Teachers Guidelines for Project

Edu4AI

Title: **Rehabilitation hands with image classification and pose recognition.**

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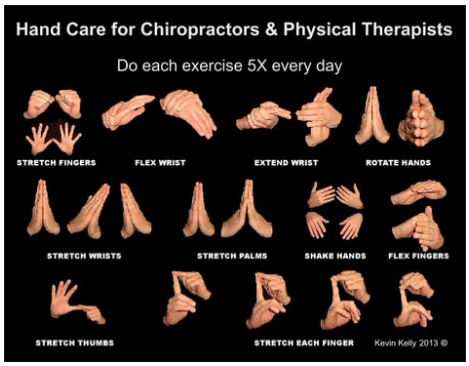
1. Pedagogical considerations and useful tips.

This project integrated in part the technique of Game-based learning in teaching of AI, that is has many advantages Some of the benefits of game-based learning are that it promotes creativity, arouses curiosity, keeps the children engaged, and helps in the development of various cognitive skills such as critical thinking, decision making, problem-solving, and many more.

We all know that games are addictive and to level up children try again and again. This skill of using different methods to resolve an issue or to reach a particular mark boosts the problem-solving skills in children. Even if a child fails in his first attempt, he/she knows that he/she would get a few more attempts to win the round. Failure in games motivates the student to try again.

The AI classifier can augment human capabilities, through AI, by extending the ability of physical therapists to capture changes in recovery that can support the current methods. The AI should not be viewed as taking people's jobs. It's a transformative technology that can complement and improve the way health professionals perform their current jobs. The project also wants to create a model to develop a technique useful for increasing knowledge of the student's body in the field of useful exercise to increase body flexibility.



Another important focus of the project is the social impact of AI, conceptualizing inclusion may become even more difficult because AI systems are powered by pattern recognition and classification, which, broadly speaking, often drive exclusionary social processes. Because of this, AI has feedback effects on the notion of inclusion itself. There are questions that we should be asking in order to further shape our own views and understandings as to how to conceptualize AI.

This project is meant to serve as a starting point for exploring the ways in which we may think about the very notion of social inclusion/exclusion itself in the age of AI, as well as

the complex ways in which autonomous systems interface with various dimensions of inclusion and questions that arise at this intersection.

In the project, the students will learn about AI techniques relating to 'data representation' and the 'collection, management and analysis of data'.

By learning about how AI uses data, students will be exploring patterns in data and learning about how digital systems represent data as text, image and audio data for the AI system to process it.

AI in other fields could help people to increase the communication provided by automatic interpreters in different communication protocols such as LIS (Sign of Italian Language) and Morse International Code for inclusive interface design.

2. Analysis of the Injuries in the hands.

Injuries to the hand, wrist and fingers can be divided into two main categories. They are either acute injuries, which occur suddenly as a result of direct impact or a fall onto an outstretched hand, or chronic overuse injuries, which develop due to repetitive stress.

Acute injuries are common in sports where players use the hands to control the ball or tackle other players. Acute injuries also include those that occur as a result of a fall, where the person has used their hand to break their fall, leading to injury.

Treatment of hand and wrist injuries depends on the nature and extent of the injury and is guided by a thorough assessment performed by the physiotherapist. Certain injuries, such as fractures and ligament injuries, may require immobilisation, whereas other injuries may require specific exercises or modification of movement patterns and work equipment. Examples of different treatments we offer at Glebe Physio include:

• Casting: This involves immobilisation of a broken bone within a fiberglass or plaster cast to allow it to heal. Visit our casting service page for more information.

• Splinting: Another form of immobilisation, splinting offers protection for a healing bone or ligament while still allowing movement of the unaffected joints.

• Taping: Often used for support of an injured muscle, tendon or ligament during sport or work activities.

• Manual therapy: “hands-on” treatment to reduce stiffness and restore movement in muscles and joints.

• Exercises: Prescription of exercises that aim to facilitate healing, improve range of motion and/or develop strength.

What is RSI (repetitive strain injury) and can physiotherapy help?

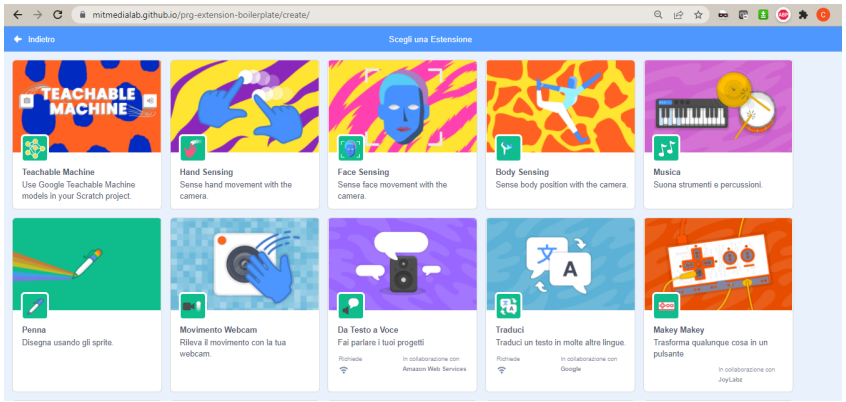
RSI is an umbrella term that encompasses any condition that involves irritation of muscles, tendons and joints and is used commonly to describe problems around the wrist and forearm. These injuries come on slowly over time and happen as a result of using the hand and wrist extensively in awkward positions. Some examples of activities that may lead to this condition include typing, hammering, drilling or working on assembly lines. The symptoms associated with RSI include pain (usually described as aching or burning), stiffness, pins and needles and/or weakness.

An other other field of analysis of this application is stroke, that is the leading cause of adult disability around the world (Burton et al., 2017), with upper-limb motor impairments being the main factor influencing the quality of life in stroke survivors (Stinear et al., 2017). Repetitive body training on movement has a notable curative effect on the restoration of arm function in different patients, and the patients' degree of recovery is positively influenced by treatment intensity (Steven et al., 2006; Gittler and Davis, 2018). Conventionally, stroke patients usually rehabilitate with the assistance of therapists. However, the involvement of therapists is challenging because rehabilitation training is a time-consuming and labor-intensive process. Many stroke survivors experience upper-limb impairment with few rehabilitation opportunities due to a lack of rehabilitation therapists. AI-assisted therapy devices, which can provide the affected arm with high intensity and repetitive treatment, have been increasingly used in rehabilitation training and can potentially enhance upper-limb functional recovery in stroke survivors (Yoo and Kim, 2015; Veerbeek et al., 2017).

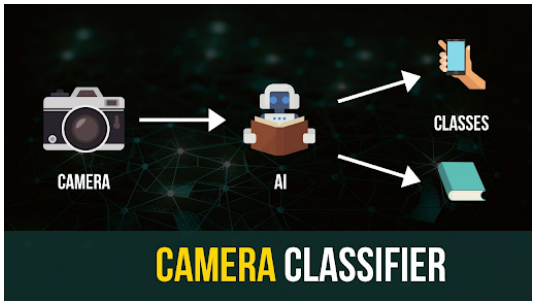
3. Hardware & Software Prerequisites

The hardware components needed for this project are:

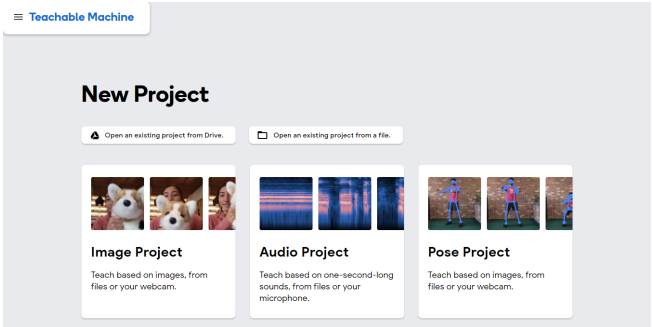
A. Personal computer with internet connection, to access a MIT cloud (Massachusetts Institute of Technology), where is available a block coding environment with a subset of a specialised extension in artificial intelligence.



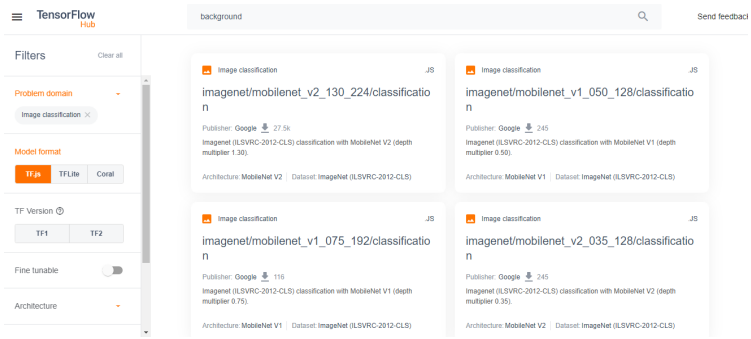
B. A camera and microphone to interact with the world.



C. Defining a tensor-flow model, in the Google Cloud platform where is published "The Teacheable Machine", the tool useful for creating the tensor-flow model.



D. Retrieving and applying pre-trained Tensor flow models, on the web.



For a further expansion of the project, you also need:

E. an elastic band and a rubber ball

The app and online services needed for this project are the cloud services of:

- Teacheable Machine
- OpenPoseBlock - MIT Scratch blocks and his extension block AI
- Google Cloud Drive to store your AI model

The programming environment is Web-platform. It works on Windows, Macintosh and

Linux, it is in part open source and in other parts the tools are released in free-ware licence.

4. Activities.

Activity 1

The first step is to invite students to visit the website of the teacheable machine. Introduction to the different project analysis provided with Teacheable machine: audio recognition, image classifier and body posing. In this context it is necessary to explore the Underlying process of AI - how does AI works?

When the student accesses the page, he must identify the passes necessary for teaching to the machine. When working with AI systems there are different processes that we can undertake to train, build and test our model. These stages include:

-Data collection: such as collecting image, sound or text data, cleaning the data and preprocessing it so that it is ready to use.

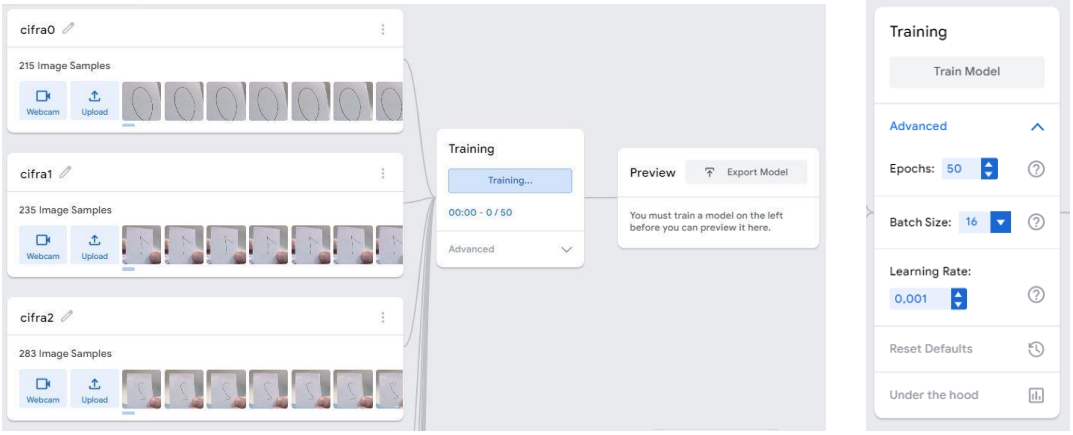
-Data labelling: such as labelling the data to tell the computer what is in the image - e.g. a kangaroo or wombat.

-Feature extraction: labelling the data to tell the computer what features the object has - e.g. how many legs, ears.

-Building the model: which involves developing the model and training it with the dataset collected.

-Testing the model: for example feeding the machine a new image (sound or text data) it has not seen before and testing the accuracy/performance of the output.

It is necessary to create different classes, each one for a different object or situation. Is necessary assigning a label for each typology of object learned from the machine, example “Opened Finger” and “Close Finger”. Another example is the identification of the different digit numbers, written on a sheet of paper.



The phase of learning is possible by adopting a set of images or, in our case, the best solution is recording the movement of fingers in front of the camera. There are different learning parameters that are necessary to optimise the learning process, in particular the Epochs (number of data collection passes), Batch size (number of data division subset) and Learning rates (data precision, that influences the model size).

In the Preview phase it is possible to test the recognition of a single object at one time. The bias is the confidentiality level or probabilistic evaluation, that represents the measurement of the correct identification. In this step, it is possible to determine, for which object is necessary to improve the knowledge of the parts of the object, by introducing new photos.

To complete the export process the user must login with a google account. The model project is saved with a name assigned as title. Next you must publish the model in the url web, pressing the "Upload model" button. The model is reachable in "JS - Javascript Tensor Flow" format, through a public link. The URL (Uniform Resource Location) must be copied in clipboard, for sharing and using the learning model, for example in scratch, the block programming tool.

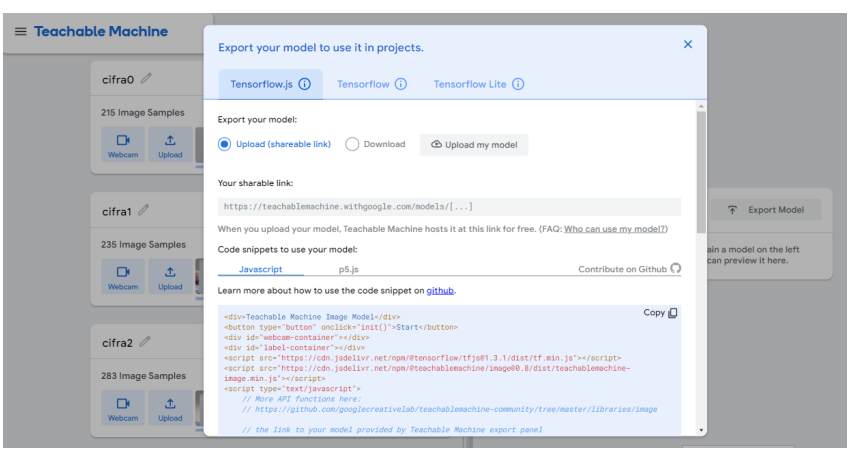
Resources for this step:

Tools for creating the models: https://teachablemachine.withgoogle.com/

Gathering phase: https://www.youtube.com/watch?v=DFBbSTvtpy4

Training activities: https://www.youtube.com/watch?v=CO67EQ0ZWgA

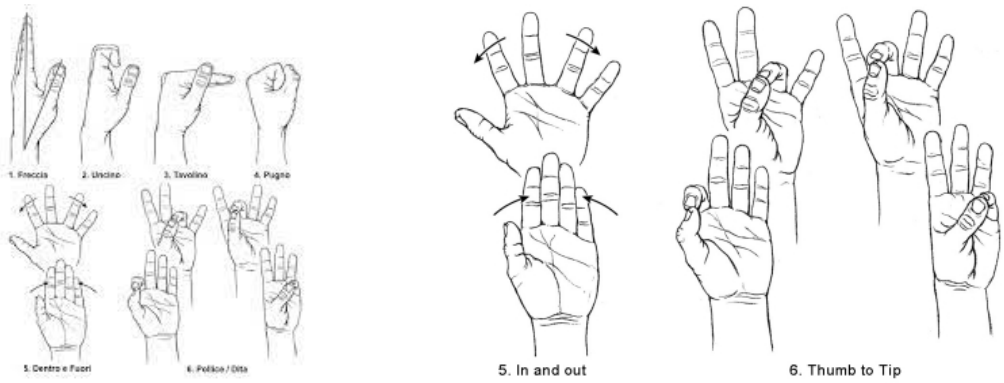
Exporting model: https://www.youtube.com/watch?v=n-zeeRLBgd0



Activity 2

The rehabilitation of the finger or the arm is the most simple situation, because it is on the plan of a desk, where the pc camera is present.

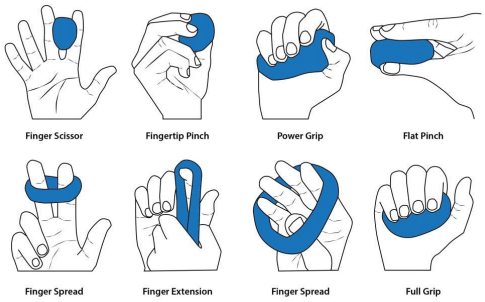
The exercises can consist of fingers open or closed by tapping with the thumb.

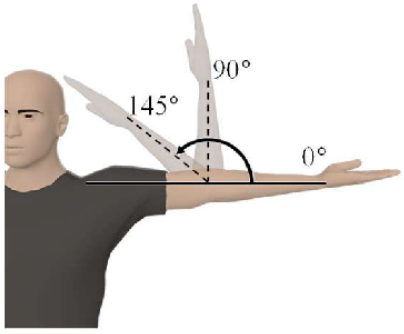


To complete the exercise it is useful to integrate a rubber band or a soft ball.

The rehabilitation exercises are often boring, so patients don't do them.

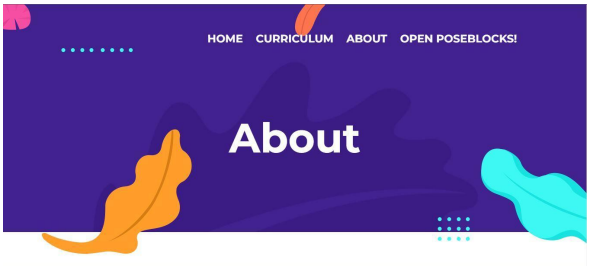
To repeat a movement at different times is useful to gamify the situation, for example by creating a game, like this a competition or reward to promote the interest.for example by creating a game, where competition or a point prize to promote and stimulate activities.

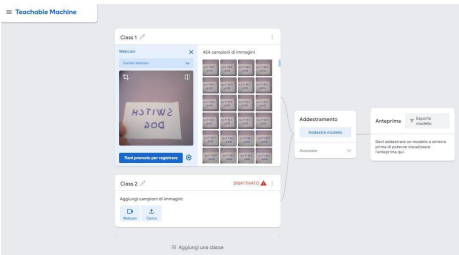




Activity 3

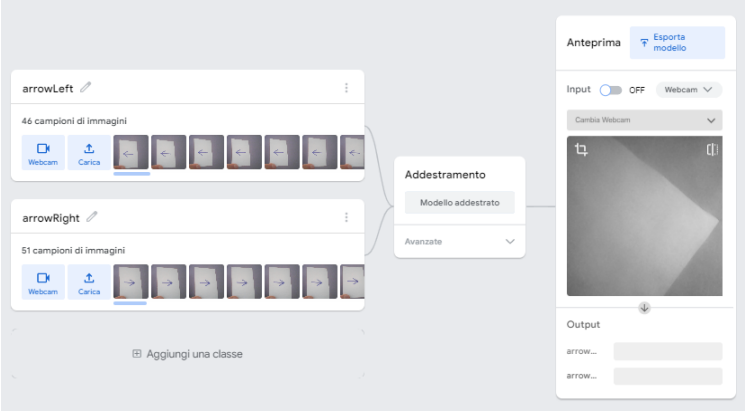
Students participating in a simple completion of activity, useful to explore the integration of coding with the classifier model. The case of study is present on “Mit Open Poseblock”, a platform derived from scratch with particular extensions useful for AI. There is a site section dedicated to go into detail on AI Curriculum with scratch blocks.



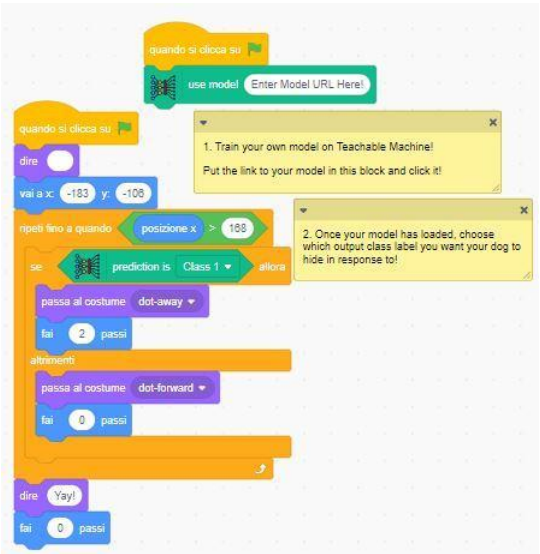


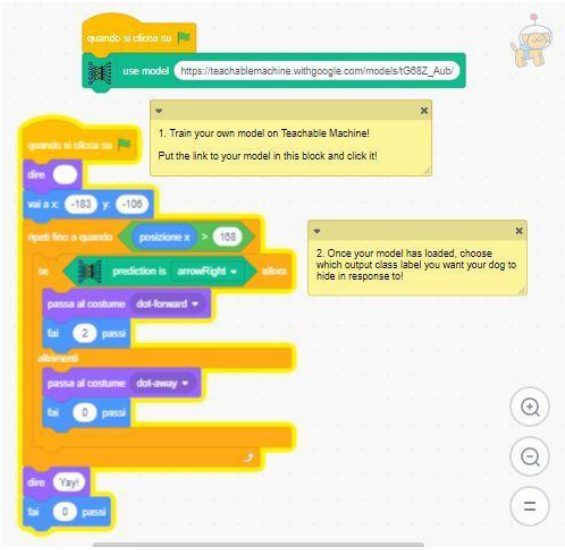
The case study is an exercise dedicated to dog movement, enabled by the presence of the right arrow in front of the camera. In the first step it is necessary to develop a model that

recognizes two arrows written on a sheet of paper. After exporting the model, it is necessary to fill the url and select the class to identify the arrowLeft. In the exercise there are two blank fields with remarks near the block that explain the steps to initialise the learning knowledge and activate the movement and costume switching.

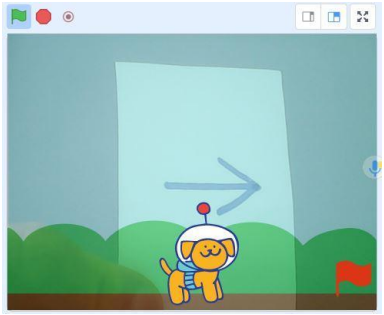


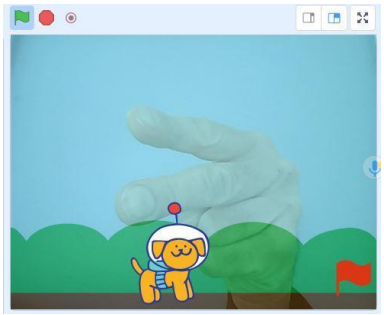
The study of the dog movement is useful to go into detail on the different shapes that are similar to an arrow. For example it is possible to simulate the arrow on the paper with two fingers open to V. The action is also activated with an image that has a similar profile. This situation could be used to introduce the phenomena of bias, how an unknown class, not determined from the learning machine process. In reality, removing the protected classes from the analysis doesn't erase racial bias from AI algorithms. It is necessary to create an additional class of knowledge to be able to distinguish an unknown situation.





Above there are 2 code stacks before and after the completion with model export url and activation class. Under there is a finger that simulates the arrow on the paper, creating a bias. The analysed project is modified from the original “NewShyDog”, present in the “Teaching materials” section.





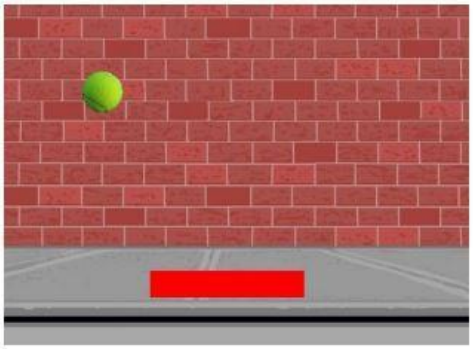
Resources for this step:

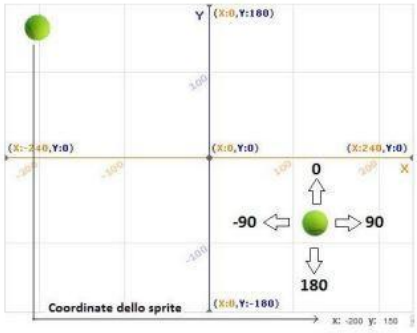
MIT tools with AI scratch extension: https://dancingwithai.media.mit.edu/about
Custom shy dog with arrow sheet paper: https://mitmedialab.github.io/prg-extension-boilerplate/create/?project=https://dancingwithai.media.mit.edu/projects/NewShyDog.sb3

Activity 4

To repeat a movement rehabilitation at different times is useful to gamify the situation, for example creating a pong, where the joystick is the command to move the racket.

In the next step the students must develop the game with the teacher supervision, starting from a blank project.





To develop a sprites game in the classic scratch version 3.0 is necessary.

- Explain the coordinates system in scratch
- Learn the technique for designing the sprites and the background of stage
- Identify the dimension and the direction of movement of each sprite
- Describe the activation code sequence based on angles and overlapping of the different sprites
- Introduce the pseudo-random numbers generation to determine the ball's reflexion and starting angle

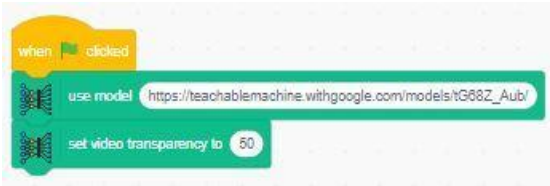
Sprite	Coding

 Ball	
 Line	No scripting associated
 Racket	

Activity 5

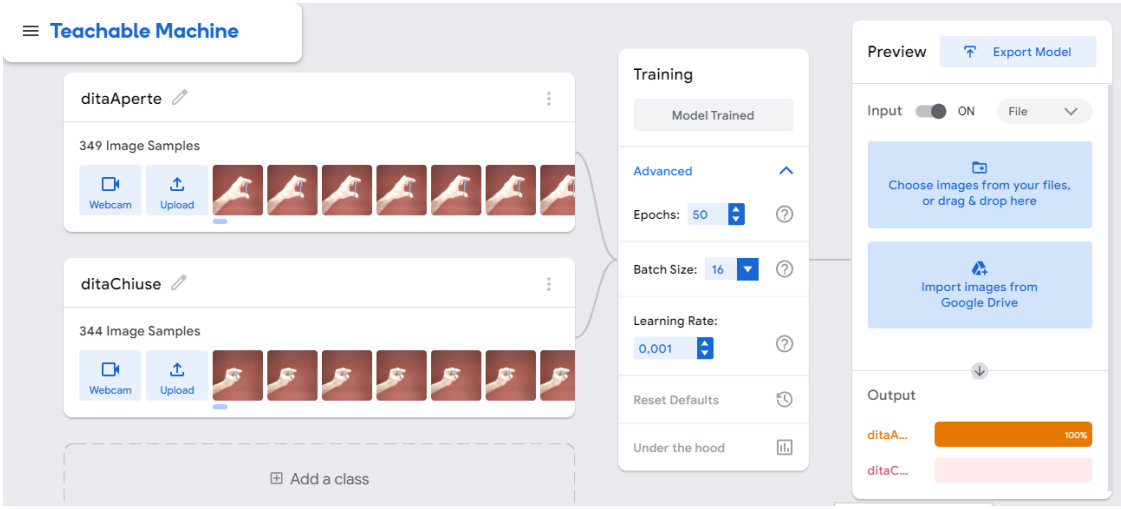
In the next step, we substitute the racket keyboard commands with the learning machine joystick. Is necessary to load a model and evaluate two classes of movements present in the model, to define the movement actions.

Sprite	**Coding**

[redacted]	
Racket - Load the learning machine model	
Racket - Identify the arrows classes to move the sprite	
MIT Teacheable Machine	

In the AI Open Pose Block is necessary to indicate the Url of Teacheable Machine.
In the teacheable machine it is important to define two different movements of one rehabilitation exercise. It is always necessary anyway the supervision of an expert physiotherapist, who evaluates the correct posture and the movement of the body. In this case it describes two classes “FingerOpened” and “FingerClosed” applying a rubber band to promote the thumb and index finger reinforcement.
In this case we select two movements that use a rubber band to extend the distance between thumb and index fingers.

It is possible to create another pong soccer activity, based on two hand positions. It use a “Pose recognition extension”, to move a two soccer player and ball on the screen.



Resources for this step:

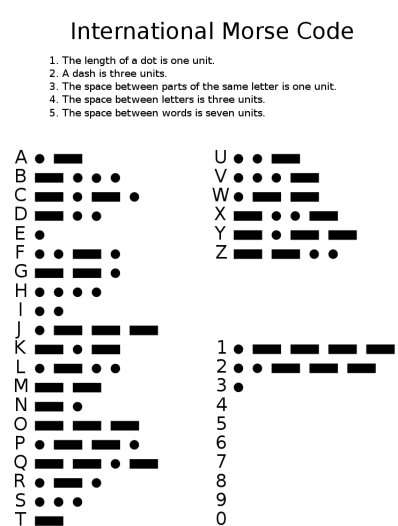
Standard pong on scratch community: https://scratch.mit.edu/projects/666367323/
Medium article in medium relative to hands soccer: https://johannaquinn.medium.com/pose-pong-made-using-media-labs-poseblocks-extension-49775d281c71
Game of hands soccer: https://www.youtube.com/watch?v=9bBMrCRFw6c&t=6s

Arrows hands model: https://teachablemachine.withgoogle.com/models/W6LSWxd_E/

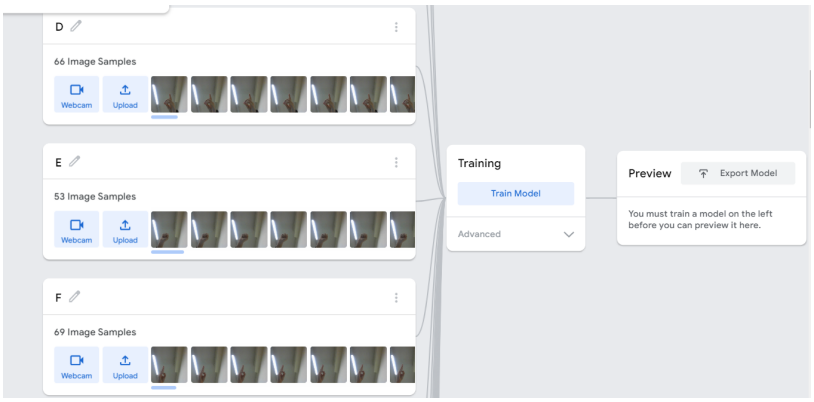
Arrows sheet model: https://teachablemachine.withgoogle.com/models/hih-W596y/

Step 6

The student can modify the project, to promote an inclusion learning experience.
Replacing the situation in other fields, for example in the communication protocol the hands are used to codify and decodify the messages. The evolution is to represent the different symbols of the LIS Sign of the Italian Language for the deaf dumb or the morse code for people with motor disabilities.
Those activities promote interaction with people that think and speak in different ways.
The learning path used to train the machine pushes the student through a different experience, in which they reveal the different instruments used by others to approach the learning process.

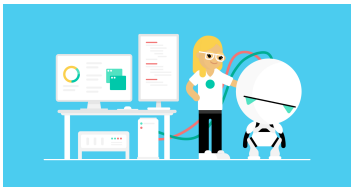


The models of LIS can be used to create a Bot that translates in audio what it recognizes.



Millions of people with motor and cognitive disabilities face hardships in daily life due to the limited accessibility and inclusiveness of living spaces which limit their autonomy and independence. A series of guidelines for domotic technology control interface design is based on Morse code that allows controlling different smart devices. The morse code can enable the access at all, caregivers consider smart technologies as a work aid and a means for enhancing autonomy and life quality for users with disabilities.

Step 7



Continue to integrate a public model, imported from TensorFlow Hub into your coding project.

Resources for this step:

Wikipedia models on TensorFlow Hub: https://www.tensorflow.org/hub

Good job and grow together your machine!