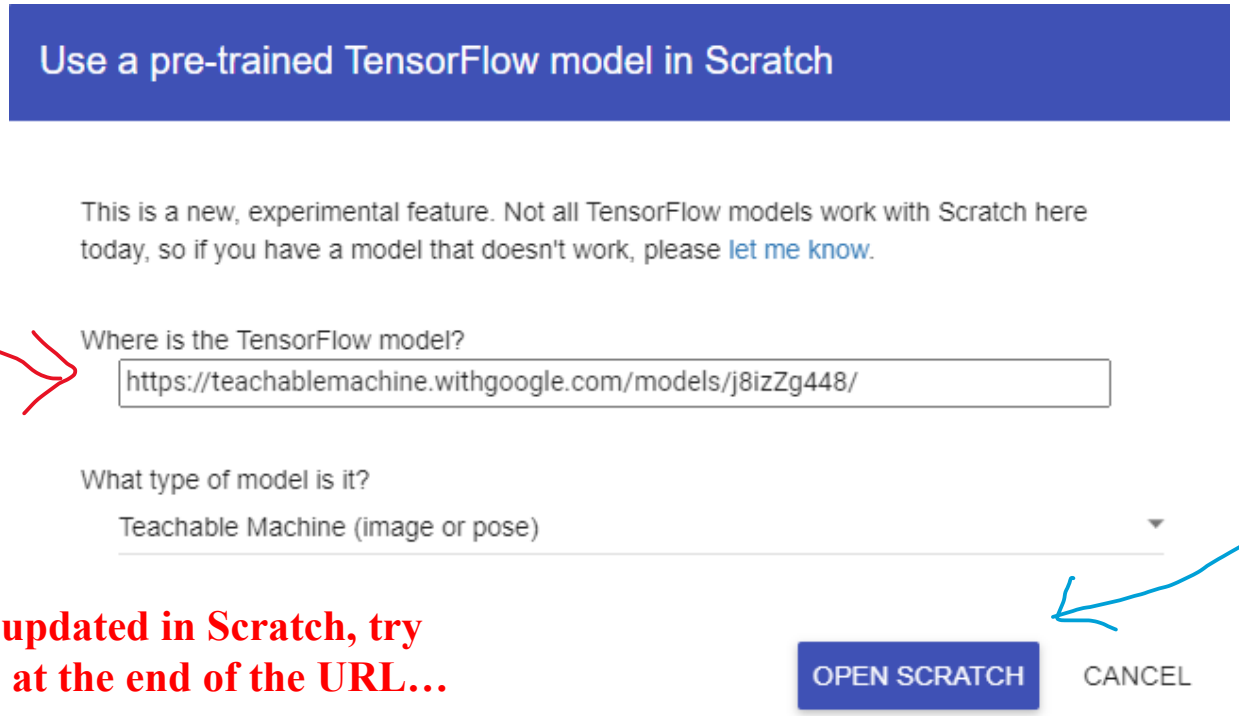
(8) Close TM or Turn off “Input” on the TM (*Scratch needs to access cam!*)



(9) Go to https://machinelearningforkids.co.uk/#!/pretrained

(10) Click on Open a TensorFlow model (at the bottom)

(11) Paste the URL copied in (7) and click on "OPEN SCRATCH"



If the model is not updated in Scratch, try removing the slash at the end of the URL…

Then you will see Scratch Project Editor.

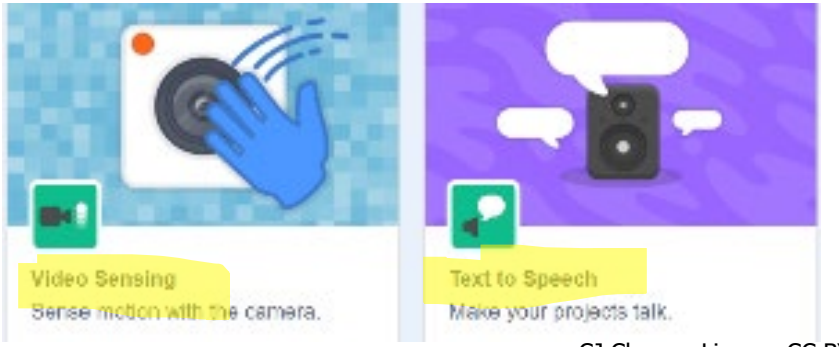
(12) When Scratch is open:

(12.1) First check

You may have another one, if the model has been updated.

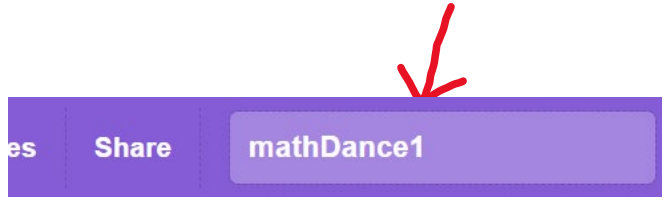
5 classes

(12.2) Import 2 extensions:

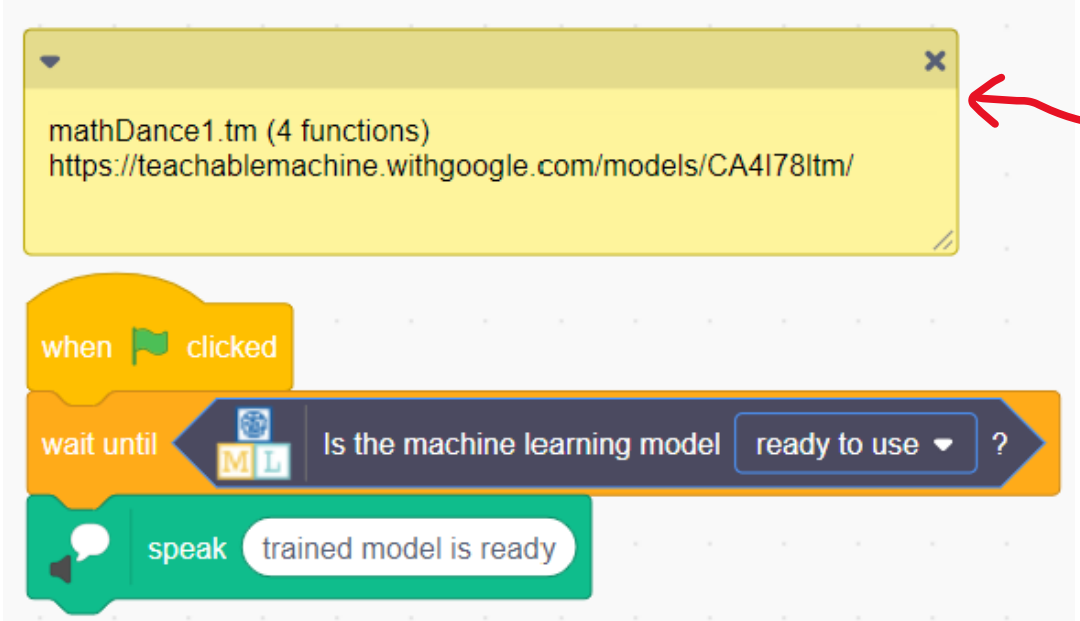


(13) Remove the “Cat” sprite

(14) Name the project file: mathDance1



(15) Create the following and test **(Task8)**



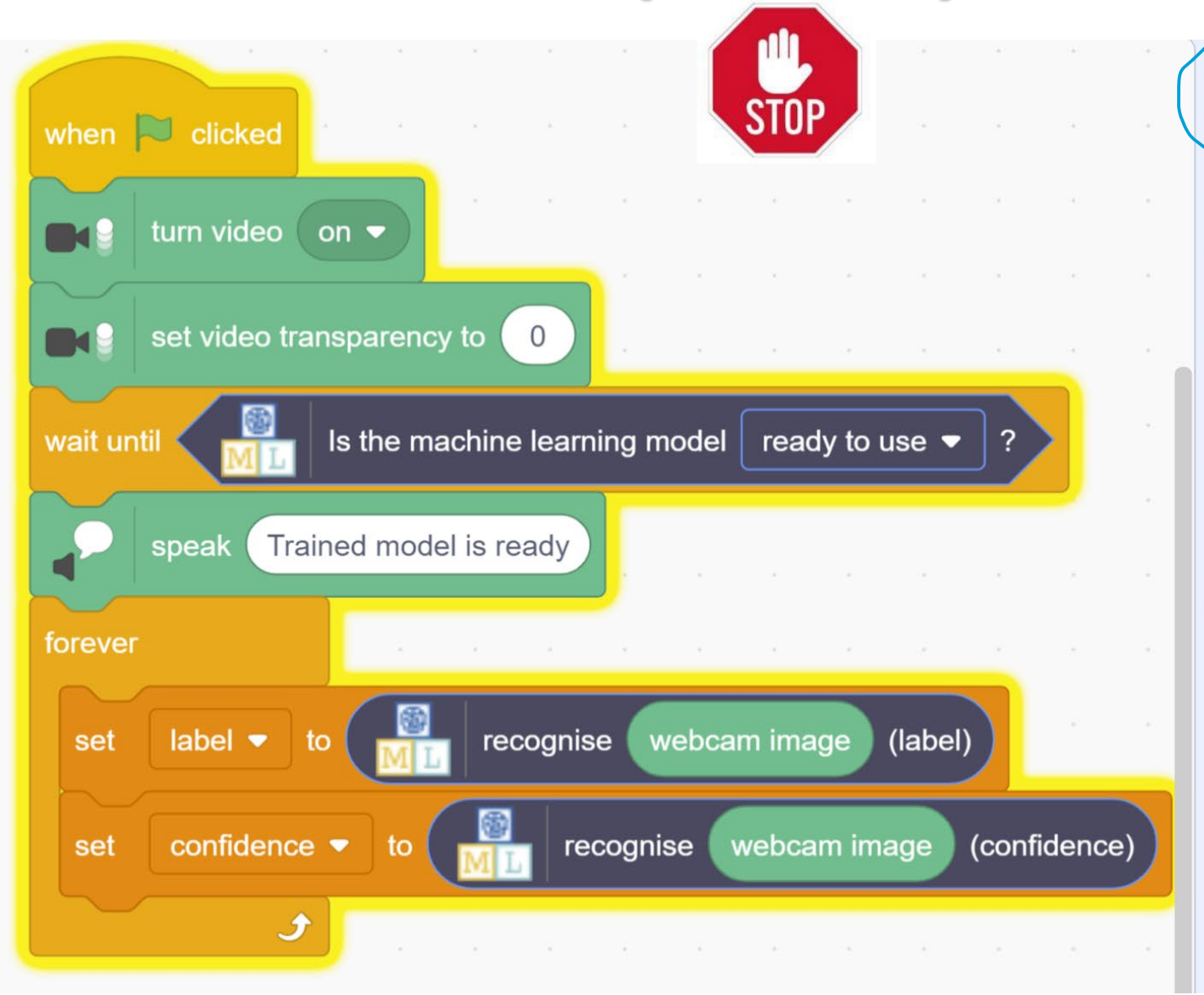
Add a **comment block** by right clicking on the coding workspace to specify the TM file and URL

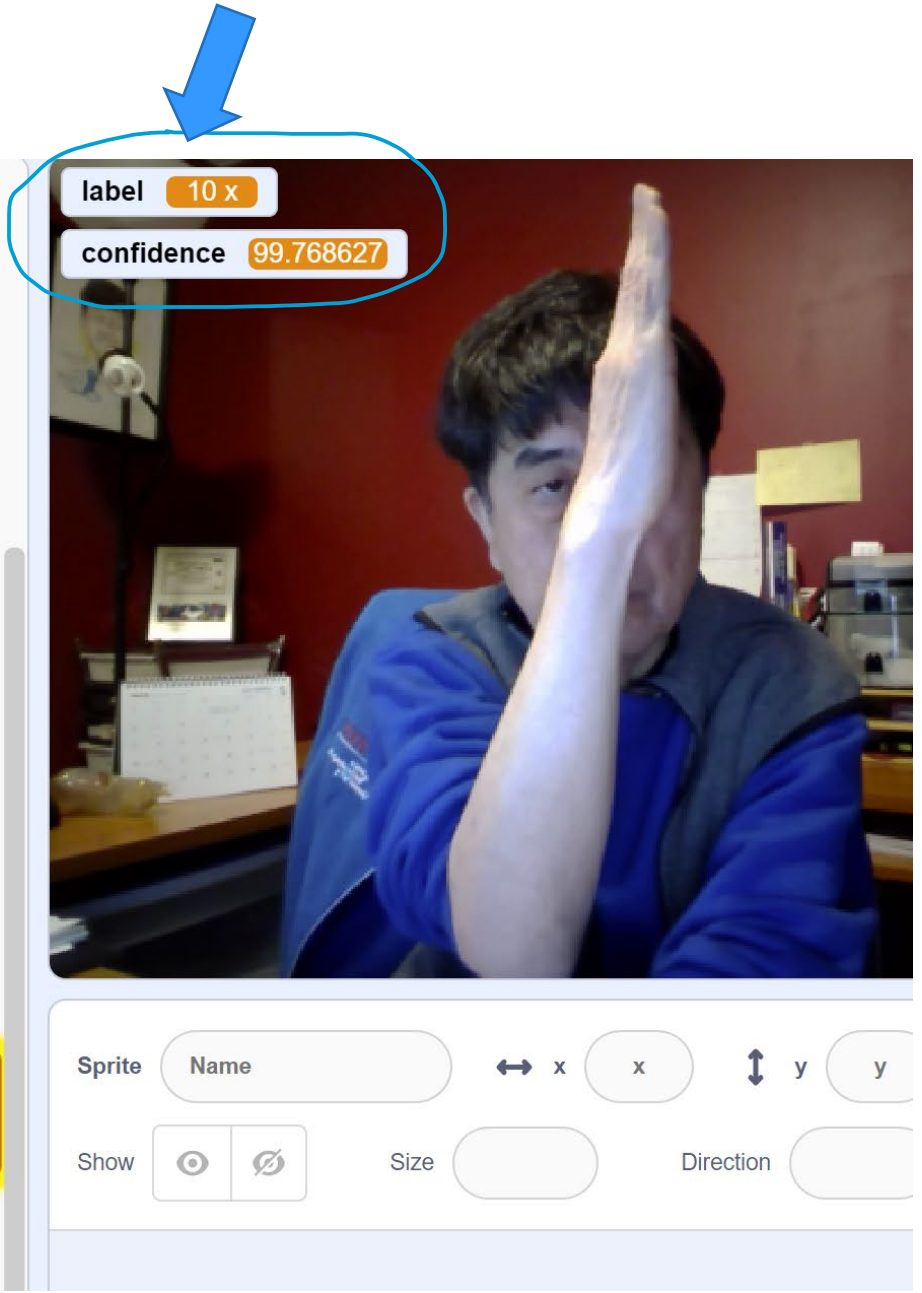
(16) Save the code as: mathDance1.sb3

Summary: Steps to train a model and create a Scratch app

1. Go to: https://teachablemachine.withgoogle.com (and open saved TM project file)
2. Collect (more) samples for each class
3. Train Model
4. Test thoroughly. Good idea to re-save your TM project to your drive
5. Click on “Export Model” button
6. Click on “Upload my model” button (will take time)
7. Copy the sharable link (URL) and paste it to a NotePad with the .tm file name
8. Close TM or Turn off camera “Input” on the TM (Important!!!)
9. Launch ML4K pretrained page: https://machinelearningforkids.co.uk/#!/pretrained
10. Click on “Open TensorFlow model” (at the bottom)
11. Paste the URL (See 7) from TM. Make sure to choose “image or pose”. Click on “OPEN SCRATCH” button
12. Check if the correct model is connected; Import extensions: “Video Sensing” and “Text to Speech”
13. Remove the “Cat” sprite (Important)
14. Name the project file
15. Create the code to check if the ML model is ready
16. SAVE the Scratch project file, for example, mathDance1.sb3

Test This Code (Task9)



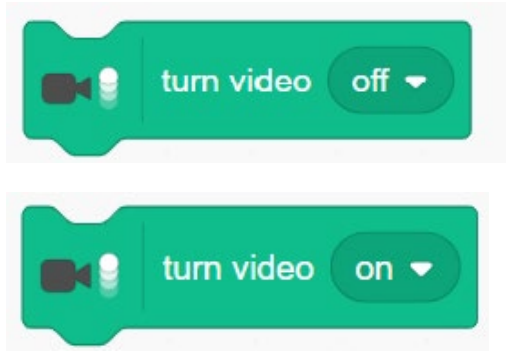


Trouble Shoot – No Wecam Image on the Stage?

Teachable Machine might be holding your camera.

Method 1:

1. Turn off the cam on Teachable Machine or close TM web browser
2. Run

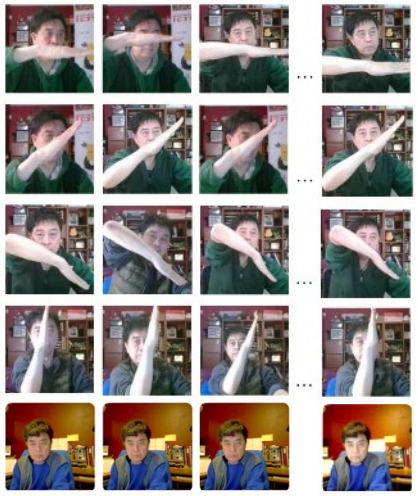


Method 2:

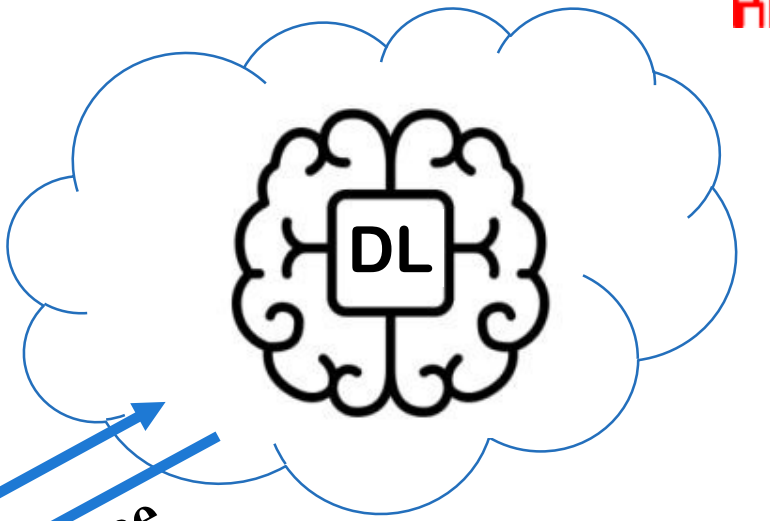
1. Turn off the cam on Teachable Machine or close TM web browser.
2. Save the current Scratch code onto a sb3 file.
3. Close the web browser.
4. Relaunch a web browser.
5. Go to ML4K and click on get started.
6. Load the saved .sb3 file.

Day 1 Project

https://youtu.be/nhMvf34A4TI



Teachable Machine



Webcam image

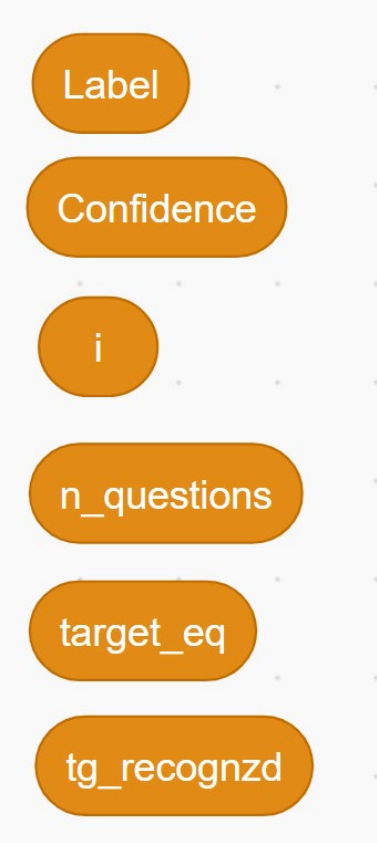
Label, confidence

Inference

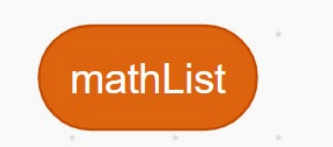
What do we get from the model when a webcam image is sent?

Day 1 Project (Task 10) Today

- Variables



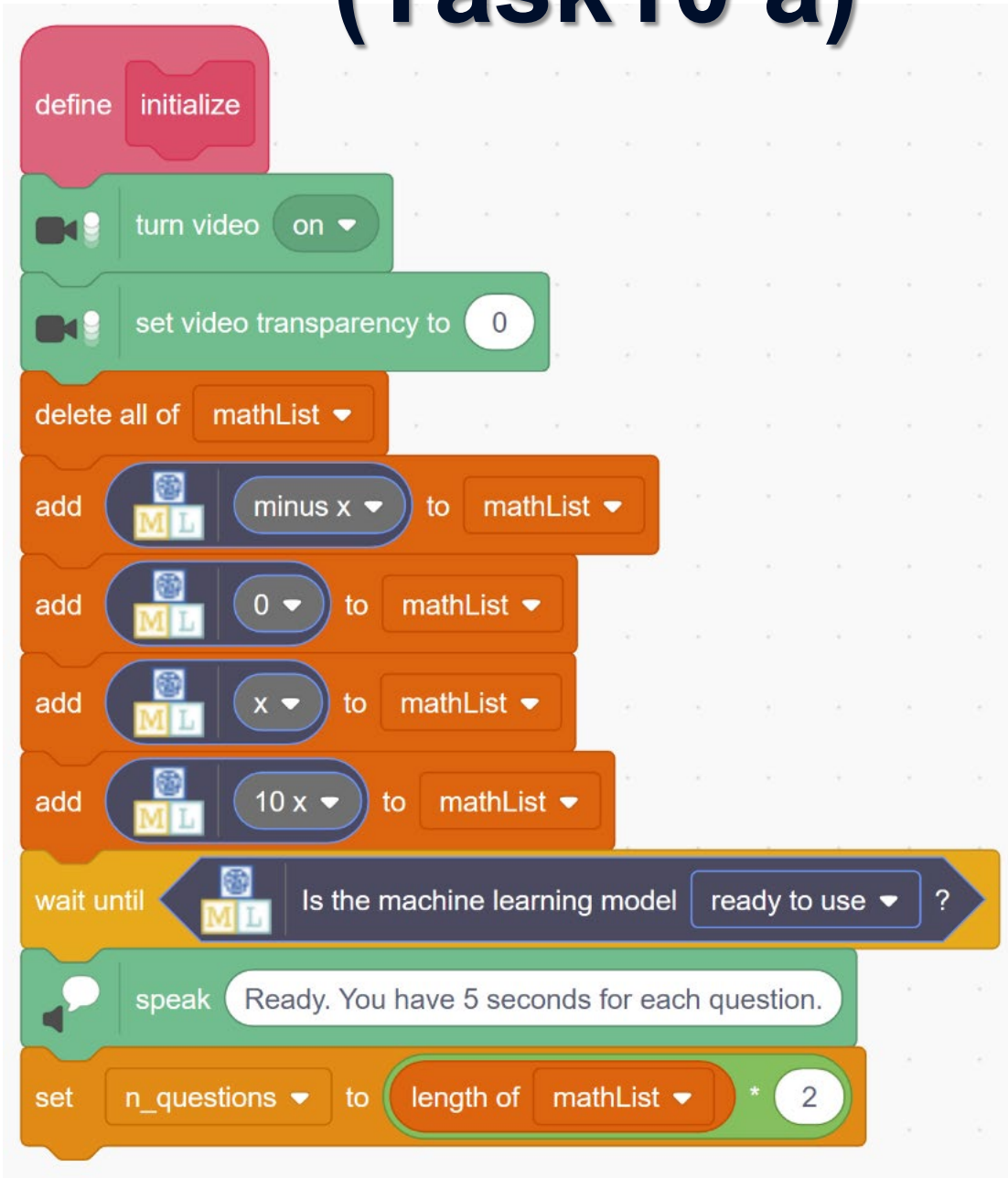
- List



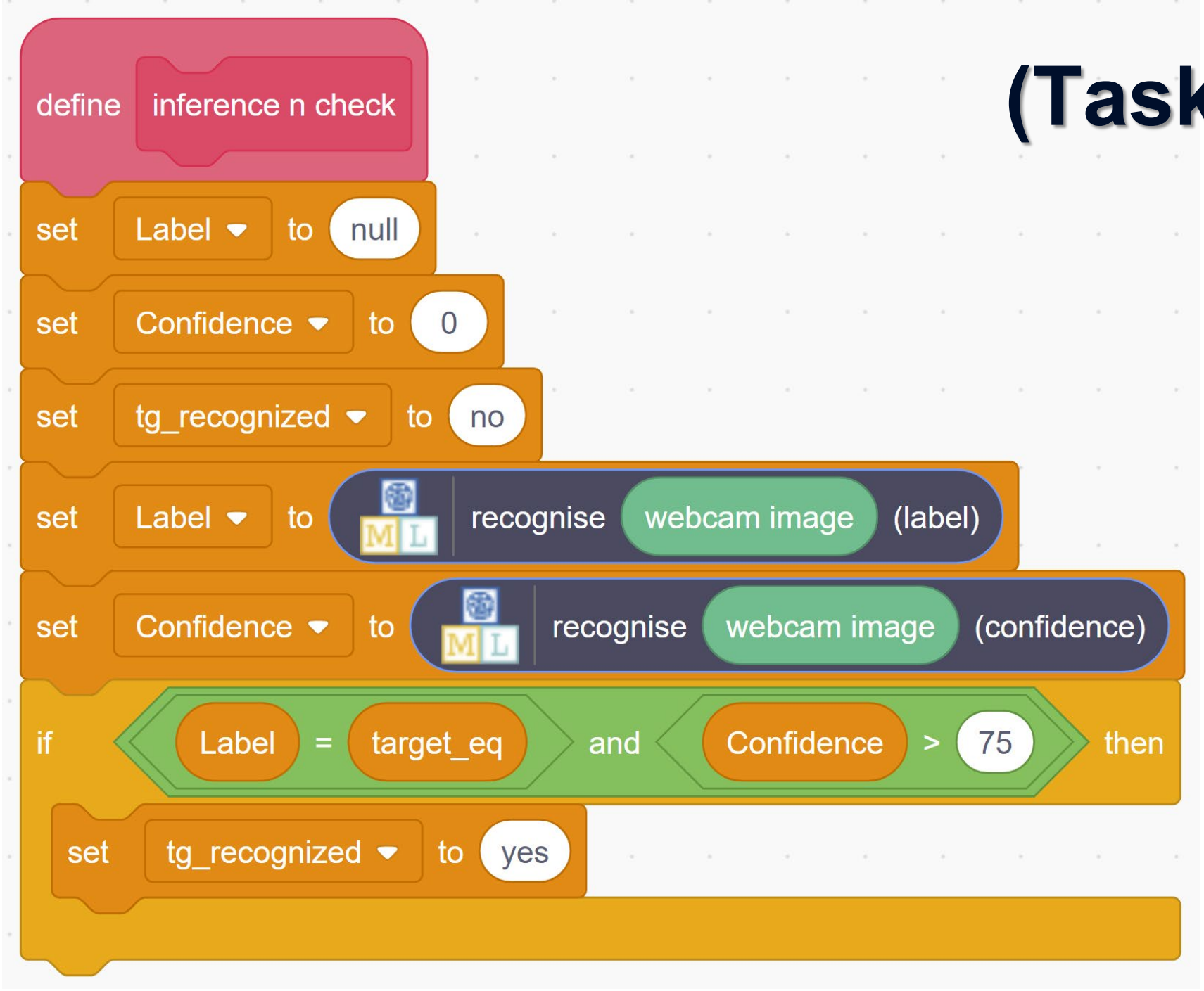
- My Blocks

(Task10 a)

Next slide



(Task10 b)



Save your .sb3 file!

Ideas to improve this program?

Day 2
Project

https://youtu.be/XDlJ6A99kSE

Agenda Day 2

(1) Review: Intro to Machine Learning (ML)

(2) Review: Intro to Teachable Machine (TM)

(3) Intro to Scratch Coding II

(4) Hand MathDance Game App Development II, III

(5) More Math Functions and Animation

(6) TM Pose Models

(7) Wrap Up

Day 2 Video – UN's AI for Good Program

- https://www.youtube.com/live/86cVxk_Sw9I?si=xkcjXx_jHAd8C0yC

United Nations

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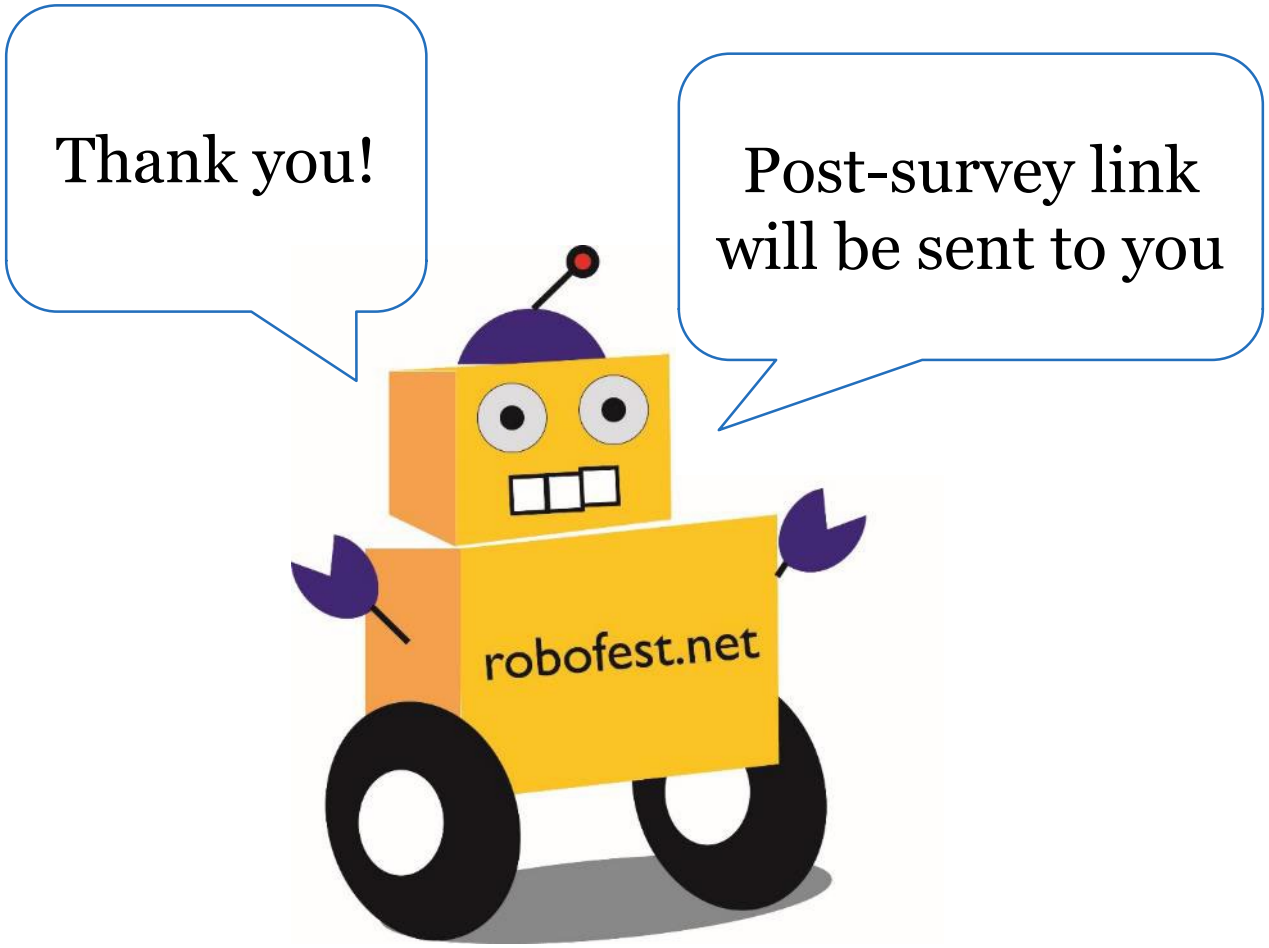
Post Survey

https://docs.google.com/forms/d/e/1FAIpQLSem0hCtfUJlOjblGslUAmd-JjmR0avpDucVc2p36vwao9sKdw/viewform?usp=sharing



Questions?