O7 - Scratch Applications for Math

TOGETHER
MATHEMATICAL

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Discover Real Everywhere
Applications of Maths

DREAM
PROJECT

Timişoara
2018

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Foreword

This intellectual output was create in the Erasmus project " DREAM - Discover Real Everywhere Applications of Maths", identification number: 2016-1-RO01-KA201-024518, through the collaboration of students and teachers from Colegiul Național "Constantin Diaconovici Loga" Timișoara, Romania, 1o Geniko Lykeio, Aigiou, Greece, Agrupamento de Escolas Soares Basto, Oliveira de Azeméis Norte, Portugalia and "TIBISCUS" University of Timișoara, Computers and Applied Computer Science Faculty.

The project main objective was to build up a new maths teaching/learning methodology based on real-life problems and investigations (open-ended math situations), designed by students and teachers together. The activities involved experimentations, hands-on approach, outdoor activities and virtual and mobile software applications. The developed material was transform into on-line courses and is freely available to all interested communities, in order to produce collaborative learning activities.

Scratch Applications for Math

1. Starting with the App Inventor

O7 is focused on the presentation of the procedures to build mobile applications in Scratch programing language. Scratch was selected because it is free, easy to learn and does not need anterior experience in programing to build useful mobile applications for math.

1.1. Generalities about Scratch and App Inventor

Scratch is an open source language developed by Lifelong Kindergarten Group at the MIT Media Lab as a programing tool for kids. It was initially designed for children between 8 and 16 years old, but became a useful tool for millions of adults around the world because it makes possible for people from all walks of life without any programming experience to create apps for Android devices.

Example: A convertor able to translate a measurement from British Imperial units (pound, gallon, inch etc.) to the International Metric System units (gram, liter, meter etc.) and reverse.

The Scratch mobile applications are designed and implemented using an easy to learn & use developing tool named App Inventor. It is based on the visual programing technology (drag & drop) that allows you to specify the app's behavior just by piecing together "blocks" as if you were working on a puzzle as showing in Figure 1.

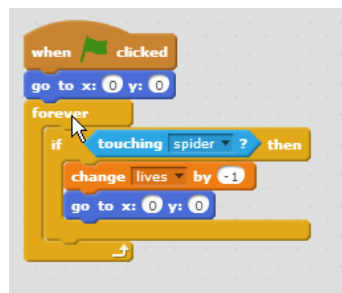**Figure 1.** Scratch blocks' "puzzle"

The Scratch programmers form a very active on-line community where you can create your own interactive stories, games, and animations. Tacking part to this community also gives you the chance to learn useful tips from more skilled members.

Exercise: Name three reasons why millions of people all over the world use Scratch programing language to build their mobile apps.

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In order to program in Scratch language you need to have:

- A desktop/laptop with good internet connection
- A browser able to handle the MIT App Inventor webpage;
- An Android mobile device (phone, tablet or phablet) for testing the apps

Test

TEST **1.1**

T   1.1.1. The Scratch programing language is:
   a. MIT propriety and must be bought from its commercial webpage;
   b. shareware;
   c. open source.

T   1.1.2. Programing in Scratch is done using:
   a. procedural code written by hand;
   b. visual programing technology;
   c. classes imported from OOP class families.

T   1.1.3. The things you need to program in Scratch are:
   a. A Java compatible PC
   b. A good internet connection
   c. A browser

T   1.1.4. The development environments for Scratch programing are:
   a. MIT App Inventor
   b. Eclipse
   c. Dot net

T   1.1.5. The apps should be tested on a:
   a. Apple mobile device
   b. Windows mobile device
   c. Android mobile device

Computers' story

The *Antikythera mechanism* is the first known analog computer (around 100 BC). It was discovered in 1902 among the remains of a shipwreck near the coast of Antikythera island (Greece). It is a complex clock composed of more than 30 meshing bronze gears. Researchers determined that it was used to predict planets positions and eclipses. It could also track the four year cycle of the Ancient Olympic Games. The mechanism's fragments can be seen in the National Archeological Museum in Athens.

More information about the Antikythera mechanism can be found at:

https://en.wikipedia.org/wiki/Antikythera_mechanism

1.2. Putting the development tools to work

In order to start programing in Scratch you must first install a developing tool on your computer. There are some different alternatives available nowadays on internet, but the most popular is the MIT App Inventor.

Step I Opening the MIT App Inventor page

The starting page address is: http://appinventor.mit.edu/explore/

Copy the above address to your browser and select the download path to your desktop as it can be seen in Figure   2.
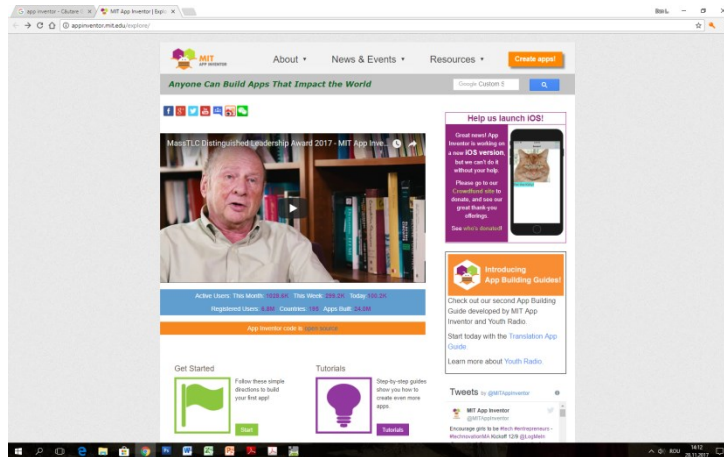
Figure   2. The App Inventor start webpage

This starting page contains some very useful links like:

- Get Started - Follow these simple directions to build your first app!;
- Tutorials – Step-by-step guides show you how to create even more apps;
- Teach - Find out about curriculum and resources for teachers;
- Forum - Join community forums to get answers to your questions.

Step 2 Opening the on-line developing environment

In the upper right corner of the webpage there is an orange button "Create apps" which must be pressed in order to enter the developing environment.

On this new page you have to select the "Start new project" Button and give a name to your future work as shown in Figure   3. When ready press OK.

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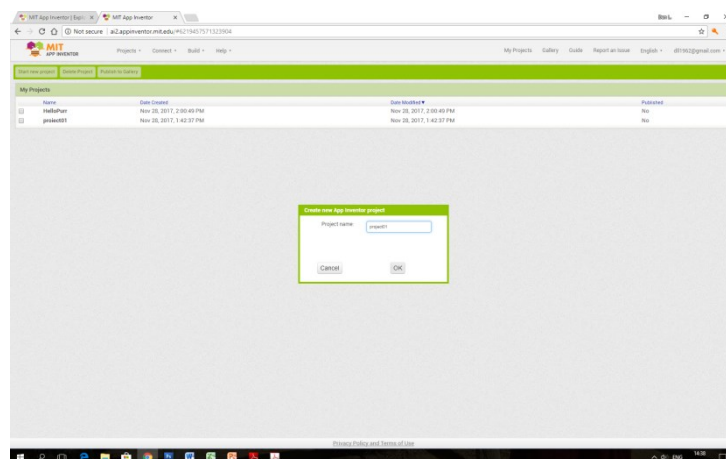
Figure 3. Starting a new project

Next, the Developing environment is shown on your screen and you can start your programing session.

Figure 4. Developing tool page

Step 3 Installing the testing device

There are three alternatives test live your apps during your programming session.
1. An Android device connected via Wi Fi to the computer you are working on
2. An Emulator installed on the computer
3. An Android device connected with the computer through cable

![Erasmus+ DREAM logos]

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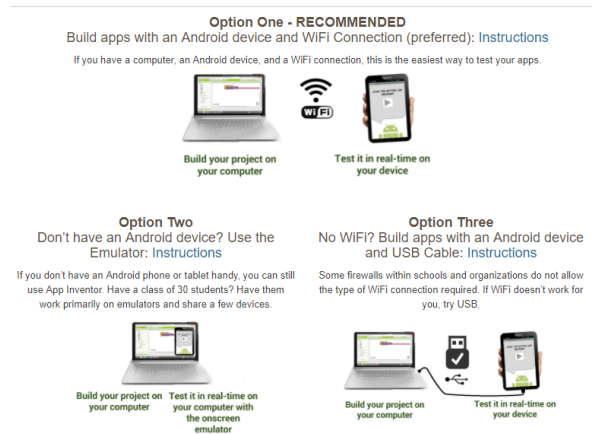
Figure   5 The three options for live testing the apps

Option One

App Inventor can be used without adding any other software to your computer.In order to perform live testing on a mobile you just have to install the MIT App Inventor Companion app on your Android device. After this, you must open your project in the App Inventor webpage, start the companion app on your Android device, and apps can be tested during you create them.

The procedure to do this is explained in detail in:
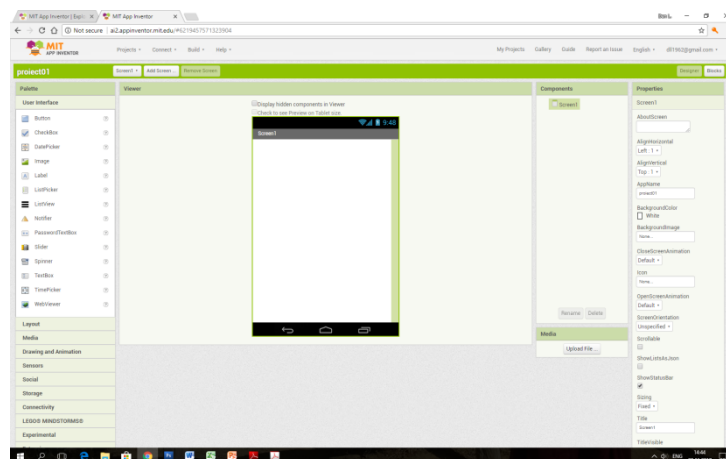http://appinventor.mit.edu/explore/ai2/setup-device-wifi.html

Example: A mobile phone with the Companion app installed becomes an Android extension of the working computer, thus an app build on a Windows PC is simply transferred and ran on the phone.

Option Two

If you do not want to use your mobile device for such experiments there is an emulator available at

http://appinventor.mit.edu/explore/ai2/windows.html

which can be install on your computer and you will have the possibility to test the current app in a virtual mobile phone as shown in Figure   6.
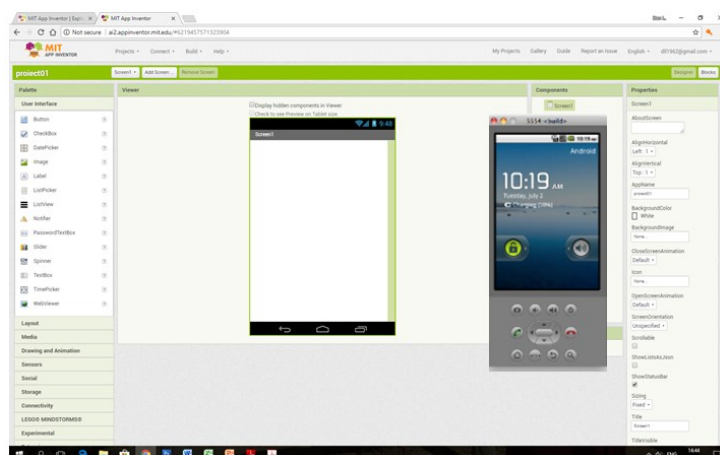
Figure   6. Developing tool page with testing device

The procedure for this alternative is very well described in:
http://appinventor.mit.edu/explore/ai2/setup-emulator.html#step2

Exercise: Instal the emulator on your computer and run an Scratch app on the virtual mobile phone. Use an app provided as an example in the MIT webpage.

Option Three
If the Wi Fi connection is not available a USB cable can assure the communication between the computer and the mobile device, The USB connection need a dedicated driver for Windows PCs Thus you must look for it on the internet and instal it on your computer. The App Inventor has a test module that checks if your device can communicate with the computer via the USB cable. This test must be runned before any app's testing.

Test

 1.2

T   1.2.1. The App Inventor is a:
a. Development tool;
b. Testing environment;
c. On-line developer.

T   1.2.2. The App Inventor is used to:
a. Run Scratch apps;
b. Compile Scratch apps;
c. Build Scratch apps.

T   1.2.3. The App Inventor Companion is used to:
a. Create Scratch apps;
b. Run Scratch apps on mobile devices;
c. Link computers to mobile devices.

T 1.2.4. The connection is done in order to:

    a. Upload the apps on mobile devices;

    b. Test the apps on mobile devices;

    c. Insure the compatibility between computer and mobile devices.

T 1.2.5. The mobile devices do have as operating system:

    a. UNIX;

    b. Android;

    c. iOS.

Computers' story

Blaise Pascal (1623 – 1662) was a French mathematician, physicist and inventor.. Pascal's made important contributions to the study projective geometry, probability theory, fluids study etc. While still a teenager, he made pioneering research on arithmetic machines. He built 20 computers (later called Pascalines). He is considered one of the first two inventors of the mechanical calculator. He designed his computer to add & subtract two numbers directly and to perform multiplications & divisions through repeated addition or subtraction.

More information about the Blaise Pascal can be found at:

https://en.wikipedia.org/wiki/Blaise_Pascal

2. The Developing Environment

This section is dedicated to the description of the Developing environment for the Scratch Language.

2.1. The App Inventor Architecture

The App Inventor is currently the most popular developing environment among the Scratch programmers. It was created in the MIT Media Lab by the same people that shaped the Scratch language itself. It was conceived as a "drag and drop" programing tool, therefor it is a simple way to let non-professional users to build applications with no prior special training needed.

App Inventor's great popularity is due also to the fact that Google supports it as open source software easy to download and install as shown in the above section.
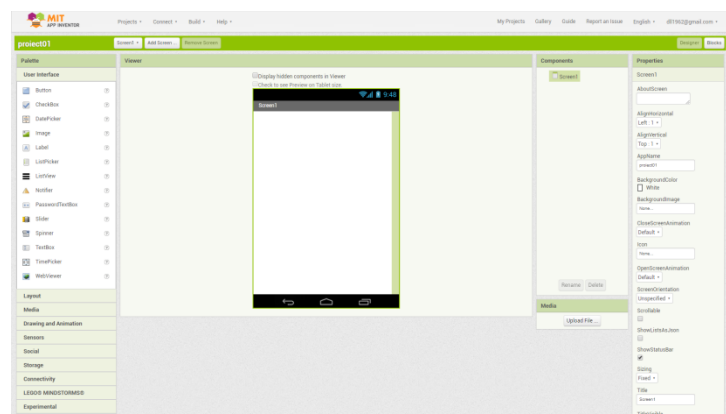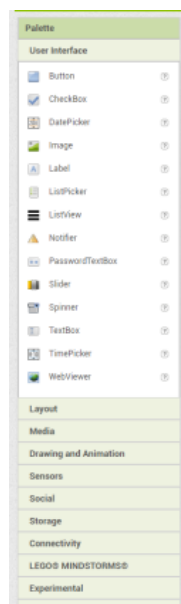
Figure 7. The Developing Environment's window

The Developing Environment's windows also called the Designer consist of the following composing areas:

A. Palette
B. Viewer
C. Components
D. Properties

A. The Palette area is the place where the main functional elements of Mobile applications are shown. The programmer can choose an element and drag it to area B in order to include it in his/hers application. The Palette elements are organized in subsets as shown in Figure 8.

These collections are:
o User Interface;
o Layout;
o Media;
o Drawing and Animation;
o Sensors;
o Social;
o Storage;
o Connectivity;
o Experimental;
o ...

Figure 8. Palette area

For example, the User Interface section contains Button, CheckBox, Label, TextBox, ListView, PasswordTextBox and all the other components needed to build a Graphical User Interface (GUI) able to insure the interaction between apps and users.
Media provides the multimedia elements as: Camcorder, Camera, ImagePicker, Player, Sound, SoundRecorder, SpeechRecognizer, VideoPlayer etc.
The Blocks Editor becomes available in the Palette area when the Blocks button is pressed. It provides the Built-in blocks that are useful when you need to use math, logic, and text. In order to access the blocks for a certain component, the programmer must first add it to the current app through the Designer.

B. Viewer zone is the space where the selected components from the Palette are put in order to be used as parts of the "action". When, for example, a button is needed in the application it is first chosen from the Palette(1), dragged to the Viewer area(2) and dropped there(3).
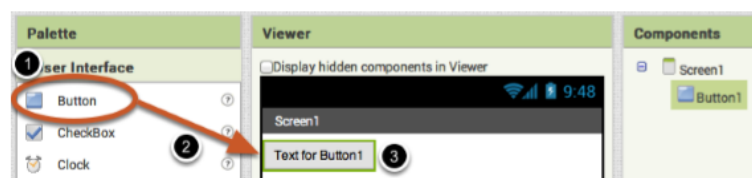
Figure 9. Adding a button in the application

C. The Components area keeps the hierarchical list of all the components added to the application. If the app has more than one screen, as it is most often the case there is a different section of the list for each screen.
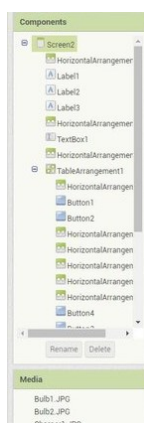
Figure 10. The components hierarchical list of an app's second screen

D. The Properties zone is the place where the programmer can establish each component's settings. When an element is selected in the Components area its features became ready to be established in the Properties zone.

Example: The available settings for a button are:
o   Background color;
o   Enabling state;
o   Fonts features (bold, italic etc.);
o   Geometrical dimensions (height and width);
o   Image on the button;
    o   Text on the button;
    o   Text alignment;
    o   Text color;
        o   …

All components settings must be chosen carefully in order to insure the applications good functionality and good looking.

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Figure   11. A button's properties

Exercise: Create a "Start" Button with green Background, width 90, height 30, default shape, text centered and white colored.

Test

2.1

T   2.1.1. The App Inventor is a development environment for:
    a. Java;
    b. C#;
    c. Scratch.

T   2.1.2. The basic App Inventor's programing technology is:
    a. Direct code writing;
    b. Drag and Drop;
    c. Metalanguages.

T   2.1.3. The App Inventor window is divided in:
    a. Functional zones;
    b. Sub screens;
    c. Not divided.

T   2.1.4. The Palette area contains components for:
    a. User interface;
    b. Media;
    c. Sensors.

T   2.1.5. The Blocks are used for:
    a. Linking objects to their corresponding actions;
    b. Set object's features;
    c. Define object's settings.

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Computers' story

Augusta Ada, Countess of Lovelace (daughter of Lord Byron; 1815 – 1852) was an English mathematician and writer, chiefly known for her work on Charles Babbage proposed mechanical general-purpose computer, the Analytical Engine. She was the first to recognize that the machine had applications beyond pure calculation, and published the first algorithm intended to be carried out by such a machine. As a result, she is regarded as the first computer programmer.

More information about the Ada Byron Lovelace can be found at:

https://en.wikipedia.org/wiki/Ada_Lovelace

2.2. First application in App Inventor

The classic first application to start with when learning a new programing language is displaying on screen the "Hello World" message. This tradition goes back to 1970s when Kernighan & Ritchie developed C.

Fist the programmer has to start a new project and name it. This requires performing the next set of actions:

1.   Press on "Start new project" button;
2.   Write the name chosen for the project;
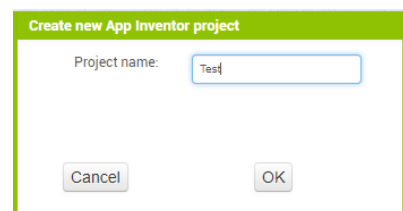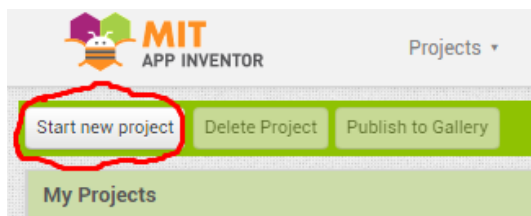3.   Press OK;

Figure   12. Starting a new project

4.   Open the new project and automatically the "Screen 1" is created.

If needed supplemental screens can be added with the Add Screen button. Hello World is a simple app, thus no supplemental screen is needed.

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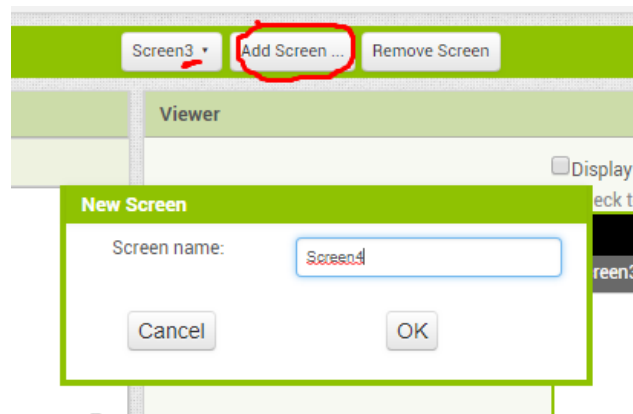
Figure   13. Adding supplemental screens to the project

5. On the Palette area the User Interface subset must be chosen
6. Select button and drag & drop it in the Viewer sector
7. Select label and similarly drag & drop it in the Viewer sector
8. Select the Button1 item in the list shown in Components area
9. Set the Button1 features as follows:
     a. BackgroundColor → default,
     b. Enabled → ☑,
     c. FontSize → 24,
     d. FontTypeFace → default
     e. Width & Height → Automatic,
     f. Image → none.
     g. Shape →. default
     h. Show feedback → ☑,
     i. Text → Hello World,
     j. TextAllignment → left,
     k. TextColor → black,

Figure   14. Building Hello World app

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10. Select the Label1 item in the list shown in Components area
11. Set the Label1 features as follows:
    a. BackgroundColor → none,
    b. FontSize → 24,
    c. FontTypeFace → default,
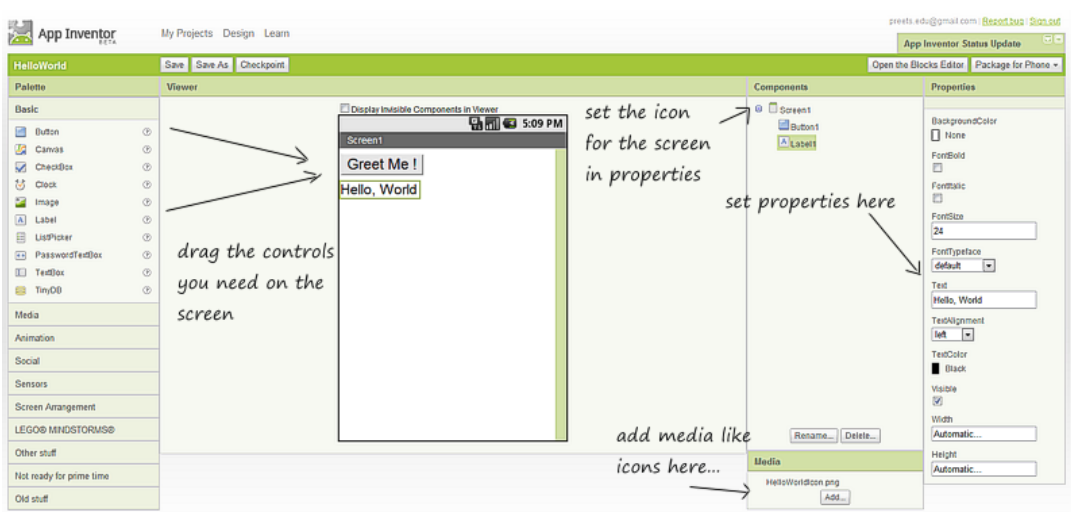   d. Text → ' '
    e. TextAllignment → center,
    f. TextColor → black,
    g. Width & Height → Automatic.
12. Press Blocks button in the upper right corner of the App Inventor's window;
13. Select Button1 and add its corresponding action → Set Label1 Text to "Hello World!" .

Figure   15. Setting the action for Button1

14. Save the project
15. Test the application both on the App Inventor simulator and on the mobile phone.

Exercise: Change the text in the above app from "Hello World" to its translation in Greek, Portuguese or Romanian.

Test

TEST   2.2

T   2.2.1. "Hello World" is an app for:
a. Change mobile interactivity;
b. Demonstrate App Inventor environment qualities;
c. Display a message on the screen.

T   2.2.2. The app's components are:
a. Totally independent;
b. Partially connected;
c. Connected through their functional role in the app.

T   2.2.3. The app's components are selected form:
a. Palette area;
b. Blocks;
c. Components area.

T   2.2.4. The Button is an element from:
a. Media section;
b. User interface section;
c. Layout section.

T   2.2.5. The main Label properties are:
a. BackgroundColor;
b. Text;
c. FontSize.

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Computers' story

Fernando Pedro Lopes Boavida Fernandes (born in 1959, in Pinhal Novo, Palmela, Portugal) is a Portuguese computer scientist & engineer, university professor and writer. He is recognized as a pioneer in computer networks research and Internet. Pedro Boavida is currently professor at University of Coimbra, Portugal. He is senior member of IEEE and member of the editorial advisory board of the Computer Communications Journal

More information about the Fernando Boavida can be found at:
https://en.wikipedia.org/wiki/Fernando_Boavida

2.3. Example of a mobile app

This paragraph is focused on the implementation of a medium complex application. In order to start the work, the programmer must start a new project. This is done by performing the 1 – 4 steps as described in the above section.
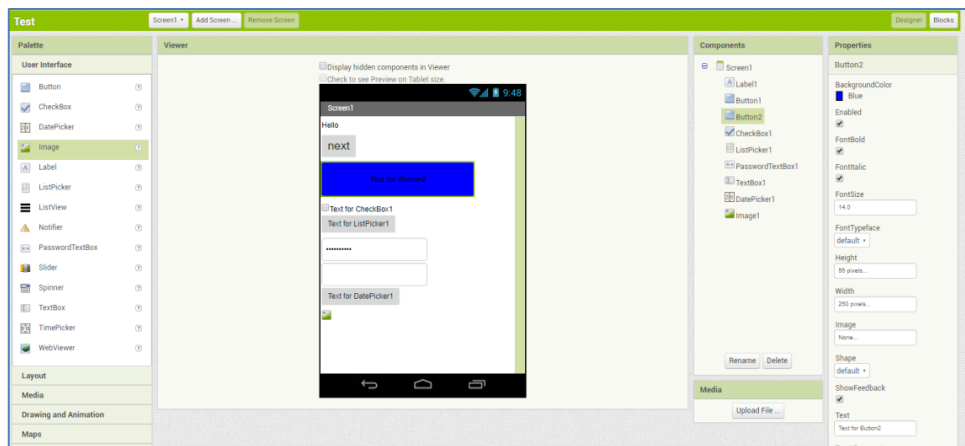
Figure 16. Components selection and settings

5. From the Palette area the needed components;
6. The components settings are establish as shown in previous paragraph;
7. Press the "Blocks" button to add functionality to the components
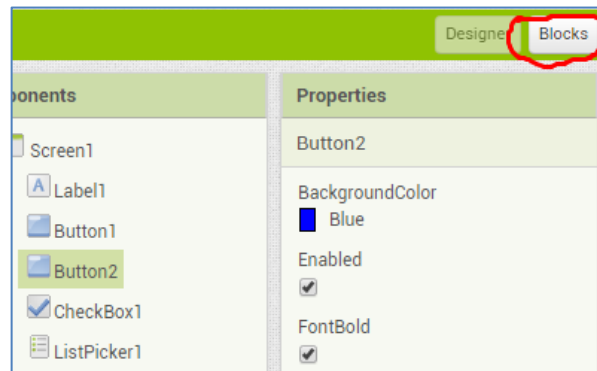
Figure   17. The Blocks Button

8. Select the working screen
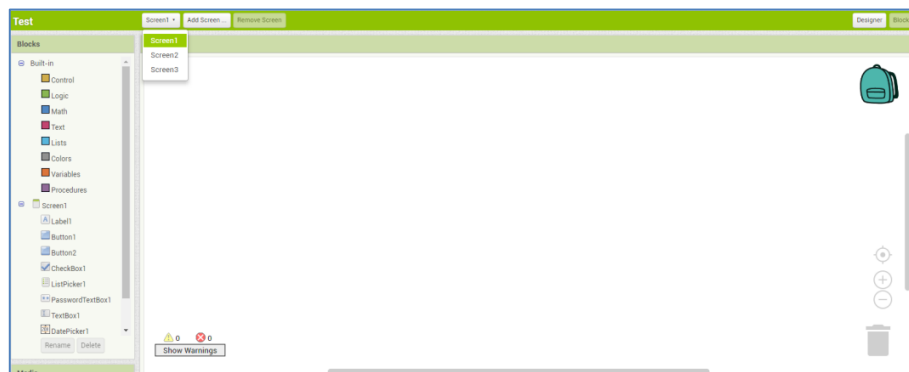
Figure   18. The screen selection

9. Chose a component in order to give it a functional tasks

Figure   19. The componet chose for task receiving

10. Select the function for the selected component
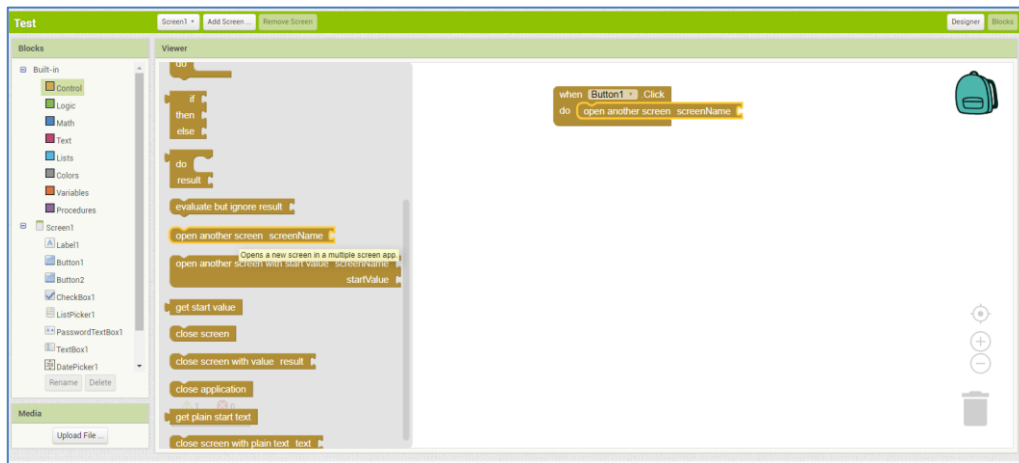
Figure   20. The component is linked with its function

11. Chose the attributed action's object

Figure   21. The atributed action's object set

12. Repeat steps 9 – 11 for each app's component

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Figure   22. Finalising the project

13. Save the project

Figure   23. Saving the project

14. Test the application both on the App Inventor simulator and on the mobile phone.
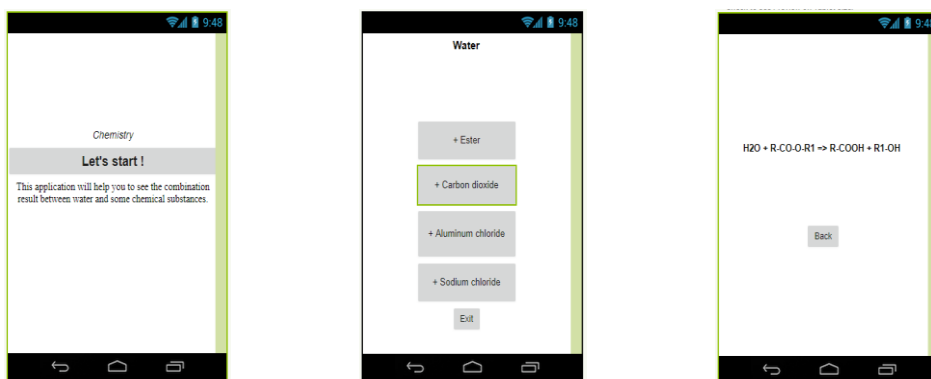
Figure   24. Project main screens

Exercise: Make a similar project by changing esthetics and keep the same functions.

Test

TEST 2.3

T   2.3.1. The application in this section is an app for:
      a. Change mobile interactivity;
      b. Demonstrate App Inventor environment qualities;
      c. Emulate a chemistry experiment.

T   2.3.2. The app's action is placed in:
      a. One screen;
      b. Multiple screens;
      c. None of the above.

T   2.3.3. The components are linked to their corresponding actions using:
      a. Components area;
      b. Blocks;
      c. Properties setings.

T   2.3.4. The Label is an element from:
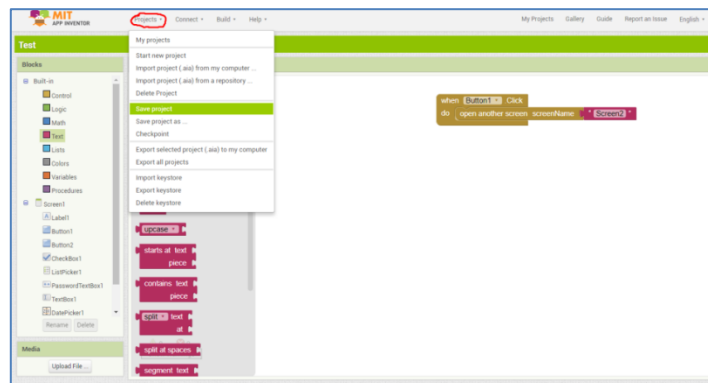   a. Sensors section;
      b. User interface section;
      c. Media section.

T   2.3.5. The main Button properties are:
      a. Shape;
      b. Text;
      c. Width & Height.

Computers' story

Ștefan Odobleja (1902 – 1978) was a Romanian scientist considered to be one of the precursors of cybernetics. His major work, „Consonantist Psychology" published in 1938-1939 in Paris lays the theoretical foundations of the generalized cybernetics and systems thinking prior to its definition by Norbert Wiener. Odoblejea's book went unnoticed because of the WWII beginning. After the war, the communist regime in Romania considered his work „evil capitalist science" and persecuted Odobleja. Now his merits are recognized by the international scientific community.

More information about the Ștefan Odobleja can be found at:

https://en.wikipedia.org/wiki/%C8%98tefan_Odobleja

3 Future trends in Information & Communications Technology

The Information & Communications Technology (ICT) is the fastest developing sector of the human research. Moreover the researches' results implementation is incredibly quick and deeply influences our daily life.

Example: In 1971, when Intel launched the first commercial microprocessor chip containing 2300 transistors, the fastest car was Ferrari Daytona able to run with 280 Km/h and the highest buildings were the New York's twin towers, 415m.Nowadays the 32-core AMD Epyc microprocessor (launched in 2017) contains more than 19,200,000,000 transistors and deliver 500,000 times more computer power. At the same rate of development, the fastest car should run almost as fast as half the speed of light and the tallest building would almost reach the Moon. Actually the current fastest car is SSC Ultimate Aero ("only" 413 km/h) and the highest building is Dubai's Burj Khalifa with "just" 828m. These last two are quite impressive achievements, but far less than the ones expected from an equal development rate with the one in ITC evolution.

There is a quite complex explanation for this explosive grows because it involves a number of different factors. Some of the most important are:

- The ITC gained large applicability in almost every human domain of activity, thus the society demand is high and rising;
- The cost of ITC research is moderate (related to other study fields) and the production prices are usually low and thus accessible to everybody;
- The ITC production does not need expensive ingredients, it is based on Si the most common element on Earth;
- The ITC factories are classified as "clean industry" because they do not create environment's pollution.

Basically, the microprocessors improved so much because every time a new generation is launched on the market, the software producers quickly try to use the new available computing power to build more and more complex applications. Therefore the upper limit of the new chip capabilities is rapidly overpassed by the new soft requirements and hence, a new generation is needed.

This increase in microchips' power & complexity is best described by the Moore's Law.

In a 1965 special issue Gordon More (director of research and development at Fairchild Semiconductor at the time) was asked to predict the integrated circuits' development for the next decade. He extrapolated the last decade evolutions and stated that the number of components in a chip will double every two years. After 50 years his prediction is still available, because the technology implementation engineers find every day better solutions to make transistors inside de integrated circuits smaller and smaller. Current technology is able to produce 14nm transistors.

Taking into account all of the above, it is a legitimate question to ask where this advances will lead, what will happened to our computers and to our life in the next few decades?

Most experts believe that the current development will accelerate and the main future trends in ICT will be:

1. **Emerging hardware technologies will lead the way**

As software becomes the driving force of many IT solutions, open source concepts allow far more people to build applications around technologies like the blockchain, natural language processing, or context-aware computing. Hardware technologies have also become vital, as IT

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industry vendors are expected to increasingly use drones, robotics, and 3D printing to explore more opportunities in the global IT industry, therefore the development of hardware technologies is projected to be one of the top IT industry trends for the next couple of years.

2.   Cloud computing will be the fastest growing information technology (IT) paradigm

More and more businesses around the world are turning to cloud computing to help support their business development demands. Cloud services allow companies to offload data management, backend development, and even design so that their talent can focus on innovation. To achieve better IT results, companies must build or reconfigure the appropriate policies and workflow for a cloud-based approach. We expect cloud computing to continue being one of the most vital future trends in information technology. Infographic: latest technology trends in information technology

3.   Internet of Things will play a major role in business strategies

Internet of Things (IoT) devices are rapidly making their way into corporate spaces. From gathering new data to the automation of infrastructure, companies are finding many benefits from adding connectivity and intelligence to physical infrastructure. According to CompTIA, adding digital capabilities to everyday components will drastically increase the scope of IT responsibilities.

4.   Artificial intelligence will stand out in the IT ecosystem

Artificial intelligence (AI) requires significant computer resources (which can be procured in the cloud), various algorithms allow learning (which can be baked into products or provided as a service) and contextual awareness (which can come from IoT devices or massive collections of data). By adding a layer of intelligence to the technical solutions they are building, companies can both manage a more extensive IT architecture and solve a broader range of problems.

5.   Data security will be the top priority

One of the top trending technologies in computer science, IT services rely on digital technology to work faster, thus, data security becomes a top priority. It's difficult to improve security efforts when technology is updating so rapidly. Many businesses have increased investments in security, but beyond the technical aspects, organizations will also begin building business processes that enhance security. In order to adapt to the rapid IT development, companies will have to shift their security mindset from technology-based defenses to proactive steps that include technology, process, and education. In this top 5 disruptive technologies list, Data security will always be import among the latest technology trends in information technology.

Exercise: Try to imagine a change in your life as a result of one of the above developments

Of course, all the above directions of growth is very important and their implications to our economy will be great, but none is so fundamental as the development of Artificial Intelligence because it will change not only the ITC industry, but our whole society and ultimately our life.

The tools were, from the very beginning of Homo sapiens' evolution, an important asset in his attempt to amplify his strength and finally conquer the current dominant position on Earth. These utensils' main role was and still is to augment the man's capacity to modify the environment according to his needs.

In time, human's tools became more and more sophisticated. People handling such utensils need to have certain abilities gained during an apprentice stage. Therefore, the working instruments directly impact human's life and their advancement during technological revolutions does have a key role in changing society.

Hence, it is straightforward to consider that the nowadays evolution of computers technology leading to Artificial Intelligence (AI) will dramatically change our social environment and our whole civilization.

It is not only about computers more powerful than human brain, but a whole category of intelligent tools capable to understand their working environment and to take decisions accordingly.

Even if probably some people would like to stop progress, this is not possible as it never was during our history. The current economic competition is mainly about technological development. The modern man dependency on IT&C is growing continuously. The consumption society requirements for "more" and "better" do push production to intelligent robotics era.

Thus, thanks to the above politics & marketing strategies the trend toward AI is the normal next stage of our civilizational advance

No doubt, there will be many angry reactions about this development. For example, traditional production lines will be replaced by flexible automatization equipment and people working there will lose their jobs. Truck & taxi drivers will soon be replaced because autonomous trucks & cars will become available. Shop sellers, office clerks, public relations people, nurses, direct combat soldiers, actors, teachers, guardians, doctors, news anchors etc. will also become jobless or will have to adapt to a dramatically changed professional environment. Affecting a large number of people in a relatively short period of time will probably trigger social unrests and high instability.

More than that, the life quality gap between the members of the developed nations and those of the non-modernized ones could become unbearable for the last. Such an evolution could lead to profound aggravation of migration crisis or terrorism.

The authors of this paper do strongly believe that, even these problems will trouble the human society in the next few decades, the majority of the people will succeed in doing, as always during history, the transition from old to new and will adapt to the changed environment governed by the AI.

Nevertheless, this AI revolution is different from others technological revolutions in the past. This time, the tools will become more intelligent than humans and this could generate a dangerous evolution, even questioning the dominant role of Homo sapiens on Earth.
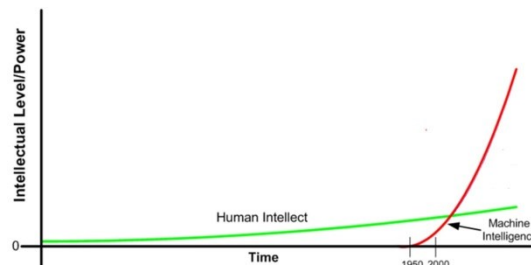

Figure   25 Human vs. Machine Intelligence

The AI will be more than a simple tool; it will control a great part of our life and of our environment. It will have the ability to decide on almost everything with no human interference and this is a risk.

The visionary businessman Elon Musk said once: "Maybe one day the omnipotent AI will decide to get rid of the spam mails and will decide the best solution for that is to exterminate the spam producers, all humans". Similar thoughts were made public by many of today influential people. They all agree that; uncontrolled AI could be the end of Homo sapiens.
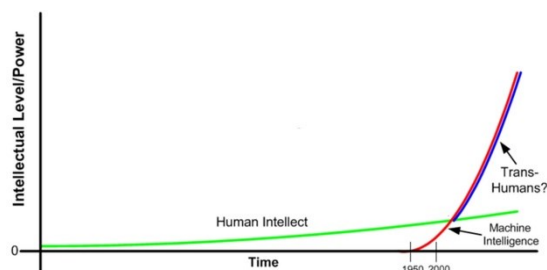

Figure   26 Trans Human vs. Machine Intelligence

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The most debated solution to this danger is to find means to integrate humans into the AI in order to retain their command role and exercise a censorship over its actions.

Human cerebellum is the most complex biological structure on Earth. It contains 1011 neurons and each of them is interconnected to around 10.000 other neighboring neurons. These means it can store large quantities of data and is capable to process these data using massive parallelism schemes.

Still, computers already surpass us on certain activities because our brain has a limited available memory and especially a much lower speed of reaction.

The best way to increase the human brain power is to link it to a computer through an interface able to provide direct communication between the biological structure and the artificial one.

This Brain Computer Interface (BCI) is not an easy task to fulfill, because its implementation raises both technical and ethical problems.

Realizing a trustworthy, non-health-risking, effective connection between the human cerebellum and an intelligent machine is not a common engineering work. Some progresses were made during last few years, but for the moment research results show that current technology can only manage a limited number connected of neurons.

On another hand, public reaction to BCIs on ethical, religious and political grounds is even more important than the technical issues. A massive negative response can delay researches progress for some decades. Hence the opinions of both leaders and commoners are an important fact to take into consideration.

Certainly large groups of people will be annoyed by the idea of creating a race of "upgraded Homo sapiens" with real "superpowers" similar to the heroes of the X Man movies. It is only logical to think that such Trans-humans can be as dangerous to our civilization as a robotic army of terminators.

Our historical experience prove that whenever a more advance human subspecies meet a less evolved one, mass extinction happens. During the last millions of years, Homo sapiens progressively occupied the whole land eliminating all his "cousins" (i.e. Homo Erectus, Homo Habilis etc.).

Even the confrontation among different human's civilizations leads to tragic effects. Firstly the Spanish conquistadors and later English, French, Dutch and American pioneers quickly destroyed the Amerindian, Australian and Oceania's societies. Then, they succeed to depopulate almost the whole western hemisphere in order to free the land for the white colonists and their black slaves.

Still, there is a different & better perspective to consider about enhancing human intelligence and power. Today medicine uses a wide range of prostheses to substitute different missing/non-functional parts of ill patients. Some of these evolved recently to intelligent apparatus able to link directly to human nervous system. Robotic arms and legs, automatic will chairs and some other medical devices tend to became more and more common.

Other promising research programs are oriented to prosthesis capable to compensate as much as possible the absence of sight or of hearing. It is not yet achieved, but soon blind and deaf people will be helped by specialized BCIs bringing images and sounds directly to the specialized neural centers in their cortex.

Degenerative brain diseases (e.g. Alzheimer, Parkinson etc.) are not efficiently treated nowadays. Some scientists believe that a link between the ill cerebellum and a computer will help compensate for a time the loss of brain's functionality.

On top of all these, the military research makes every day spectacular progresses in improving the combat abilities of fighter pilots and tank drivers. Night view, augmented reality, high speed reaction chains will be soon accompanied by new upgrades based on BCIs. It is here, where the great risk for human civilization stays. If this goes wrong a confrontation between man and an AI controlled army of combat robots could mean our civilization end.

Soon, these army technologies will be imported to computer games and many people will use them for fun and will become routine for them.

Therefore, the BCIs idea is not a horror SF, but a real fact entering step by step into our lives. It has light and dark sides, but it is our scientist & engineers task to choose the good from evil.

Hence, the public acceptance for direct linking brain to computer will come in time and many intelligent devices connected through BCIs to different nervous centers in our cortex will populate our environment.

Example: No one will walk on city streets without GPS & Augmented reality glasses able not only to indicate shops, cafeterias and restaurants in our neighborhood, but also recognizing people around and giving us hints about: name, phone number, common history etc. Other popular BCIs could be a universal remote controller linked to one of our specially trained neural center for mastering everything in the house from lights to game box.

Exercise: "Invent" an hypothetic BCI used to control something around you and improve your own everyday life

A Brain Computer Interface is an apparatus that translates neural commands into coherent information for controlling external software & hardware. Hence BCI is a bidirectional interface for human brain to computer interaction. Usually the computer is used to further control a mechanical device such as a robotic arm/leg, an automatic wheel chair etc.
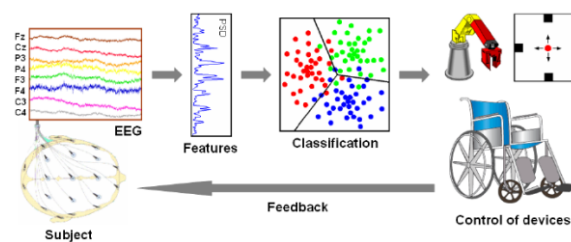

Figure   27 BMI for handicapped people

These interfaces are still quite rare. The technology of robotic prostheses is young, thus it is expensive and not all details are perfected. The BCI is connected to the group of neurons previously controlling the replaced arm/leg. Difficult training is required to acquire the ability to command the artificial arm/leg and the functionality is just partially recovered.

A connection among BCI and multiple neural centers in the cortex area or even with the whole brain is not technically solved yet. Such wide range communication channel would be an extraordinary bidirectional way to convey information between us and our environment.

For realizing this, our knowledge on the human cerebellum should progress to more sophisticated models which could explain better the delicate process inside the neuron and the complex electric & chemic interaction between the axon's terminals and the dendrites.

Luckily many BCIs applications require just the access to a single neural center for commanding a certain precise element. The neural centers in the cortex are now mapped with good precision. Thus specially designed BCIs can link directly to the region directly responsible of a certain action.

Hence, for commanding a BCI connected to a general remote house's controller, one available neural center in the cortex would be selected and trained. The interaction with a single BCI instead of different interfaces for each individual device would certainly be easier to learn. Furthermore, complex commands, involving more than one house device would be less difficult to perform.

Consequently our perception of the neighboring reality will adjust to a more complex scheme as our contact with the world will be both direct and through BCIs as in Figure   28.

The artificial entity (computer + BCI) existence as a third relevant part in the human environment interaction would fundamentally change our way of understanding and acting.

Things in our house will communicate to each other through the Internet of Things and the main computer would control everything to the finest detail. Thus our only job will be to control the main computer.
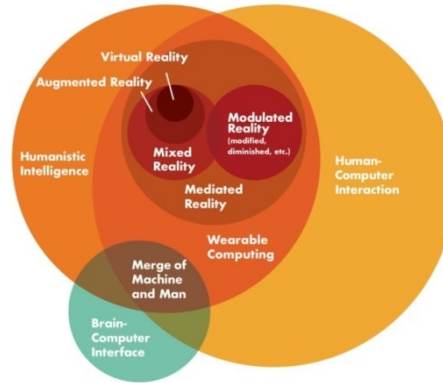
Figure **28** Human – Computer – Environment interaction

This perception shift would probably have a psychological impact on every person and its consequences must be investigated.

Anyhow, people will certainly become dependent on such BCIs more than they are now on mobile phones.

Brain – Computer Interfaces are beneficial not just because we must control our intelligent utensils, but we also must diminish the speed difference among these AI equipment and our responses.

Todays, we relate with PCs and laptops through hand/voice/senses and the I/O peripherals.
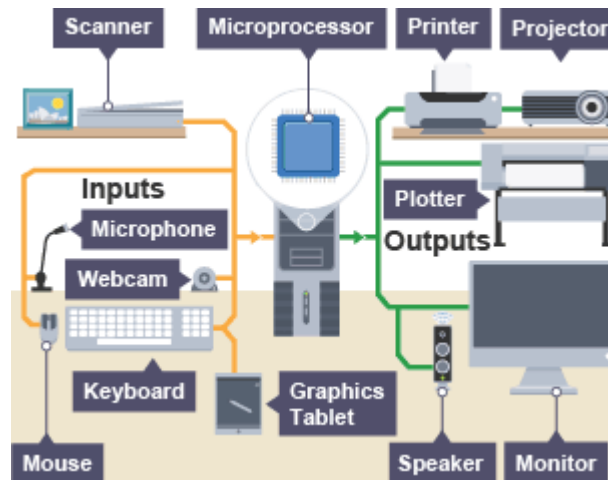

Figure **29** Today Human Computer Interaction

Thus, there is an unavoidable delay coming from perceiving computer's output time (To) and from input execution needed time (Ti). If man has to reply to a computer action the total delay (TT) is:

$$T_T = T_o + T_b + T_i \qquad (\quad 1)$$

where Tb is the duration human brain need to decide its answer to the computer.

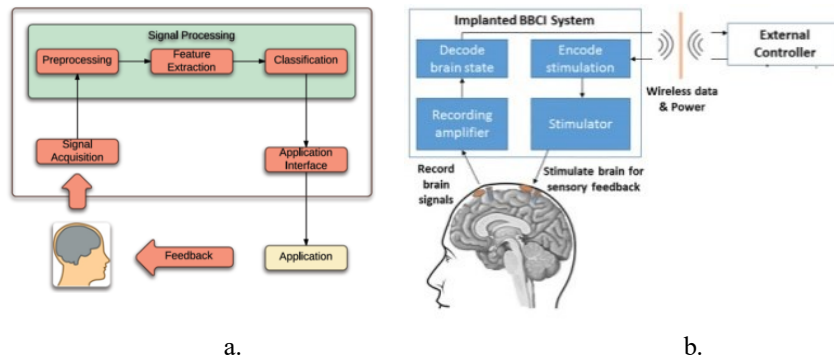a.   b.

Figure   30 Types of BCIs

There are two methods to reduce this delay using BCIs:

A.   The interface reads and interprets the brain input command. Hence the TT became:

$$T_T = T_b + T_o \qquad\qquad (\ \ 2)$$

B.   The interface is able to both interpret the input command and to produce a direct to brain output
   Therefore the TT is minimized to:

$$T_T = T_b \qquad\qquad (\ \ 3)$$

The first strategy is feasible with a BCI linked to just one neural center in the brain. The second needs direct access to the entire cortex region responsible with our senses (touch, view, hear, etc.). Certainly B is the best, but building such a BCI is yet not technically achievable.

The computers development to super-human intelligence cannot be obstructed. The AI will soon be a reality in our world. Thus, the clever tools will action autonomously and will decide independently the course of their activities.

Our youth will have to deal with this new situation and they will need to live in a quite changed society. Their natural talents will probably be insufficient to adapt to such an environment. Hence, they need to integrate as part of the new technologies, as part of the AI world.

BCIs are a possible benefic answer for humans to evolve and stay in command of the Earth. BCIs are, even now, a reality in our life helping handicapped people to counterbalance their problems. Tomorrow BCIs will become customary to our work & life. Our whole interaction with our environment will be influenced by them.

Researchers would have to be careful to choose the good path for progress in order to circumvent the possible risks to human civilization.

Test

TEST 3:

T. 3.1. Which is the transistor's dimension in nowadays microprocessors?
   a. 14 µm;
   b. 14 pm;
   c. 14 nm.

T. 3.2. What are the future trends in computer technologies?
   a. Internet of Things;
   b. Cloud computing;
   c. Artificial Intelligence.

T. 3.3. The Artificial Intelligence means:
   a. tools more powerful than human muscles;
   b. robots able to understand the environment and take decisions accordingly;
   c. interconnected human brains.

T. 3.4. Present Brain – Computer Interfaces connect:
   a. one human neural center in the cortex to a computer;
   b. several human neural centers in the cortex to a computer;
   c. all human cortex to a computer.

T. 3.5. Present BCIs are necessary in order to:
   a. allow people to control computer's components;
   b. allow people to connect with their prosthesis;
   c. allow people to control the natural environment.

Computers' story

John von Neumann (1903 – 1957) was an American mathematician, physicist and computer scientist. He was a pioneer in the application of operator theory to quantum mechanics, in the development of functional analysis and a key figure in the development of game theory & the concepts of cellular automata, the universal constructor and the digital computer. The "von Neumann Model" he defined is the standard architecture for nowadays computers.

More information on von Neumann at:
https://en.wikipedia.org/wiki/John_von_Neumann