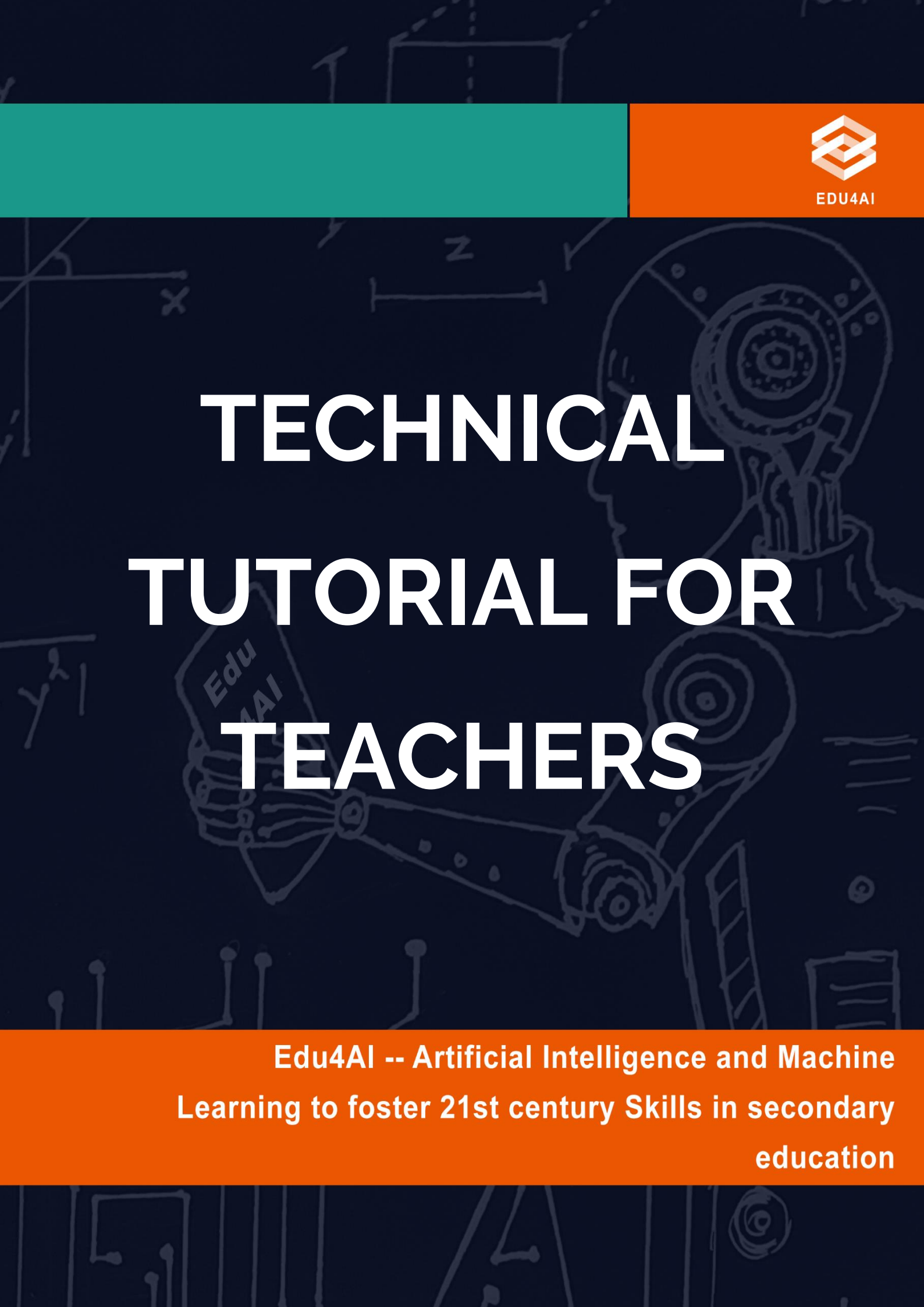
EDU4AI

TECHNICAL TUTORIAL FOR TEACHERS



Edu4AI -- Artificial Intelligence and Machine Learning to foster 21st century Skills in secondary education

Edu4AI

IO2: Technical Tutorial for Teachers

Edu4AI -- Artificial Intelligence and Machine Learning to foster 21st century Skills in secondary education

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https://www.edu4ai.eu

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ABSTRACT

"**Technical Tutorial for Teachers**" can be used as training material for teachers within and beyond the partnership. It covers issues related to how one can start with Artificial Intelligence in education and the following AI services that will be put forward:

- Voice Recognition.
- Printed Text Recognition.
- Text to Speech.
- Image Classification.
- Emotion Recognition.
- Chatbots.
- Programmable AI Toys.

The Technical Tutorial is intended to make it easy to start with Artificial Intelligence in Education with examples for teachers and several technical solutions. The Technical Tutorial is written in an easy-to-grasp way so that teachers to become familiar with the technical aspects of AI and Machine Learning and the related tools and technologies for teachers.

1. INTRODUCTION

The "**Technical Tutorial for Teachers**" allows following the necessary steps to implement the results of the EDU4AI Project in the schools.

This document provides guidelines and recommendations on how to carry out the implementation of Artificial Intelligence for educational purposes in schools.

First of all, it is important to know the fundamentals of Artificial Intelligence, understand what it is and how it works, and the possible applications that AI are having and will have in the real world.

Different Artificial Intelligence services will be explained, where it will be explained in detail what Voice Recognition, Printed Text Recognition, Text to Speech, Image Classification, Emotion Recognition, Chatbots, and finally, Programmable AI Toys.

Once it has been understood what Artificial Intelligence is and the different services that can be used, we will detail why it is so important for students to learn the basics of Artificial Intelligence, and to gain fluency with these new technologies, since students are the citizens and professionals of tomorrow and it is vitally important that they are aware of these new technologies and their possible uses.

In addition, different free tools that are currently available on the Internet will be shown, which allow the easy integration of AI in the applications that students can develop, in such a way that they are motivated to create applications that can self-learn, to facilitate the people actions from day to day.

Finally, several practical examples of Artificial Intelligence will be detailed, which can motivate teachers to put into practice possible projects that students can work on as a team and promote collaborative and integrative work.

RATIONALE & MOTIVATION TO USE ARTIFICIAL INTELLIGENCE IN SCHOOLS

We are witnessing constant changes in the current world, and in the field of education, these changes are increasingly visible. The students must become builders of their knowledge and builders of real and relevant solutions. School time is the most important educational period. The students must create learning skills, build critical thinking and develop problem-solving skills.

The STEAM professions (based on Science, Technology, Engineering, Art and Mathematics) have a growing demand, but many, students do not decide on these professions. EDU4AI can contribute to making STEAM careers more attractive for students. The introduction of Artificial Intelligence in technology subjects is one more resource for STEAM subjects to become more motivating for students.

Keeping in mind that technology is really popular for new generations, the objective is to use Artificial Intelligence for all students using student-centred pedagogies that favour students learning, their creativity, increasing engagement and real learning, in line with constructivist learning and critical thinking.

Therefore, teachers need to know how we can integrate Artificial Intelligence technology into the teaching and learning process. This Technical Tutorial Guide is a step to this end, taking advantage of the use of technology to improve student learning.

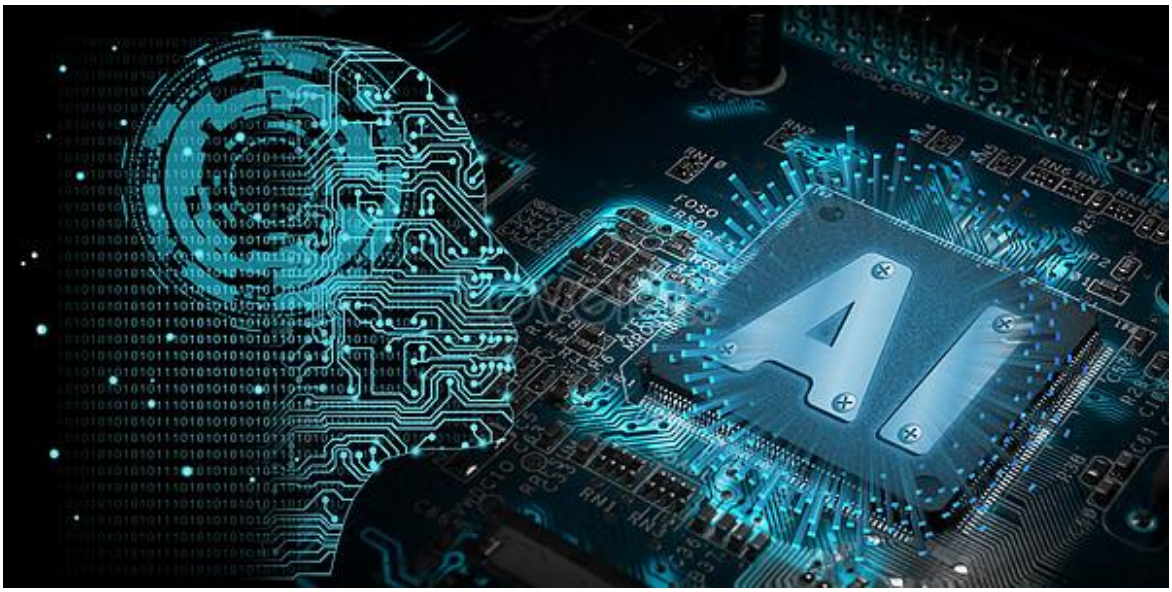
2. WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial Intelligence, or AI, is the intelligence shown by machines or electronic devices through the combination of algorithms, to show the same capabilities as humans.

The AI applied in **machines** or **devices**, perceives their environment and intends to carry out actions that maximize their chances of success when facing one or different tasks.

But, why is it called Artificial Intelligence? This term is derived from the ability to **solve problems** and **learn automatically**, through the collection of data during the learning process of the algorithms that make machines or devices work, so that, as they acquire more data, the more accurate and effective they will be when tackling a task. In short, AI is applied when a machine mimics the cognitive functions of people.

Artificial Intelligence can correctly interpret external data, learn from said data and use that knowledge to achieve specific tasks and goals through flexible adaptation and self-learning.



Within Artificial Intelligence there are several types: systems that are created to act intelligently, or systems that self-learn and think intelligently, whose objective is to reproduce the mental processes of humans, through artificial neural networks. In Artificial Intelligence it is very common to hear the term, "Neural Networks", but what does this term mean?

Artificial neural networks are a Machine Learning paradigm inspired by the way the biological nervous system works, where millions of neurons, working as a team, produce outputs to received stimuli. These networks are capable of abstracting essential characteristics from inputs that present non-relevant information and learning from experience. The more data they process, the more efficient the artificial neural network will be.

The most common applications of this type of Artificial Intelligence are prediction in the financial market, weather predictions, and more generally, the classification and recognition of patterns.

Personalities such as Sundar Pichai, CEO of Google, highlights that the power of machine learning and AI allows utilities such as “use your voice to search for information, translate the web from one language to another, filter spam from your inbox, search imperfections in your photos and improve them and in general, to solve many problems in your daily life. It is what allows us to build products that improve over time, making them always more useful”. He also adds, “Going forward, the next big step will be that the very concept of device’ is going to disappear. In time, the computer itself, whatever its shape, will be a smart assistant to help you with your day. We are going to go from the mobile world first to a world where Artificial Intelligence comes first”.

Investigating the different services that Artificial Intelligence puts at our disposal, we will explain the terms in more depth: Voice Recognition, Printed Text Recognition, Text to Speech, Image Classification, Emotion Recognition, Chatbots, and finally Programmable AI Toys.

Until now, the term ***Machine Learning***[1] has been mentioned several times, which is the discipline of Artificial Intelligence that is responsible for creating systems that learn automatically.

Learning is understood as the identification of complex patterns in millions of data. The "machine" that actually "learns" is an algorithm that reviews data and can predict future behaviour. And the term "automatic" is understood as that these systems are improved autonomously over time.

As large amounts of data are impossible for a single person to analyze, Machine Learning provides algorithms that can detect patterns of behaviour, make predictions, and draw conclusions.

Another branch of Machine Learning is **Deep Learning**[2], which consists of, through a model, the algorithm can evaluate examples through a small collection of instructions that can modify the given model when errors occur. One of the most used techniques in Deep Learning is the artificial neural network system, which has been described above.

Deep Learning allows image recognition, natural language analysis and anticipating problems thanks to the extraction of behaviour patterns.

For example, through image recognition, Deep Learning can detect all objects in an image:

[1] https://cleverdata.io/que-es-machine-learning-big-data/
[2] https://robocademy.com/2020/05/01/a-gentle-introduction-to-yolo-v4-for-object-detection-in-ubuntu-20-04/

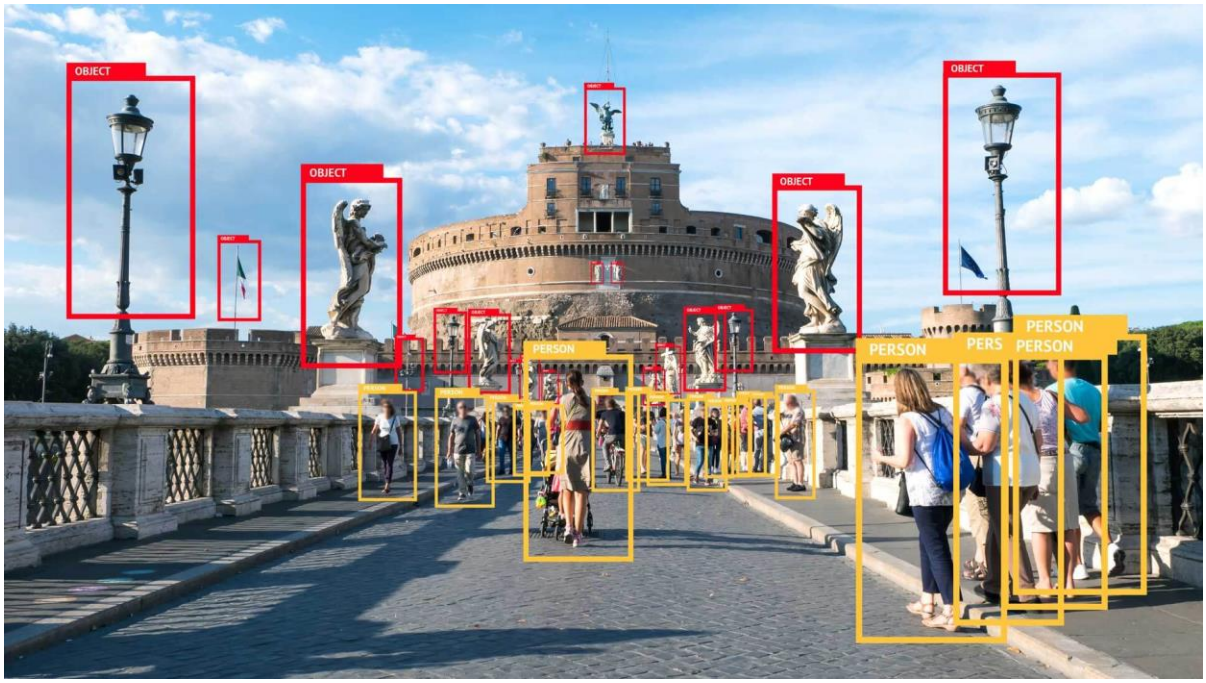


Image 1 - Detection of Elements in an image

In short, Artificial Vision derived from Deep Learning is a field of Artificial Intelligence that trains to interpret and understand the real world. The machines can identify and locate objects with precision and then react to what they "see" using digital images from cameras, videos and models, in addition to being complemented by neural processing, allowing the translation of texts in real-time.

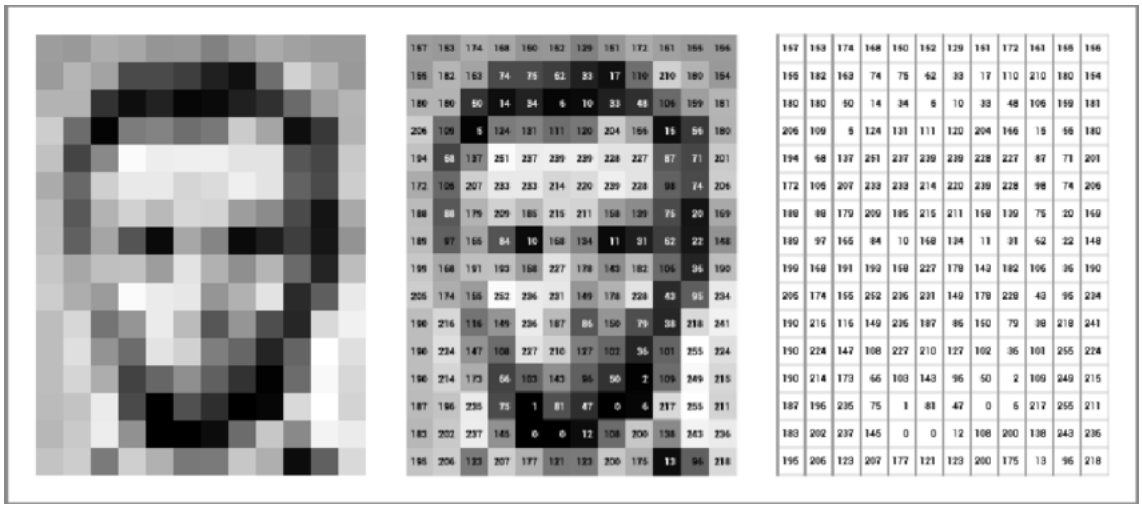


Image 2 – Image of Abraham Lincoln taken from the web researchgate.net[3]

[3] https://www.researchgate.net/figure/Pixel-Data-Diagram-of-Abraham-Lincoln-166_fig4_337402608

Therefore, the most important challenge in this transformation process as we know it in the world of Artificial Intelligence, is the optimization of the use of large volumes of data for the extraction of patterns. It is necessary to adapt the storage of this data, index it and that the access is fast enough so that it can be scaled and obtain value from the data, which can be transformed into new opportunities and business models.

Summarizing the main objectives pursued by Artificial Intelligence, highlight:

- **PROCESS AUTOMATION**: Reproduce repetitive tasks and think faster than humans.
- **MINIMIZE MISTAKES**: The errors that humans can have been reduced due to our limitations since AI is used to detect errors that may be undetectable to our eyes.
- **IMPROVED DECISION MAKING**: Better decisions can be made by having better-structured information.
- **INCREASE IN PRODUCTIVITY AND QUALITY**: It increases the productivity of the machinery and that of the workers themselves.
- **CONTROL AND OPTIMIZATION**: This is because the processes that are followed are more efficient, with greater control and with hardly any errors.

But how does an Artificial Intelligence system work? If, for example, we have an Image Recognition application in our smartphone, this application would need Machine Learning services to process the collected images and interpret what object it is.

To do this, through a Communication API (Application Programming Interface), the captured images are transferred to the server, which stores different Artificial Intelligence algorithms that will process the images and make a prediction about what type of object is displayed in the image.

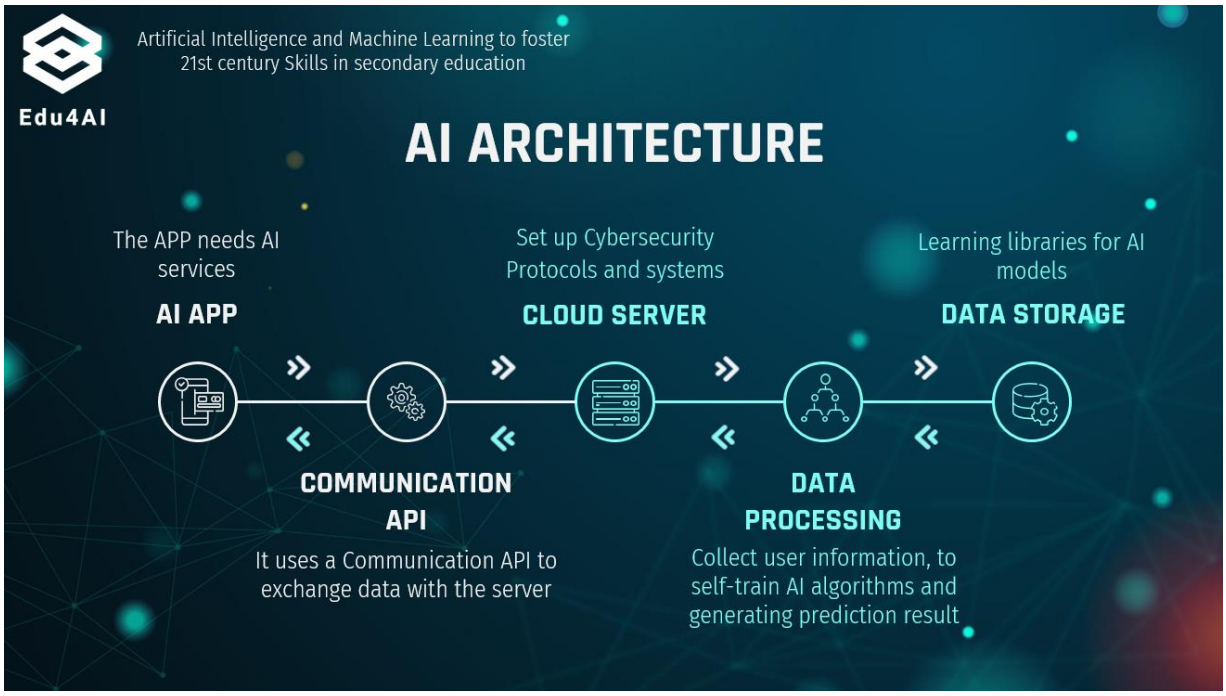
It should be noted that the server that has all the data collected and the AI services must have exceptional cybersecurity and privacy measures, which guarantee data protection against possible hacks by third parties.

Once the image has reached the server, it is processed with the training images available to the system, so that it checks those images that are more similar to the one captured by the user.

As the Artificial Intelligence system trains itself with more images, the more accurate and truthful the result will be.

Once all the data processing has been carried out, the result goes the other way, where the Communication API returns the result to the user application, so that the user can already know which objects or elements appear in the image.

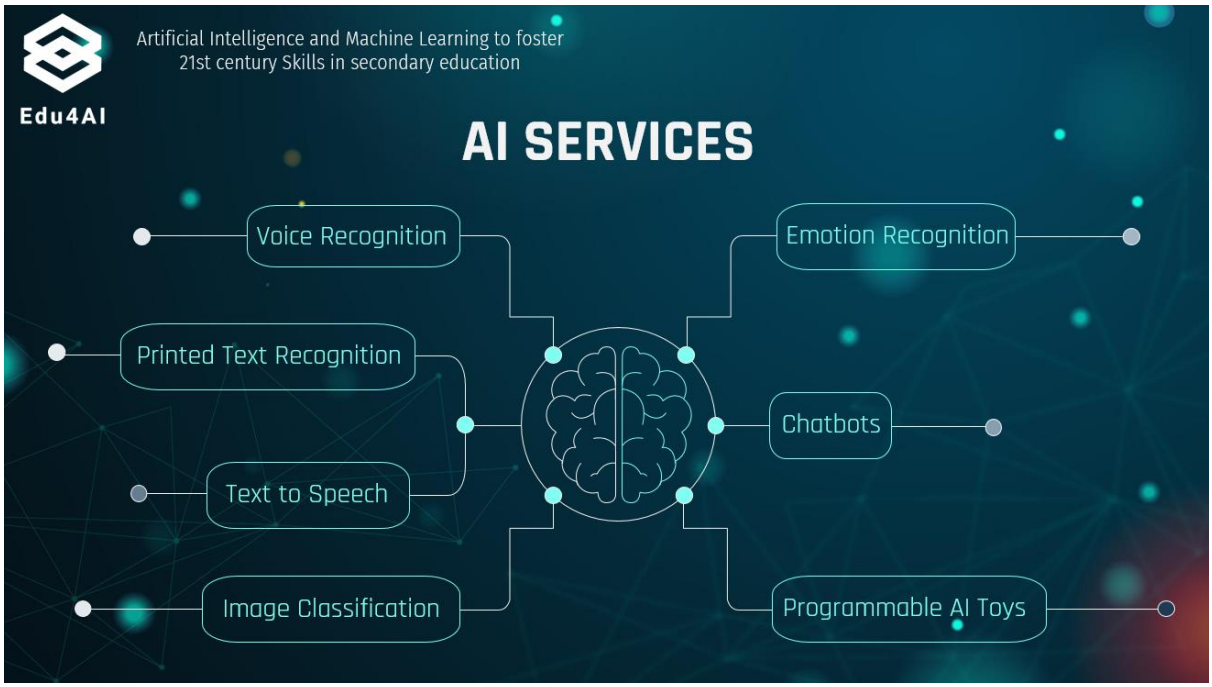
As a summary, and in a more visual way, the following image presents an architecture of the data process in an Artificial Intelligence system:



Finally, and before developing the main Artificial Intelligence services, it should be noted that AI has a place in all sectors that move the economy of our countries:

- Technology.
- Logistics and transport.
- Manufacturing.
- Health care.
- Energy.
- Insurances.
- Education.
- Tourism.
- Retail.
- Economy.
- Marketing.
- Toys.

Investigating the different services that Artificial Intelligence puts at our disposal, we will explain the following popular services in more depth: Voice Recognition, Printed Text Recognition, Text to Speech, Image Classification, Emotion Recognition, Chatbots, and Programmable AI Toys:



2.1 Voice Recognition

Voice or speaker **recognition** is the ability of a machine or program to receive and interpret understand and carry out spoken commands.

This Artificial Intelligence technology has been booming thanks to AI and smart assistants, such as:

Image 3 - Image taken from the website medium.com[4]

Voice recognition systems enable consumers to interact with technology simply by speaking to it, enabling hands-free requests, reminders and other simple tasks.

But how Voice Recognition works? This technology requires that analogue audio be converted into digital signals, known as analogue-to-digital conversion. For a computer to decipher a signal, it must have a digital database, or vocabulary, of words or syllables, as well as a speedy means for comparing this data to signals.

A comparator checks these stored patterns against the output of the A/D converter -- an action called pattern recognition.

[4] https://medium.com/voice-tech-podcast/voice-the-rise-of-the-third-platform-and-why-it-matters-db4399b787f8

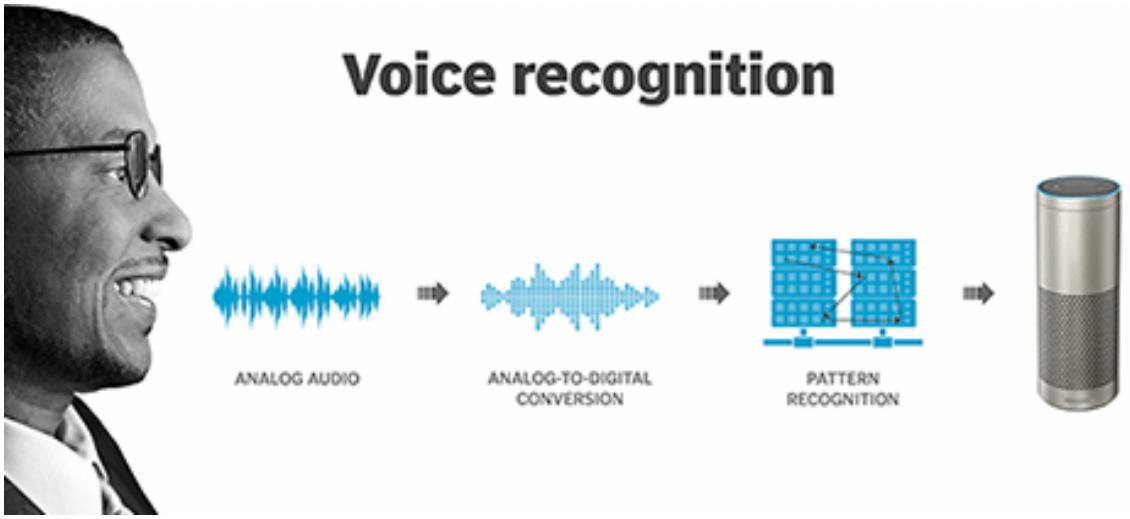


Image 4 - How Voice Recognition works?

As uses for voice recognition technology grow and more users interact with it, the companies implementing voice recognition software will have more data and information to feed into the neural networks that power voice recognition systems, thus improving the capabilities and accuracy of the voice recognition products.

But for Voice Recognition to correctly interpret people's words, it makes use of Natural Language Processing or NLP.

The NLP[5] is the field of knowledge of Artificial Intelligence responsible for electronic devices to understand, process and generate language just as people do.

Natural Language Processing is more advanced in word processing, where there is more data and it is easier to interpret. Therefore, when the language is oral, this language must be processed to transcribe it into letters, so that the system understands the question. For the answer, the process would be inverse, first, the sentence is elaborated and then the voice is synthesized.

[5] http://www.iic.uam.es/inteligencia/que-es-procesamiento-del-lenguaje-natural/

Image 5 - Image taken from the website medium.com[6]

The NLP works through machine learning or Machine Learning, where machine learning systems store words and how they are combined, just like any form of data. Different types of phrases, sentences, dictionaries, and even books are incorporated into these search engines, where they are processed according to the grammar rules and/or linguistic habits of people's real life. Therefore, Voice Recognition systems use this information to find patterns and extrapolate it to the user.

Voice Recognition uses

The main uses of Voice Recognition technology today are very diverse, such as:

- Voice-to-text transcription.
- Setting up reminders.
- Searching the internet.
- Responding to simple questions.
- Responding requests, such as:
  - Playing music.
  - Sharing weather.
  - Traffic information.

[6] https://medium.com/soldai/procesamiento-de-lenguaje-natural-5315cf212d0f

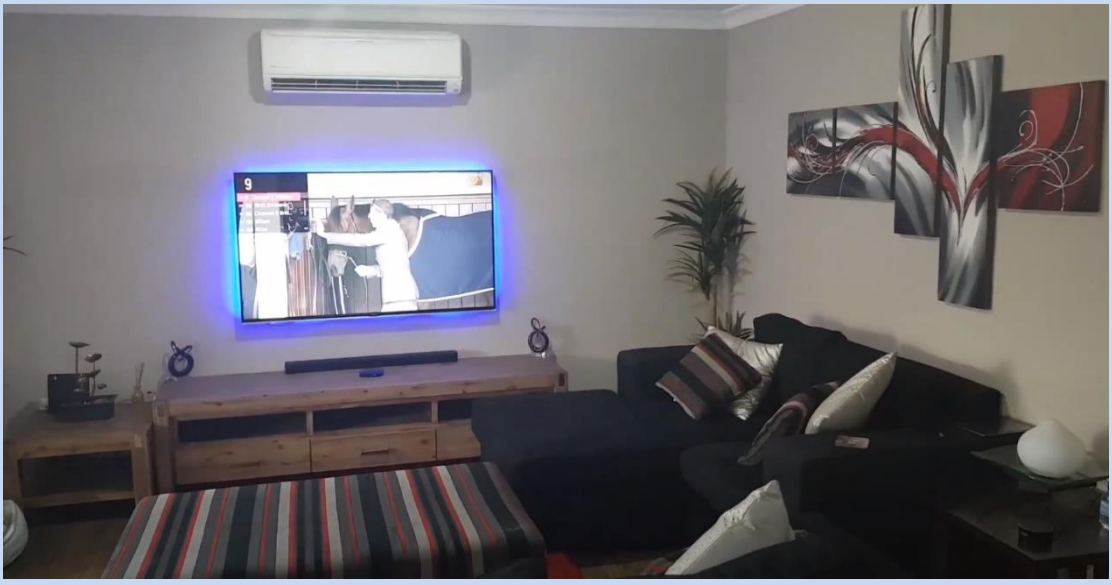
The principal advantage of the use of this AI technology is by using Machine Learning and sophisticated algorithms, Voice Recognition technology can quickly turn your spoken word into written text.

And the disadvantages of using Voice Recognition are while accuracy rates are improving, all voice recognition systems and programs make errors, and the background noise can produce false inputs, which can be avoided by using the system in a quiet room. And the last, there is also a problem with words that sound alike, but that are spelt differently and have different meanings -- for example, hear and here.

A real example of Voice Recognition

Alexa Home Automation

https://www.youtube.com/watch?v=xwq7kIVnORo

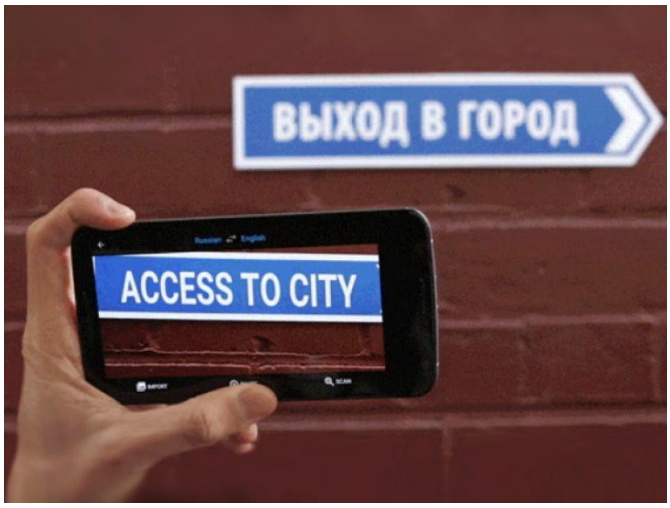


2.2 Printed Text Recognition

Printed Text Recognition is the technology to distinguish printed or handwritten text characters inside digital images of physical documents, such as scanned paper documents.

The basic process involves examining the text of a document and translating the characters into code that can be used for data processing.

Currently, Printed Text Recognition technology is very used for **Text Translation**.



But how Printed Text Recognition works? This AI technology converts the document or the image into a two-colour, or black and white, version. The scanned-in image or bitmap is analyzed for light and dark areas, where the dark areas are identified as characters that need to be recognized and light areas are identified as background.

The dark areas are then processed further to find alphabetic letters or numeric digits. The Printed Text Recognition software involves targeting one character, word or block of text at a time. Characters are then identified using one of two algorithms:

1. Pattern recognition: The AI system is fed examples of text in various fonts and formats which are then used to compare, and recognize, characters in the scanned document.

Pattern recognition is essential for many overlapping areas of computer science, in addition to Artificial Intelligence, such as big data analytics, biometric identification or cybersecurity.

2. Feature detection: Programs apply rules regarding the features of a specific letter or number to recognize characters in the scanned document.

   Features could include the number of angled lines, crossed lines or curves in a character for comparison. For example, the capital letter "A" may be stored as two diagonal lines that meet with a horizontal line across the middle.

   When a character is identified, it is converted into an ASCII code that can be used by computer systems to handle further manipulations. Users should correct basic errors, proofread and make sure complex layouts were handled properly before saving the document for future use.

Printed Text Recognition uses

The main uses of Printed Text Recognition technology today are very diverse, such as:

- Scanning printed documents into versions that can be edited with word processors, like Microsoft Word or Google Docs.
- Automating data entry, extraction and processing.
- Deciphering documents into text that can be read aloud to visually-impaired or blind users.
- Archiving historic information, such as newspapers, magazines or phonebooks, into searchable formats.
- Electronically depositing checks without the need for a bank teller.
- Placing important signed legal documents into an electronic database.
- Recognizing text, such as license plates, with a camera or software.

- Sorting letters for mail delivery.
- Translating words within an image into a specified language.

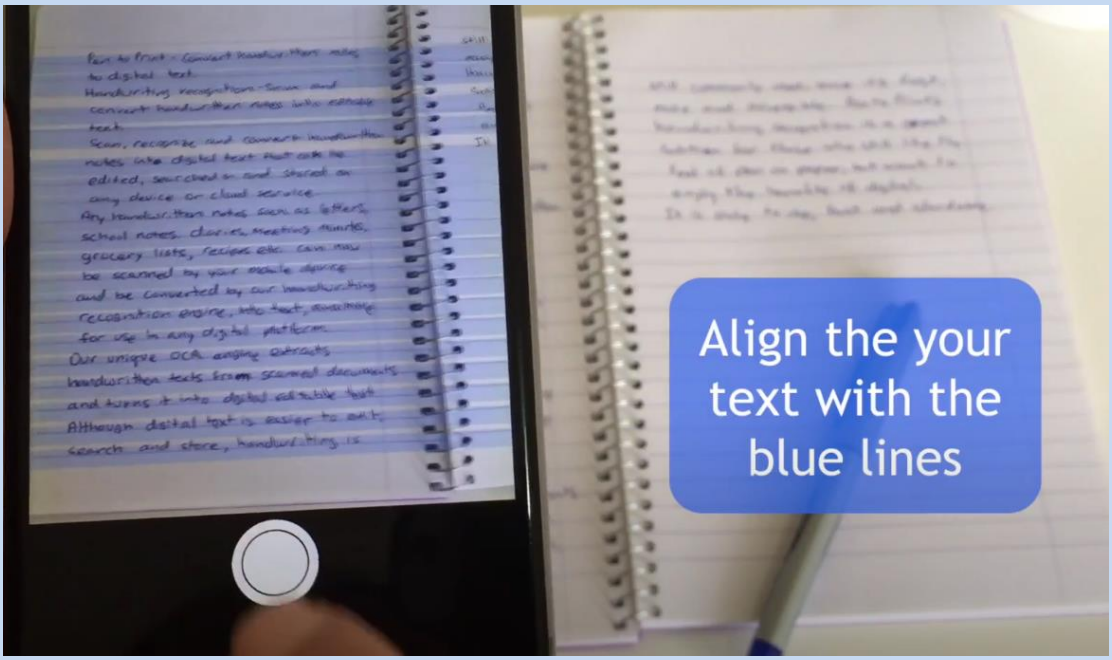
The principal advantage of the use this AI technology is to save time when we want to translate texts, decrease mistakes and minimize the effort. Also, provides the added functionality of being able to edit and search in scanned documents.

And the Disadvantage of using Printed Text Recognition is a difficult interpretation in blurry or poorly legible images.

Real examples of Printed Text Recognition

Pen to Print - Convert handwriting to digital text

https://www.youtube.com/watch?v=HZYii8EeCoQ



2.3 Text to Speech

Text to Speech is the ability of a machine or program to identify words spoken aloud and convert them into readable text.

Rudimentary speech recognition software has a limited vocabulary of words and phrases, and it may only identify these if they are spoken very clearly.

Text to Speech can accept natural speech, different accents and languages.

But how Text to Speech works? Text to Speech works using algorithms through acoustic and language modelling. Acoustic modelling represents the relationship between linguistic units of speech and audio signals. And Language modelling matches sounds with word sequences to help distinguish between words that sound similar.

A very popular method used in Speech Recognition may include **Natural Language Processing** (NLP), which makes the speech recognition process easier and take less time.

These systems will use grammar, structure, syntax as well as the composition of audio and voice signals to process speech.

Software using Machine Learning will learn more the more it is used, so it may be easier to learn concepts like accents.

Text to Speech uses

The main uses of Text to Speech technology today are very diverse, such as:

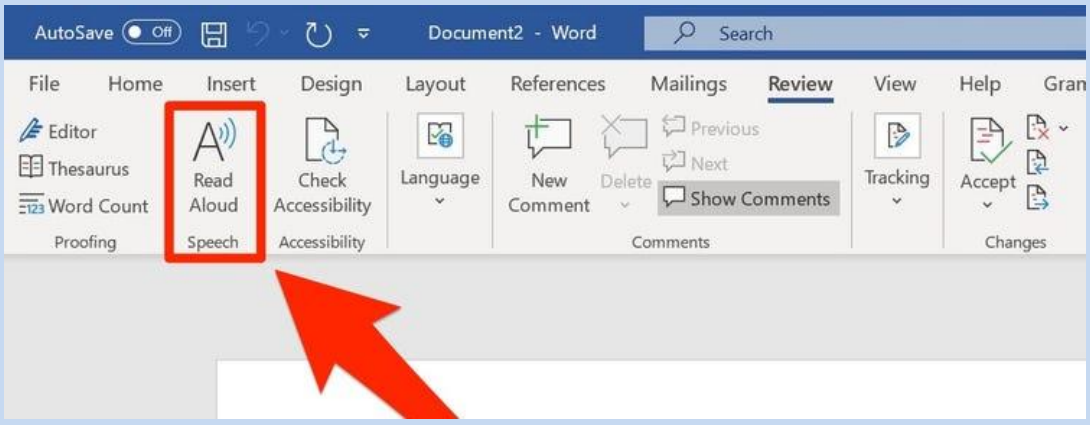
- In smartphones for call routing, speech-to-text processing, voice dialling and voice search setting up reminders.
- To respond to a text without having to look down at their phone.
- Speech recognition can also be found in word processing applications, like Microsoft Word, or WhatsApp, where users can dictate what they want to show up as text.

The principal advantage of the use of this AI technology is the easy to use and readily available in everyday use on our smartphones

And the disadvantages of using Text to Speech are the inability to sometimes capture words due to variations of pronunciation, the lack of support for some languages, and the inability to sort through background noise.

Real examples of Text to Speech

Text to Speech in Word:



2.4 Image Classification

Image Classification is the ability of software to identify objects, places, people, writing and actions in images.

Computers can use machine vision technologies in combination with a camera and Artificial Intelligence software to achieve Image Recognition.

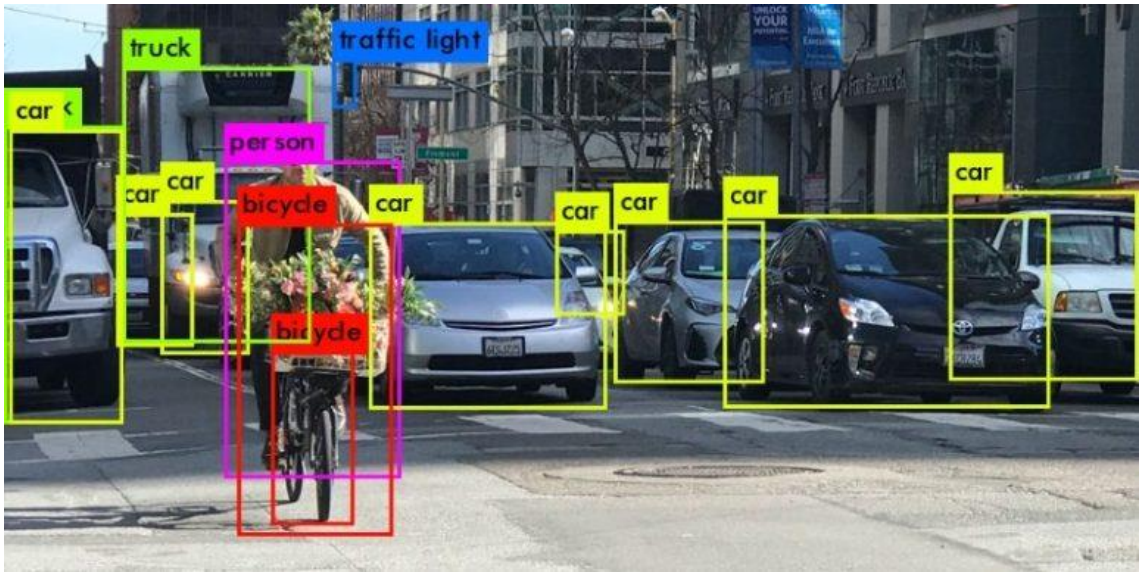


Image 6 - Image take to robocademy.com web[7]

But how Image Classification Works? Software for image recognition requires Deep Learning, but it needs higher performance.

Deep Learning is one of the main Machine Learning technologies. With Deep Learning, we are talking about algorithms that can mimic the actions of the human brain using artificial neural networks. The networks are composed of dozens or even hundreds of "layers" of neurons, each of which receives and interprets information from the previous layer.

Image recognition algorithms can function by use of comparative 3D models, and appearances from different angles using edge detection or by components.

[7] https://robocademy.com/2020/05/01/a-gentle-introduction-to-yolo-v4-for-object-detection-in-ubuntu-20-04/

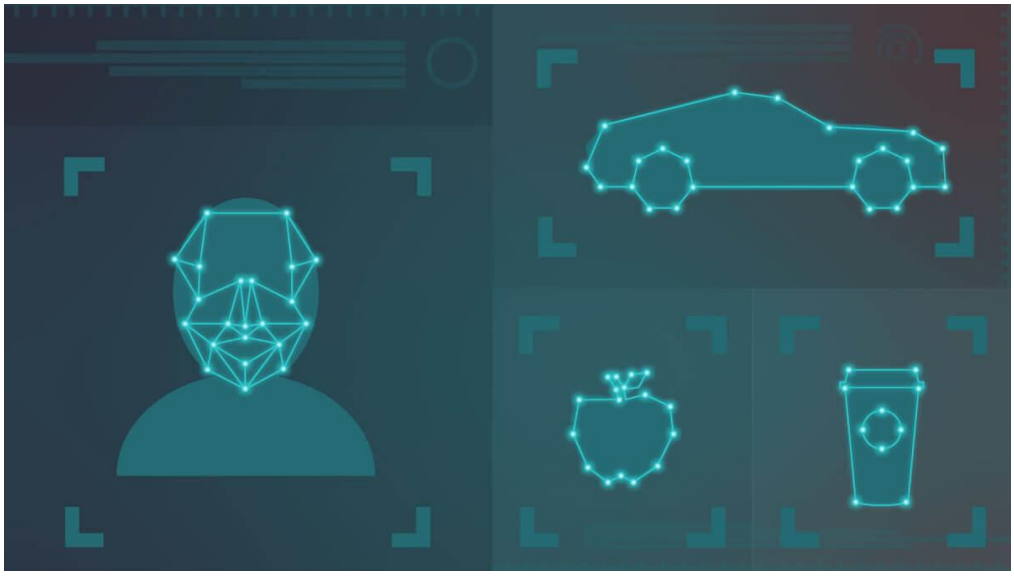


Image recognition algorithms are often trained on millions of pre-labelled pictures with guided computer learning.

Image Classification uses

Image Classification is used to perform a large number of machine-based visual tasks, such as:

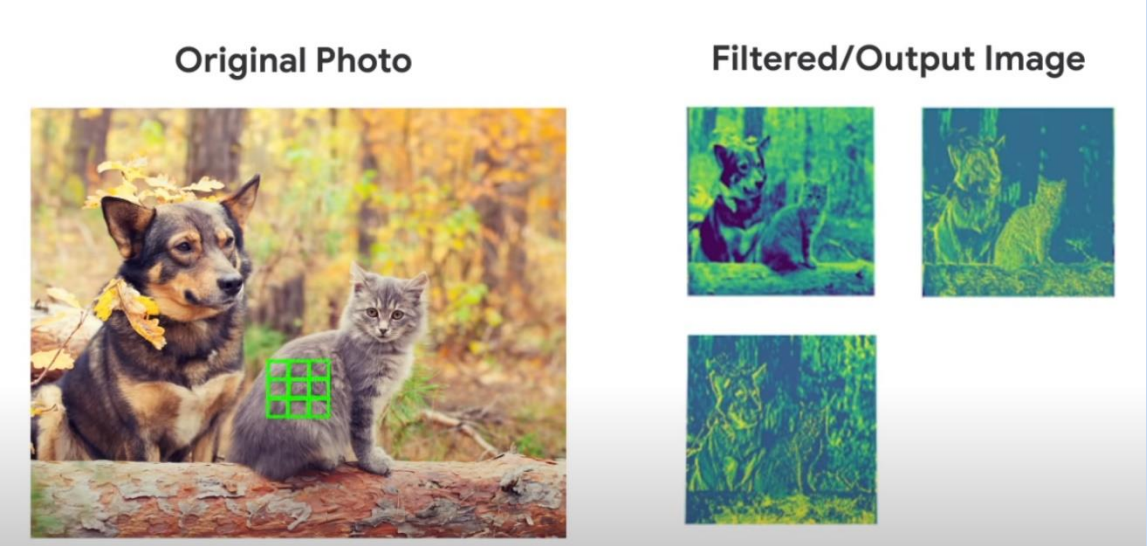
- Labeling the content of images with meta-tags.
- Performing image content search.
- Guiding autonomous robots.
- Self-driving cars.
- Accident avoidance systems.

The principal advantages of the use of this AI technology are for creating smart photo libraries, targeted advertising, accessibility for the visually impaired and enhanced research capabilities.

One of the main disadvantages of using Image Classification is that if people appear in the images, their privacy must be taken into account.

Real examples of Image Classification

Machine Learning Practicum: Image Classification:



The image shows a dog and a cat, so the AI system needs to segment the different features of the image to be able to classify it.

To do this, it applies different filters that facilitate the correct interpretation of the image's characteristics until the results are obtained and the dog and cat can be differentiated.

2.5 Emotion Recognition

Emotion Recognition is the cognitive computing and Artificial Intelligence that is concerned with gathering data from faces, voices and body language to measure human emotion.

Emotion Recognition collects data on how a person communicates verbally and nonverbally to understand the person's mood or attitude.

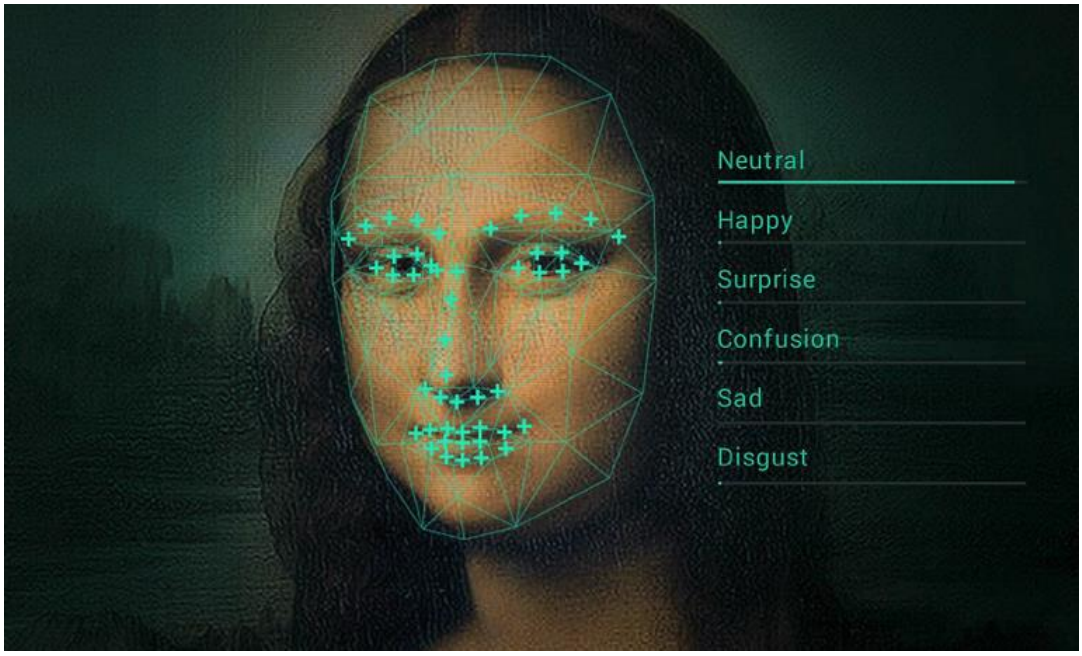


Image 7 - Mona Lisa Emotion Recognition[8]

But how Emotion Recognition works? Emotions analytics software development requires vast amounts of labelled emotions data.

The emotional data comes from video cameras that capture facial expressions and microphones that collect data on tones of voice, for example.

This data is fed into Machine Learning algorithms, which learn to recognize expressions, tones and other characteristics that correlate to specific emotions.

[8] https://blog.realeyesit.com/mona-lisas-smile-in-the-mind

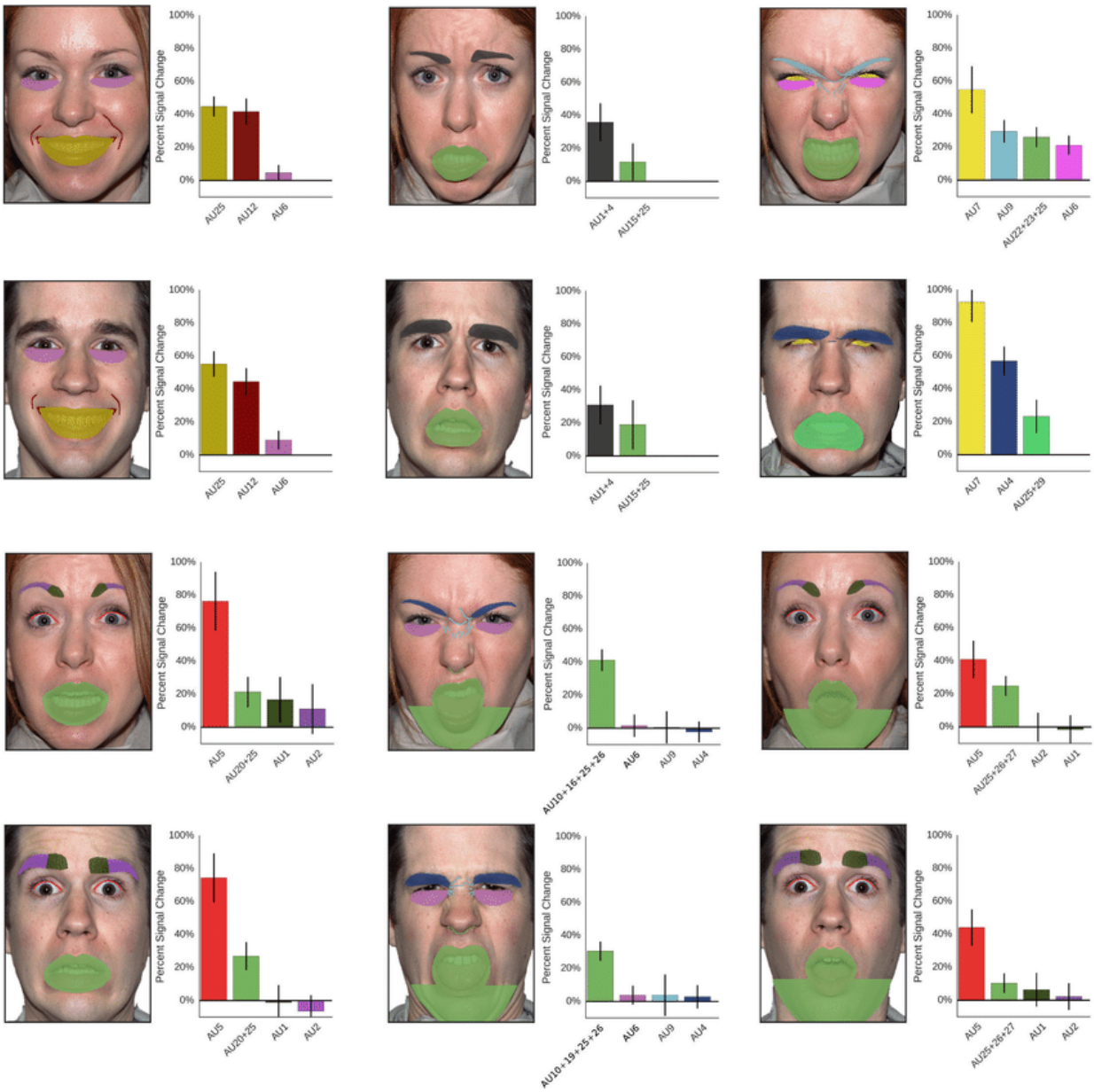


Image 8 - Emotion Recognition Analysis[9]

[9] https://www.researchgate.net/figure/Role-of-specific-action-units-for-emotion-recognition-Colours-of-each-action-unit-as_fig3_317194366

Today's emotions recognition technology typically categorizes emotions as either:

- Anger.
- Contempt.
- Confusion.
- Disgust.
- Fear.
- Frustration.
- Joy.
- Sadness.
- Surprise.

Image 9 - Emotion Status[10]

Emotion Recognition uses

The main uses of Emotion Recognition technology today are very diverse, such as:

- Telemedicine:
  Can help doctors quickly understand a remote patient's mood or look for signs of depression.
- E-Learning:
  Could detect when a student is frustrated and offer expanded explanations or additional information.
- Sales Marketing Departments:
  To gain insights into customer emotions and provide personalized ad campaigns.

[10] https://searchcustomerexperience.techtarget.com/definition/emotions-analytics-EA

- Police:

  For the investigation of criminal events, seeing the emotional state of the suspect, patterns of guilt, regret, etc., could be detected.

The principal advantage of the use of this AI technology is to know the emotional state of our children or students and be able to help them.

And the disadvantage of use Image Classification is the use of Emotion Recognition software in business is controversial, primarily because companies that employ emotions analytics may not disclose the fact that they collect emotional data.

Real examples of Emotion Recognition

Emotion Recognition in Real Time:

https://www.youtube.com/watch?v=trznYRc11Ho

2.6 Chatbots

A Chatbot is programming that simulates the conversation or "chats" of a human being through text or voice interactions.

They have the advantage that they are always available to answer the questions of users who want to contact you at any time of the day.

Image 10 - User-machine interaction representation[11]

Chatbots are part of Natural Language Processing systems since they are integrated into virtual assistants so that they are activated when you mention them. Some criticize that these assistants are always listening, but if they did not, they would never know when they are requested.

Another of the outstanding functionalities of the NLP is to analyze the "sentiment" of the companies' customers, that is, NLP tools help to discern if the tweets or comments on social networks are good or bad for their reputation. This sentiment analysis not only processes words but also analyzes the context in which they appear.

[11] https://blog.sirena.app/los-mejores-chatbots-son-los-mas-humanizados

But how Chatbot works? Chatbots are built on Artificial Intelligence technologies, including Deep Learning, Natural Language Processing (NLP) and Machine Learning algorithms, and require massive amounts of data.

The more an end user interacts with the bot, the better Voice Recognition becomes at predicting an appropriate response.

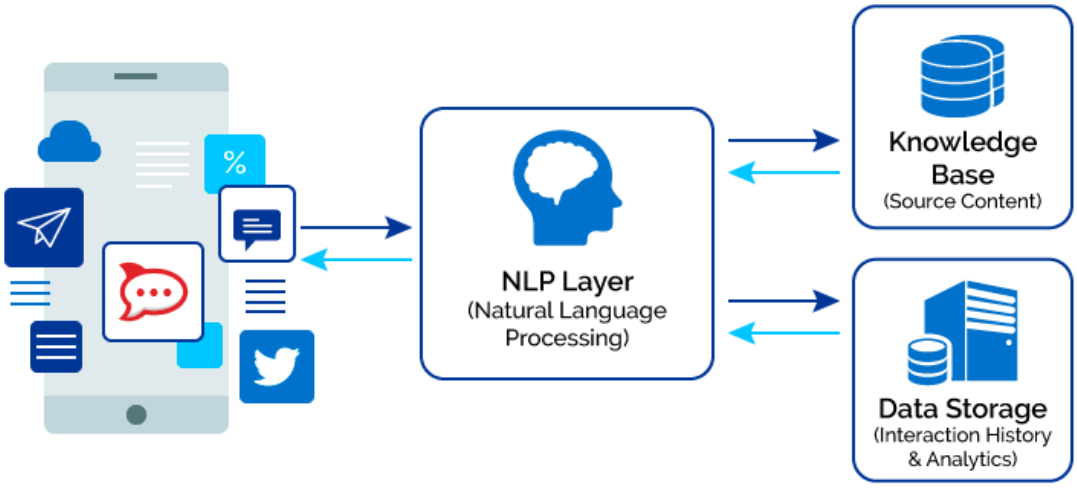


Image 11 - Representative diagram of a Chatbot's functionality[12]

By using the technologies mentioned above, the Chatbot will try to understand what the user has said, the tools it uses are such as lexicons, synonyms and topics.

These tools are used together as algorithms or rules to build the dialogue that will tell the chatbot how to respond in the best possible way.

The are two types of the chatbot, depending on their design and programming, we can find two well-differentiated types of chatbots:

- **Simple Chatbots:** This Artificial Intelligence software works based on a series of commands and keywords (previously "prepared").

  If the user asks a question without using that keyword, the "robot" will not be able to understand it and will respond by inviting to ask another question.

[12] https://www.technovature.com/services/ai/

- **Smart Chatbots**: They are a category of more level and complexity. Designed in line with the concepts and philosophy of Artificial Intelligence, it does not work based on questions or keywords.

  The live chat responds with suggestions or ideas about the written text. It is a step further by offering a wide variety of streams of dialogue and providing a more natural and "human" experience.

Chatbot uses

The main uses of Chatbot technology today are very diverse, such as:

- In sales, Chatbots are being used to **assist consumers shopping online**, either by answering noncomplex product questions or providing helpful information that the consumer could later search for, including shipping price and availability.
- Chatbots are also used in **service departments**, assisting service agents in answering repetitive requests. Once a conversation gets too complex for a Chatbot, it will be transferred to a human service agent.
- Chatbots are also used as **virtual assistants**. Apple, Amazon, Google and Microsoft all have forms of virtual assistants. Apps, such as Apple's Siri and Microsoft's Cortana, or products, like Amazon's Echo with Alexa or Google Home, all play the part of a personal Chatbot.

The principal advantages of the use of this AI technology are the timesaving and efficiency in conversing and answering reoccurring questions. Chatbot-based virtual assistants are increasingly used to handle simple tasks, freeing human agents to focus on other tasks.

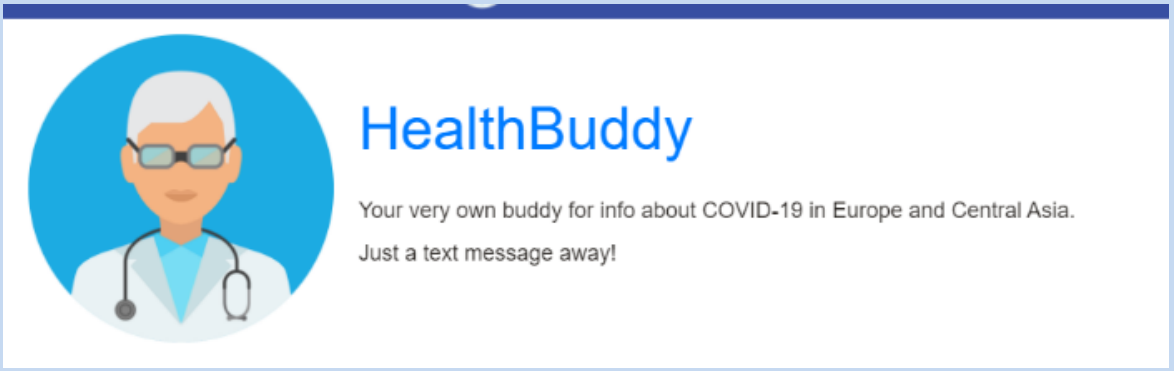
And the disadvantages are sometimes they do not correctly interpret what the user asks for human beings are random and user behaviour is controlled by emotions

and moods; users may quickly change their minds. Chatbot technology must be able to adapt to and understand this element of randomness and spontaneity.

Real examples of Chatbots

Covid Info:

https://healthbuddy.info/index#webchat



2.7 Programmable AI Toys

Programmable AI Toys, or Smart Toys, are Intelligent Toys able to learn how children play, allowing interaction between both.

Artificial Intelligence allows a toy to know when and how it should behave, in addition to allowing the toy to be trained through Machine Learning and improve the user's gaming experience.

Image 12 - Augmented Reality App

The Programmable AI Toys objective is to complement the Traditional Toy with new Technologies that allow to extend the useful life of the Toy and make it more attractive to users.

But how Programmable AI Toy works? The toys are connected via the Internet to the Server that contains the data, and stores the users' way of playing, as the user plays and interacts with the toy, the system recognizes different patterns of play and adapts the way they play to the child's needs.

```
In [0]: X = X / 255.0
        X_t = X_t / 255.0

In [0]: visualize_example(X[0])
```

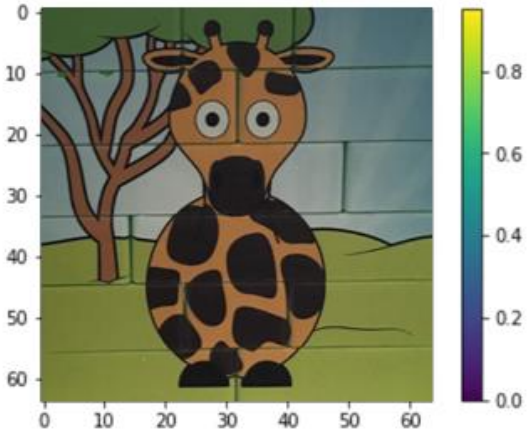


Image 13 - App Toy Development

The toys are connected via the Internet to the Server that contains the data, and stores the users' way of playing, as the user plays and interacts with the toy, the system recognizes different patterns of play and adapts the way they play to the child's needs.

Programmable AI Toys use

The main uses of Programmable AI Toys are:

- ❖ Through toys we can know the emotional state of our children and students.
- ❖ Toys to enhance social skills and learning.
- ❖ Toys can be created that enhance the learning of different subjects.
- ❖ Therapeutic toys for children with disabilities or rehabilitation processes.

The principal advantages of the use of this AI technology are that Artificial Intelligence can provide, both to toys and their manufacturing processes, a true revolution. In toys, it can provide the same advantages as a video game, but with the attraction that it is real toys with which children interact. And in manufacturing

processes, AI can allow better efficiency in production resources and prevent possible errors in production.

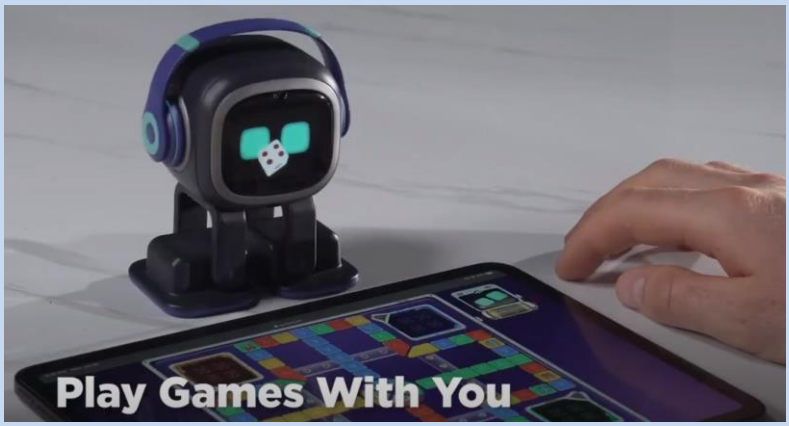
This evolution of the traditional toy aims to provide users, specifically the child target, with higher levels of motivation and attraction.

And the disadvantages are, perhaps, the essence of the traditional toy can be lost as it is more technological. And another important aspect is to take care of the privacy of children, since being toys connected to the Internet, there may be privacy risks.

Real examples of Programmable AI Toys

Emu Desktop Pet:

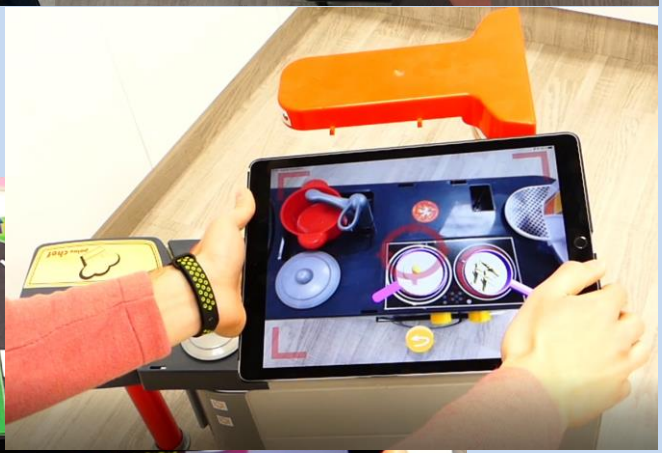
https://www.youtube.com/watch?v=hjS2NXtzUz0

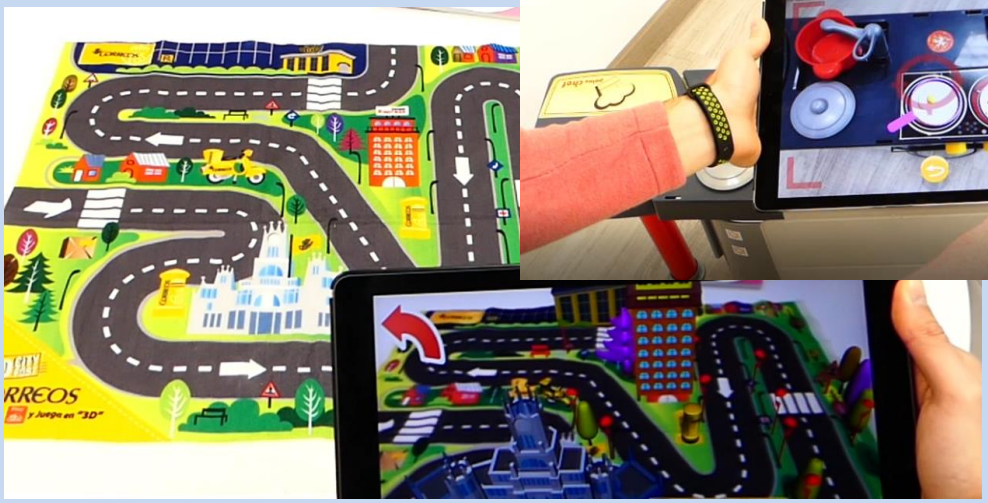


Resume AI Toys:

https://www.youtube.com/watch?v=1lcerCoVZ-k

AIJU's Developments:

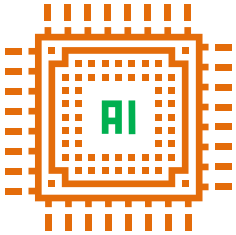




3. WHY ARTIFICIAL INTELLIGENCE IN EDUCATION?

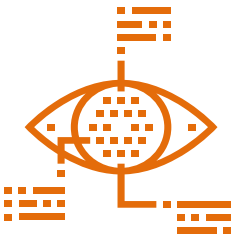
In this chapter, we will talk about the importance of students learning the basics of Artificial Intelligence, since we are facing a world in constant change, with frenzied technological growth, young generations must be aware of how our world works.

The best way to understand the capabilities and implications of Artificial Intelligence & Machine Learning is to be able to build with these technologies for themselves.

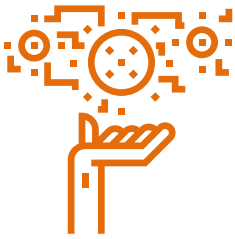


AI & ML is all around us and used every day, such as spam filters, the recommendation engines of Amazon or Netflix, language translation services, Chatbots and digital assistants like Alexa, Siri or Cortana, and search engines like Google, Bing, etc.

It will soon be normal for AI & ML systems to drive cars and help doctors to diagnose and treat our illnesses, but these are technologies that will transform our society, economy and jobs to a greater extent over the next decades.



Early education in Artificial Intelligence goes beyond computational thinking, and explores how computers are capable of: sensing, thinking, acting, learning, making decisions, créate, perceiving, and making sense of things.

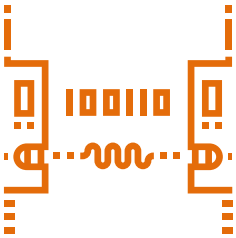


Influential studies now suggest that perhaps one in two occupations in industrialized countries is likely to become automated using already existing AI technologies.

So AI is going to have a strong impact on today's society, as it is going to modify and innovate the main sectors, including learning, teaching and education.

It is therefore important to understand the potential impact of AI on learning, teaching, and education, so we have to:

- Making better use of digital technology for teaching and learning.
- Developing relevant digital competences and skills for digital transformation.
- Improving education through better data analysis and foresight.



Therefore, to facilitate this entire process of change, the members of the EDU4AI Project want to help you using age-appropriate tools and block-based programming environments to provide an easy-to-use interface that provides AI cloud services as well as other AI functions that can scaffold students' learning about AI.

The main goal of the Edu4AI Project is to introduce AI in schools, democratising access to AI education and innovation development for all learners which in turn will be a bold step towards equity in education.

Students from across the EU from every background should have the ability to build new products using innovative AI technologies and tools that could change lives around the world.

EDU4AI CONTRIBUTION

Thanks to this guide developed as Intellectual Output 2, it is expected that teachers who are interested in introducing Artificial Intelligence and Machine Learning in their classrooms, can learn what the mentioned technologies consist of and how they can apply the different Artificial Intelligence services.

To understand the potential impact of AI on learning, teaching and education, training was conducted for teachers with open educational resources and tools that have enabled them to implement AI and ML in school classrooms.

Therefore, thanks to the training that the teachers have received, and the development of this technical guide, there will be, as a consequence, a better quality of learning taught in school classes and, especially, in the education of ICT-related subjects, developing 21st-century skills for students.

In this way, thanks to this Technical Tutorial for Teachers, an important effort has been made so that teachers and students can benefit from the:

- Teachers and, consequently, students can know better what AI is and can reinforce their knowledge and skills in their future work.
- To know different AI services and tools to be able to carry them out, so that they can face the future with determination, confidence and security.

- When carrying out projects with students, it would be good practice for the students to take the initiative in the project they are going to develop, which in turn helps the teacher to become a facilitator who gives them enough freedom to be the ones who try to find a solution to the problems they encounter along the way.
- As teachers and students are learning AI with different projects, they will develop new skills, enhance teamwork, exchange ideas and manage possible conflicts and mistakes in a much more realistic way as they face new challenges independently.
- All the tools shown in this guide can be used on mobile or tablet, Students will be more motivated because they will be able to develop their applications on their mobile or tablet, which will allow them to be more creative.
- In addition, they will learn English and innovative technologies that will enhance their skills for a better professional future.

4. ARTIFICIAL INTELLIGENCE TOOLS

On the Internet, numerous tools have the objective of facilitating the learning and integration of Artificial Intelligence in applications that students can carry out in a more or less simple way.

Therefore, the consortium of partners of the EDU4AI Project has compiled a series of age-appropriate tools that are considered very useful to carry out this learning process, which is mentioned below:

4.1 AI with MIT App Inventor

Image 14 - MIT APP Inventor Logo

- Get Started: https://appinventor.mit.edu/explore/get-started
- Tutorials: https://appinventor.mit.edu/explore/ai2/tutorials
- Teachinh with APP Inventor: https://appinventor.mit.edu/explore/teach
- Community Support: https://community.appinventor.mit.edu/

To develop mobile applications with App Inventor[13] you need a web browser and an Android or iOS phone or tablet (if you don't have one, you can test your applications in an emulator). Being a free program from Google you can access it with your Gmail account. To do this, you must access the AppInventor project website and start creating applications for your Android or iOS mobile device.

[13] https://appinventor.mit.edu/explore/ai2/setup

App Inventor is a software development environment created by MIT for the development of applications for the Android operating system. The language is free and can be easily accessed from the web. The applications created with App Inventor are limited by their simplicity, although they allow for covering a large number of basic needs on a mobile device.

With MIT App Inventor, a significant increase in the number of Android applications is expected due to two major factors: simplicity of use, which will facilitate the appearance of a large number of new applications; and Google Play, the Android application distribution centre where any user can freely distribute their creations.

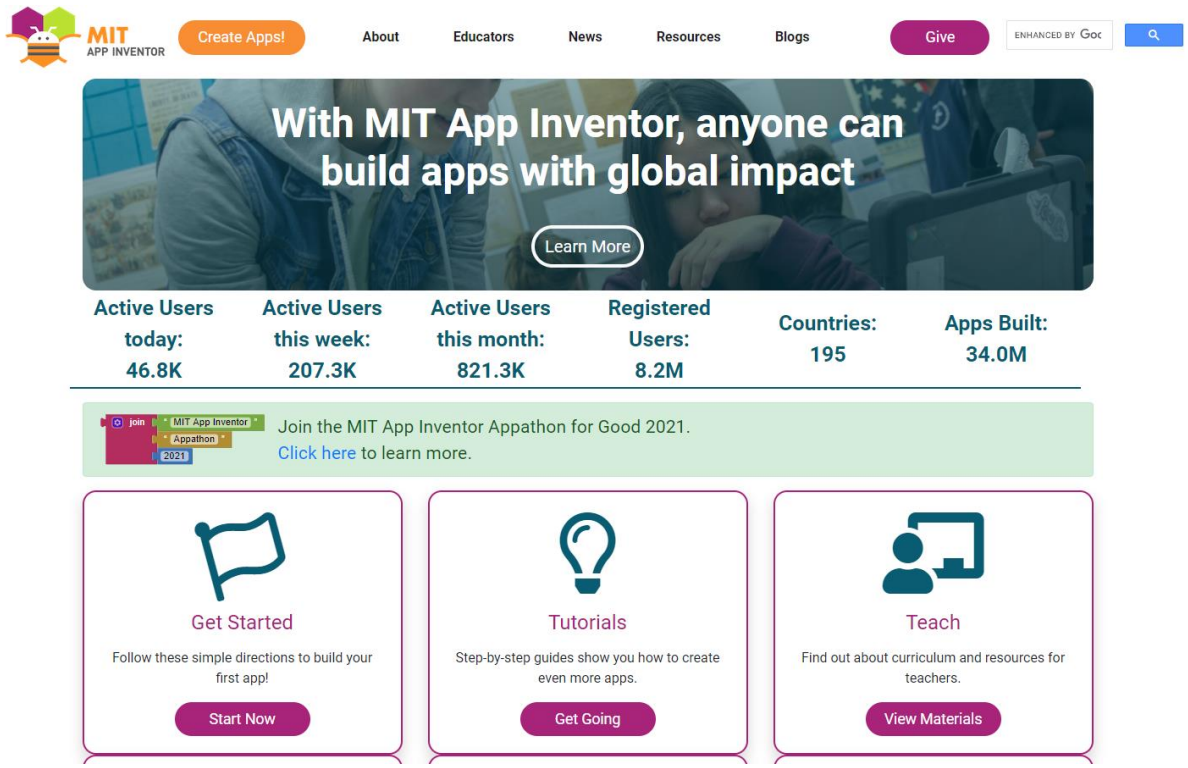


Image 15 - MIT APP INVENTOR Website[14]

It is also important to know the main advantages of using MIT App Inventor:

- Applications can be created through blocks intuitively and graphically, without the need to know programming code.

[14] https://appinventor.mit.edu/

- It can be accessed anytime and anywhere as long as we are connected to the internet.
- It offers us several ways to connect: direct, wi-fi or through the emulator.
- It allows us to download the application through the "*.apk*" to our pc.

However, there are several drawbacks encountered by an intermediate or advanced user:

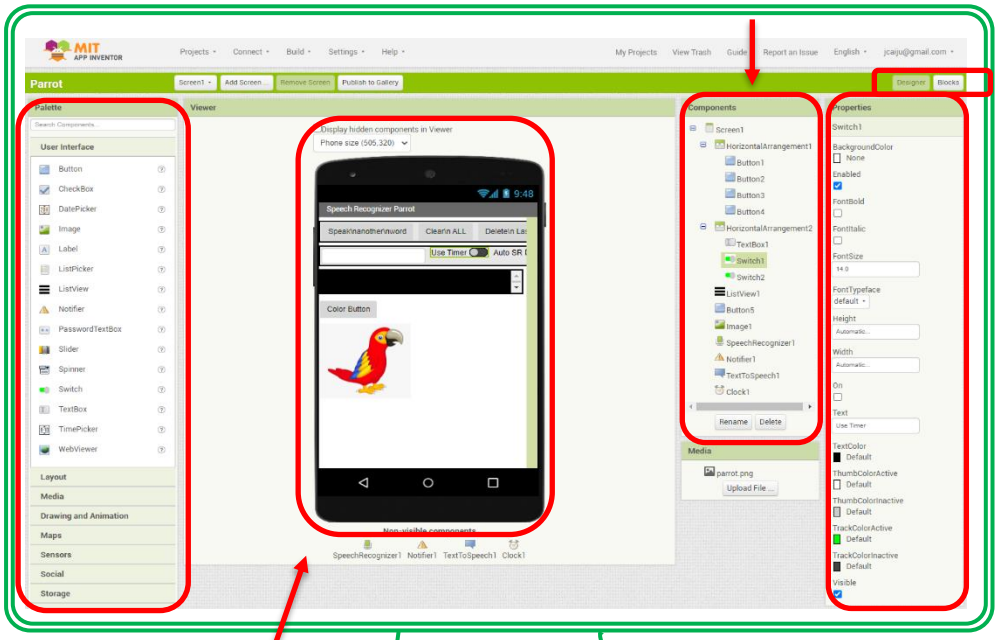
- It does not generate Java code for deeper development.
- It can only be developed for Android.

To start developing applications, you will have to enter the following link with our Google account: http://ai2.appinventor.mit.edu/

To build applications you work with:

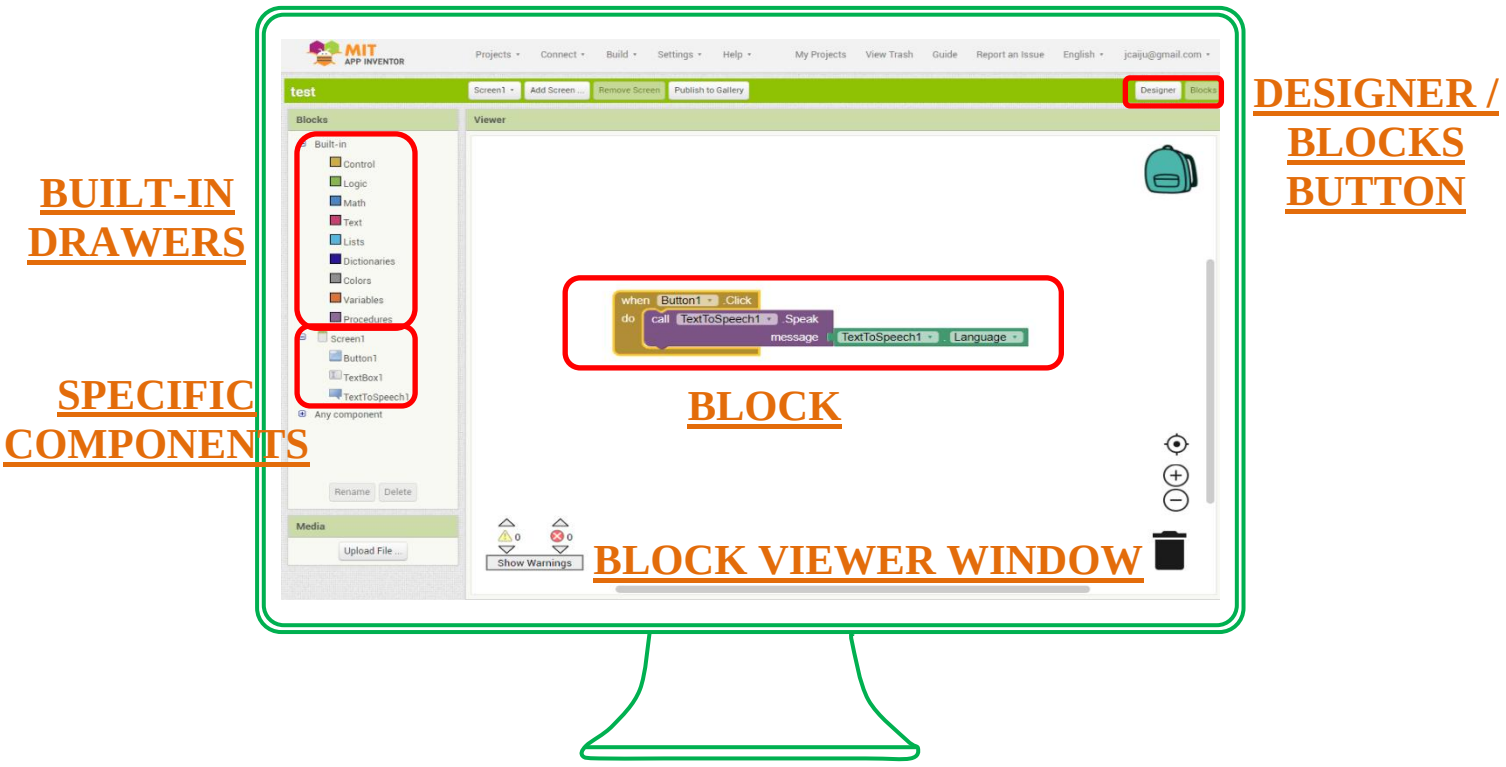
- The **App Inventor Designer**, where you can select the components for your application:

COMPONENTS:
Active Components in our Project



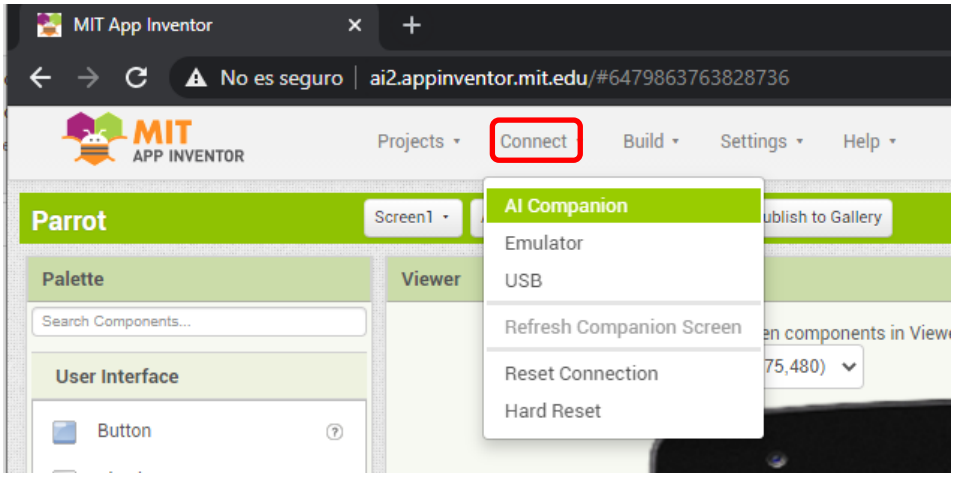
- **Palette**: Find the components and drag them to the *Viewer* to add them to your app.
- **Viewer**: Drag *Components* from the *Palette* to the Viewer to see what your app will look like.
- **Components**: List of Active *Components* in the Project
- **Designer and Blocks Buttons**: Click from any tab to go to the Designer tab or go to the Blocks tab.
- **Properties**: Select a *Component* in the *Components List* to change its properties, like colour, size, behaviour, etc.

- The **App Inventor Blocks Editor**, where program blocks are assembled to specify how their components should behave. The programs are developed visually, assembling pieces that fit together like a puzzle:

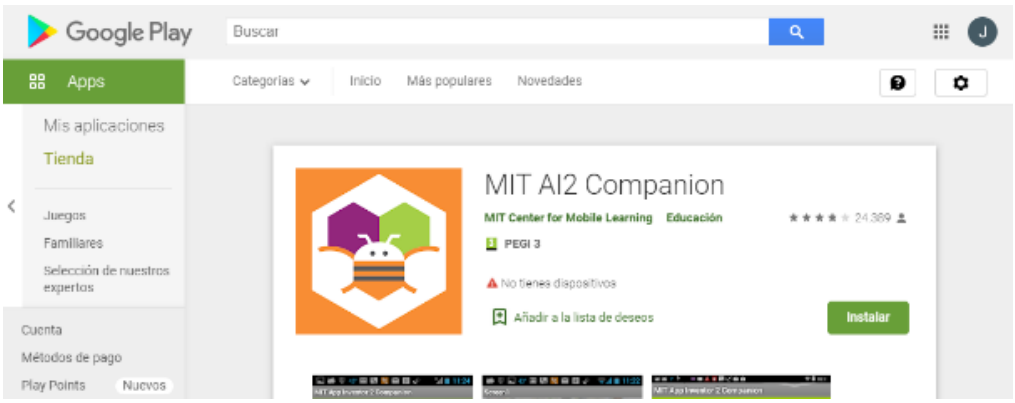


- **Built-in Drawers**: Find *Blocks* for general behaviours for specific *Components* and drag them to the *Blocks Viewer*.
- **Specific Components**: Find *Blocks* for behaviours for specific *Components* and drag them to the *Blocks Viewer*.
- **Block**: Snap *Blocks* together to set app behaviour.
- **Designer and Blocks Buttons**: Click from any tab to go to the Designer tab or go to the Blocks tab.
- **Block Viewer Window**: Drag *Blocks* from the *Drawers* to the *Block Viewer* to build relationships and behaviour.

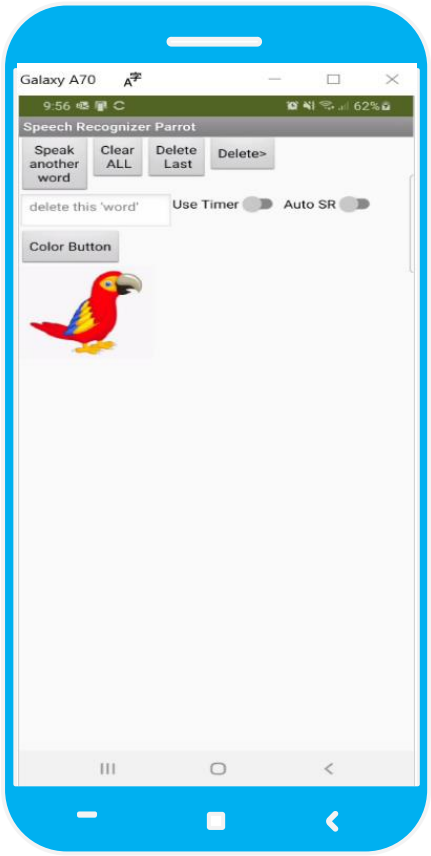
When we have our Project finished, we can test it on our Smartphone or Tablet, in the Connect Menu > AI Companion:



A QR code will appear, which we must open with the application in the Play Store or Apple Store, call of MIT AI2 Companion:



This would be the vision we would have on our Smartphone or Tablet:



4.2 Teachable Machine Software

Image 16 – TEACHABLE MACHINE Logo

- Tutorials: https://teachablemachine.withgoogle.com/faq
- Create Projects: https://teachablemachine.withgoogle.com/train

Teachable Machine[15] is a web-based tool that makes it possible to create machine learning models quickly, easily, and accessible to everyone.

But how is it used?

1. Compilation: Collect and group the examples you want the computer to learn by classes or categories.

2. Preparation: Prepare the model and test it on the spot to see if it can correctly classify the new examples.

3. Export: Export the model for your projects: sites, applications and much more. You can download the model or host it online for free.

Teachable Machine is flexible (use files or capture live samples). In addition, it is a tool that respects the way you work, and you can use it entirely on the device, without any data from the webcam or the microphone coming out of your computer.

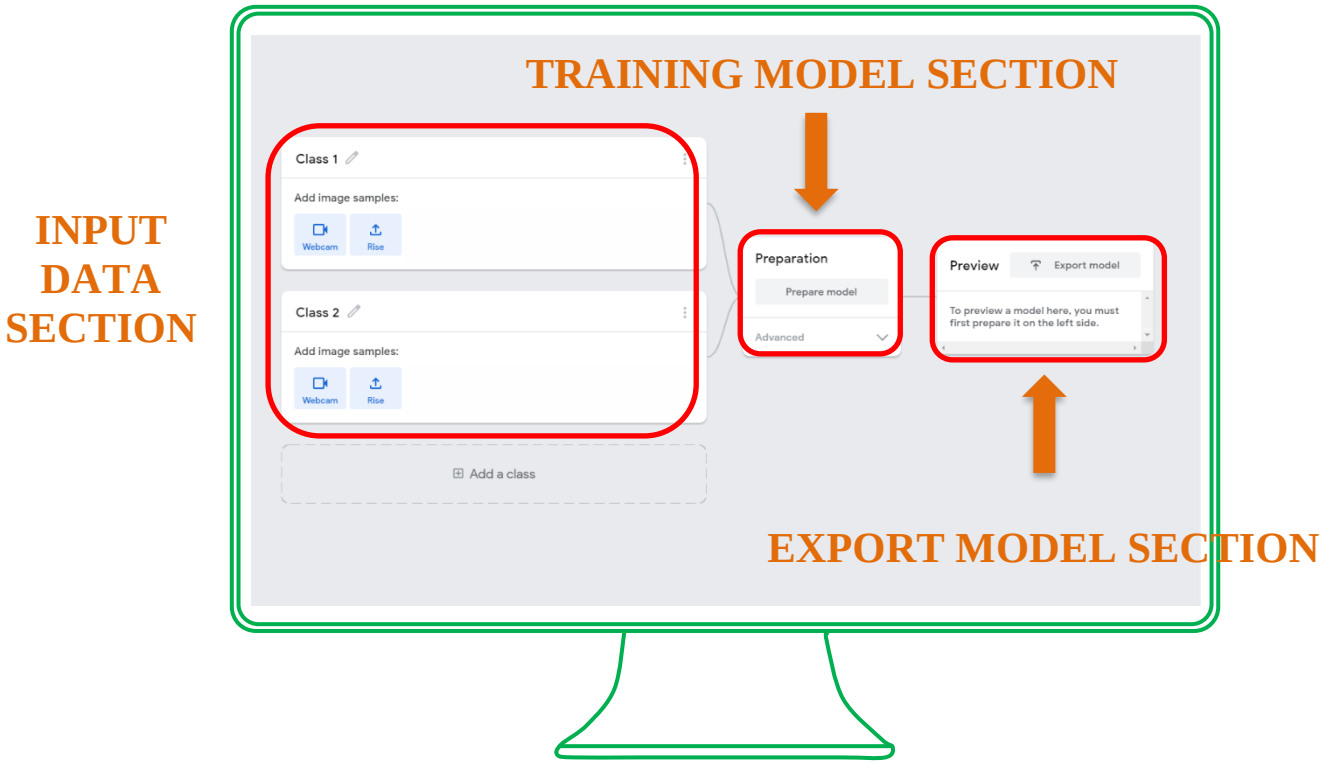
To perform Model preparation, you can use ***images*** to teach a model to classify images using files, and you can even use your webcam.

[15] https://teachablemachine.withgoogle.com/

You can also train the model using ***sounds***, where you can record small sound samples to teach a model to classify audio.

Finally, you can teach a model to ***classify body positions***, using files or adopting striking positions in front of your webcam.

The interface of this software would be the following:



4.3 Machine Learning for Kids

Image 17 – MACHINE LEARNING 4 KIDS Logo

- Tutorials: https://machinelearningforkids.co.uk/#!/pretrained
- Community Support: https://machinelearningforkids.co.uk/#!/help
- Create Projects: https://machinelearningforkids.co.uk/scratch3/
- Worksheets: https://machinelearningforkids.co.uk/?lang=en#!/worksheets

Machine Learning for Kids[16] it's a free tool that introduces Machine Learning by providing hands-on experiences for training Machine Learning systems and building things with them.

It provides an easy-to-use guided environment for training Machine Learning models to recognise text, numbers, images, or sounds.

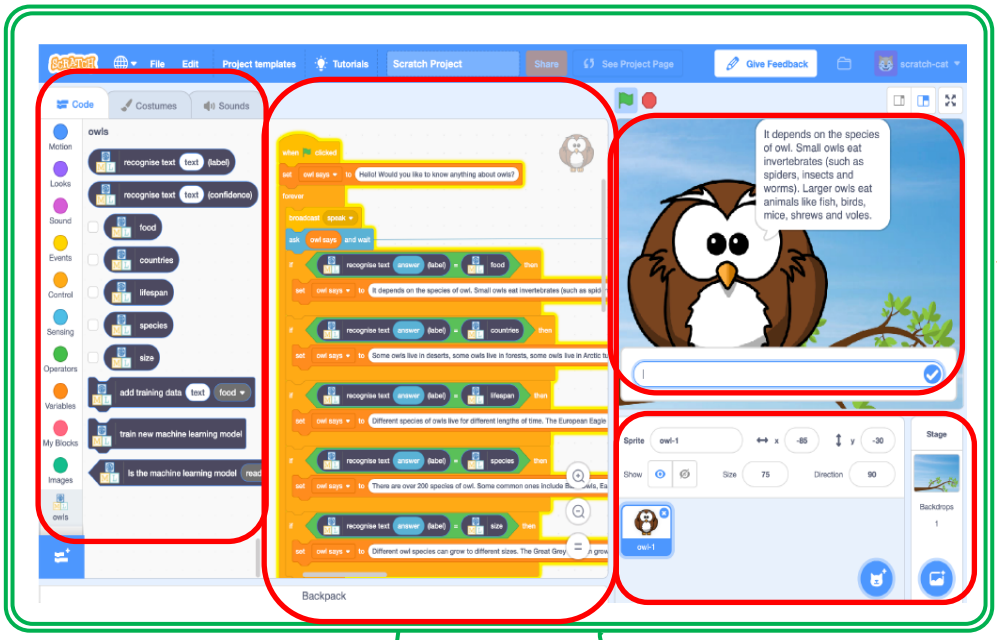
This builds on existing efforts to introduce and teach coding to children, by adding these models to educational coding platforms Scratch and App Inventor and helping children create projects and build games with the machine learning models they train.

The tool is entirely web-based and requires no installs or complicated setup to be able to use.

[16] https://machinelearningforkids.co.uk/?lang=en#!/about

It was designed for use in the classroom by schools and volunteer-run coding groups for children and provides an admin page for teachers or group leaders to be able to manage and administer access for their students.

The interface to be able to carry out applications with the Machine Learning 4 Kids software would be the following:



4.4 mBlock Software

Image 18 – mBLOCK Logo

- Tutorials: https://education.makeblock.com/professional-development/
- Community Support: https://forum.makeblock.com/c/mblock
- Create Projects: https://ide.mblock.cc/#/

mBlock 5[17] is a block-based and text-based programming software based on Scratch 3.0.

mBlock 5 allows users to program Makeblock robots or Arduino boards. Also, you can use mBlock 5 without any hardware, to code games and animations.

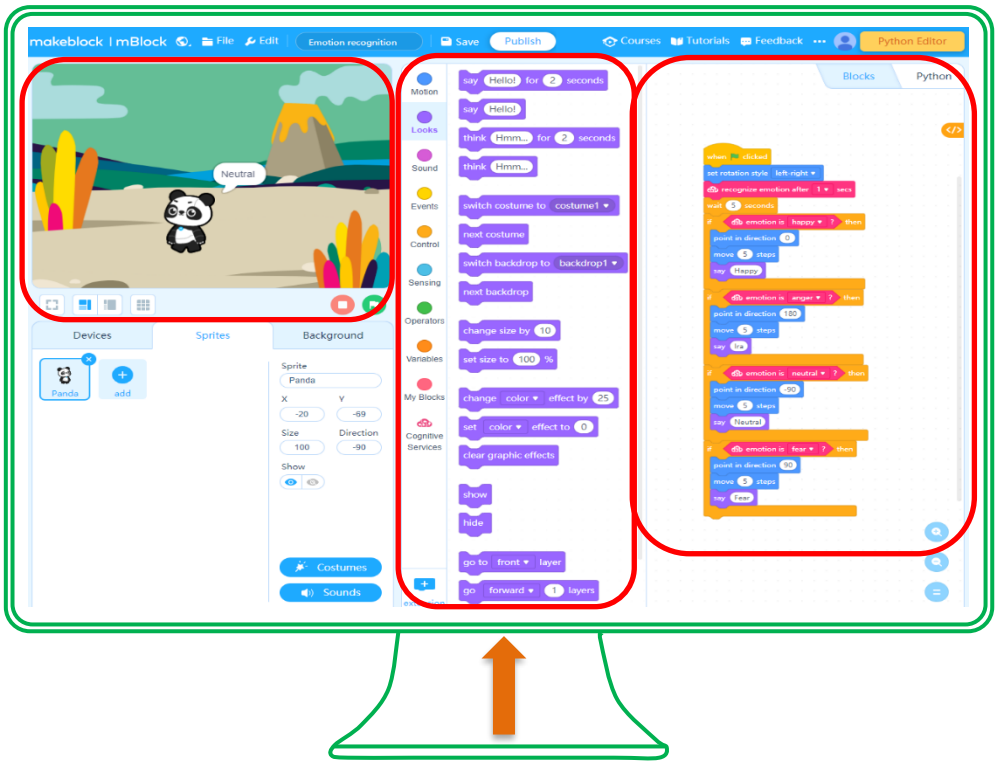
The block-based code can be converted to Python code, be connected to IoT and supports AI-functionality such as face and voice recognition, as well as mood sensing.

It supports various operating systems including macOS and Windows.

mBlock also provides software programming services, software design services and maintenance of computer software services in the education of programming for those who want to promote their programming abilities.

[17] https://mblock.makeblock.com/en-us/

The interface to be able to carry out applications with the mBlock software would be the following:



4.5 Cognimates Software

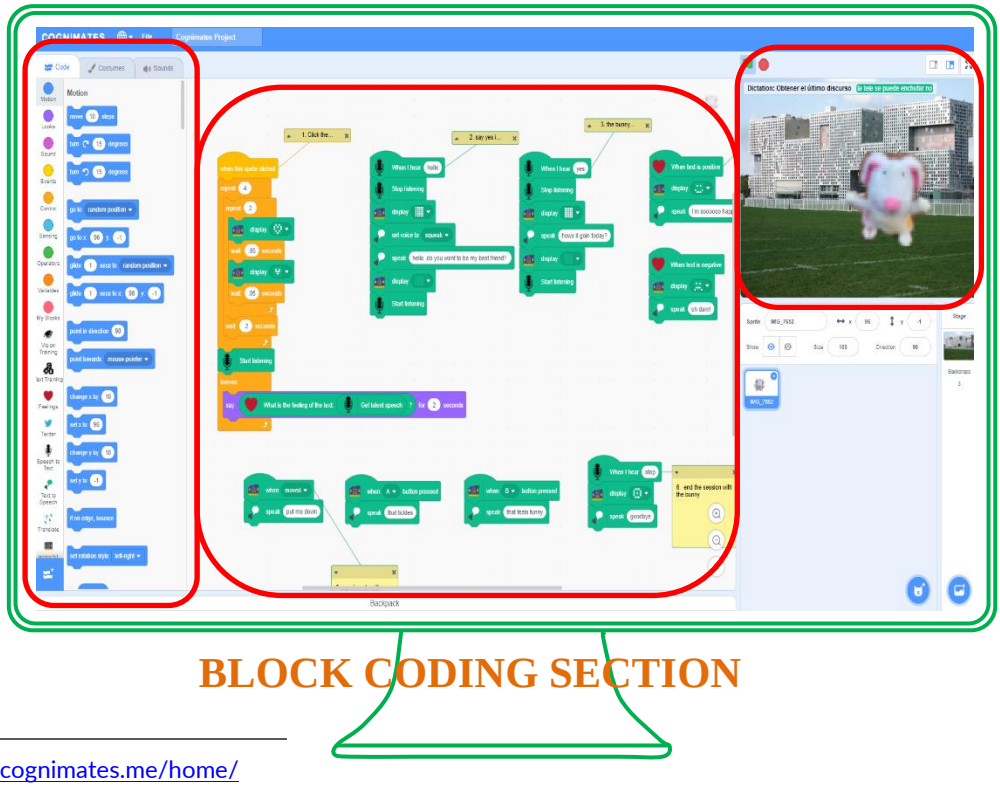
COGNIMATES

Image 19 – COGNIMATES Logo

- Tutorials: http://cognimates.me/guides/
- Starter Projects: http://cognimates.me/projects/
- Create Projects: https://codelab.cognimates.me/

Cognimates[18] is a platform that allows the development of creative programming activities, where students can learn to build games, program robots and train their own AI models.

The interface to be able to carry out applications with the Cognimates software would be the following:



[18] http://cognimates.me/home/

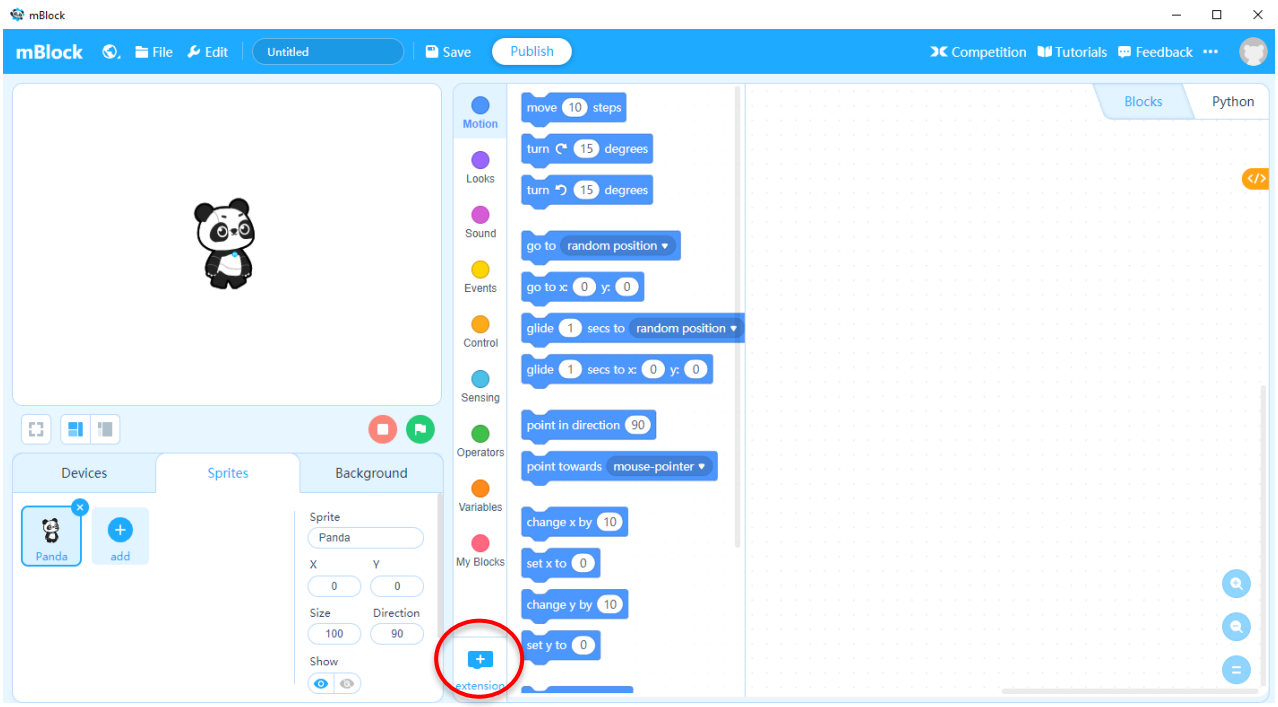
5. ARTIFICIAL INTELLIGENCE PRACTICE EXAMPLES

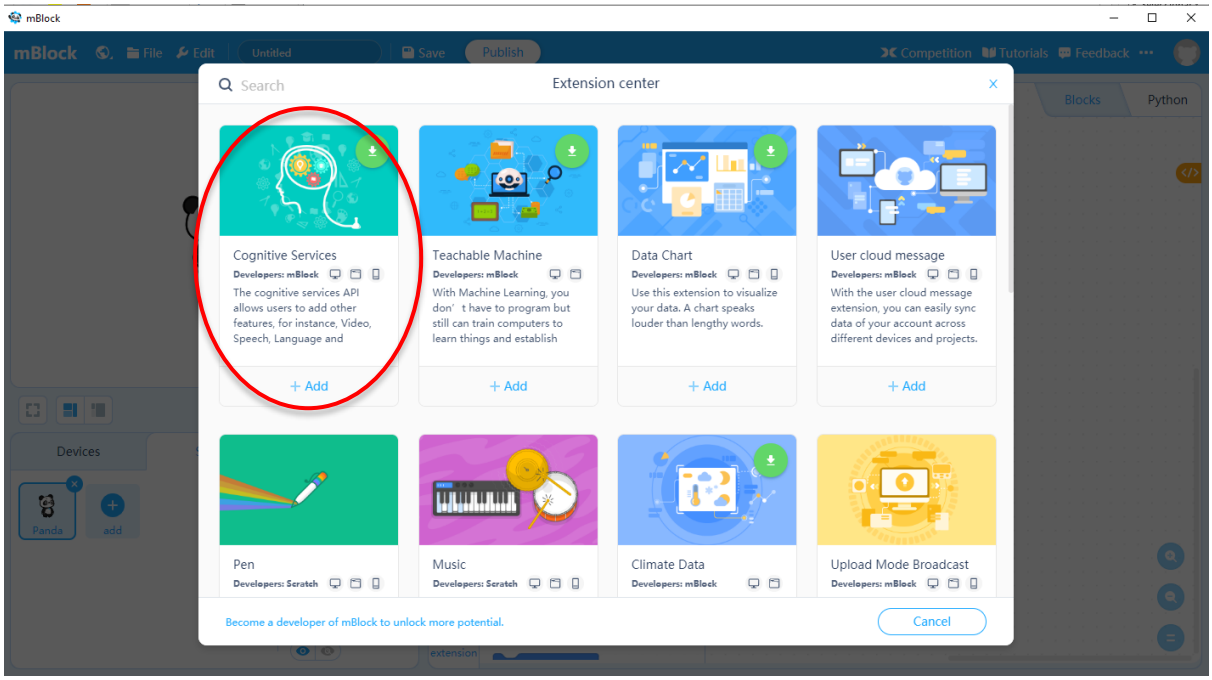
5.1 Emotion Recognition Example

The first example that we will show will be a simple example, where we will perform a recognition of the emotions of the person in front of the WebCam. For this, we will use the mBlock software:

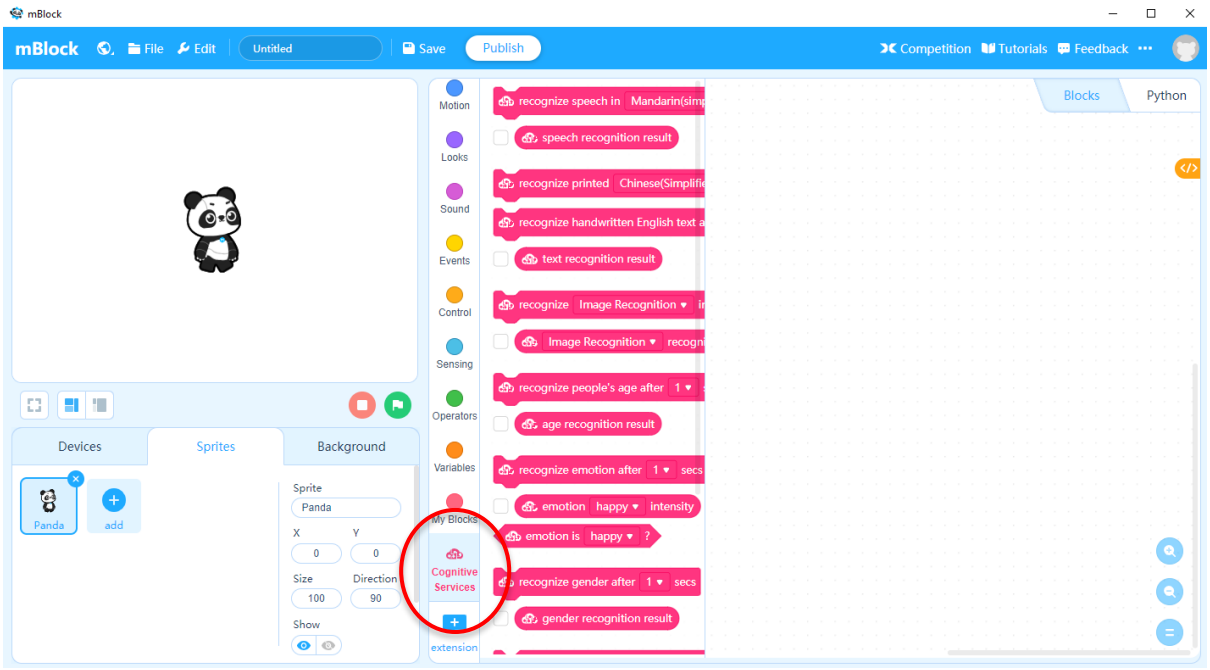
1. We must install the "Cognitive Services" library. Thanks to the library, we can make use of cognitive services in a very simple way, since the library will be in charge of enabling image recognition thanks to the use of different Artificial Intelligence algorithms.

   To do this, we will go to the "extension" button and add the extension:





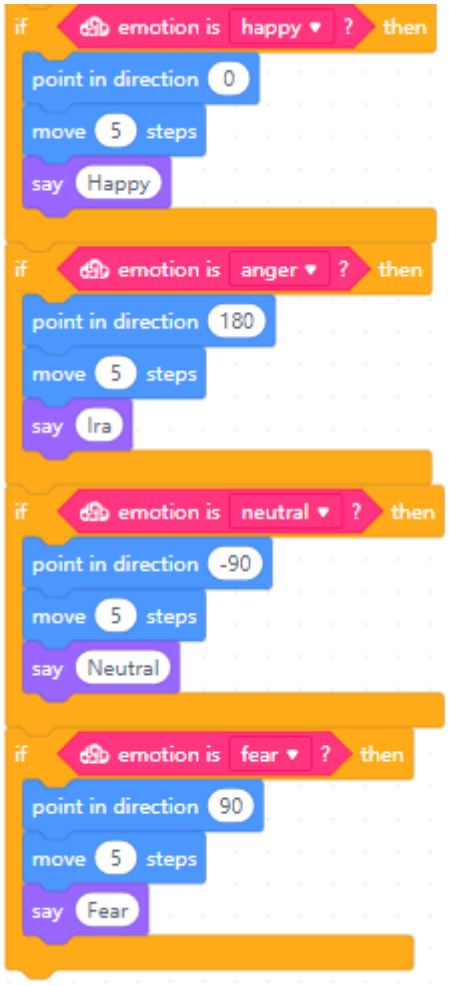
2. Once installed, it will appear in the actions panel:



3. Now, we start with the programming:

The first step will be that, by clicking on the green flag, our sprite, the “Panda Bear”, will rotate from left to right, and in the second step, the camera will start to recognize the user's emotion. After 5 seconds, the "Panda Bear" will say what emotion it is:

The code referring to each emotion is the following:



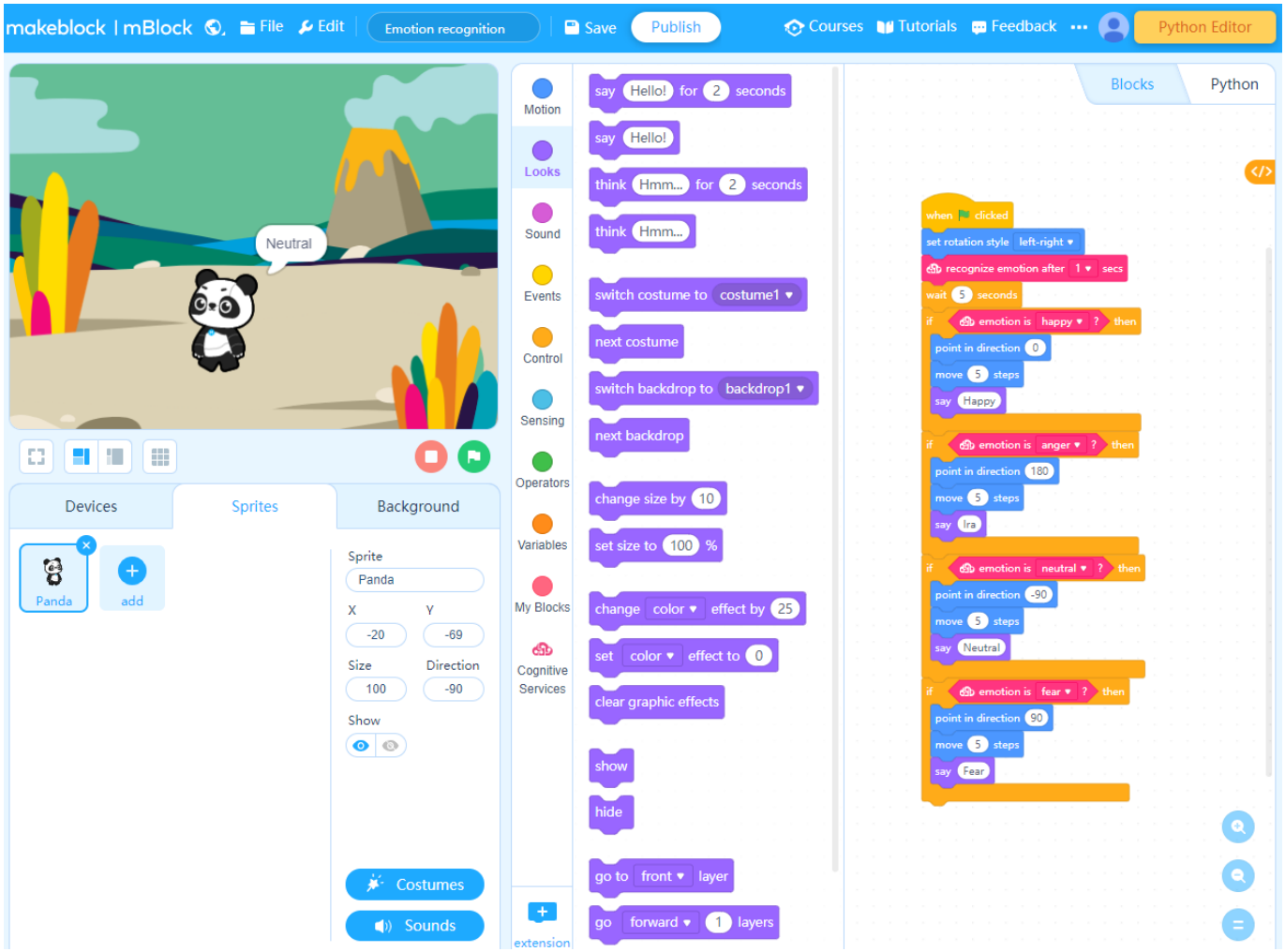
If the “Panda Bear” detects that the user is “Happy”, it will point to the direction “0”, and it will move 5 steps. The “Panda Bear” will display the message: “Happy”.

In the case that the user is "Anger", it will point to the direction "180" and will move 5 steps. The “Panda Bear” will display the message: “Anger”.

In the case that the user is "Neutral", it will point to the direction "-90" and will move 5 steps. The "Panda Bear" will display the message: "Neutral".

In the case that the user is "Fear", he will point to the address "90" and move 5 steps. The “Panda Bear” will display the message: “Fear”.

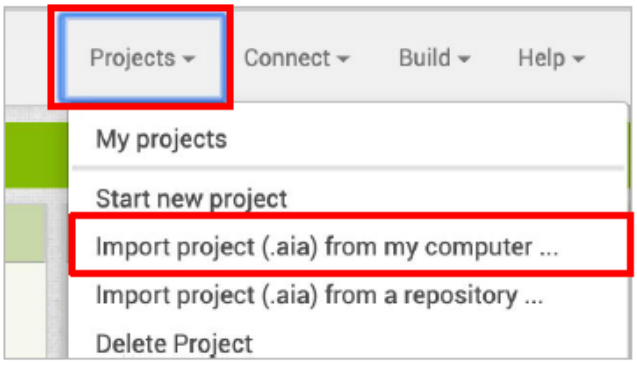
Finally, the complete code of the example is shown:



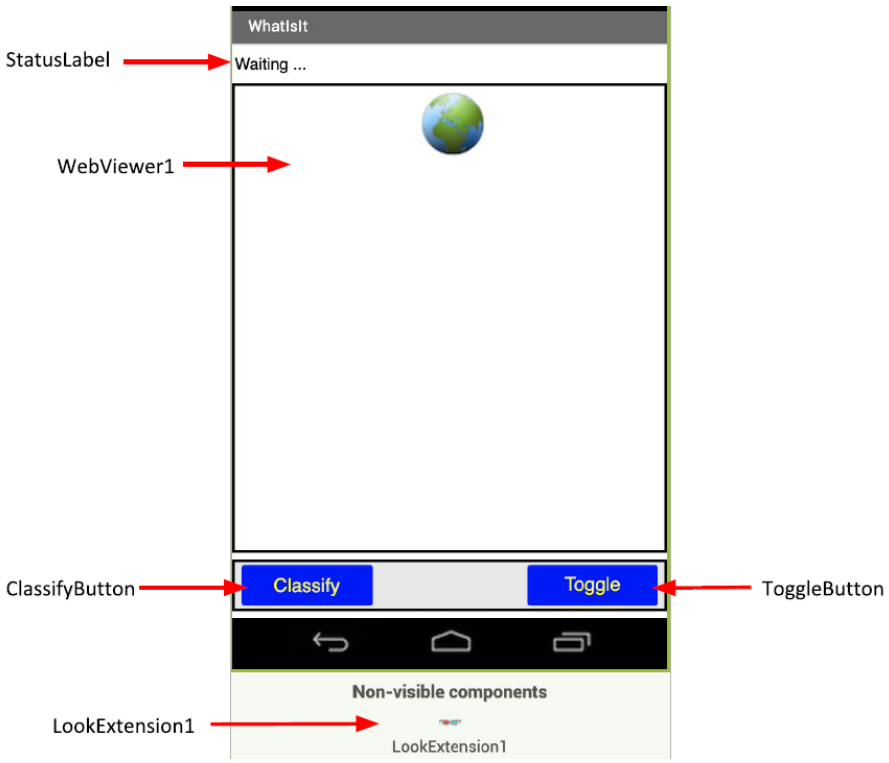
5.2 Image Classification Example

In this second example, we will use the MIT APP Inventor software. We will make an example of Image Classification, where we will use our smartphone or tablet.

1. We will download the following template from the APP INVENTOR website https://appinventor.mit.edu/assets/files/WhatisitTutorial.aia and we will import it into our Project:



2. The next step will be to make the graphic composition, which should be the same as in the following image:



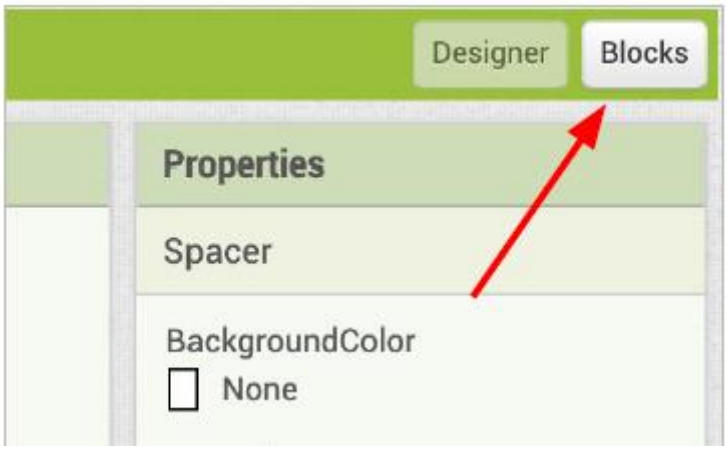
It is important to highlight that the "LookExtension1" library is in charge of doing the entire process of training and interpreting the images.

"LookExtension1" is an extension to MIT App Inventor that helps run image classification on the app. An extension is a set of rules and blocks that are not part of the core MIT App Inventor but can be imported from an outside source. The "LookExtension1" will have already been imported to the Whatisit app template your students will complete.

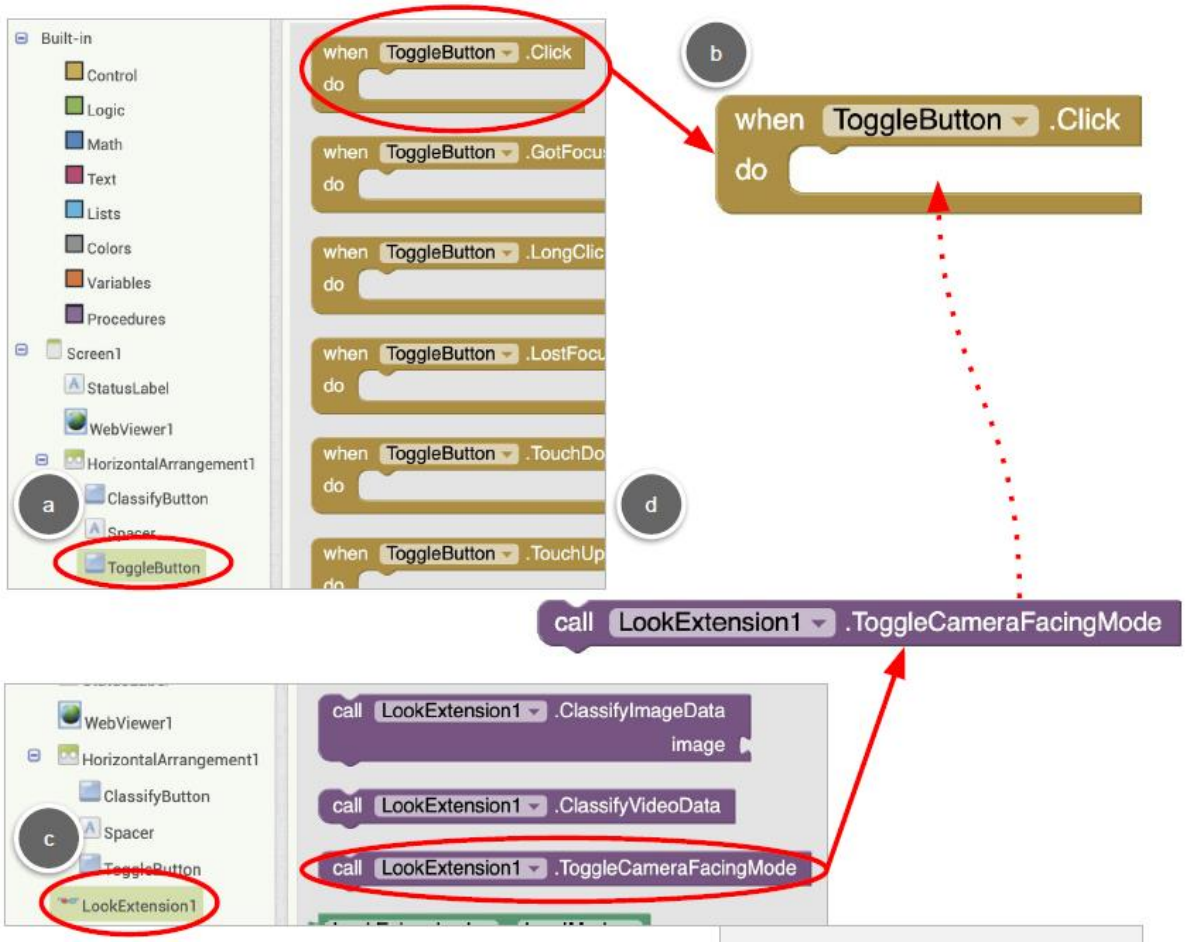
LookExtension image classification uses a neural network to classify input images. A neural network is an interconnected series of nodes that work together to create output. A node is usually a series of random computations, although they may be connected or have specific computations.

This extension uses a type of neural network called a mobilenet that is specifically designed to work well for image classification on smartphones. The mobilenet in the Look extension has been pre-trained to recognize 999 classes, based on training with millions of images. You can check all classes here, and observe which tags are included. You can also use the LookExtension.knownClasses block in App Inventor to get the list of classes for use in new applications.

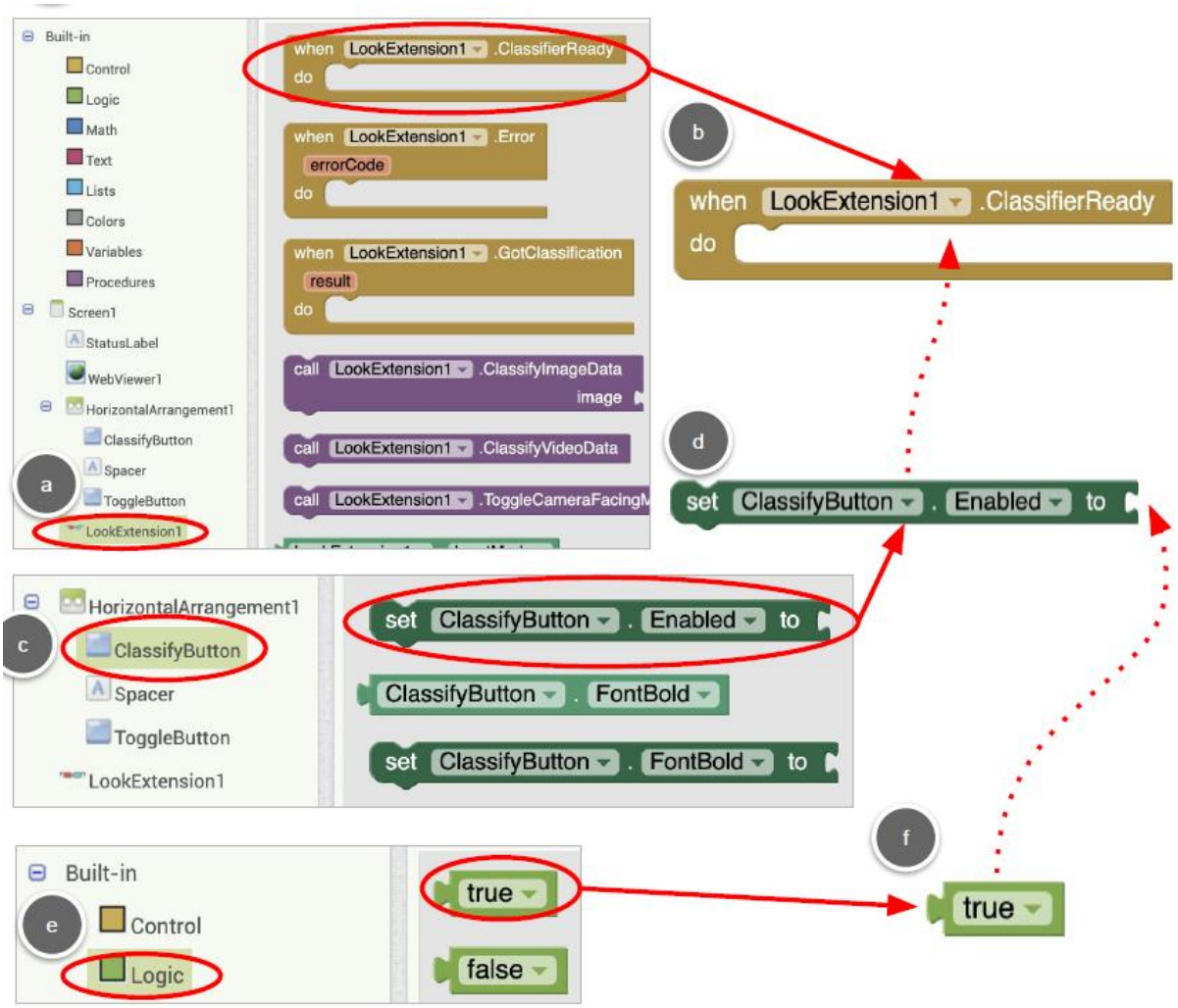
3. Once the graphic composition is done, we will go to the “Blocks” menu, and we will begin to program the different buttons:



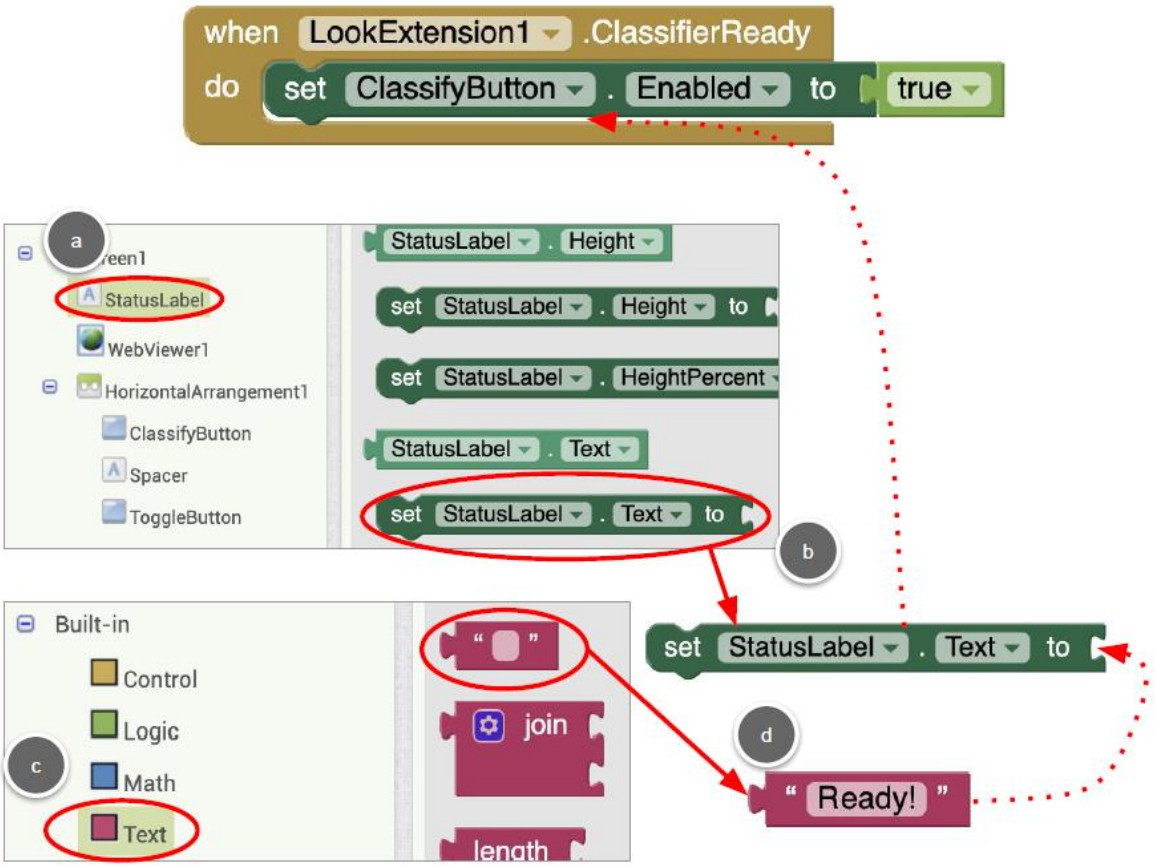
4. Now we will program the “Toggle” button, to be able to use the front and rear cameras of our device:



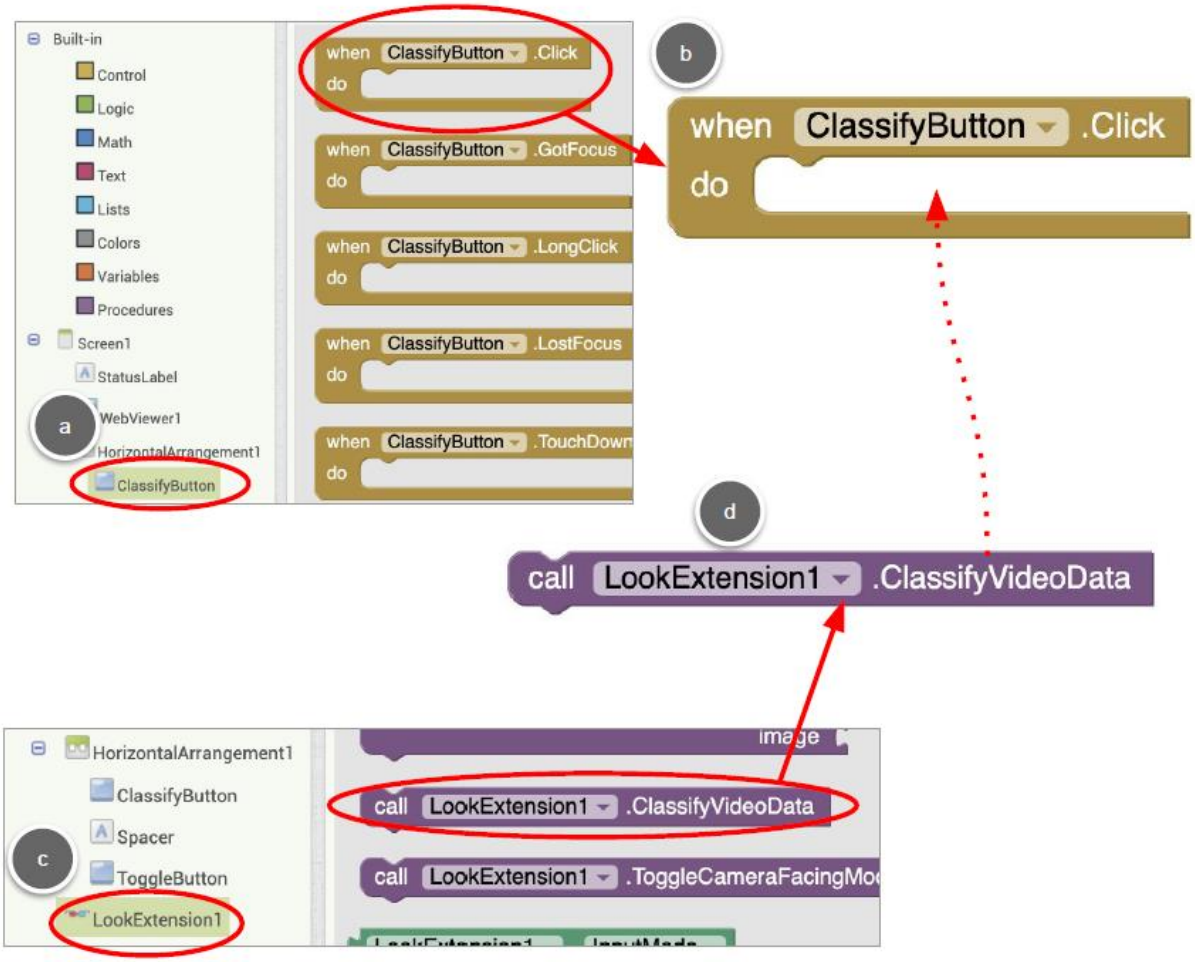
5. In the next step, we will prepare the elements so that the Image Classification works correctly:



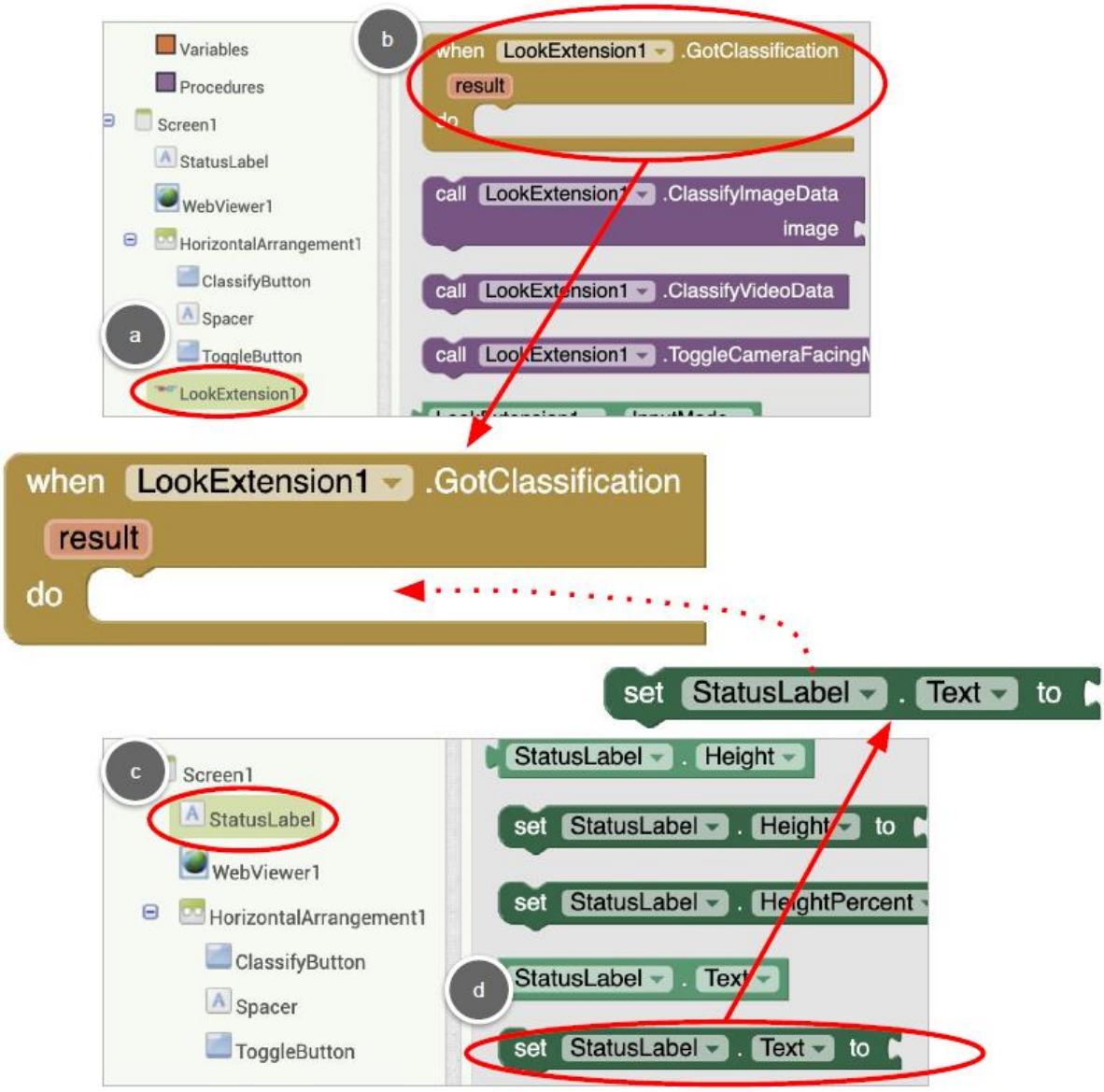
6. Now we will show in the section of the screen, called “Status Label”, the status of the application if it is processing the image or is ready to process it:



7. In the next step, we will program the “Classify” button, which will be in charge of classifying the images that we will view with our device:



8. Now we will display the Search Results on the screen:



9. For a more precise search result, add the following items to the extension block “Look Extension1”:

10. Now you can use your application: