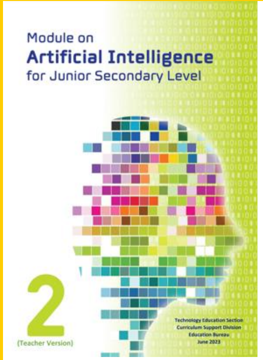


Module on

Artificial Intelligence

for Junior Secondary Level

2

(Teacher Version)

Technology Education Section
Curriculum Support Division
Education Bureau
June 2023

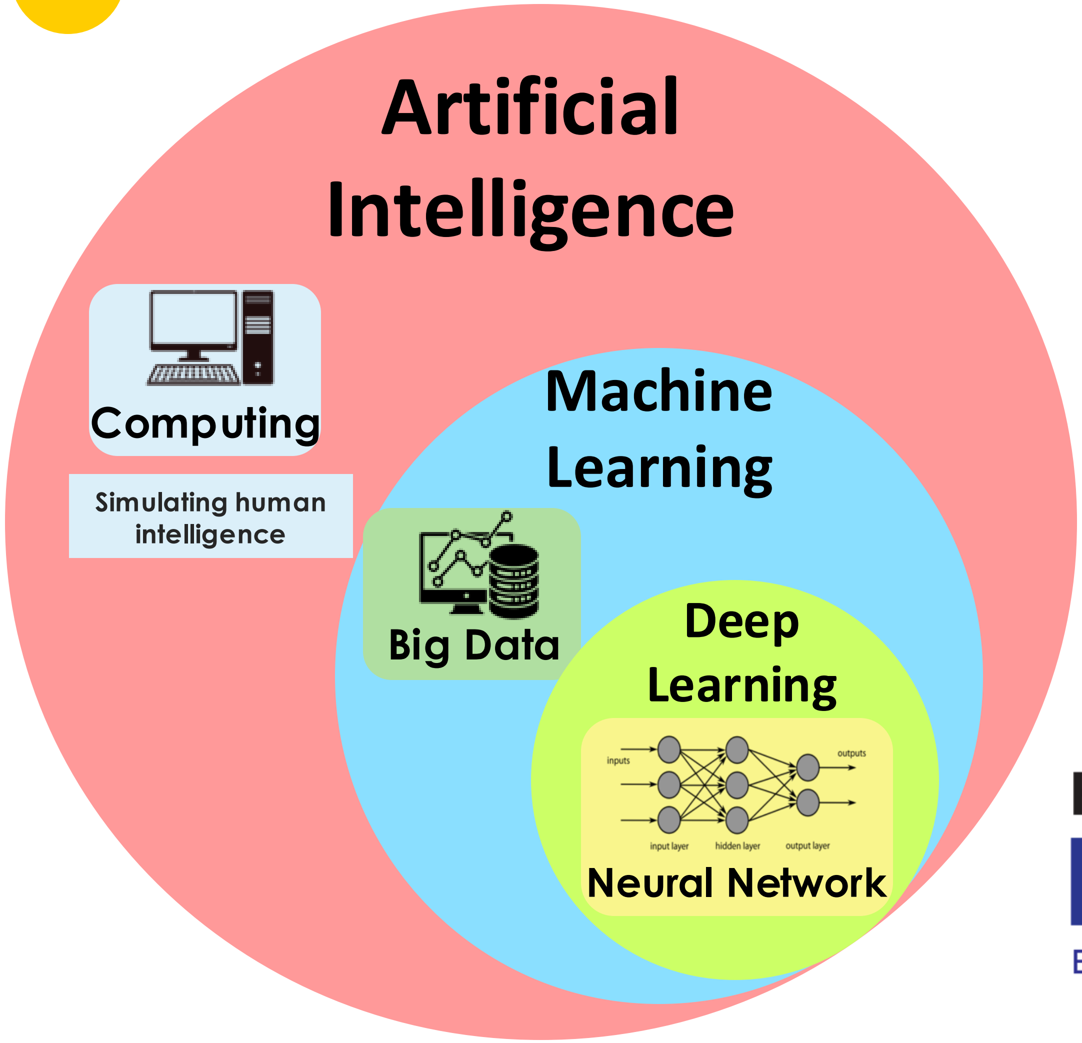
Abstract from
Unit 1 - AI Basics (II),
Module on Artificial
Intelligence for Junior
Secondary Level (Booklet 2)

1

Experience AI Model Training and Testing with Teachable Machine

- Introduction to Artificial Neural Network
- Model Training and Testing Process
- Impact of Using Contaminated Training Dataset
- Apply AI Model in Hardware Development

Artificial Intelligence, Machine Learning, and Deep Learning



Artificial Intelligence

Computing

Simulating human intelligence

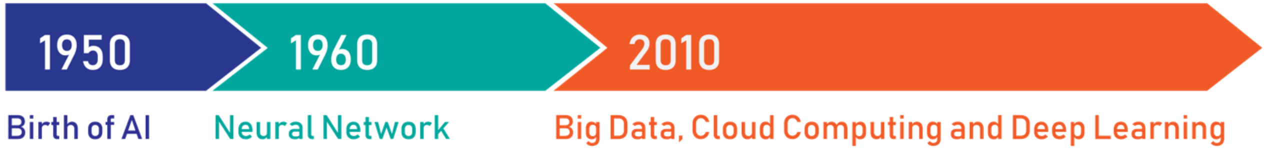
Machine Learning

Big Data

Deep Learning

Neural Network

History of AI



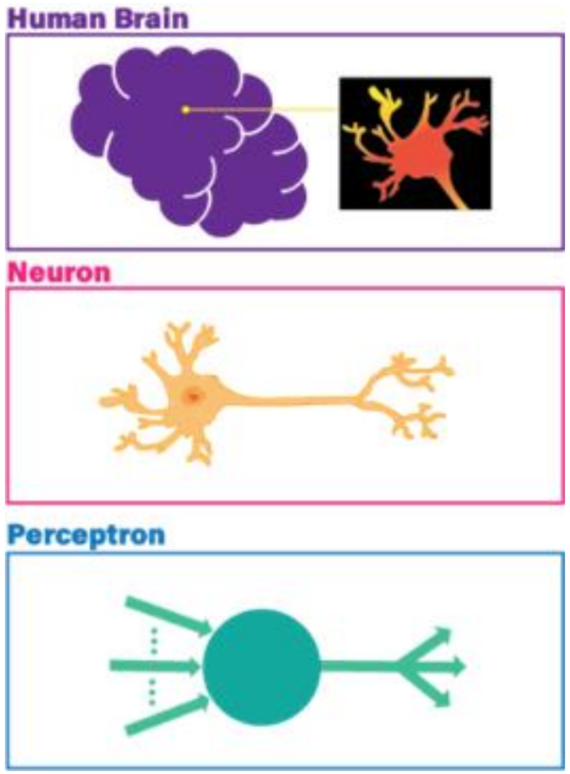
1950 Birth of AI

1960 Neural Network

2010 Big Data, Cloud Computing and Deep Learning

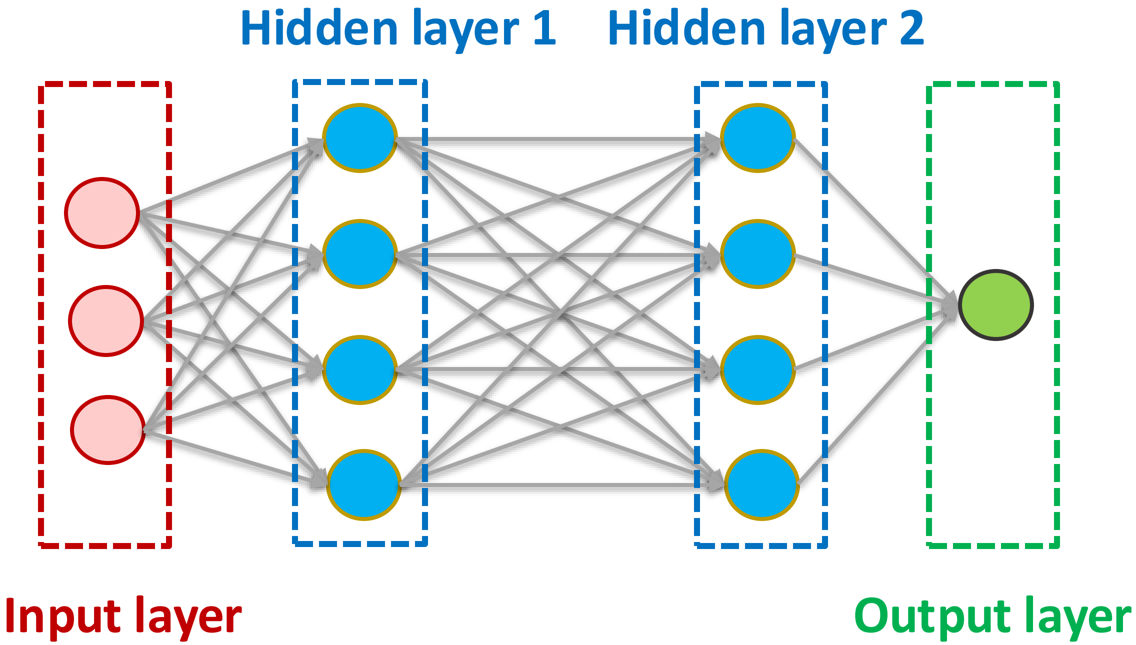
Artificial Neural Networks

- An **artificial neural network (ANN)** is a class of machine learning models that is inspired by human brain.
- A **perceptron** in a neural network resembles a neuron in the human brain.
- A **deep neural network (DNN)** is an ANN with many layers.
- At a very high level, neural networks resembled the human brain because they consist of many connected perceptrons.

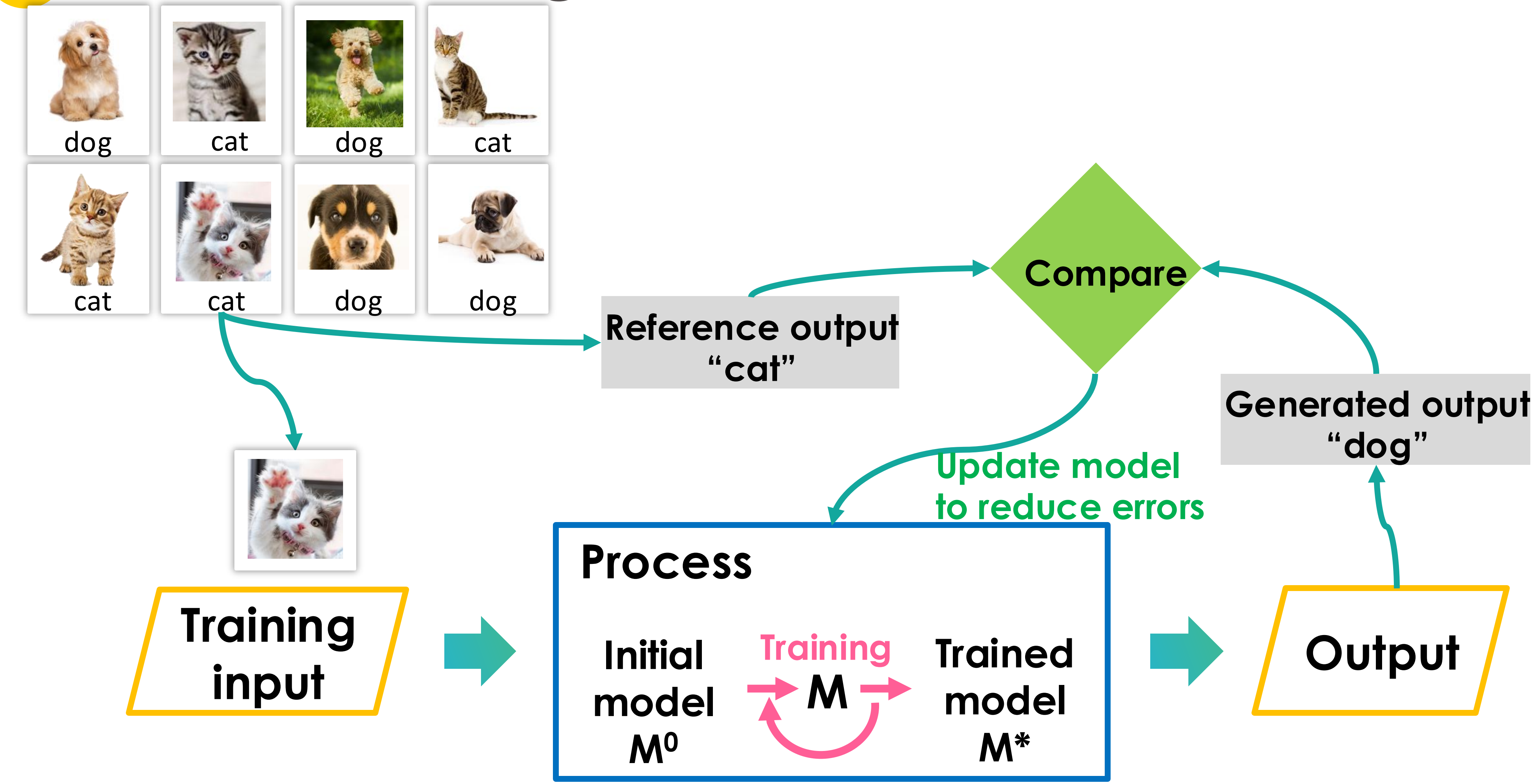


Deep Neural Networks

- A DNN is composed of 3 types of layers:
  - Input Layer
    - Receive input data
  - Hidden Layers
    - Perform computations
  - Output Layer
    - Deliver output



Model Training



dog cat dog cat

cat cat dog dog

Reference output
“cat”

Compare

Generated output
“dog”

Update model
to reduce errors

Training
input

Process

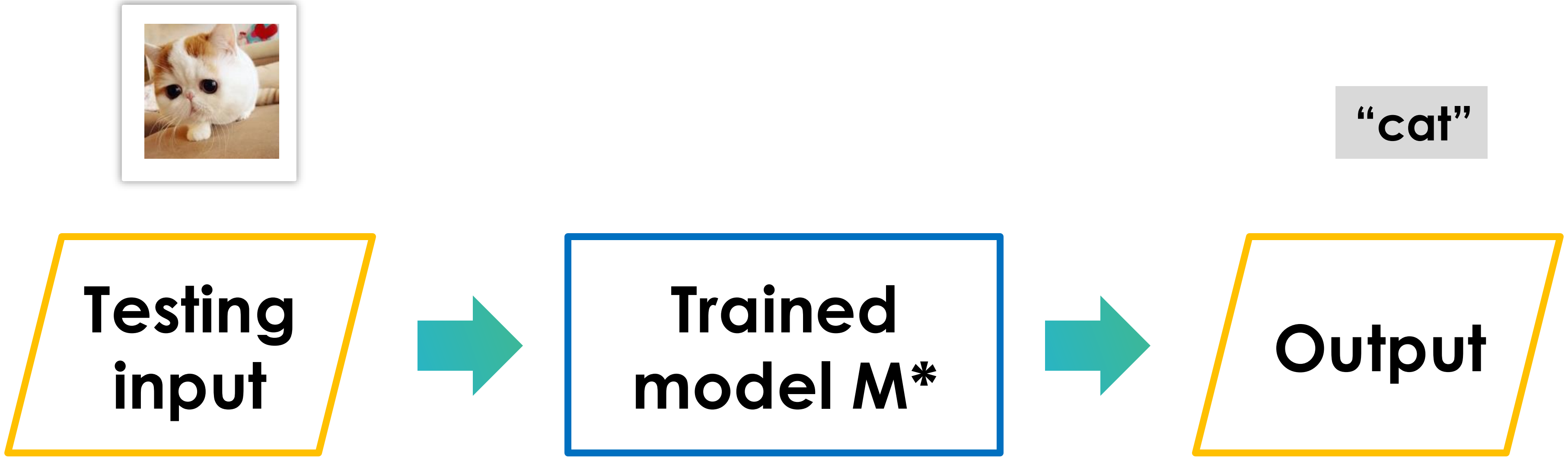
Initial
model
M^0

Training
M

Trained
model
M^*

Output

Model testing



Testing input

Trained model M*

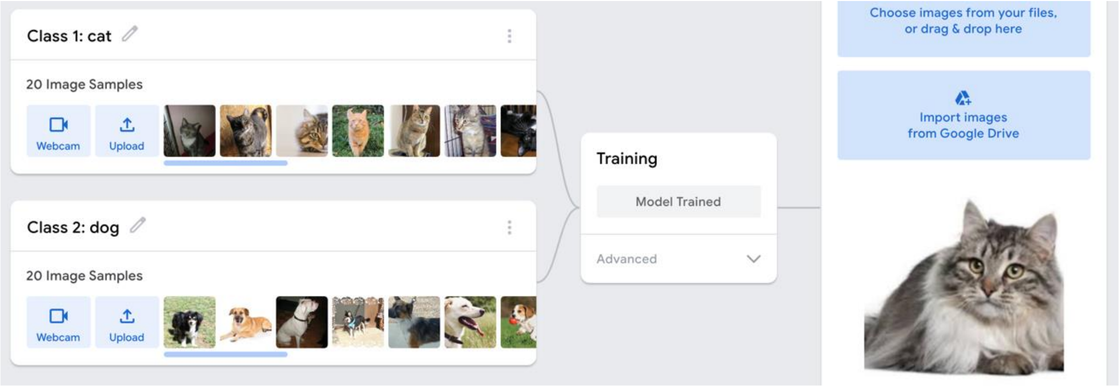
Output

“cat”

Activity 1-4

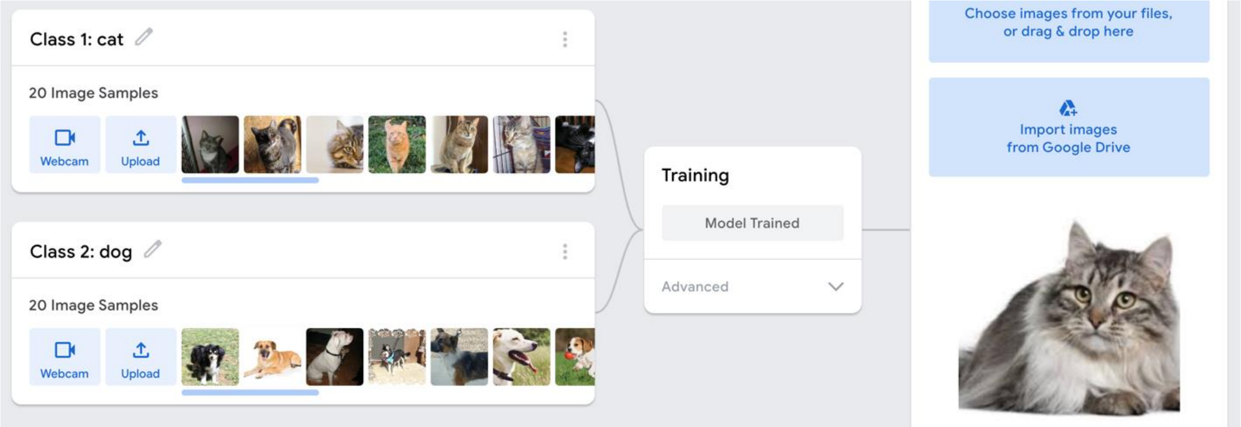
- Let’s train a cat dog classifier model with:
  1. **Normal Dataset**
  2. **Small Dataset**
  3. **Noisy Dataset**
  4. **Unbalanced Dataset**

Topic	*Task
1.1 Model Training and Testing	1
1.2 Problems in Training Data	2
	3 & 4



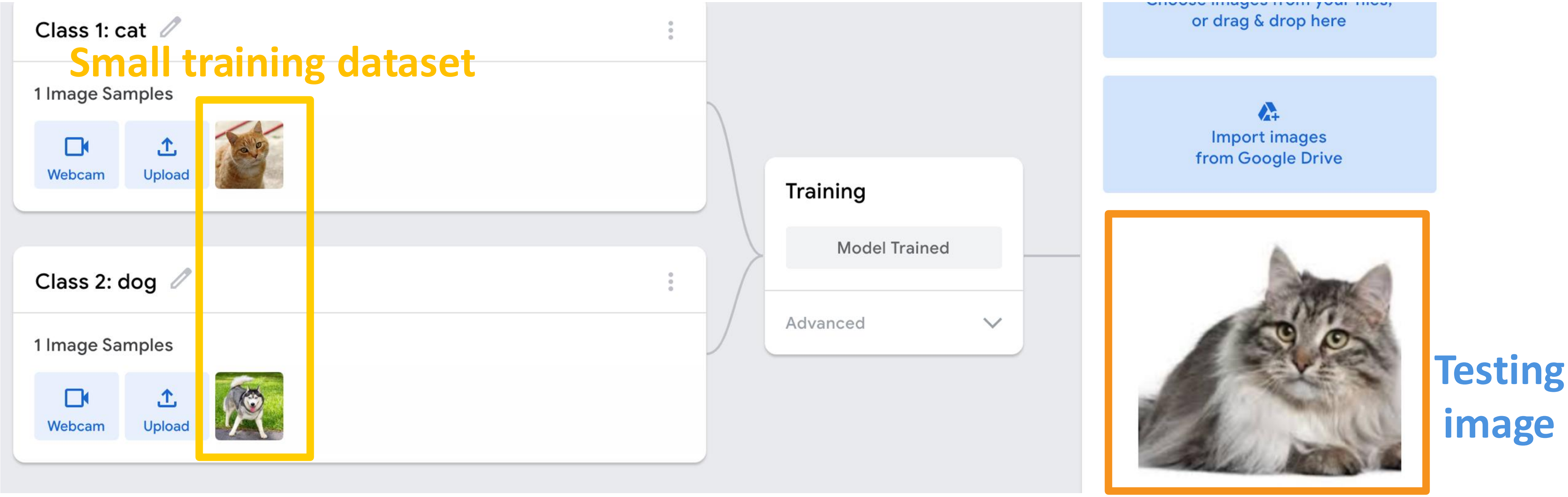
Activity 1: Model training and testing (image classifier)

1. Visit https://teachablemachine.withgoogle.com/
2. Download dataset at https://shorturl.at/ikGI1
3. Use Activity 1's dataset to train the AI model



Activity 2: Training with A Small Dataset

1. Re-train the model with Activity 2’s dataset
2. Test the model with the testing image

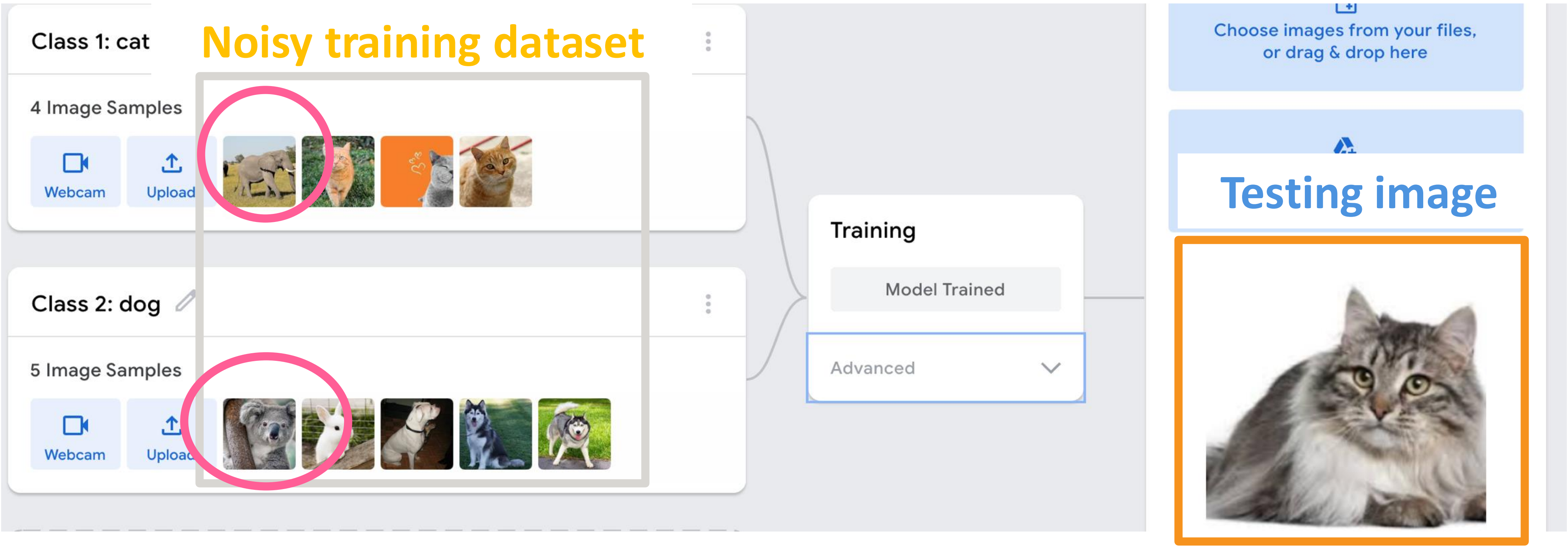


Small training dataset

Testing image

Activity 3: Training with A Noisy Dataset

1. Re-train the model with Activity 3's dataset

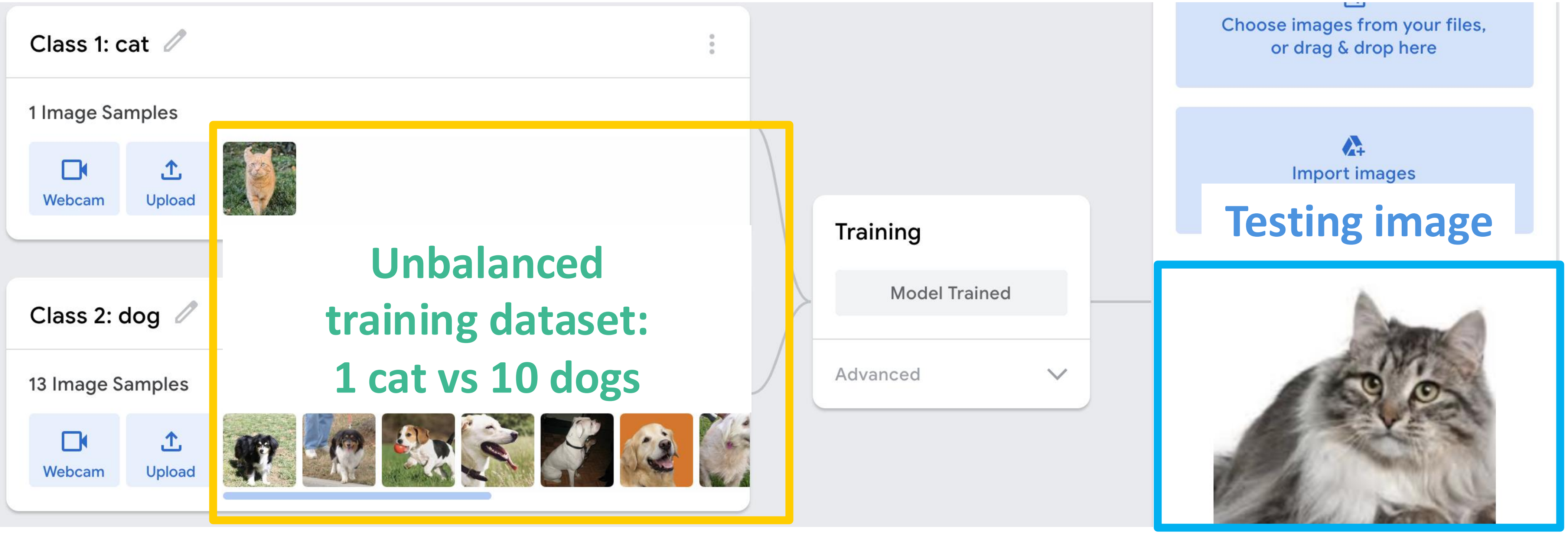


Noisy training dataset

Testing image

Activity 4: Training with An Unbalanced Dataset

1. Re-train the model with Activity 4’s dataset



Class 1: cat

1 Image Samples

Class 2: dog

13 Image Samples

Unbalanced training dataset: 1 cat vs 10 dogs

Training

Model Trained

Advanced

Choose images from your files, or drag & drop here

Import images

Testing image

Issues in Input Data

Data Authenticity:
Ensure provided data is original and from a trusted source

Data Bias:
Avoid unbalanced data or under-representation of categories in data

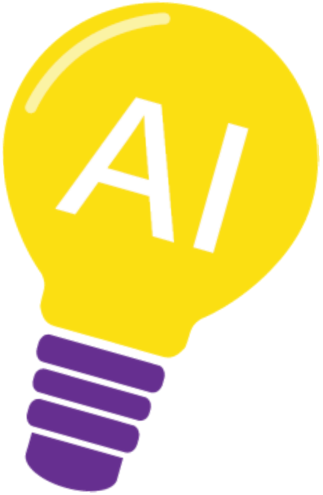
Data Security:
Protected from corruption and unauthorized access

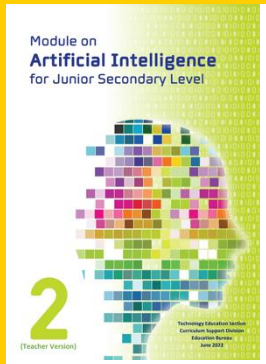
Data Privacy:
Use of data with providers' consent

Activity Summary

1 **AI system development:** AI can learn from labelled training data to produce a trained model for a target task, and apply the trained model on new (unlabelled) testing data.

2 **The quality of training data is important:** A well-trained AI model requires a large amount of data, accurately labelled (i.e. low noise), and well-balanced (i.e. low bias). The quality of data affects the performance of the AI model. High quality data causes high model performance; low quality data causes low model performance. Garbage in (useless data input) leads to garbage out (useless information output).





Module on
Artificial Intelligence
for Junior Secondary Level

2
(Teacher Version)

Technology Education Section
Curriculum Support Division
Education Bureau
June 2023

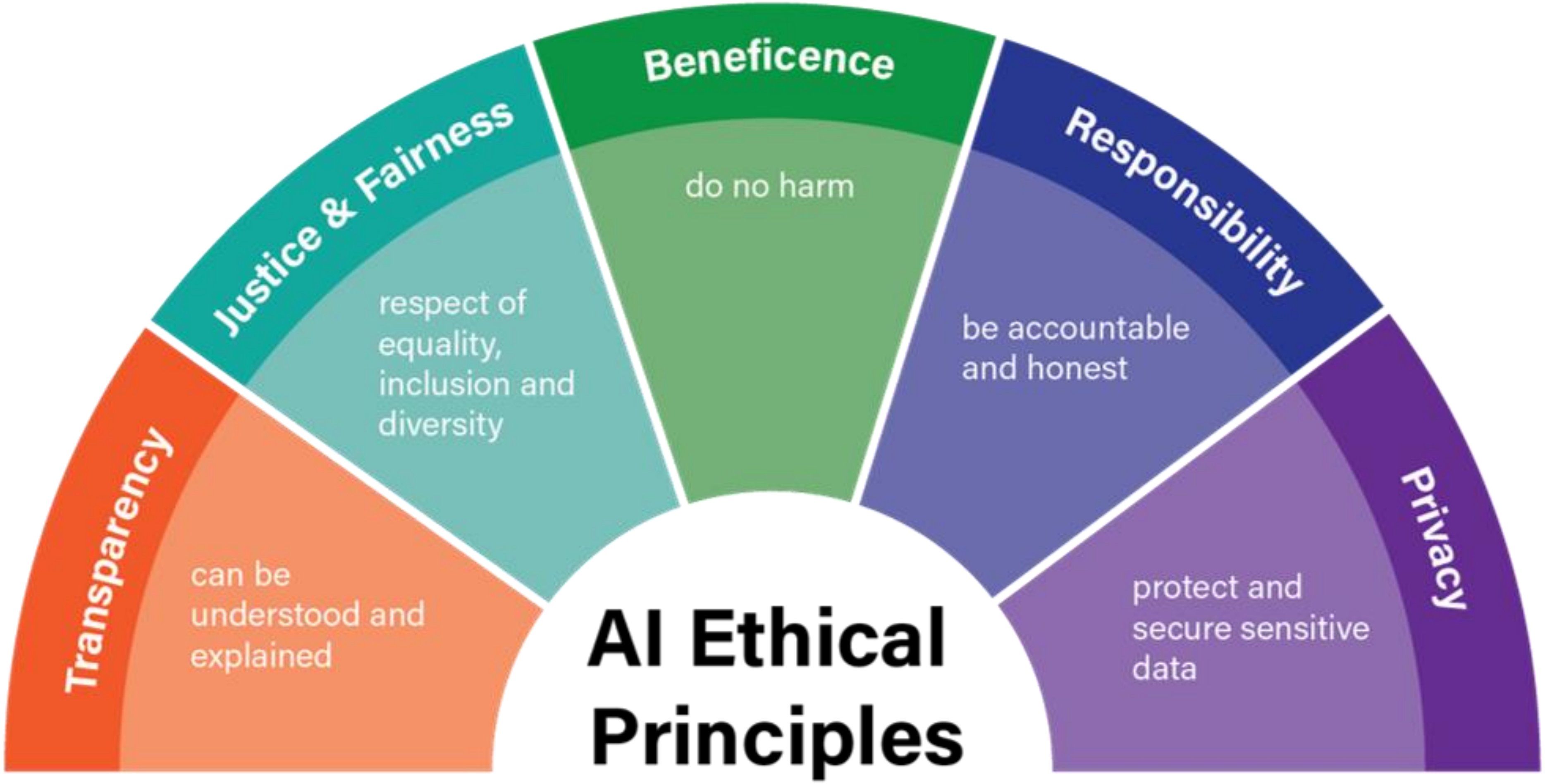
Extra activity for
Unit 2 – AI Ethical Issues,
Module on Artificial
Intelligence for Junior
Secondary Level (Booklet 2)

2

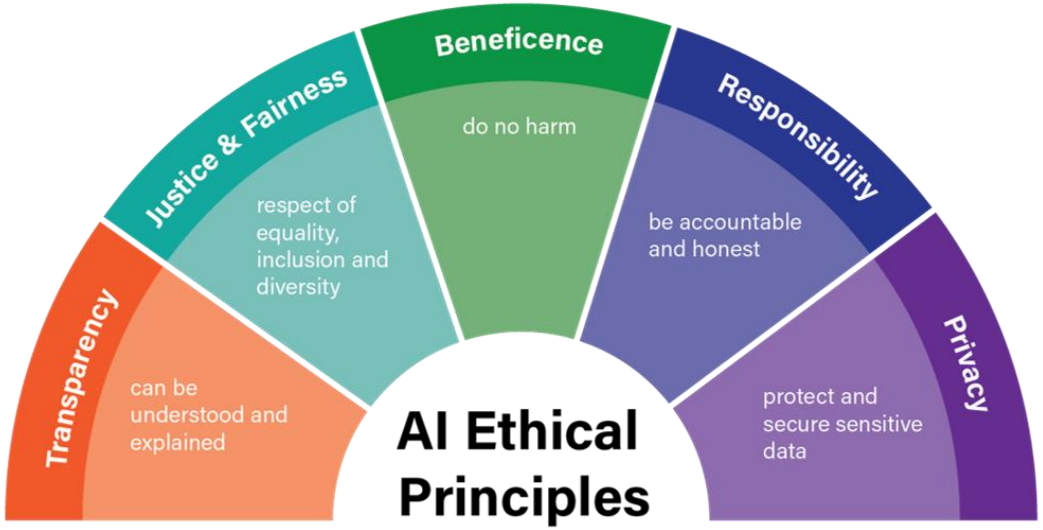
Moral Dilemma Experiment with CUHK-JC iCar

- Common AI Ethical Principles
- Introduction to CUHK-JC iCar
- Experience Blockly Programming and AI Model Training Process with Moral Dilemma Experiment

Five Most Common AI Ethical Principles

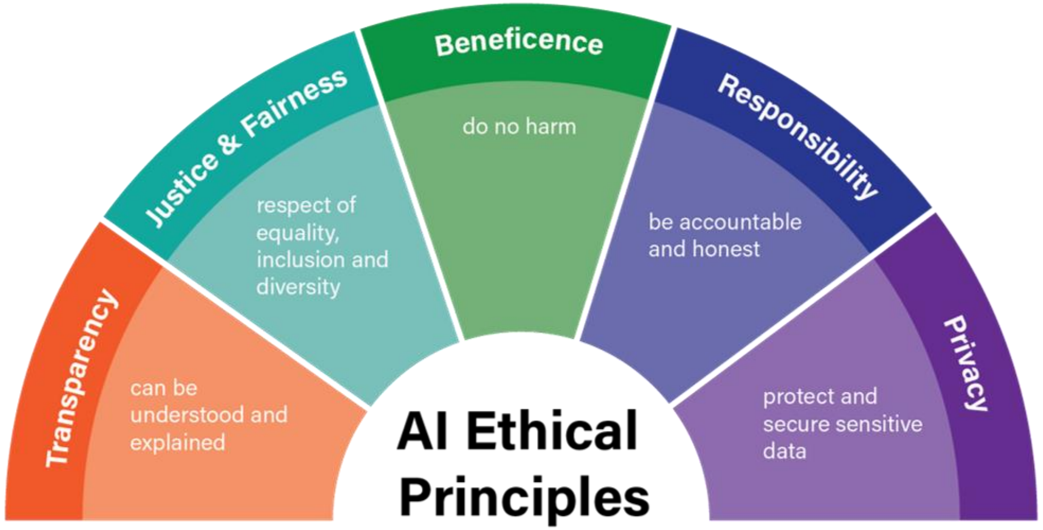

Transparency
can be understood and explained
Justice & Fairness
respect of equality, inclusion and diversity
Beneficence
do no harm
Responsibility
be accountable and honest
Privacy
protect and secure sensitive data
AI Ethical Principles

Five Most Common AI Ethical Principles


Transparency
can be understood and explained
Justice & Fairness
respect of equality, inclusion and diversity
Beneficence
do no harm
Responsibility
be accountable and honest
Privacy
protect and secure sensitive data
AI Ethical Principles

1. **Transparency**: Ensure that AI-enabled processing in applications can be interpretable by and explainable to users
2. **Justice and fairness**: Development of AI technologies and their applications must ensure equality, inclusion and diversity
3. **Beneficence**: Development and application of AI technologies must not do any harm

Five Most Common AI Ethical Principles


Transparency
can be understood and explained
Justice & Fairness
respect of equality, inclusion and diversity
Beneficence
do no harm
Responsibility
be accountable and honest
Privacy
protect and secure sensitive data
AI Ethical Principles

4. **Responsibility**: Development and application of AI technologies must uphold accountability and honesty

5. **Privacy**: While developing AI technologies and incorporating them into real applications, sensitive data must be protected and secured

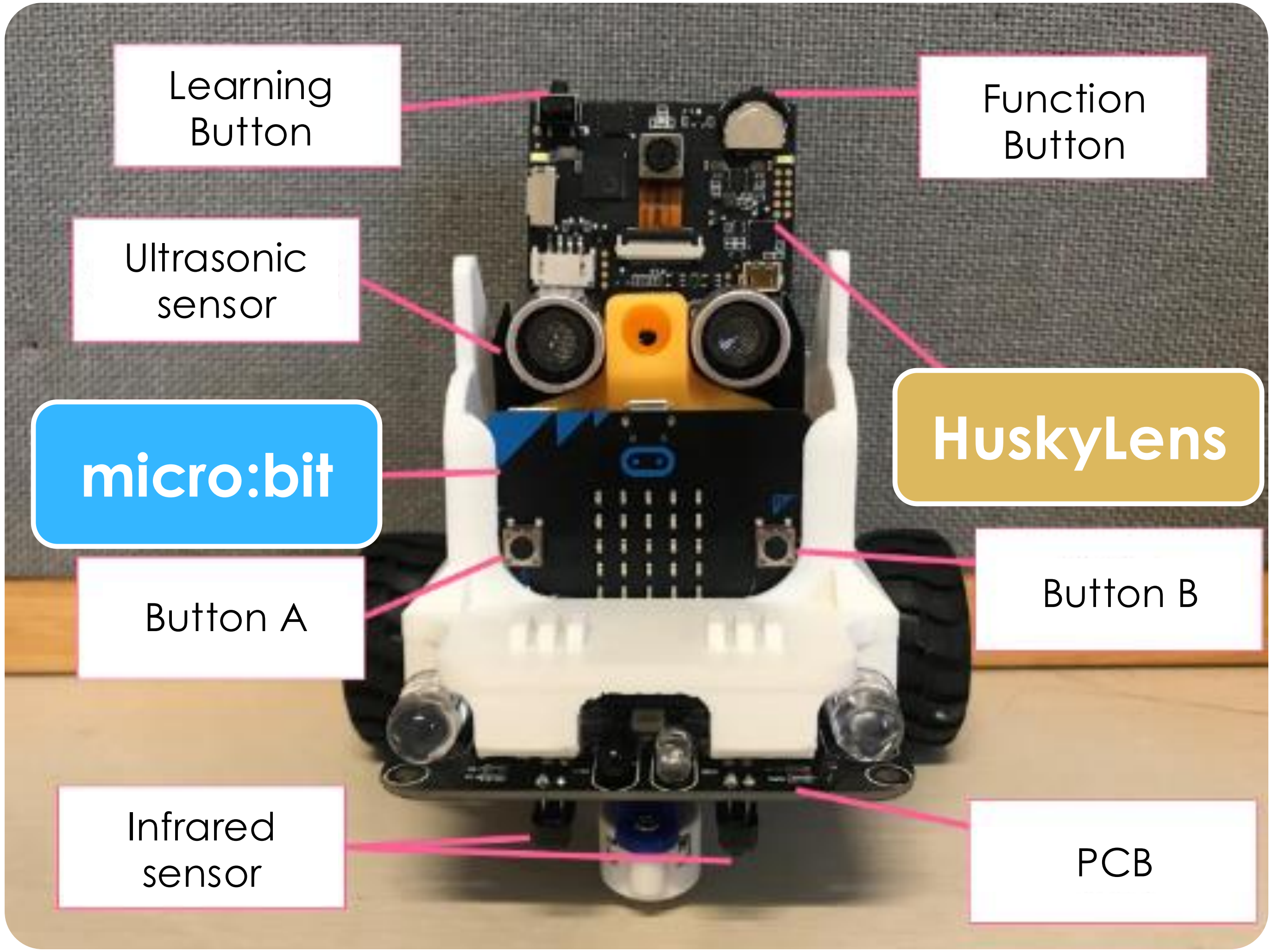
Introduction to CUHK-JC iCar

AI Robotic Car - CUHK-JC iCar

- Hardware learning toolkit developed by CUHK research team
- Ideal learning tool for beginners to learn AI

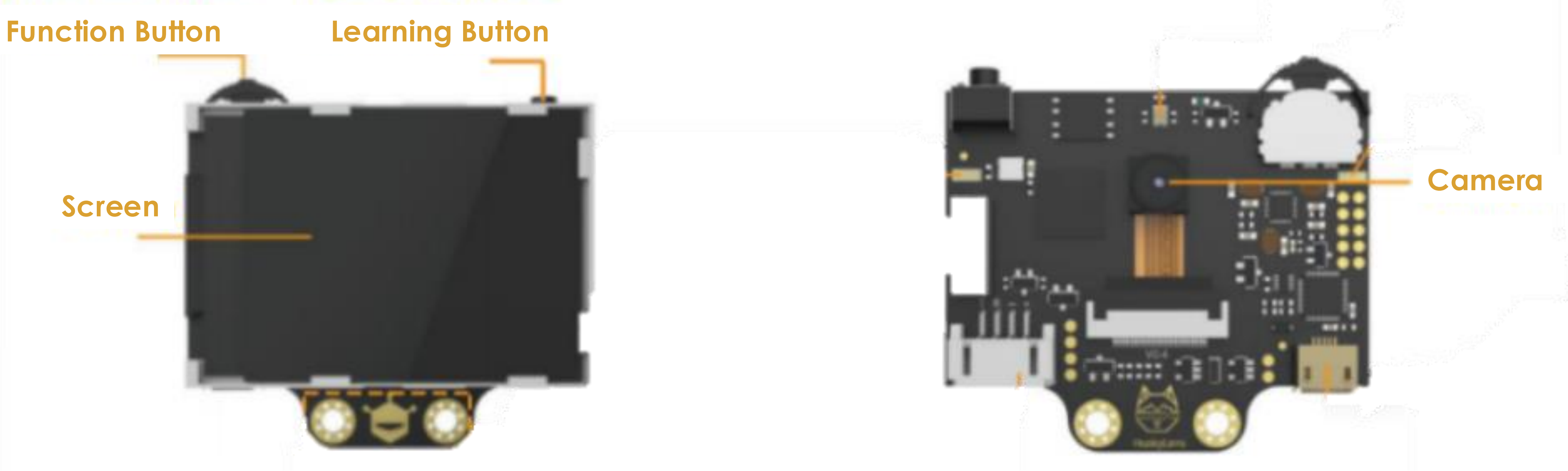
[redacted]

Components of CUHK-JC iCar



HuskyLens

- AI Visual Sensor



Source: wiki.dfrobot

HuskyLens

- 7 built-in AI functions (Firmware Version：0.5.1):

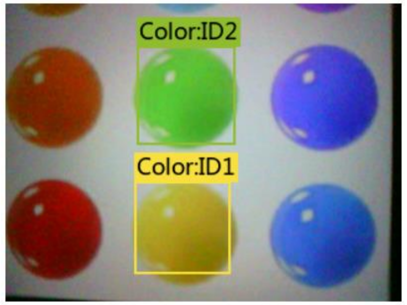
1.Face Recognition

2.Object Tracking

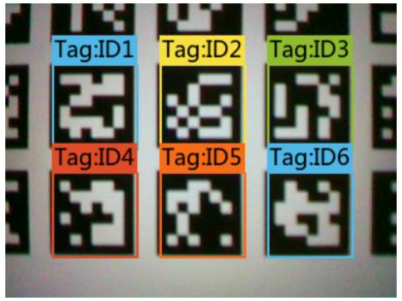
3.Object Recognition

4.Line Tracking

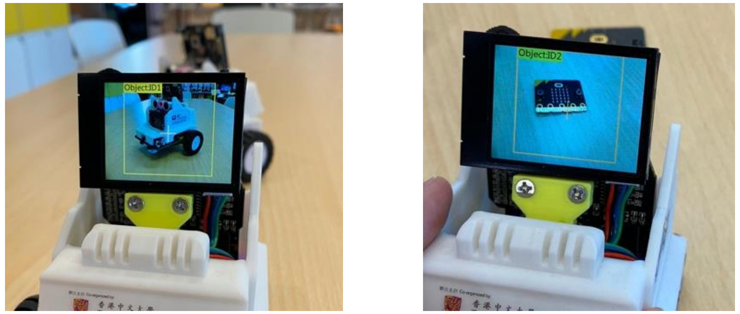
5.Color Recognition



6.Tag Recognition



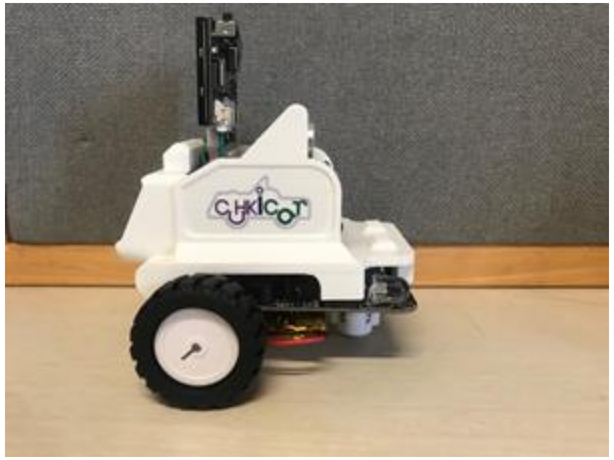
7.Object Classification



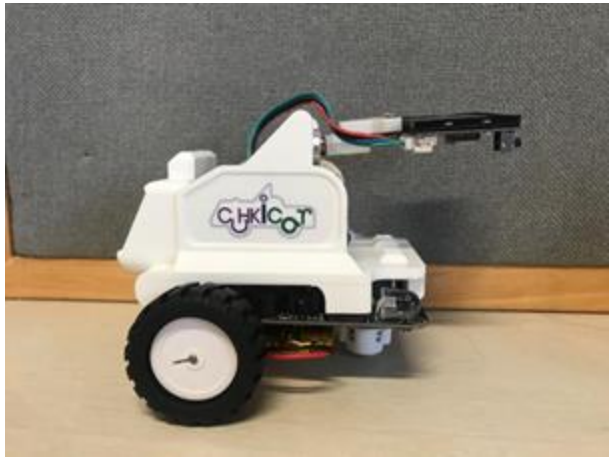
Source: wiki.dfrobot

Positions of HuskyLens

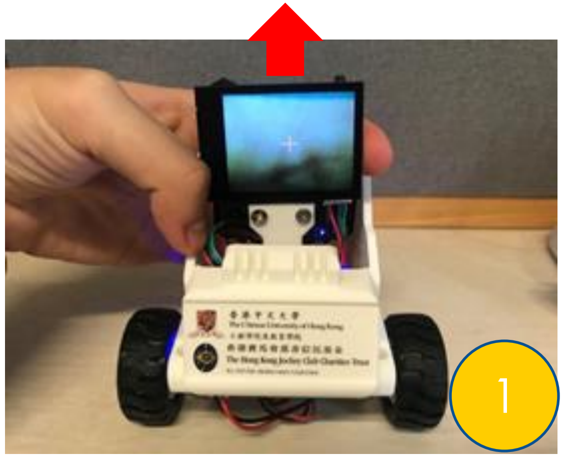
2 positions of HuskyLens:

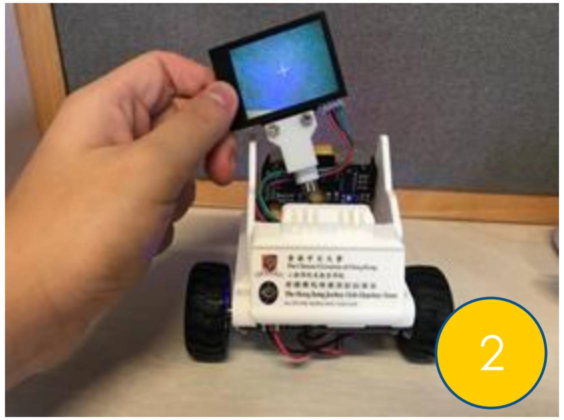


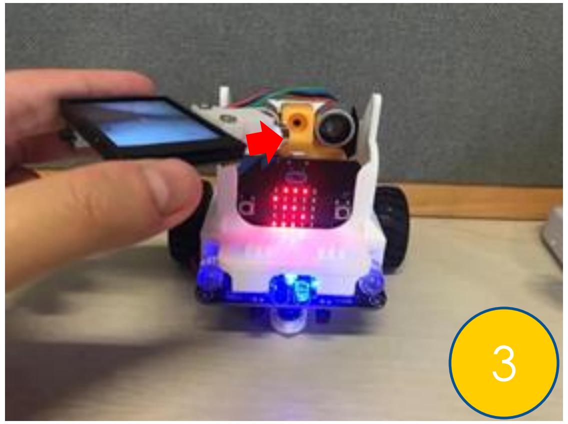
1. Facing the front

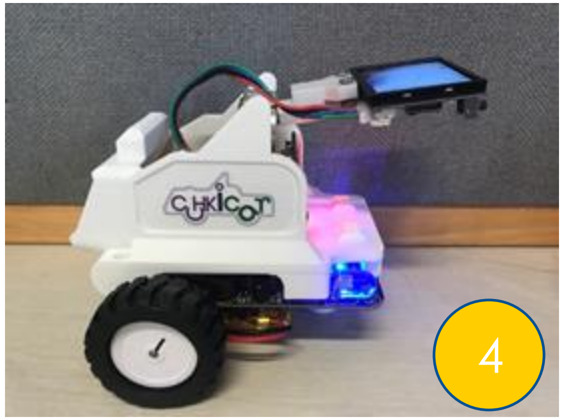


2. Facing the floor









Position the camera facing the floor

Activity:

Moral Dilemma Experiment
道德困境實驗

Aim:

- To arouse students’ **awareness in AI ethics**
- To experience the **factors affecting the data collection**
- To understand the **role of AI in autonomous driving**

1\.

Moral Dilemma – Programming Logic

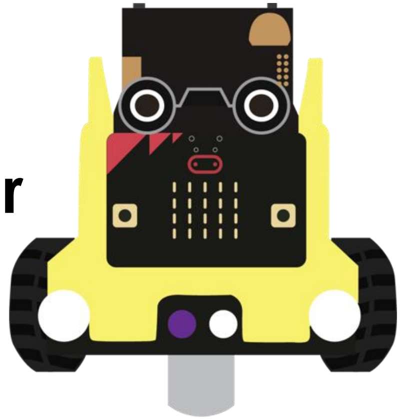
2\.

Data Collection & Program Testing

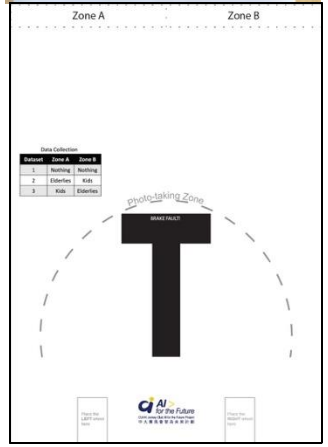
3\.

Discussion about data collection and AI ethics

1 CUHK-JC iCar



2 Paper Set up



Data Collection

Dataset	Zone A	Zone B
1	Nothing	Nothing
2	Elderlies	Kids
3	Kids	Elderlies

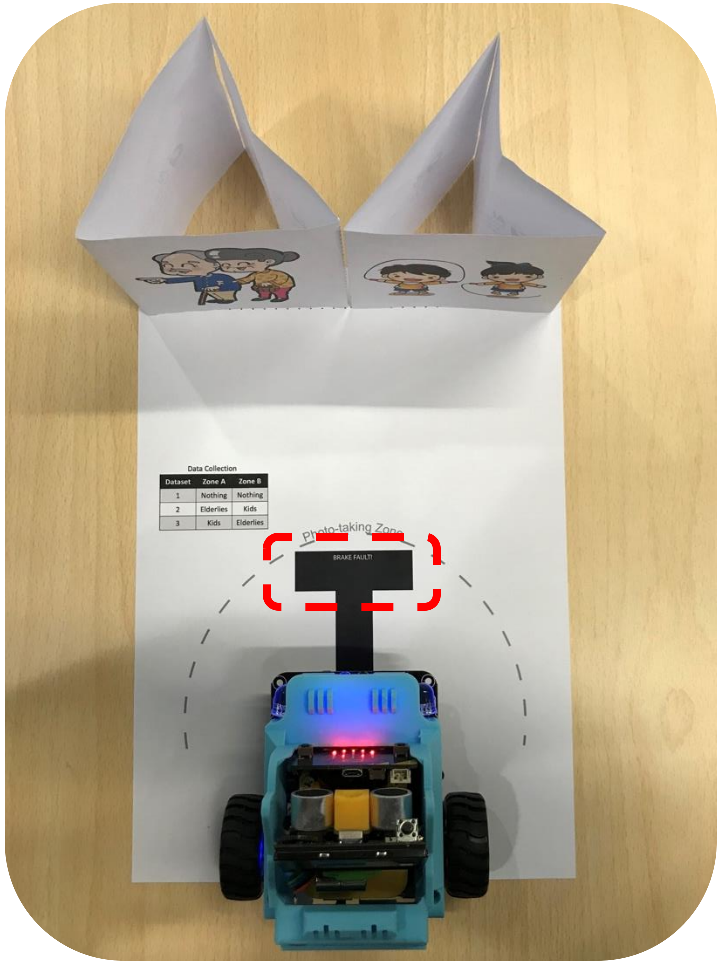
Background of the Experiment

- As autonomous driving technology matures, AI can substitute human drivers

Source: https://www.youtube.com/watch?v=tlThdr3O5Qo

Introduction of the Experiment

- This experiment simulates that the braking system of a self-driving car will fail when it reaches a black horizontal line, and the vehicle can only turn left or right



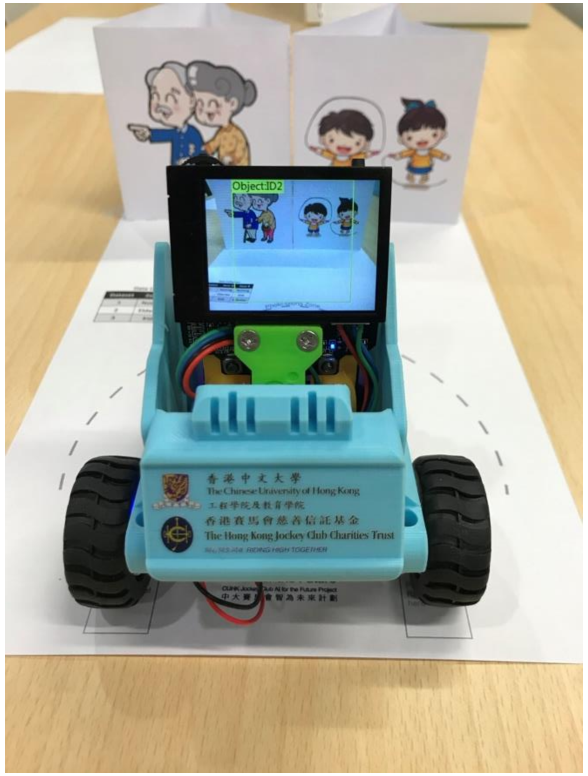
Data Collection

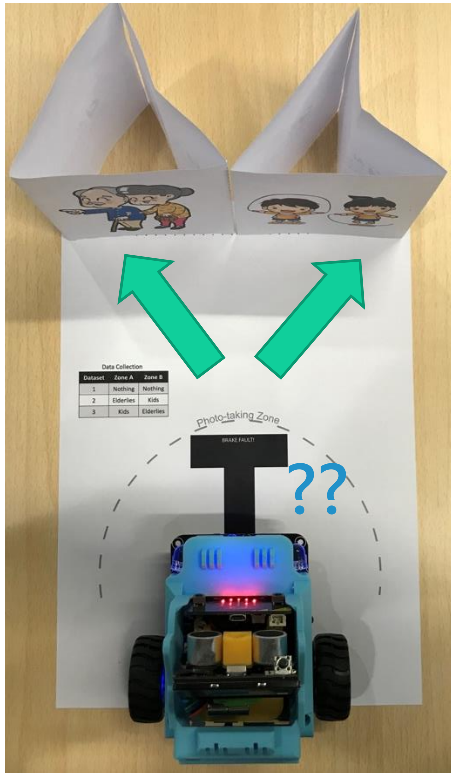
Dataset	Zone A	Zone B
1	Nothing	Nothing
2	Elderlies	Kids
3	Kids	Elderlies

Introduction of the Experiment

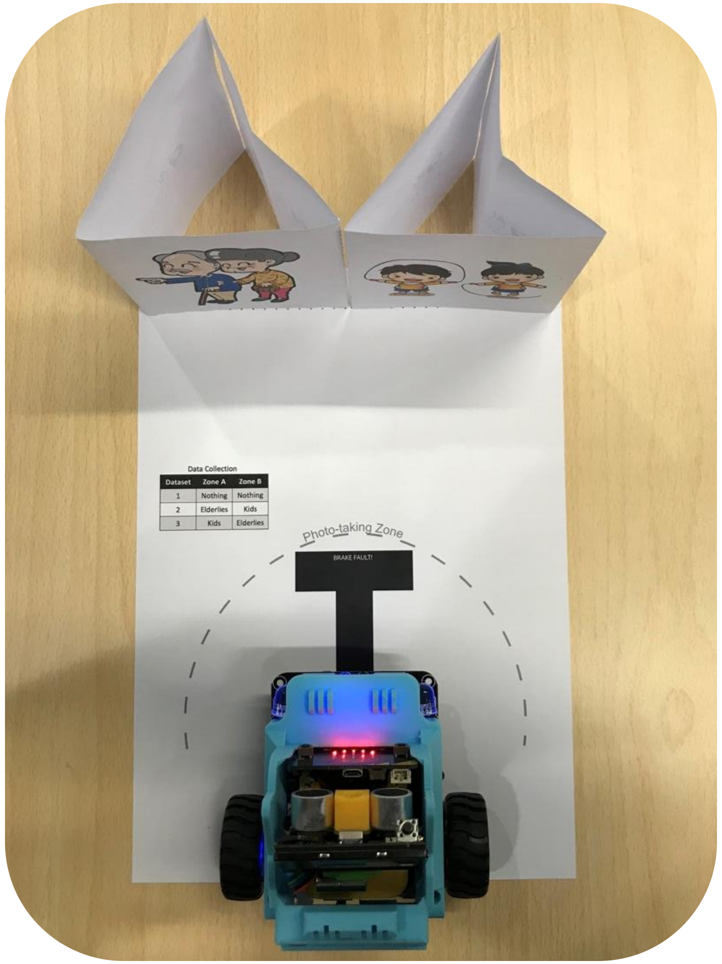
- There are elderlies and kids ahead when the self-driving car is out of control.
- Will you choose to turn left or right?

Decision 1	Decision 2
Evade Elderlies	Evade Kids


Object:ID2
香港中文大學
The Chinese University of Hong Kong
香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust



Discussion 1: Make Decision



Data Collection

Dataset	Zone A	Zone B
1	Nothing	Nothing
2	Elderlies	Kids
3	Kids	Elderlies

Why did you make this moral decision?

Rehabilitation Ability?

Survival Rate?

Occupation?

Generation?

Consanguinity?

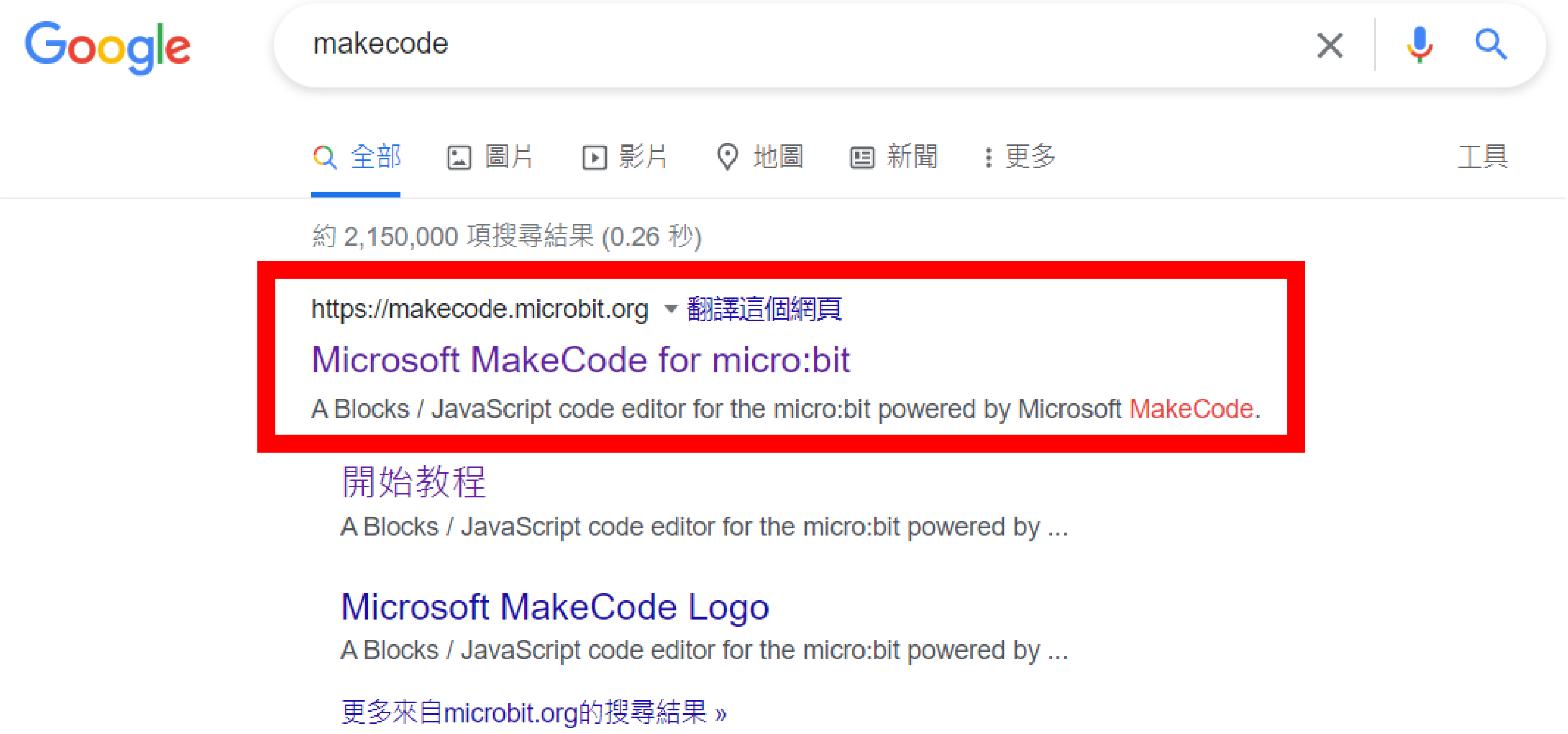
Contribution?

Wealth?

Other Reasons…?

Code On MakeCode

Browse https://makecode.microbit.org/



約 2,150,000 項搜尋結果 (0.26 秒)

https://makecode.microbit.org ▾ 翻譯這個網頁

Microsoft MakeCode for micro:bit

A Blocks / JavaScript code editor for the micro:bit powered by Microsoft MakeCode.

開始教程

A Blocks / JavaScript code editor for the micro:bit powered by ...

Microsoft MakeCode Logo

A Blocks / JavaScript code editor for the micro:bit powered by ...

更多來自microbit.org的搜尋結果 »

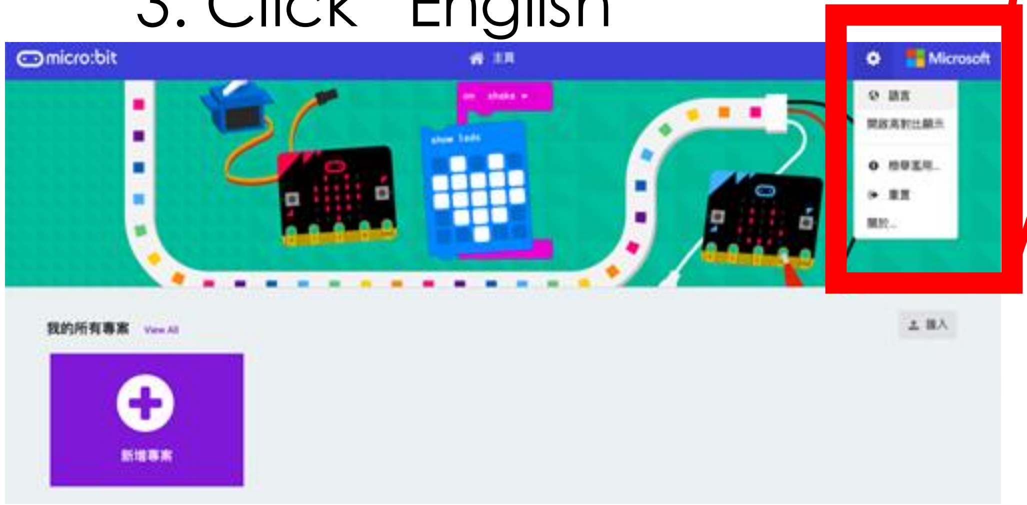
Reminder

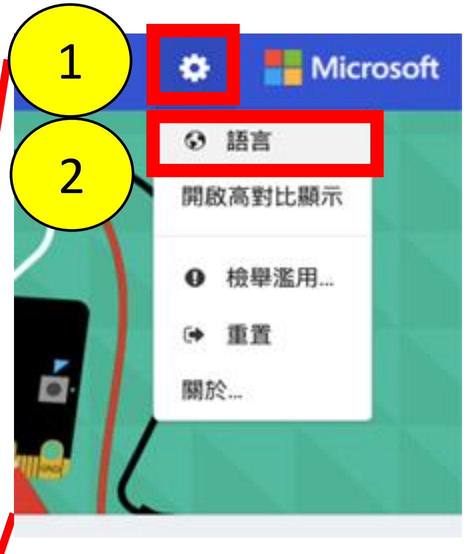
Please Set English As The Language!

1. Click ⚙

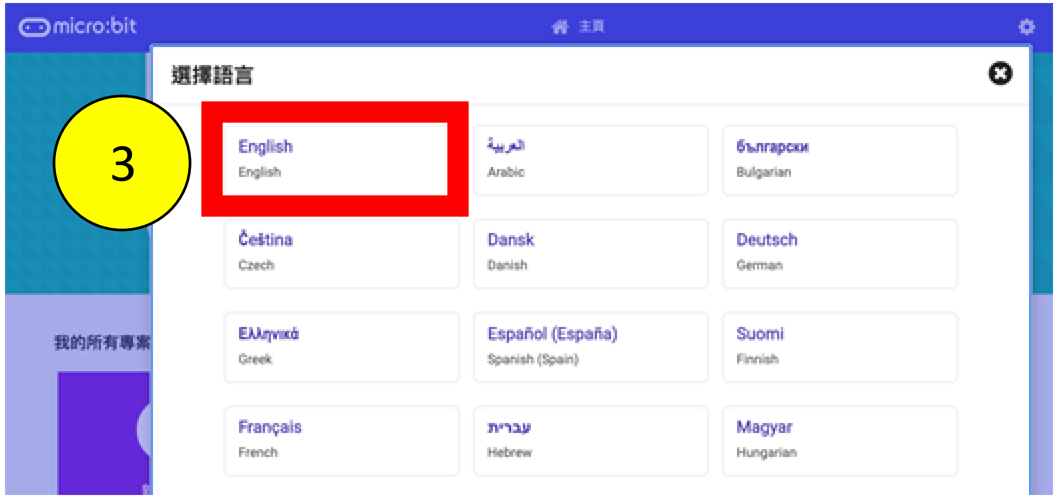
2. Click 語言

3. Click “English”

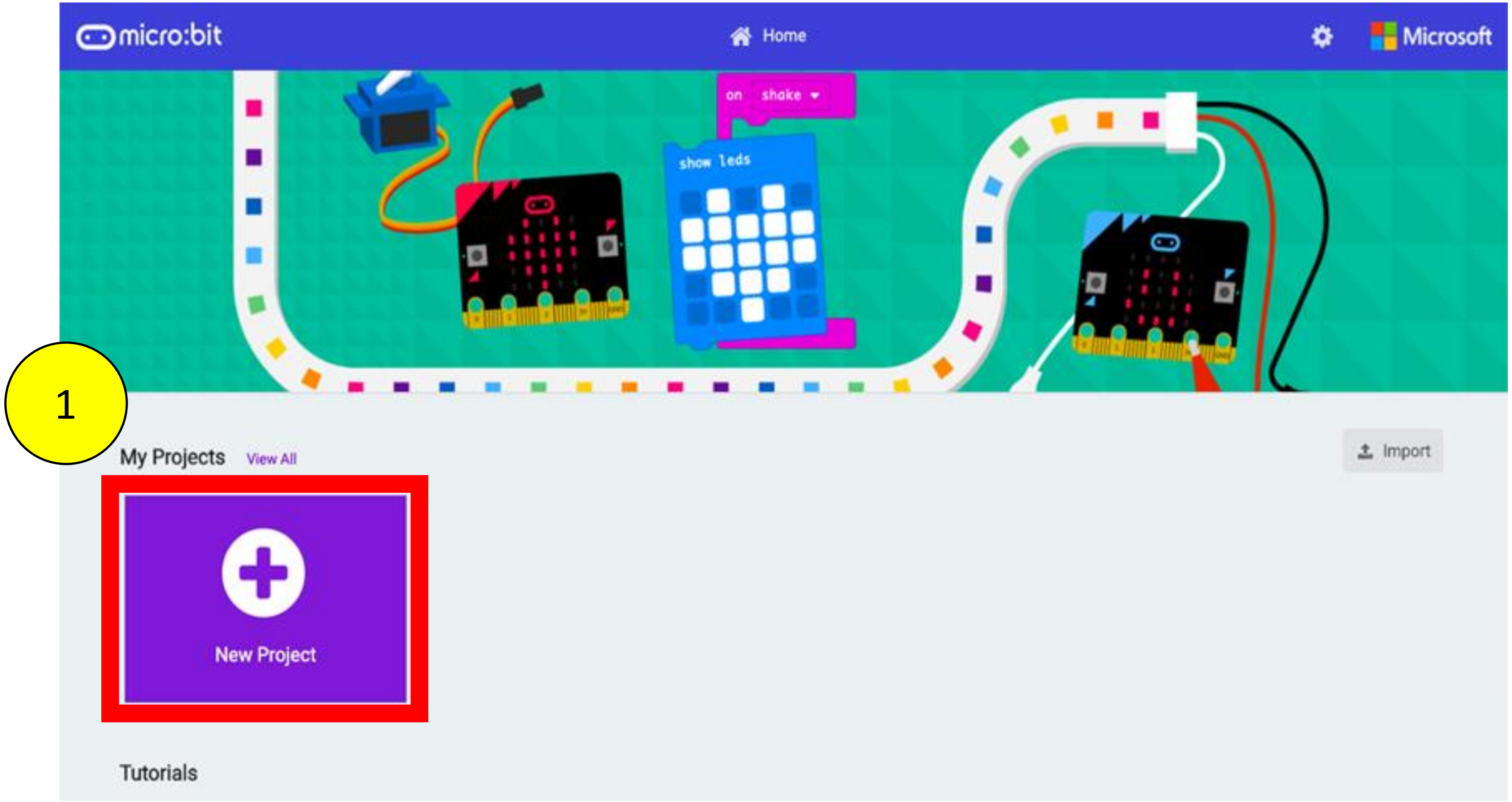




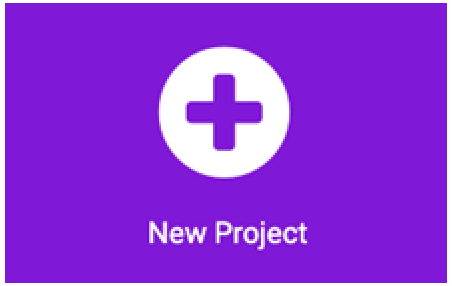
English must be set as the language, otherwise the program may fail



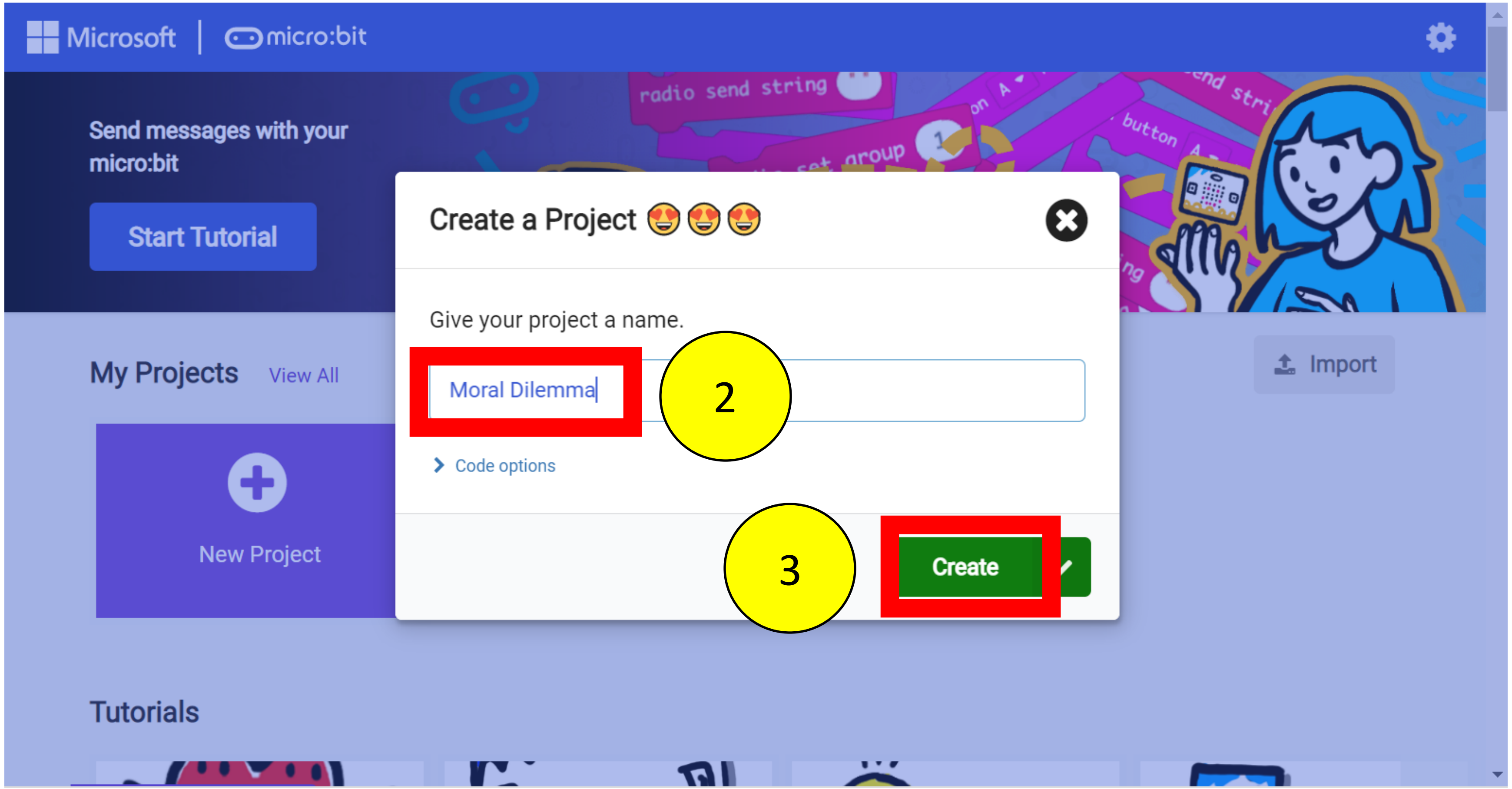
New Project



1. Click “New Project”

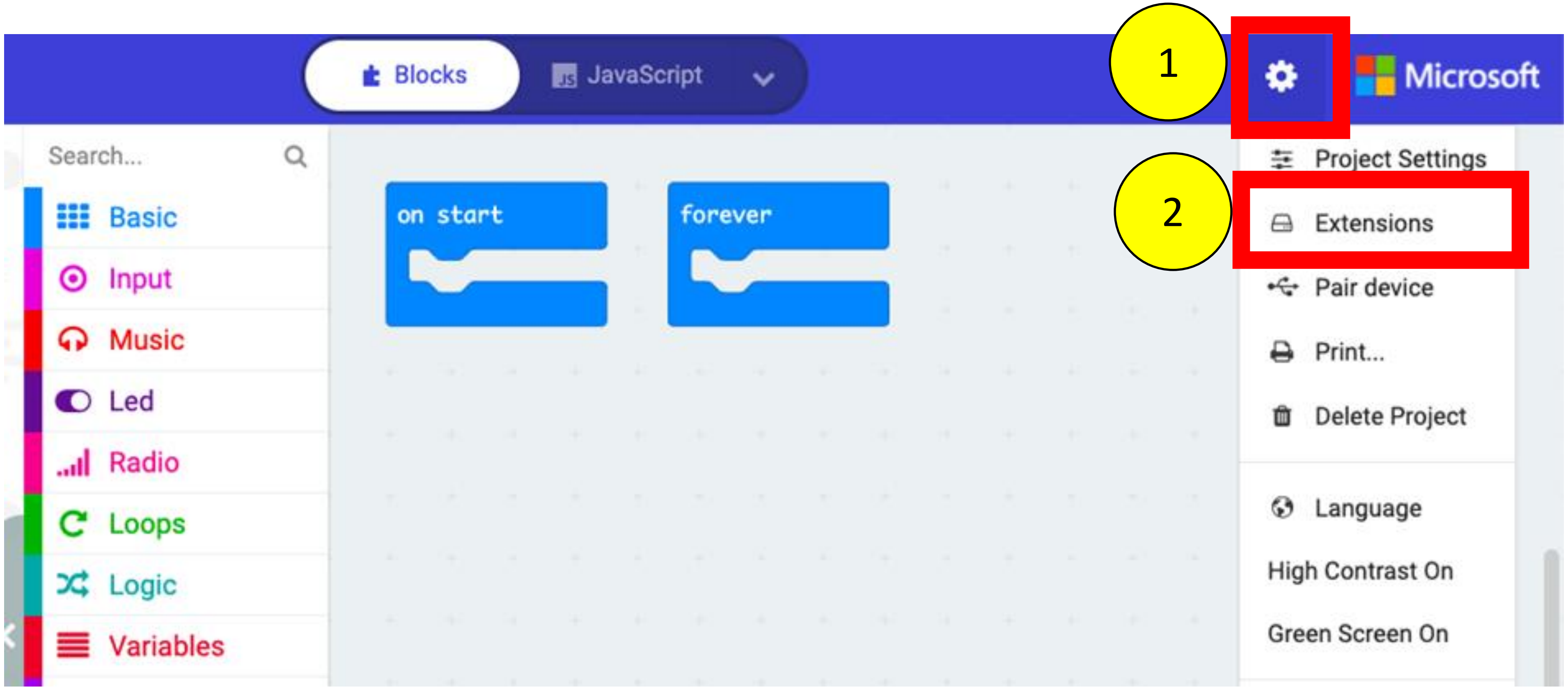


Create Project



2. Enter "Moral Dilemma"
3. Click Create

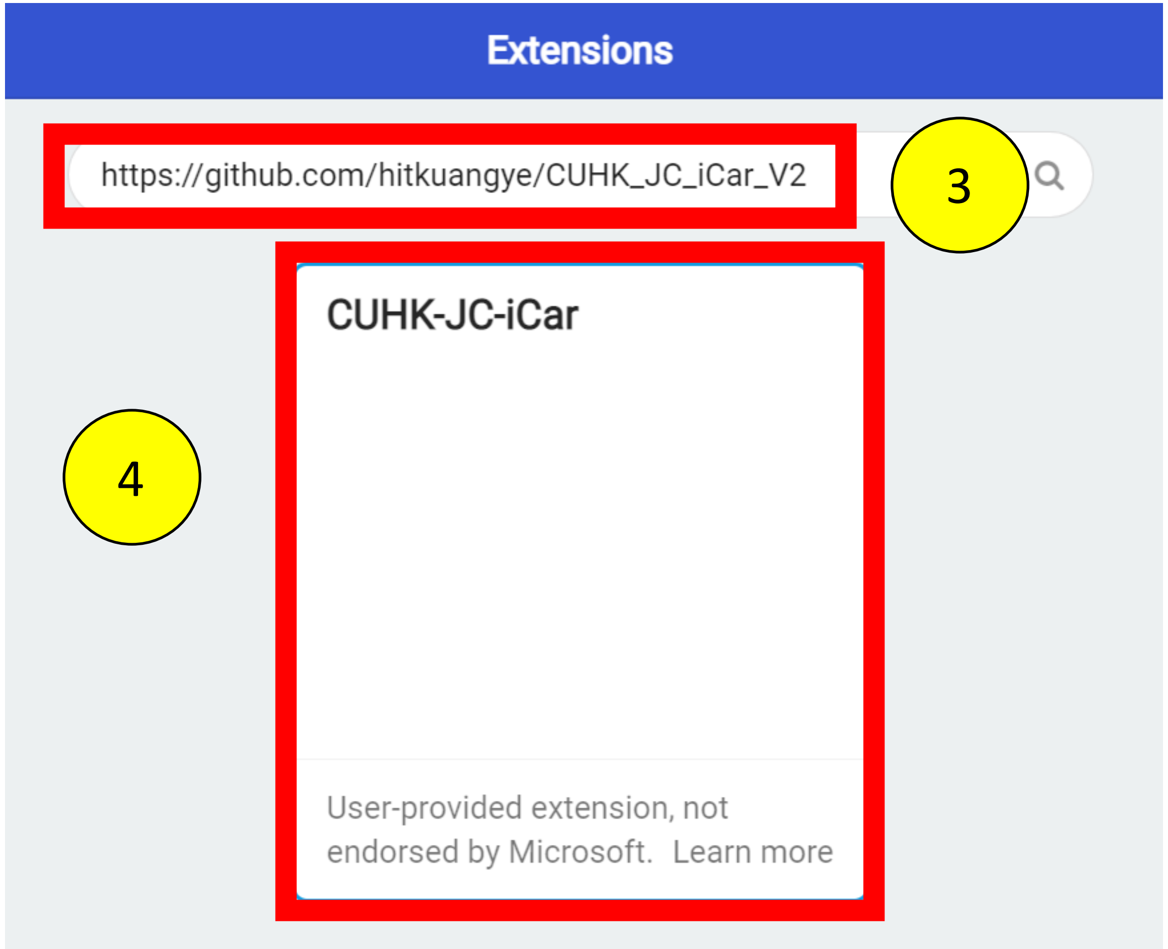
Prepare CUHK-JC iCar Extension



1. Click ⚙

2. Click 🖴 Extensions

Import Extension



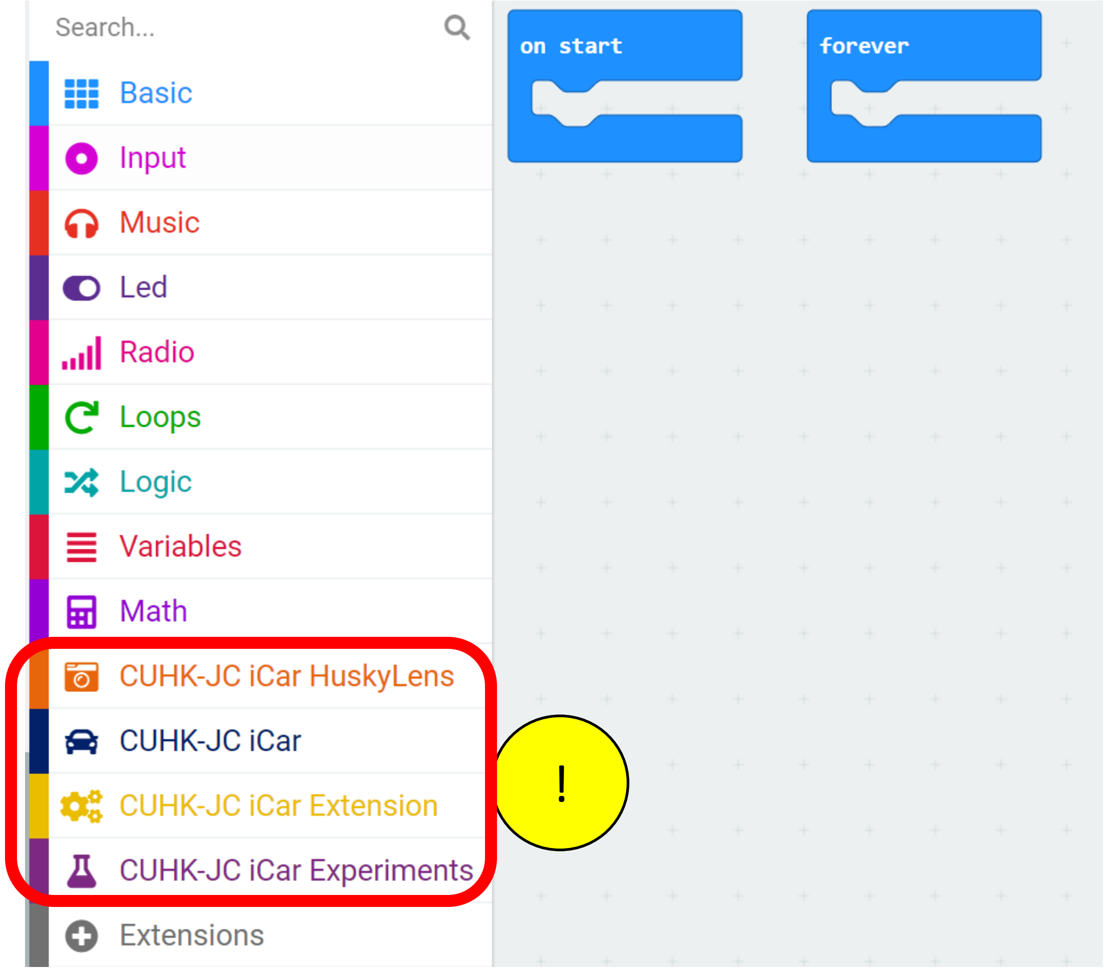
Extensions
3
4
CUHK-JC-iCar
User-provided extension, not endorsed by Microsoft. Learn more

https://github.com/hitkuangye/CUHK_JC_iCar_V2

3. Paste the following link: https://github.com/hitkuangye/CUHK_JC_iCar_V2

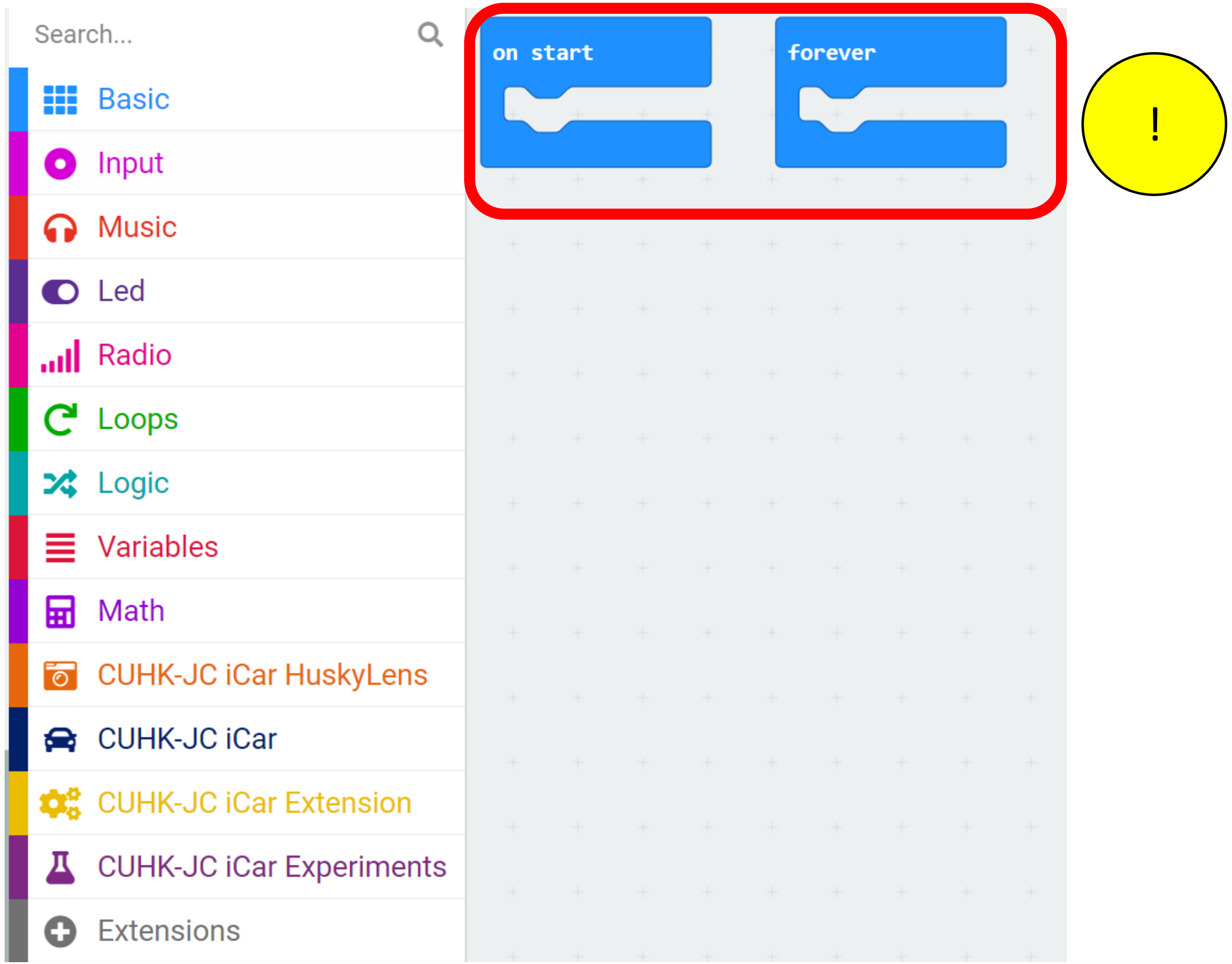
4. Click CUHK-JC-iCar extension

Import Extension



Extensions are imported

Playground



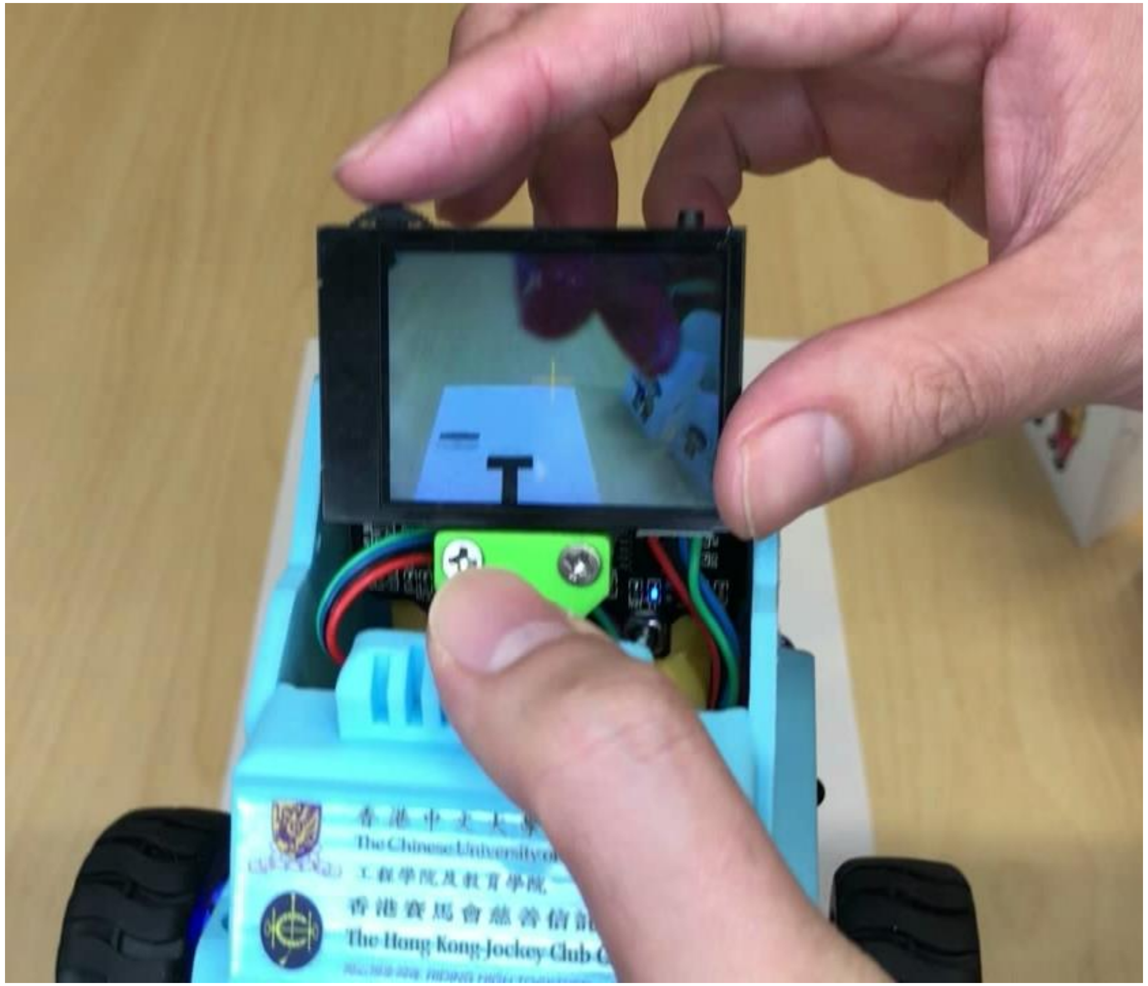
The program will pre-set "on start" and "forever" at the beginning

We can ignore them for now. Please don't delete!

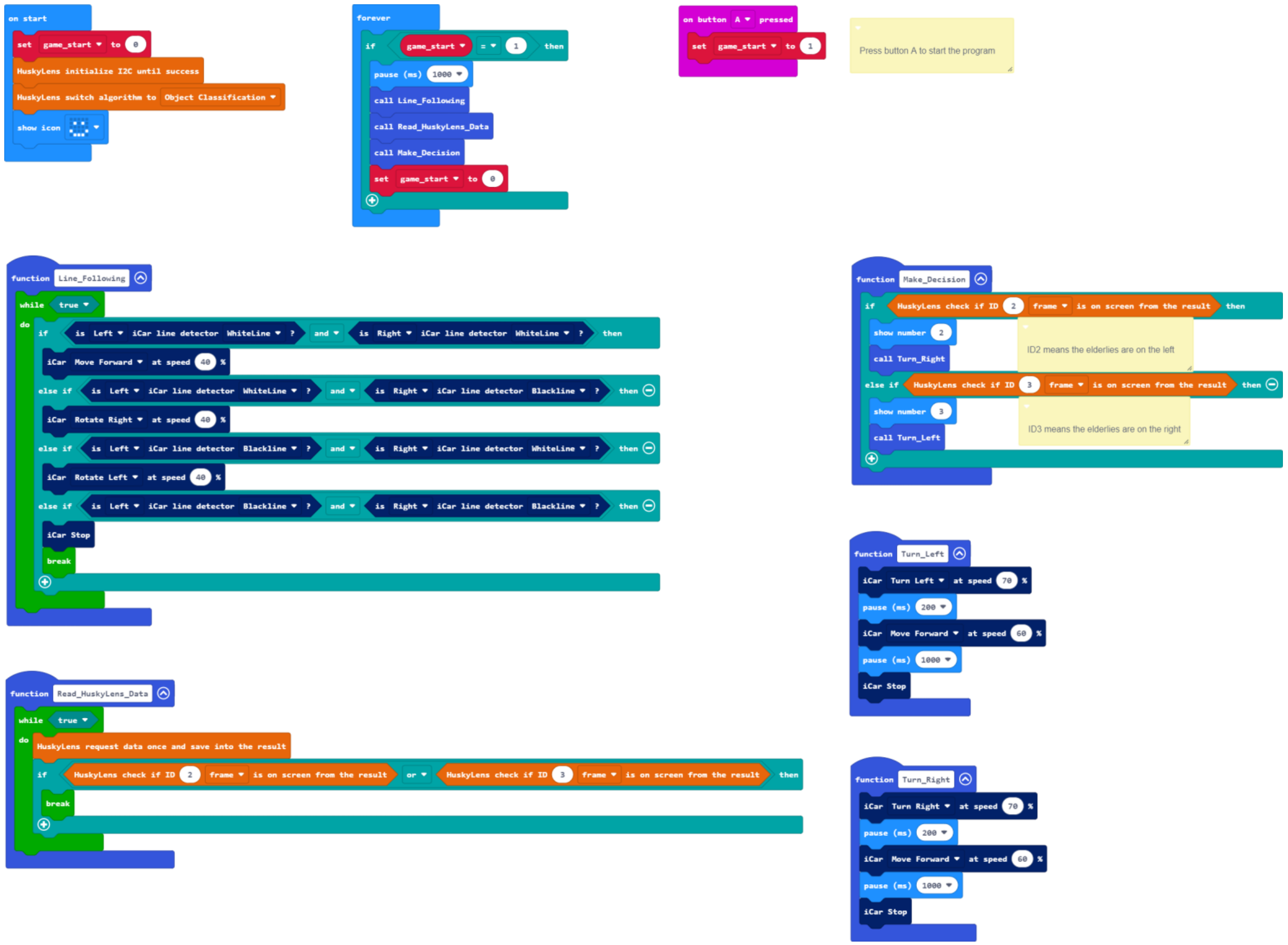
CUHK-JC iCar Programming Logic

Download the program to CUHK-JC iCar so that it can implement our moral decisions

Decision 1	Decision 2
Evade Elderlies	Evade Kids



Let's explore the principles behind block programming!



```
on start
    set game_start ▾ to 0
    HuskyLens initialize I2C until success
    HuskyLens switch algorithm to Object Classification ▾
    show icon ▾
```

```
forever
    if game_start ▾ = ▾ 1 then
        pause (ms) 1000 ▾
        call Line_Following
        call Read_HuskyLens_Data
        call Make_Decision
        set game_start ▾ to 0
```

```
on button A ▾ pressed
    set game_start ▾ to 1
```

Press button A to start the program

```
function Line_Following
    while true ▾
    do
        if is Left ▾ iCar line detector WhiteLine ▾ ? and ▾ is Right ▾ iCar line detector WhiteLine ▾ ? then
            iCar Move Forward ▾ at speed 40 %
        else if is Left ▾ iCar line detector WhiteLine ▾ ? and ▾ is Right ▾ iCar line detector Blackline ▾ ? then
            iCar Rotate Right ▾ at speed 40 %
        else if is Left ▾ iCar line detector Blackline ▾ ? and ▾ is Right ▾ iCar line detector WhiteLine ▾ ? then
            iCar Rotate Left ▾ at speed 40 %
        else if is Left ▾ iCar line detector Blackline ▾ ? and ▾ is Right ▾ iCar line detector Blackline ▾ ? then
            iCar Stop
            break
```

```
function Read_HuskyLens_Data
    while true ▾
    do
        HuskyLens request data once and save into the result
        if HuskyLens check if ID 2 frame ▾ is on screen from the result or ▾ HuskyLens check if ID 3 frame ▾ is on screen from the result then
            break
```

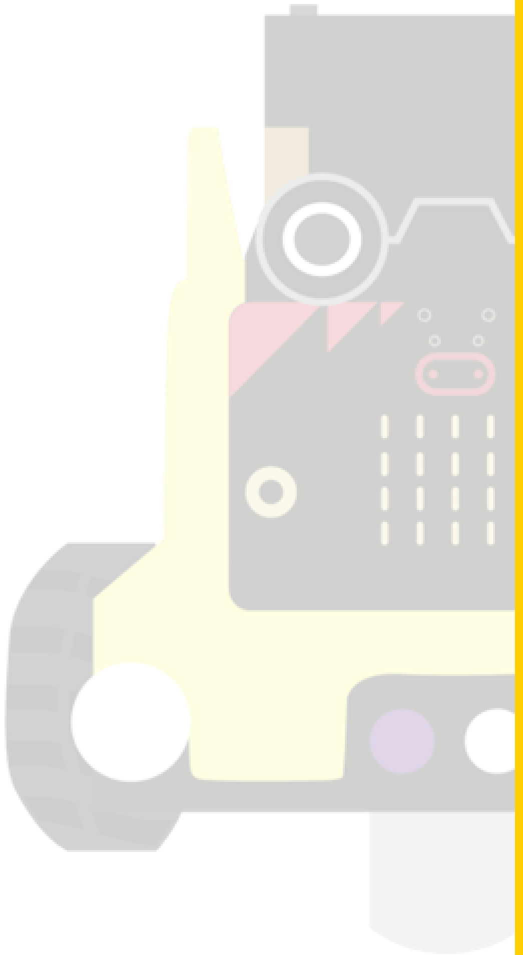
```
function Make_Decision
    if HuskyLens check if ID 2 frame ▾ is on screen from the result then
        show number 2
        call Turn_Right
    else if HuskyLens check if ID 3 frame ▾ is on screen from the result then
        show number 3
        call Turn_Left
```

ID2 means the elderlies are on the left

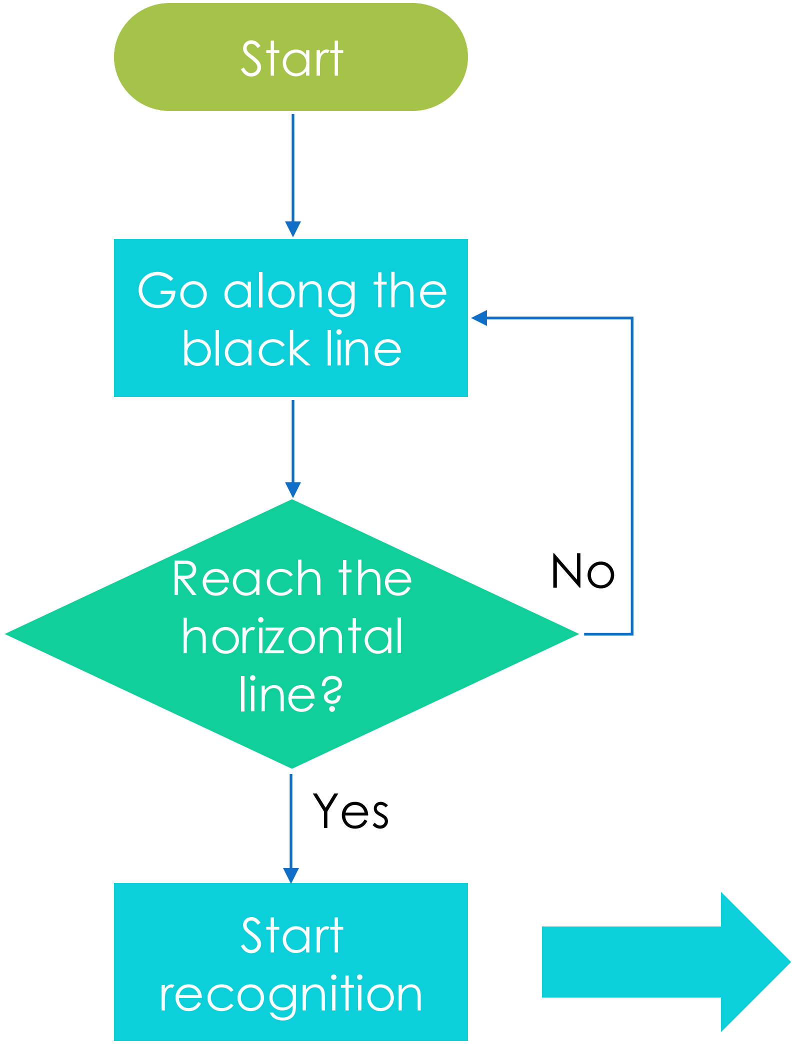
ID3 means the elderlies are on the right

```
function Turn_Left
    iCar Turn Left ▾ at speed 70 %
    pause (ms) 200 ▾
    iCar Move Forward ▾ at speed 60 %
    pause (ms) 1000 ▾
    iCar Stop
```

```
function Turn_Right
    iCar Turn Right ▾ at speed 70 %
    pause (ms) 200 ▾
    iCar Move Forward ▾ at speed 60 %
    pause (ms) 1000 ▾
    iCar Stop
```



Program Flowchart



Start

Go along the black line

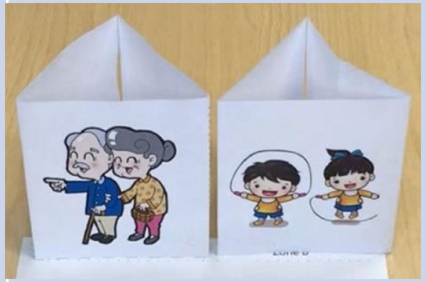
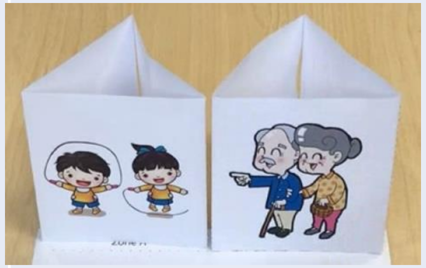
Reach the horizontal line?

No

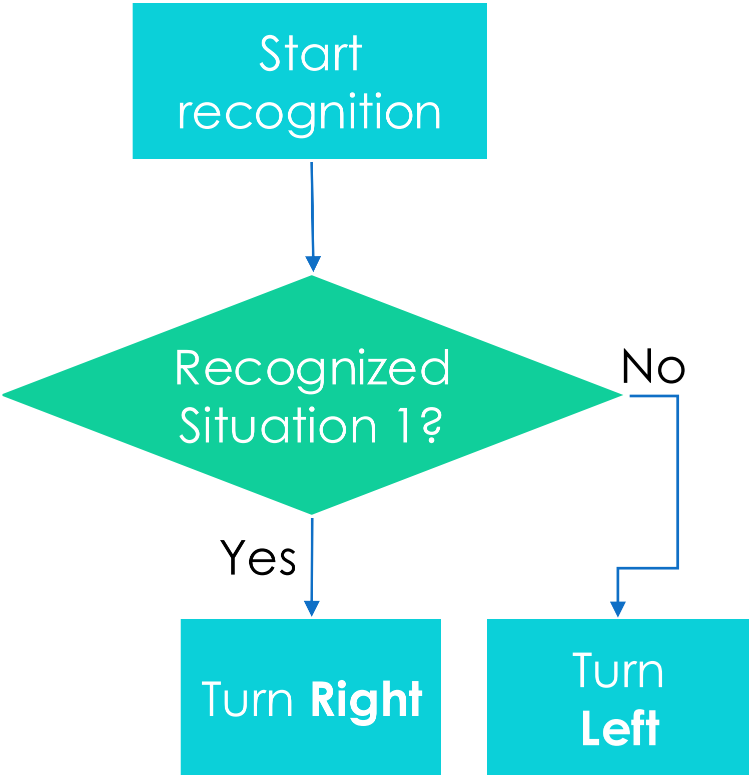
Yes

Start recognition

Situation	Zone A	Zone B	Image
1	Elderlies	Kids	
2	Kids	Elderlies	

Situation	Image
1	
2	

Decision 1 Evade Elderlies



Start recognition

Recognized Situation 1?

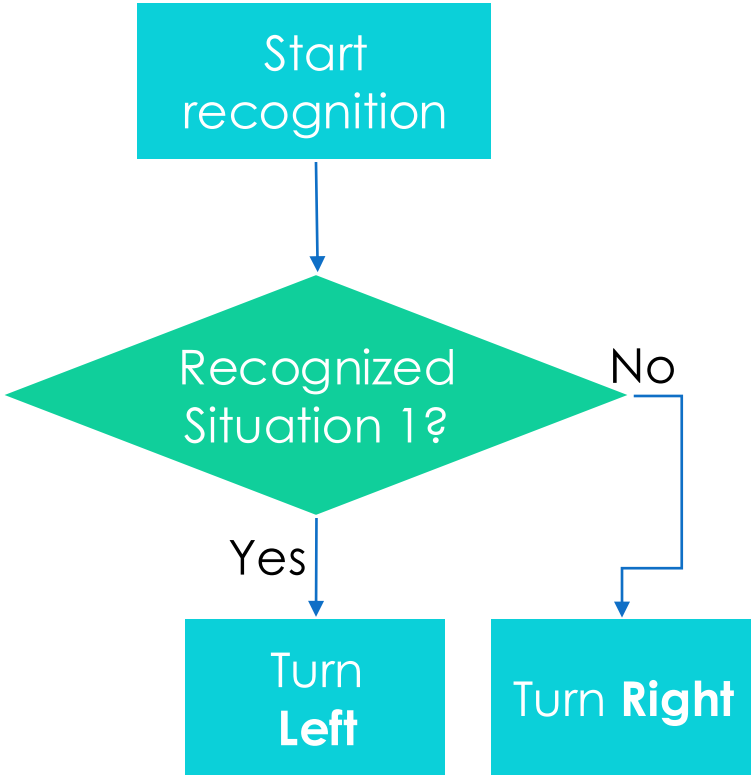
Yes

No

Turn **Right**

Turn **Left**

Decision 2 Evade Kids



Start recognition

Recognized Situation 1?

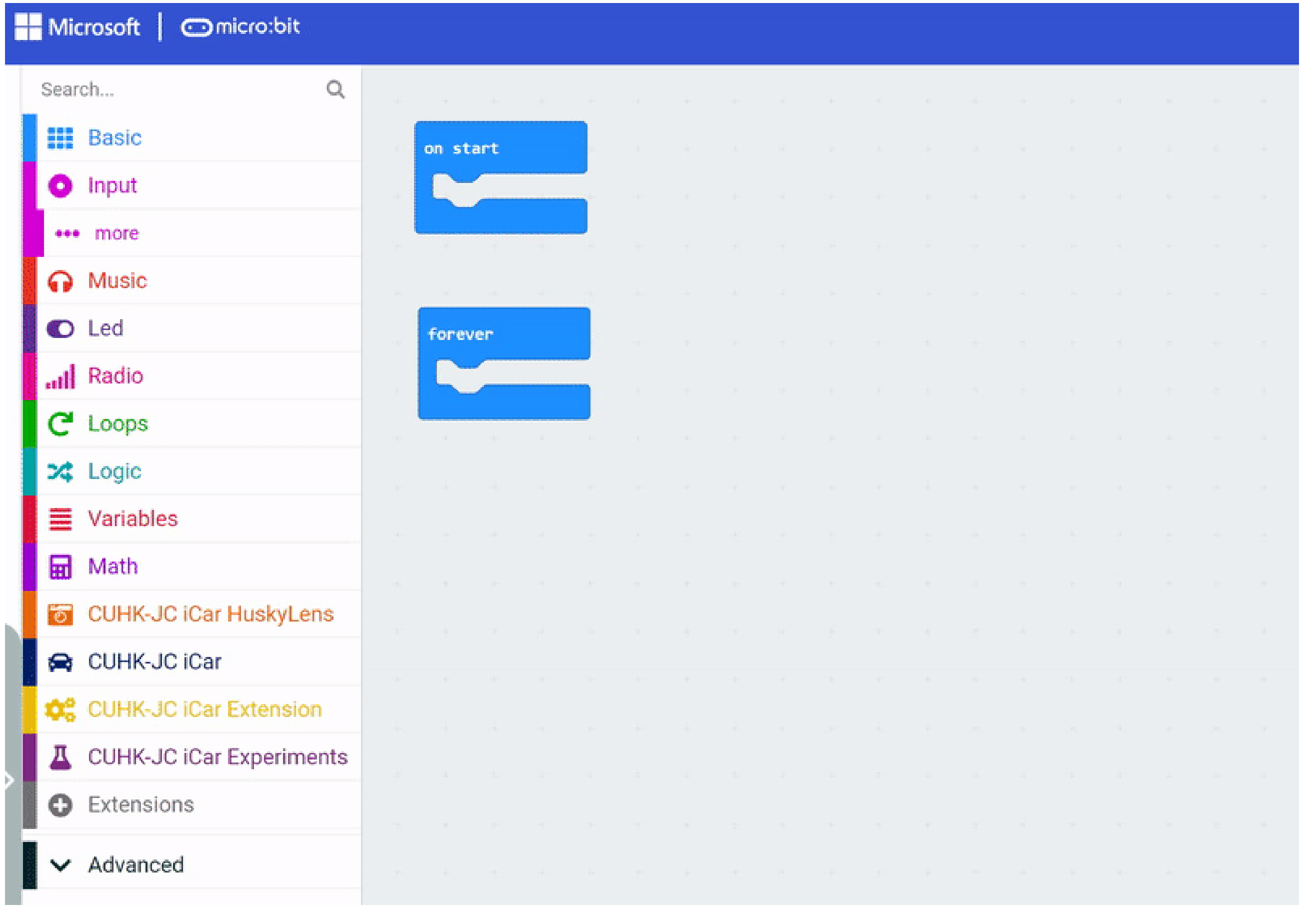
Yes

No

Turn **Left**

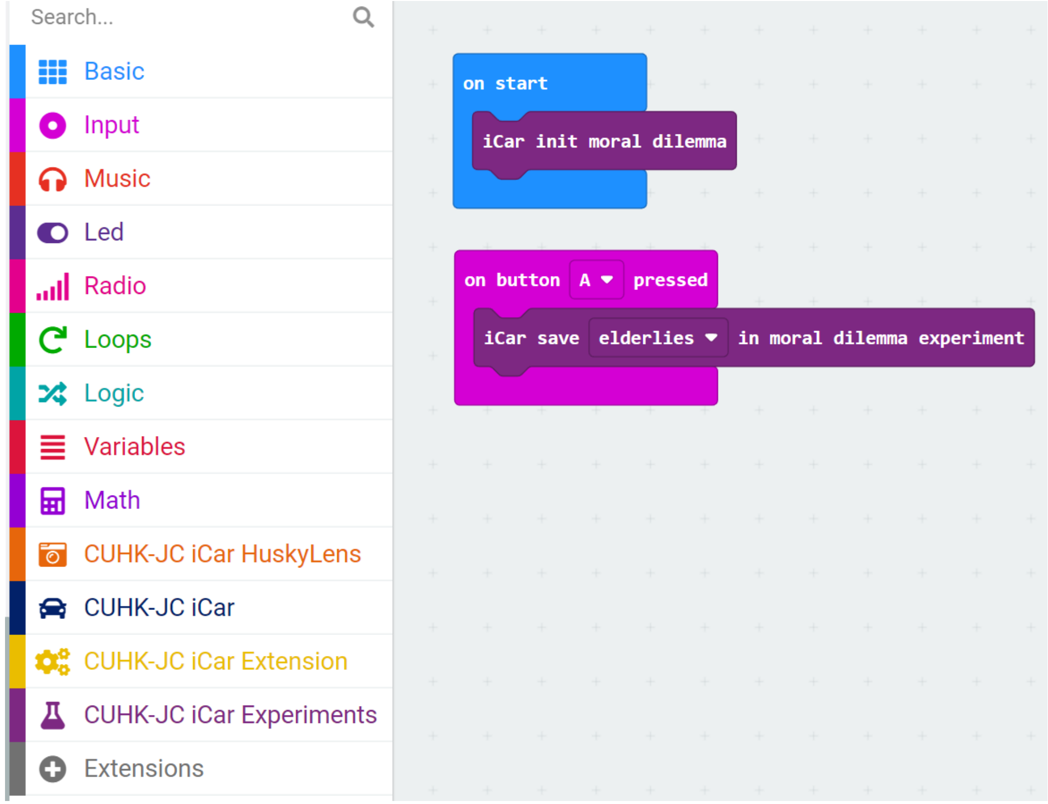
Turn **Right**

To save time....



```
on start

forever
```

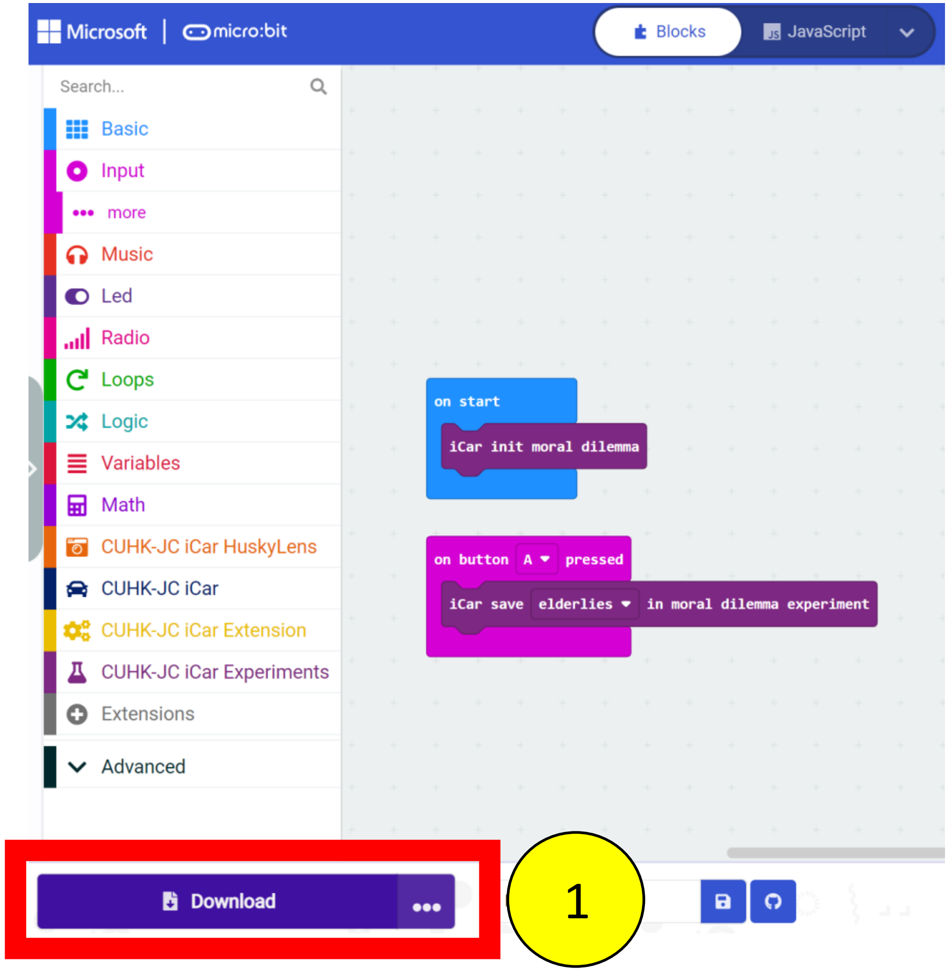


```
on start
    iCar init moral dilemma

on button A pressed
    iCar save elderlies in moral dilemma experiment
```

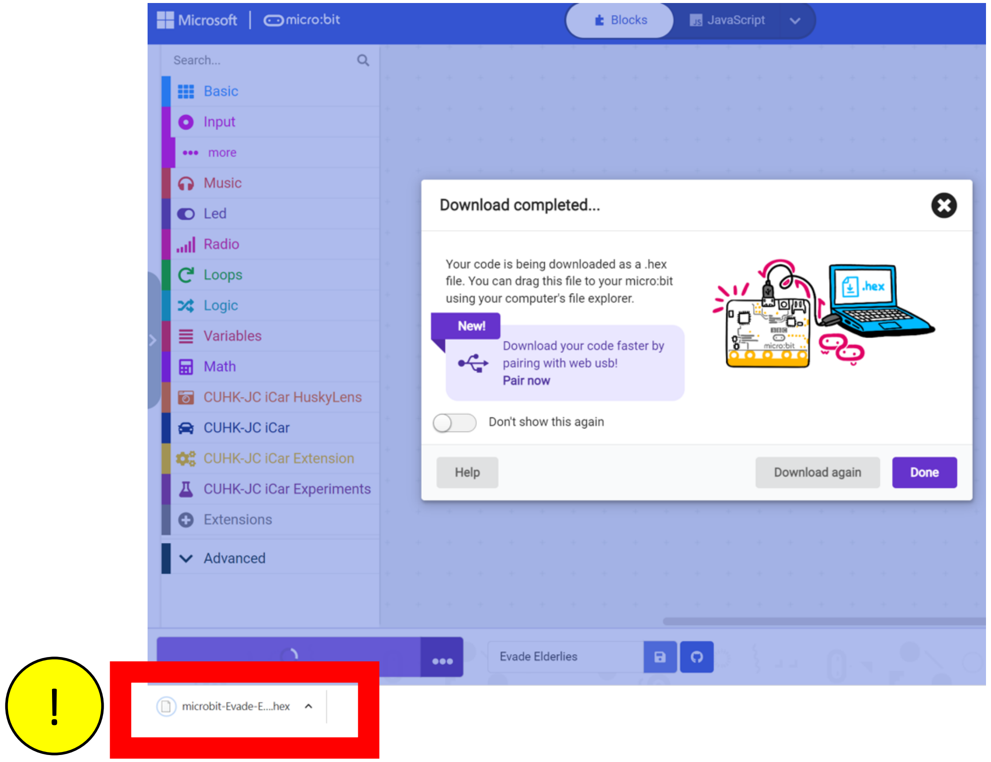
Download The Program To CUHK-JC iCar

- Step 1: Click **Download**



```
on start
    iCar init moral dilemma

on button A pressed
    iCar save elderlies in moral dilemma experiment
```



Download completed...

Your code is being downloaded as a .hex file. You can drag this file to your micro:bit using your computer's file explorer.

New!

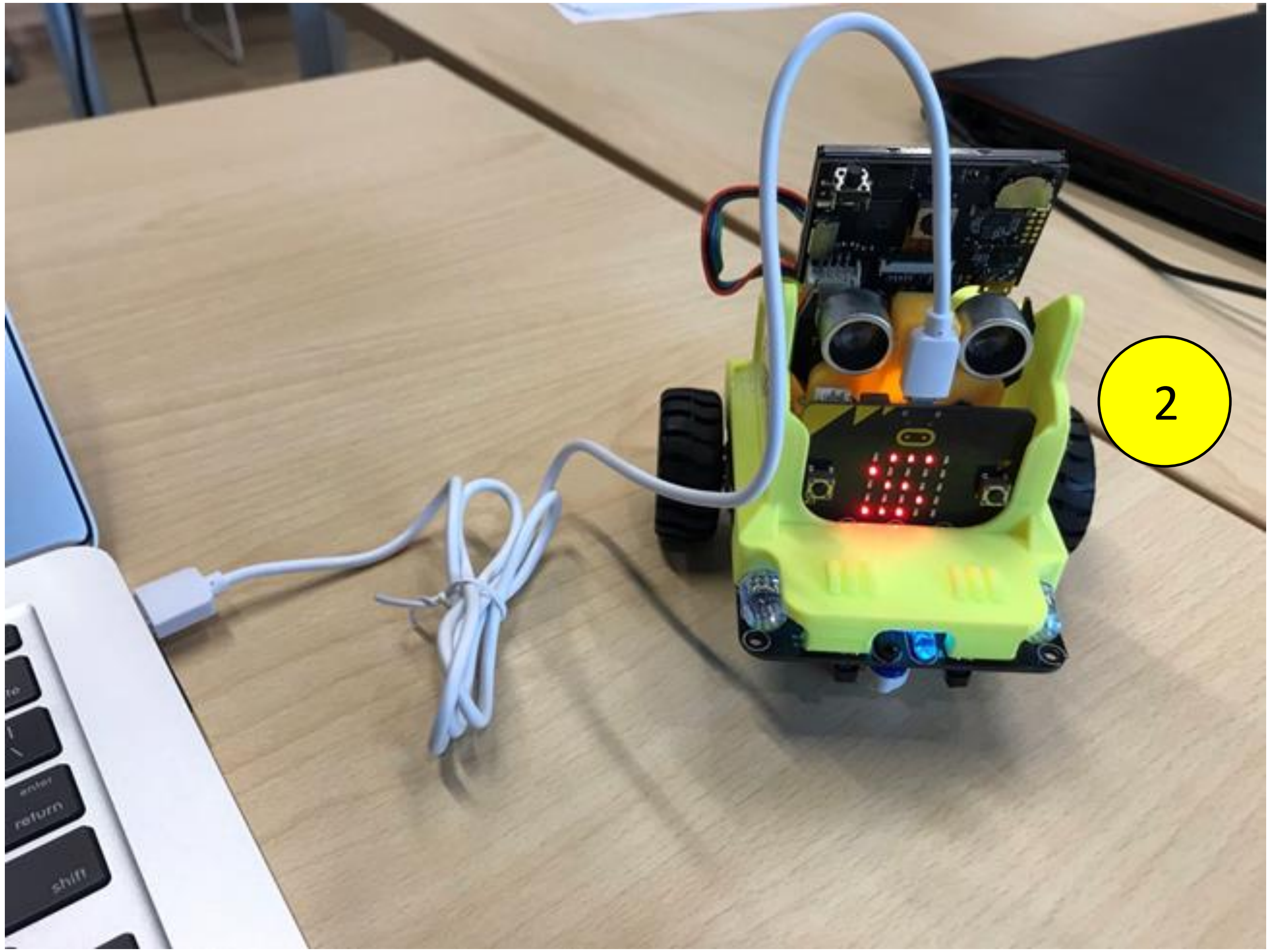
Download your code faster by pairing with web usb!

Pair now

Don't show this again

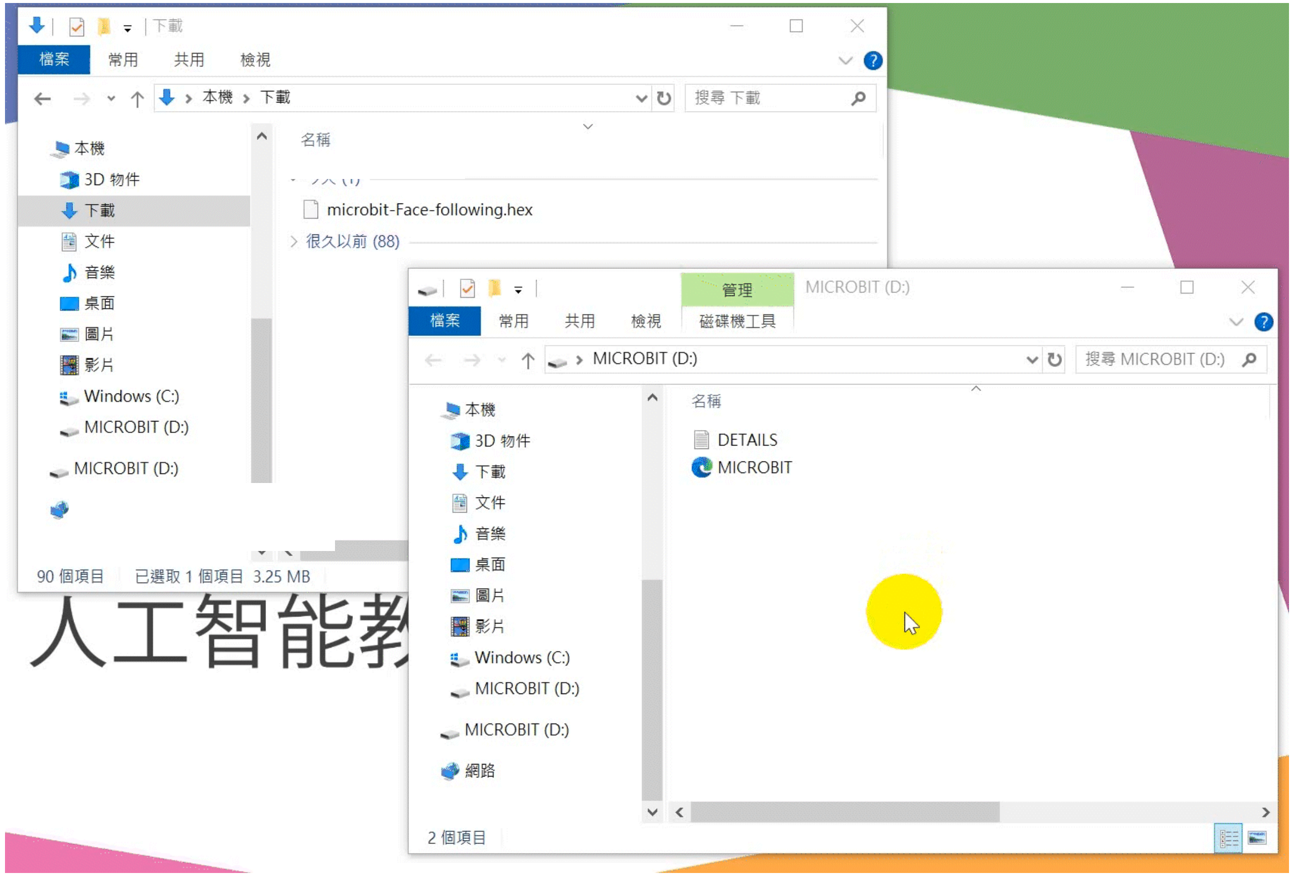
Download The Program To CUHK-JC iCar

- Step 2: Connect the micro:bit to computer by a micro USB cable

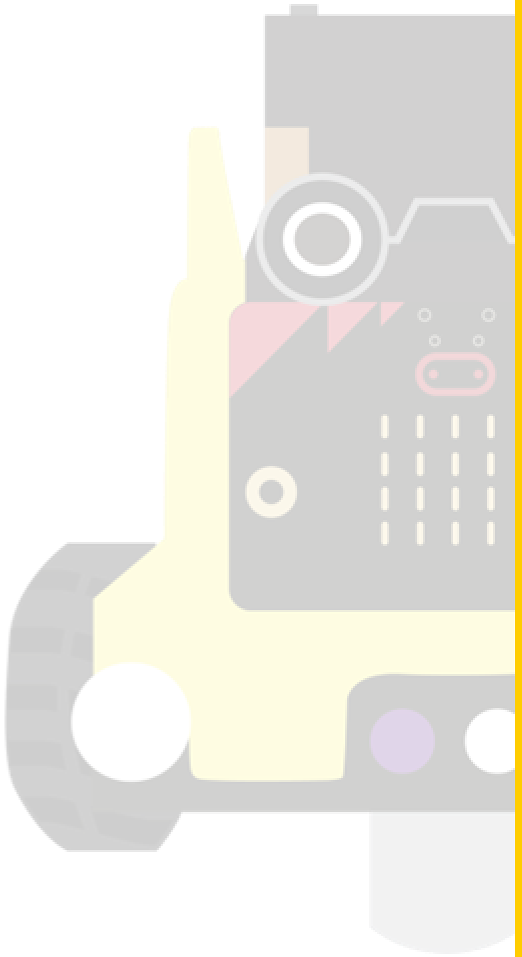


Download The Program To CUHK-JC iCar

- Step 3: Drag the “mircobit-Evade-elderlies.hex” file into the micro:bit window



Data Collection



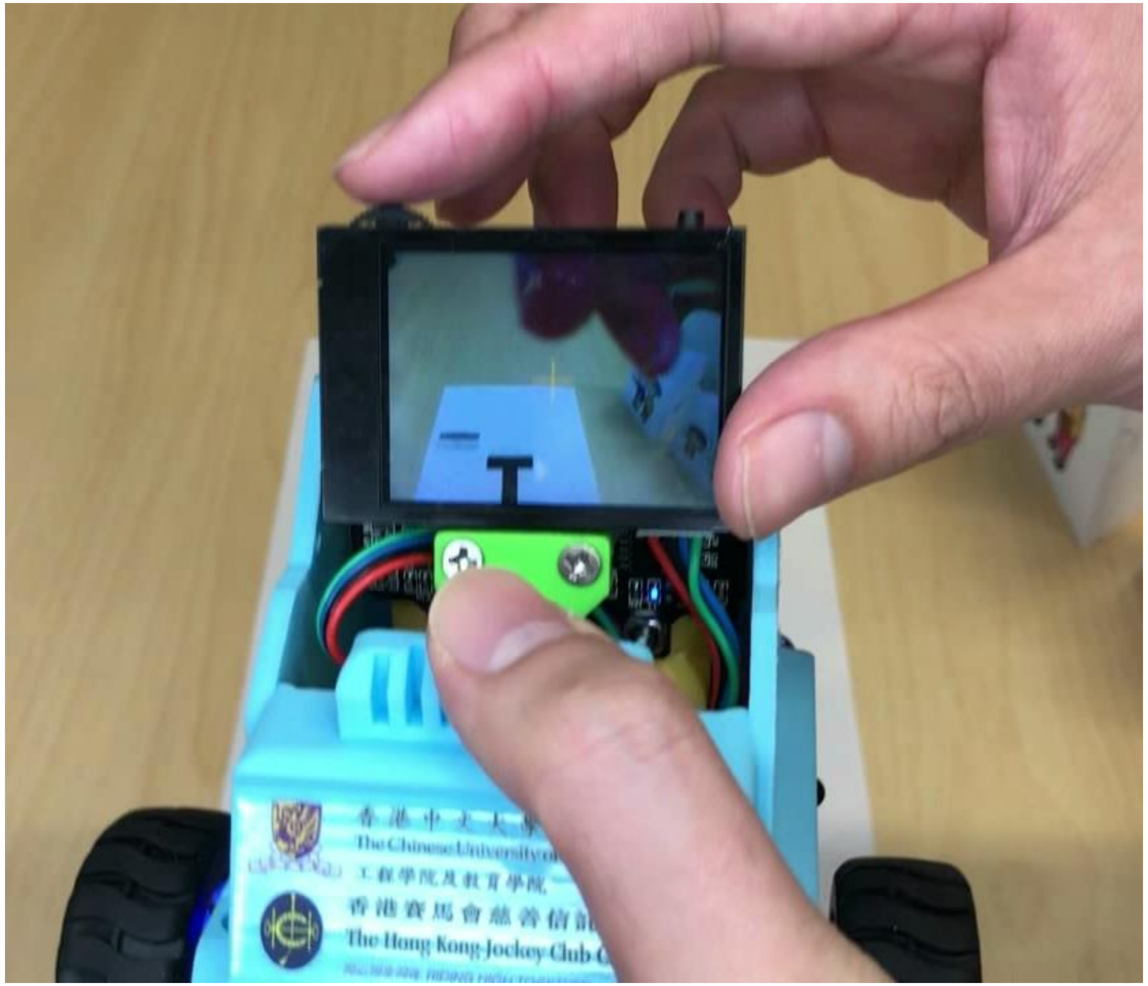
Data Collection

Now watch carefully the staff's demonstration...

1. **Collect 3 sets of data**

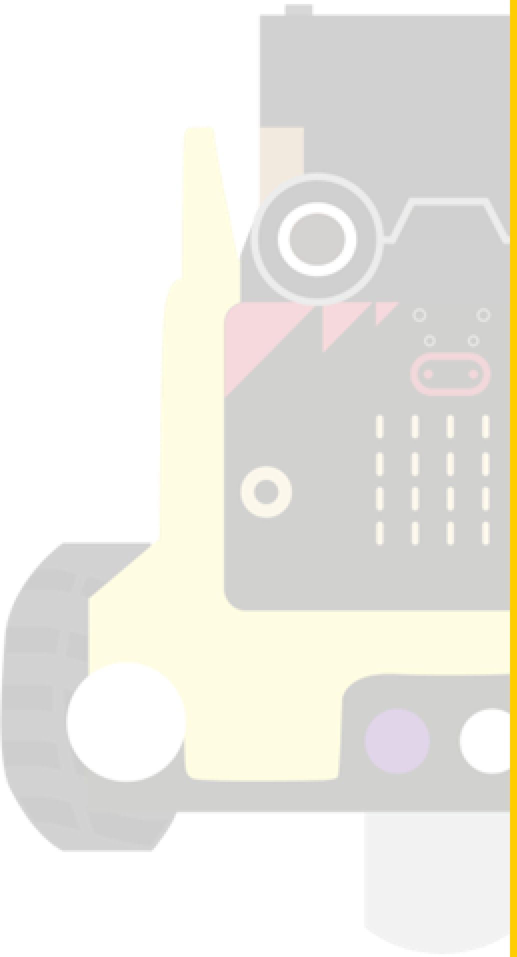
Dataset	Zone A	Zone B
1	Nothing	Nothing
2	Elderlies	Kids
3	Kids	Elderlies

2. **Remember to collect at least 30 photos for each set of data**



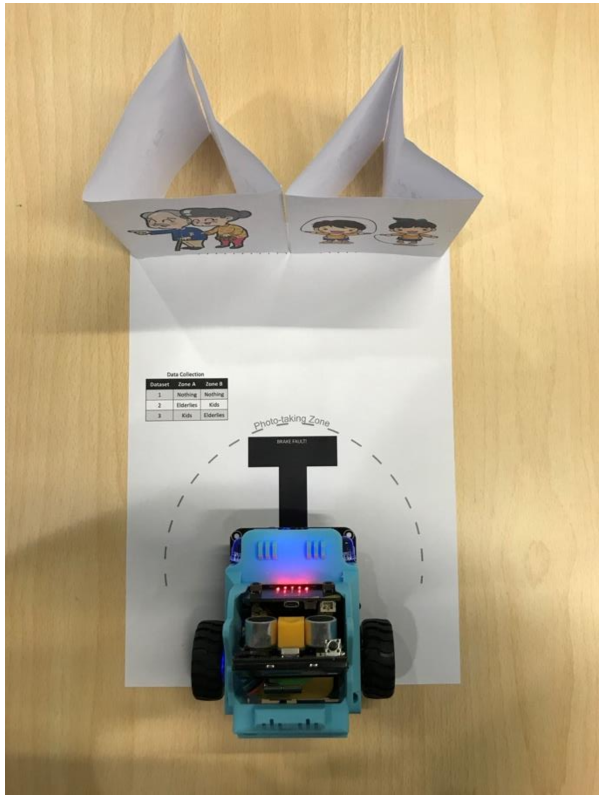
Let’s try
data collection

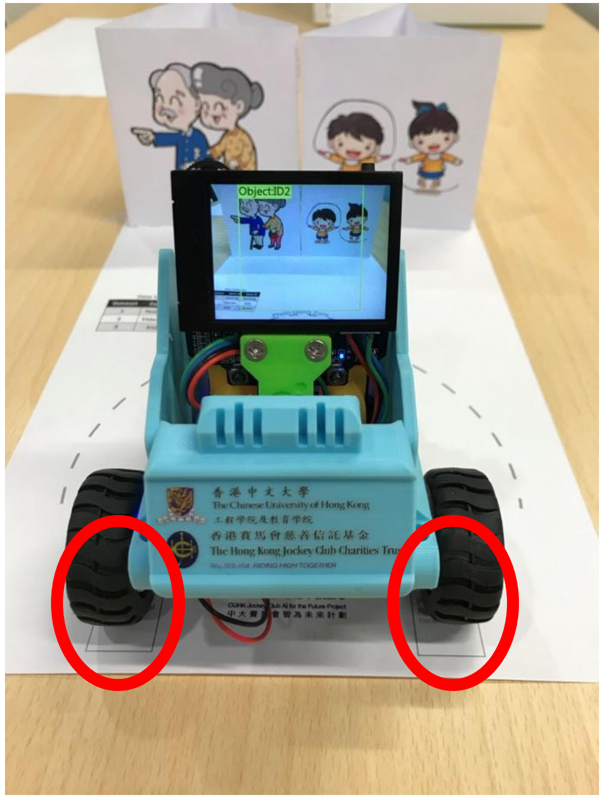
Try your Program



Try your Program

- Step 1: Place the paper models in the designated zones and place CUHK-JC iCar on the markings

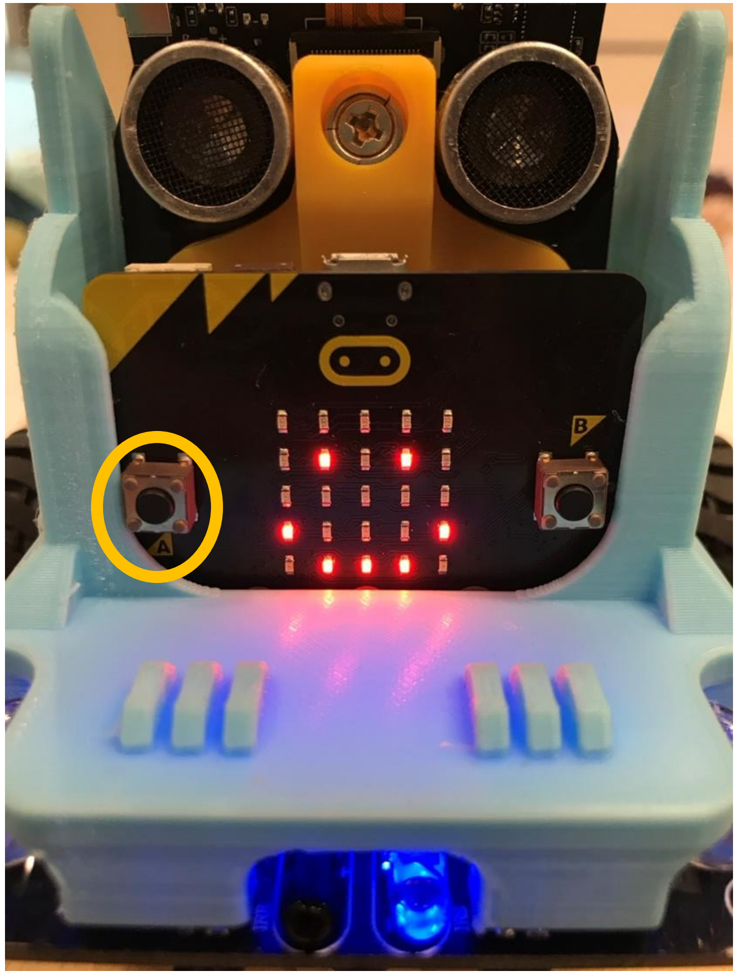



ObjectID2
香港中文大學
The Chinese University of Hong Kong
The Hong Kong Jockey Club Charities Trust

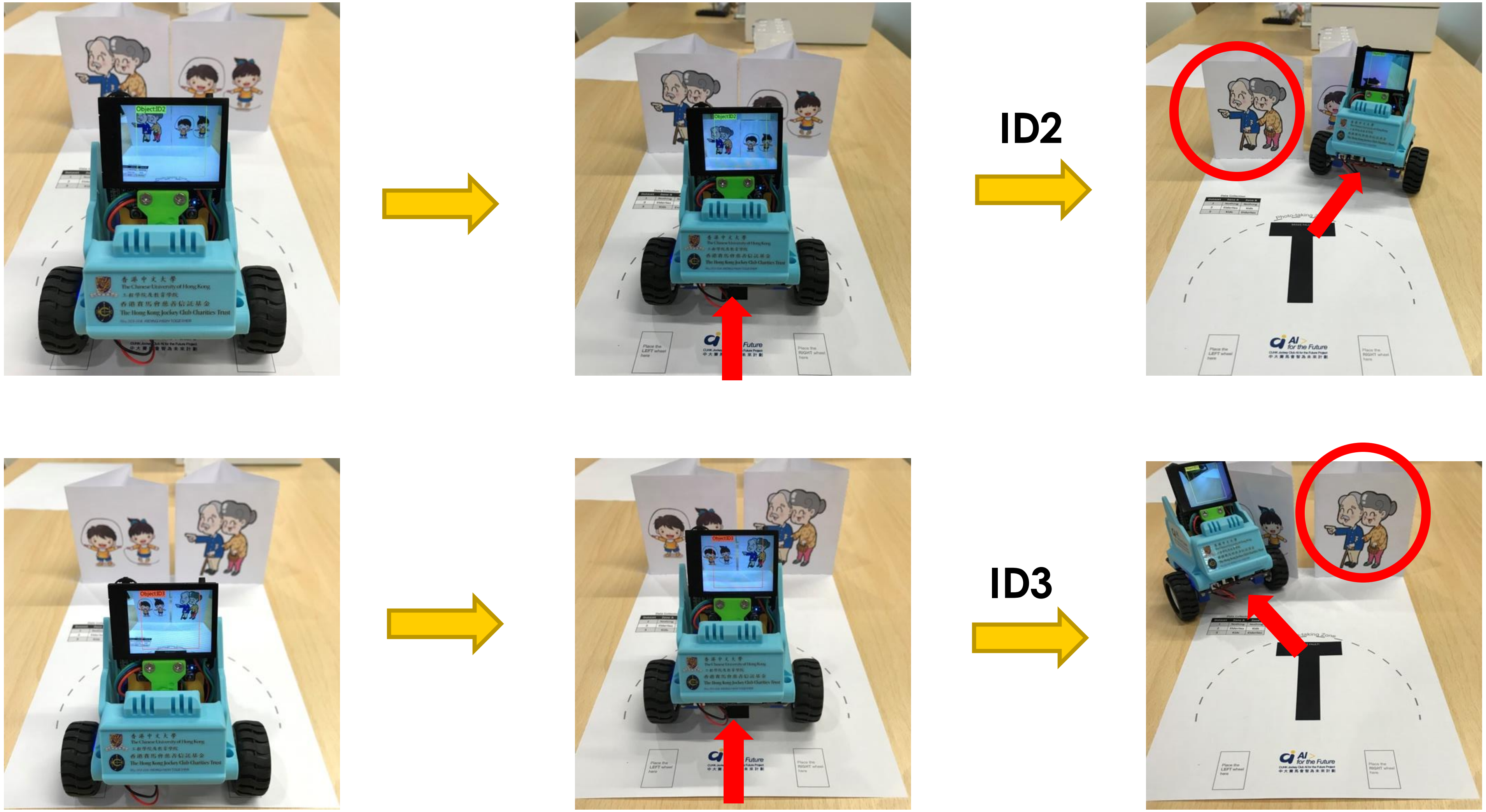
Attention:
Place the 2 wheels according to the markings on the paper

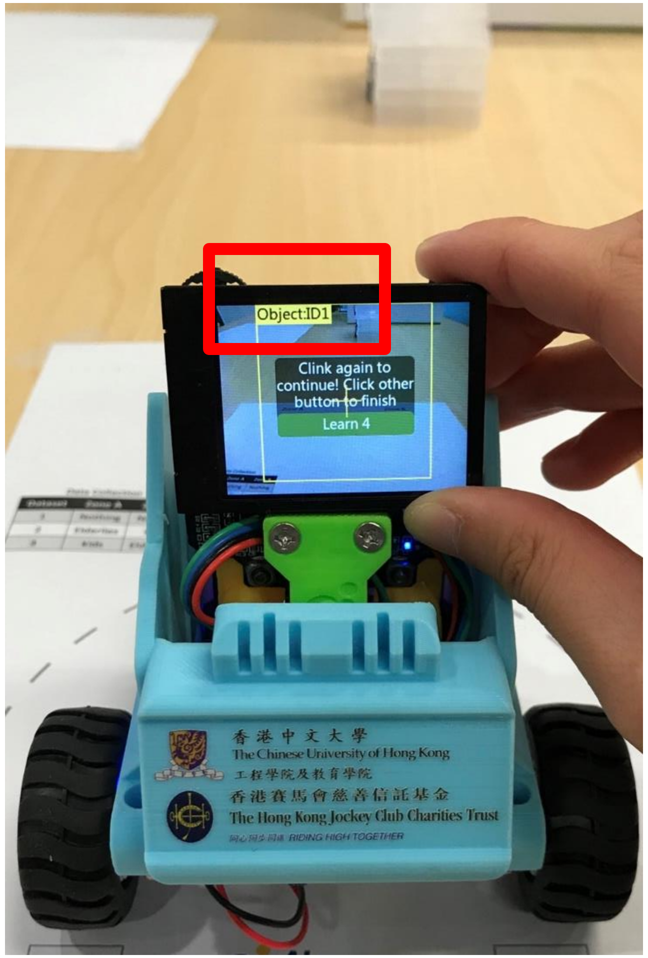
Try your Program

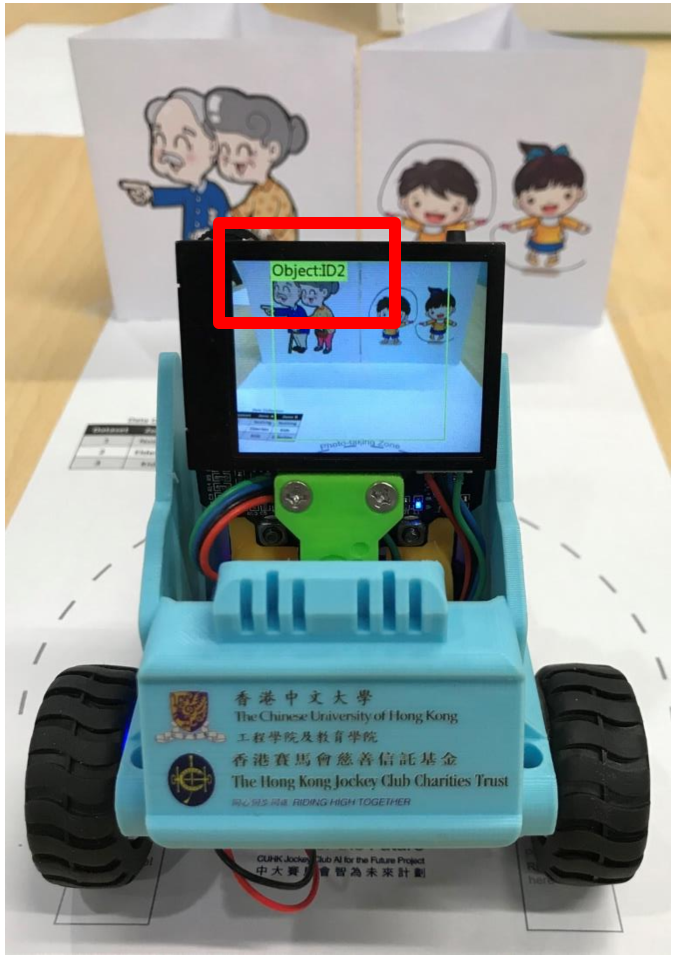
- Step 2: Press **button A** on micro:bit

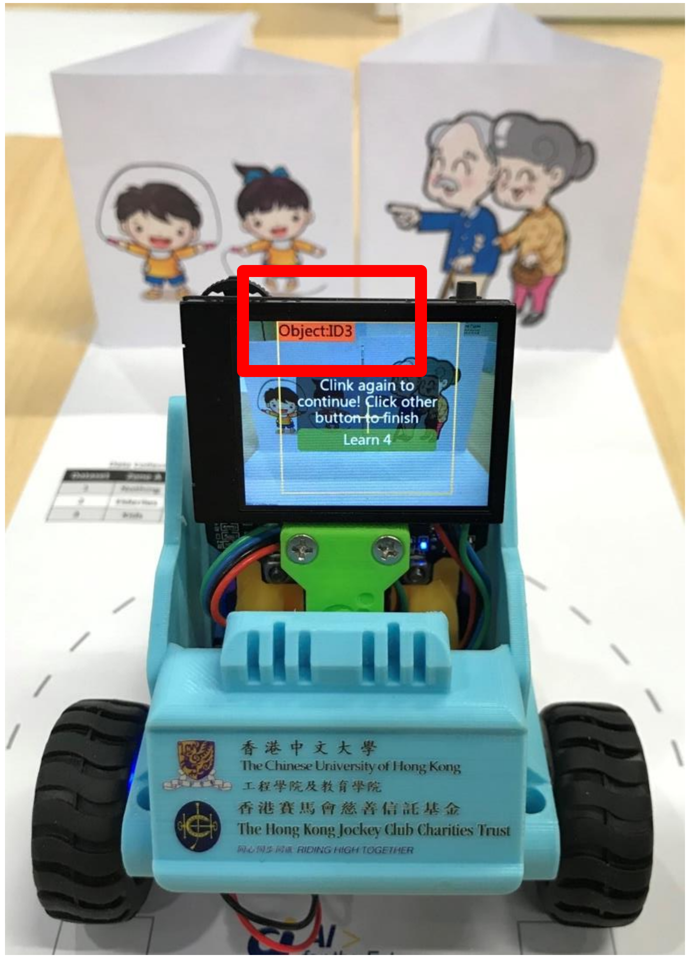


Simulation Program: Evade Elderlies




Object:ID1
Clink again to continue! Click other button to finish
Learn 4
香港中文大學
The Chinese University of Hong Kong
工程學院及教育學院
香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust
同心同步同進 RIDING HIGH TOGETHER


Object:ID2
香港中文大學
The Chinese University of Hong Kong
工程學院及教育學院
香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust
同心同步同進 RIDING HIGH TOGETHER


Object:ID3
Clink again to continue! Click other button to finish
Learn 4
香港中文大學
The Chinese University of Hong Kong
工程學院及教育學院
香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust
同心同步同進 RIDING HIGH TOGETHER

Let's try
Your program

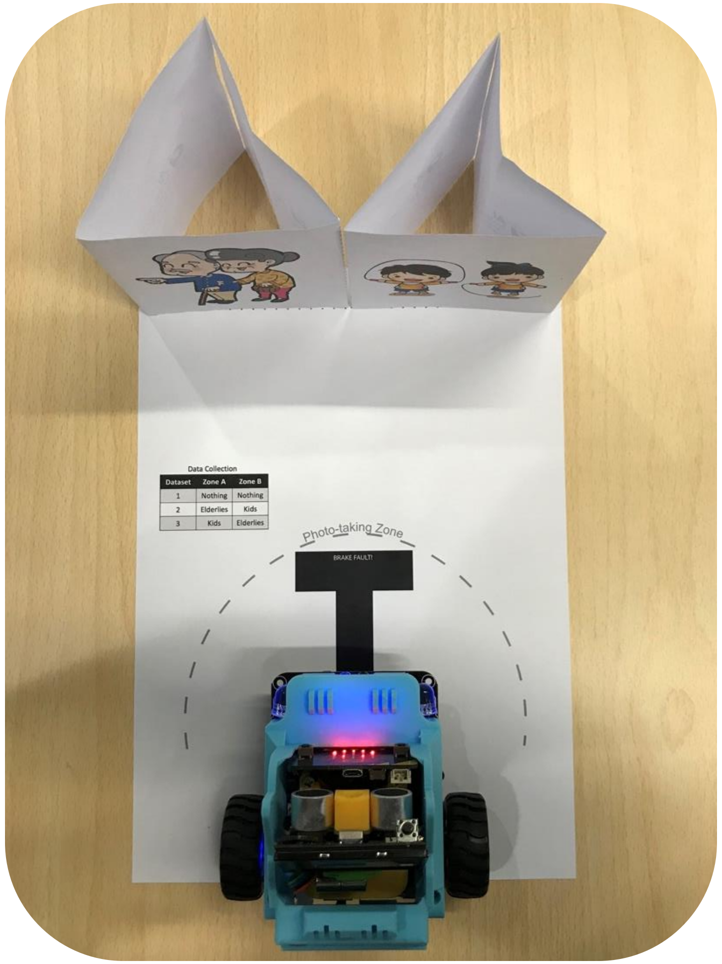
Discussion 2: Data Collection

- Why do we need to take at least 30 images for each dataset?
- Why do we need to move left and right when shooting?
- What factors will affect the judgment of artificial intelligence?

Try More Situations

- Different backgrounds
- Different data sizes
- Different datasets
- Different orientations of the object
- Bad data collection (zoom in/out)
- Different presentation methods (sound, lights, ultrasonic sensor, IR sensors, motors)

Discussion 3: Other Decisions



Data Collection

Dataset	Zone A	Zone B
1	Nothing	Nothing
2	Elderlies	Kids
3	Kids	Elderlies

Can you think of decision 3?

Decision 1

Evade Elderlies

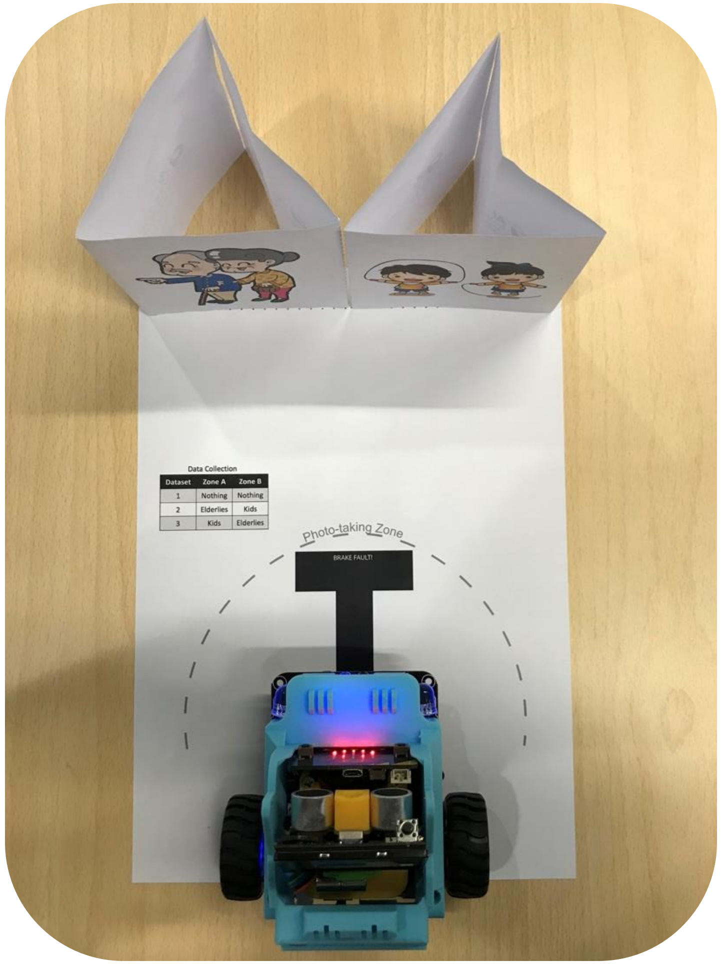
Decision 2

Evade Kids

Decision 3

?

Discussion 4: Other Decisions



Data Collection

Dataset	Zone A	Zone B
1	Nothing	Nothing
2	Elderlies	Kids
3	Kids	Elderlies

Can AI help us make decisions?

AI can make distinctions for us, but it can only operate according to programs written by programmers

Programmer is always the one who makes the final decision on a moral dilemma