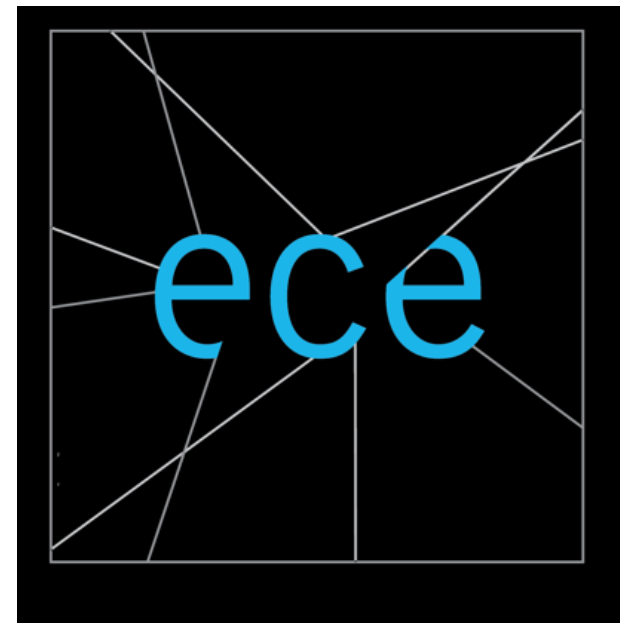# APSC160 open-source hardware/software laboratory re-fit

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Introduction

This project focused on developing teaching material for APSC160 – Introduction to Computation in Engineering - in the School of Applied Science (APSC) at UBC Vancouver.

The material consisted of five video sets introducing these topics: Programming and Debugging, Arduino Interface Elements, Arduino Analog Inputs, Random Numbers Generation, and Embedded Systems. To complement the videos, application examples and slides were developed.

Introduction to Programming and Debugging

Basic C-programming structures such as IF-ELSE, FOR, and WHILE were explained and implemented on an Arduino Board and Tinkercad.

Arduino [1], is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects. The most basic Arduino board is the Arduino UNO one, which enables learning the basics of programming and debugging using the C/C++ programming language.
To practice how to program these boards, a simulator is required. The simulator suite used in these project is Tinkercad by Autodesk [2].
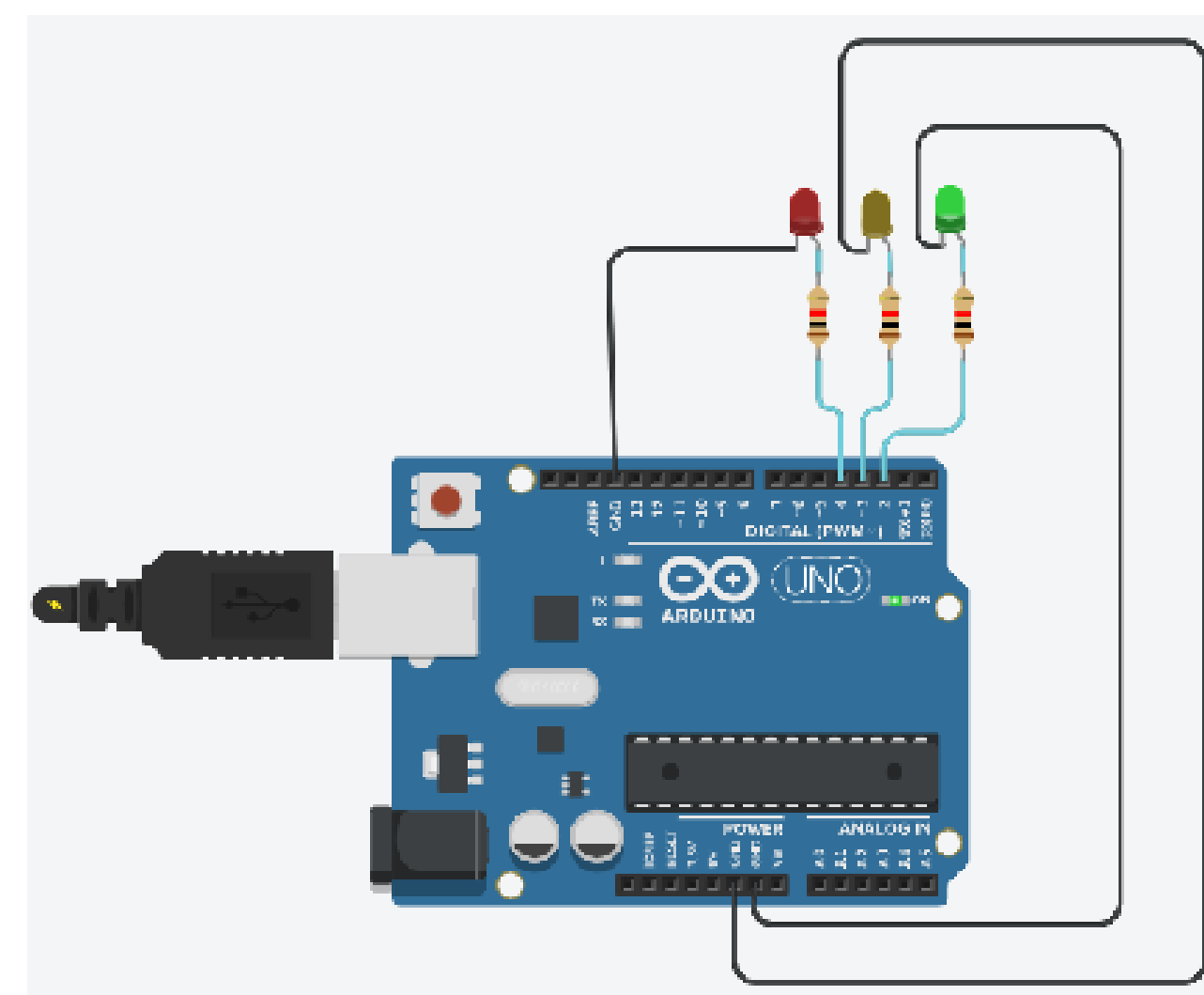
Arduino I/O Interface Elements

To interface elements with an Arduino Board, the Digital Inputs or Outputs are used. These digital I/Os are used to read or write data from the outside world. Examples of elements found in the Tinkercad library are
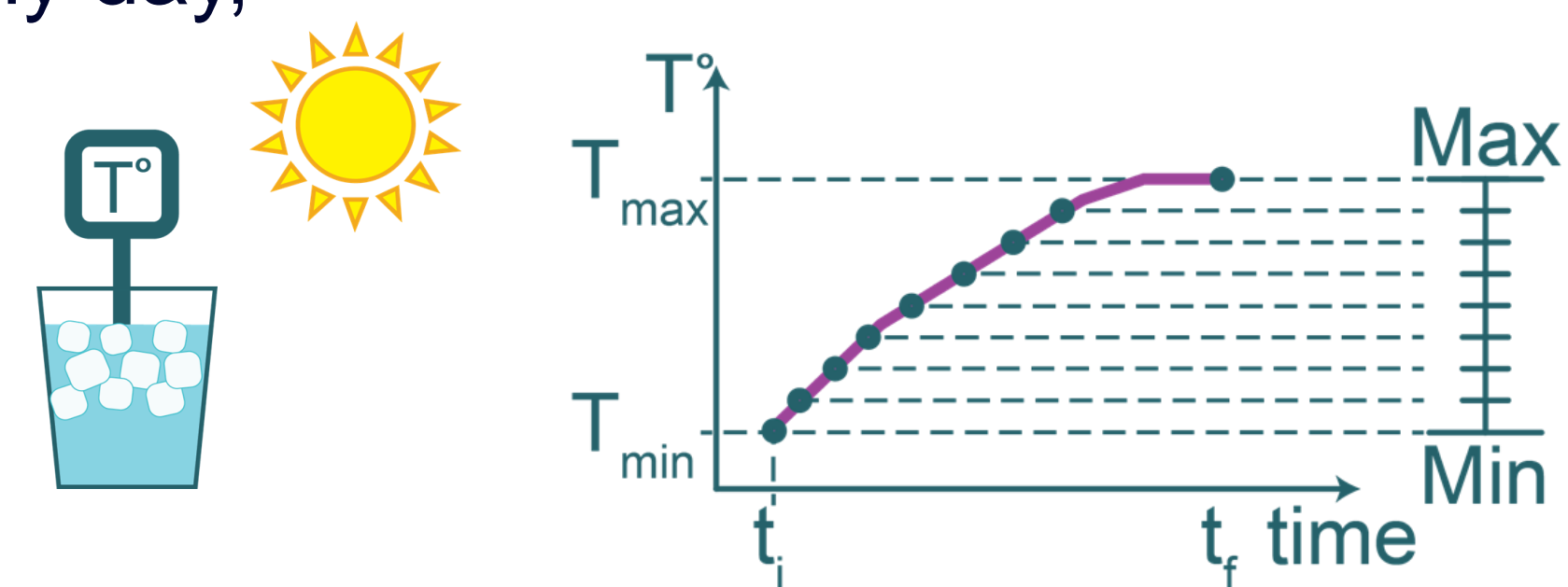
| Resistor | LED | Slideswitch | DC Motor |
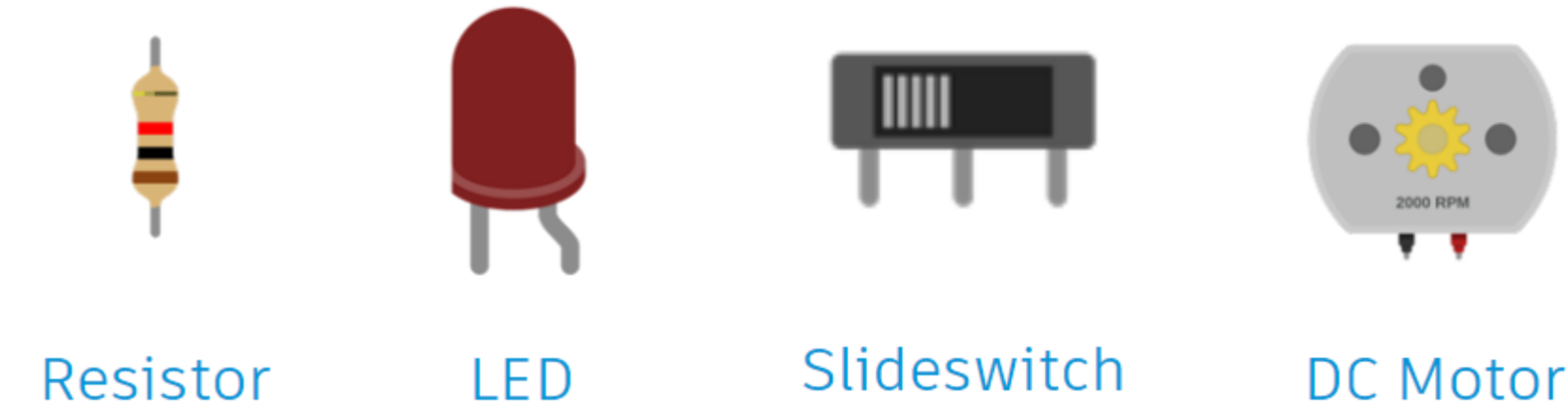
These were used to implement simple examples such as a Traffic Lights Controlle.

Arduino Analog Inputs

Analog Inputs are used to discretize continuous signals through the analog to digital converter, for example the evolution of the temperature of a glass of water witch ice left outside in a very sunny day,

A variety of elements can be used to connect to these inputs on the Arduino board, such as: potentiometers, flex sensors, and force sensors

| Potentiometer | Flex Sensor | Force Sensor |
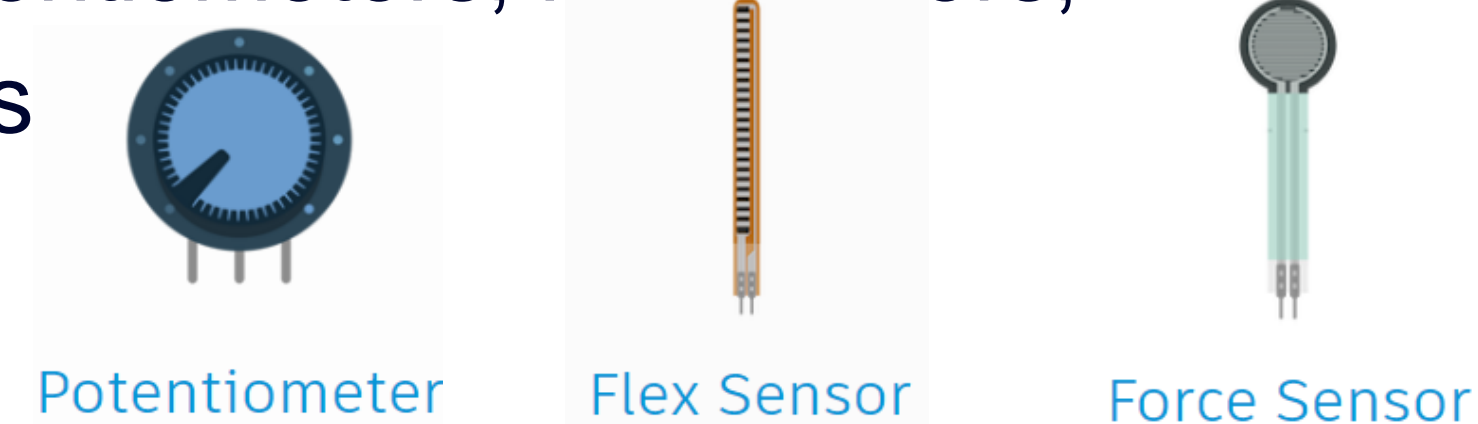
Random Numbers Generation (RNG)

Random numbers have many applications in engineering and scientific computing. RNG is introduced through a programming exercise that requires the design of a lottery system. A seven-segment display was employed to indicate the numbers generated at the push of a button.
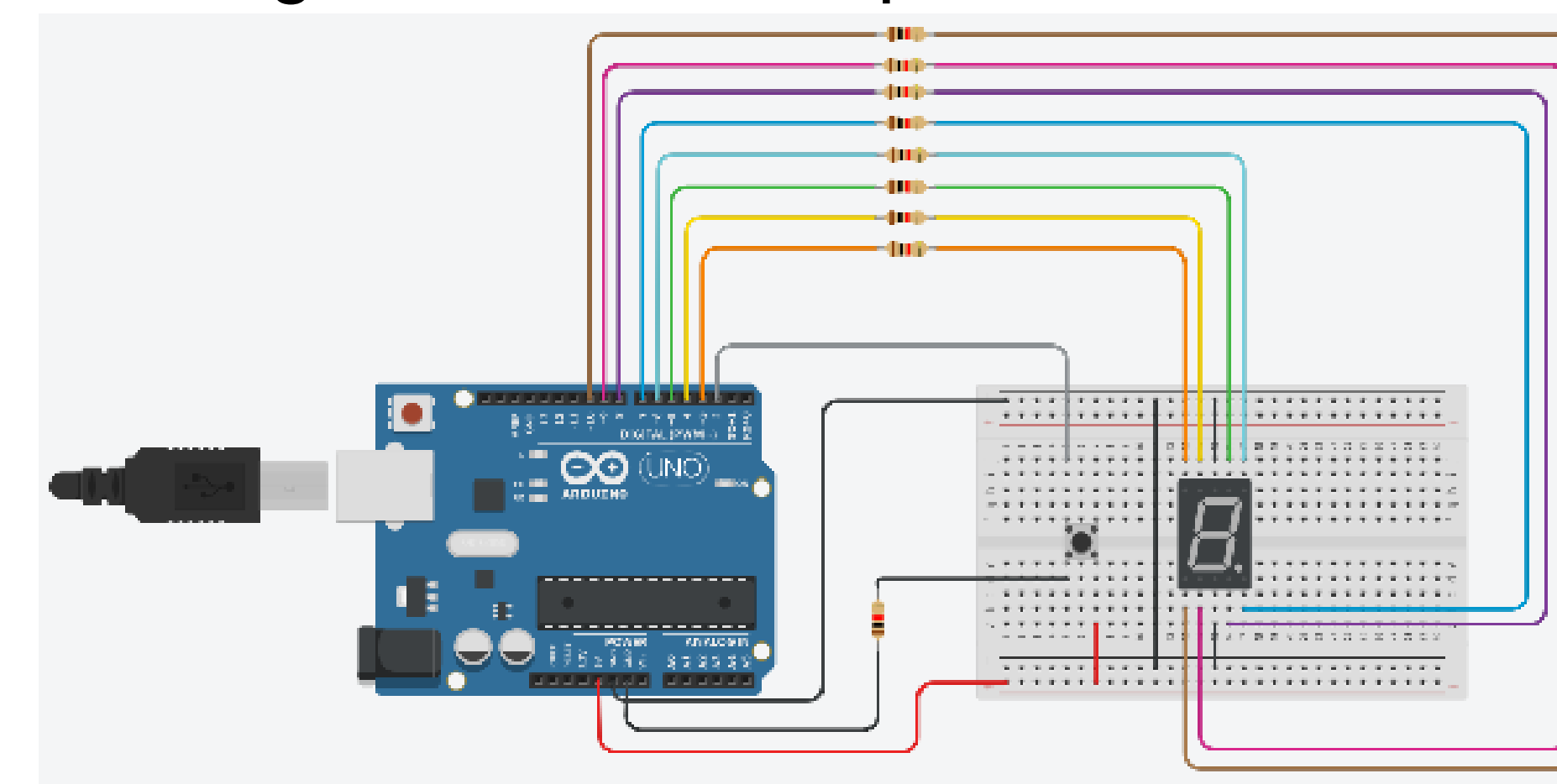
Embedded Systems

Embedded systems are computer systems dedicated for a special purpose. Many of these systems are sensitive to time. Real-time embedded systems are designed to work synchronized with their environment. Examples of these are pacemakers and aircrafts landing system.
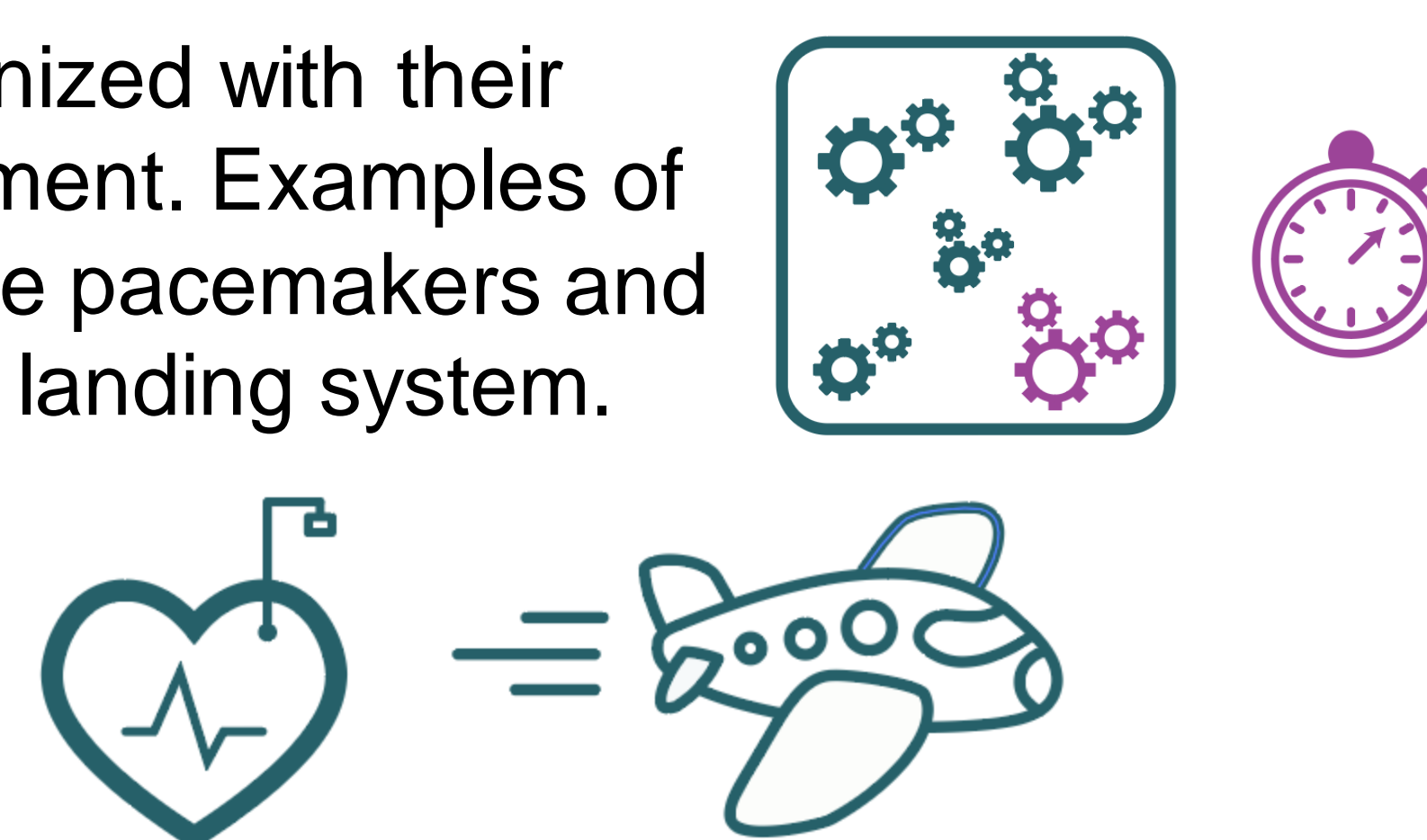
There are functions to keep track of time in an Arduino Board. These were employed to develop a Runner's Tool example to time milestones.
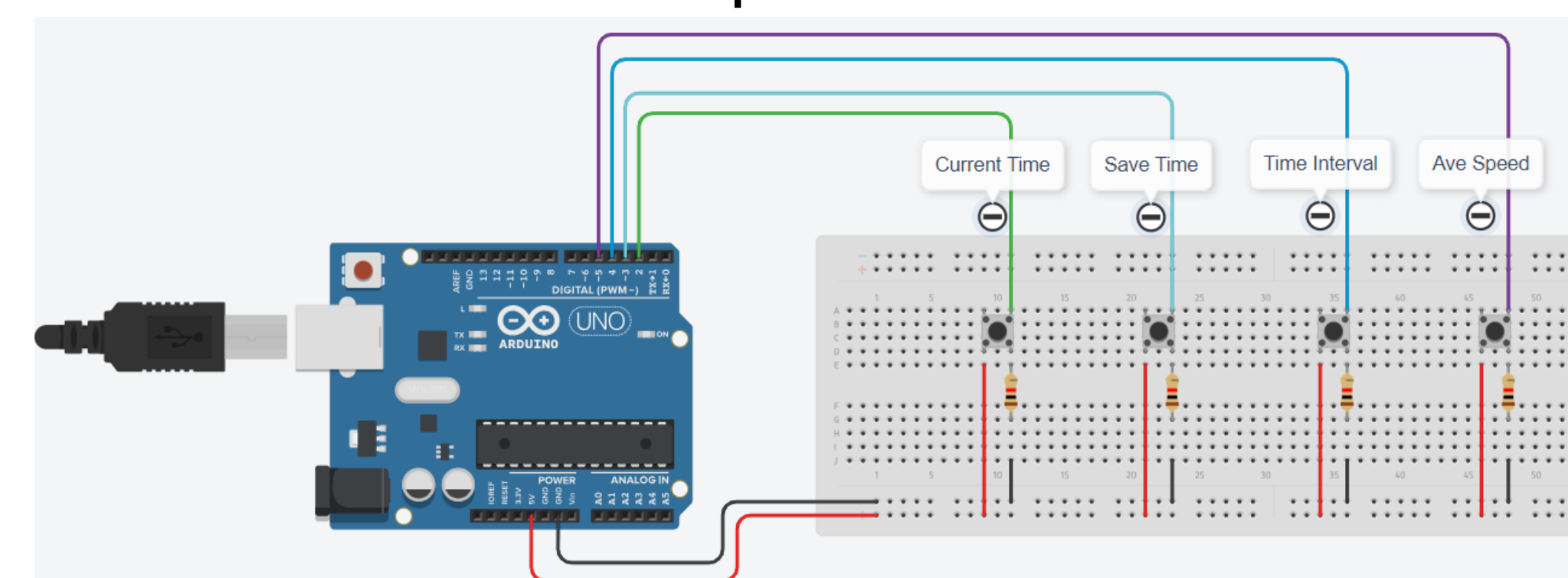
Videos Voice Over

The videos voice over was created with a text-to-speech tool based on Artificial Intelligence (AI) due to its versatility, and the provided efficiency for this application. There are multiple companies that offer voice generations based on AI. In this project, Eleven Labs [3] was utilized.

Eleven Labs' was found to be very easy to work with, flexible, and generated the best voice quality among a few alternatives that were tested. Eleven Labs offers a free trial and various paid options to suit different needs.
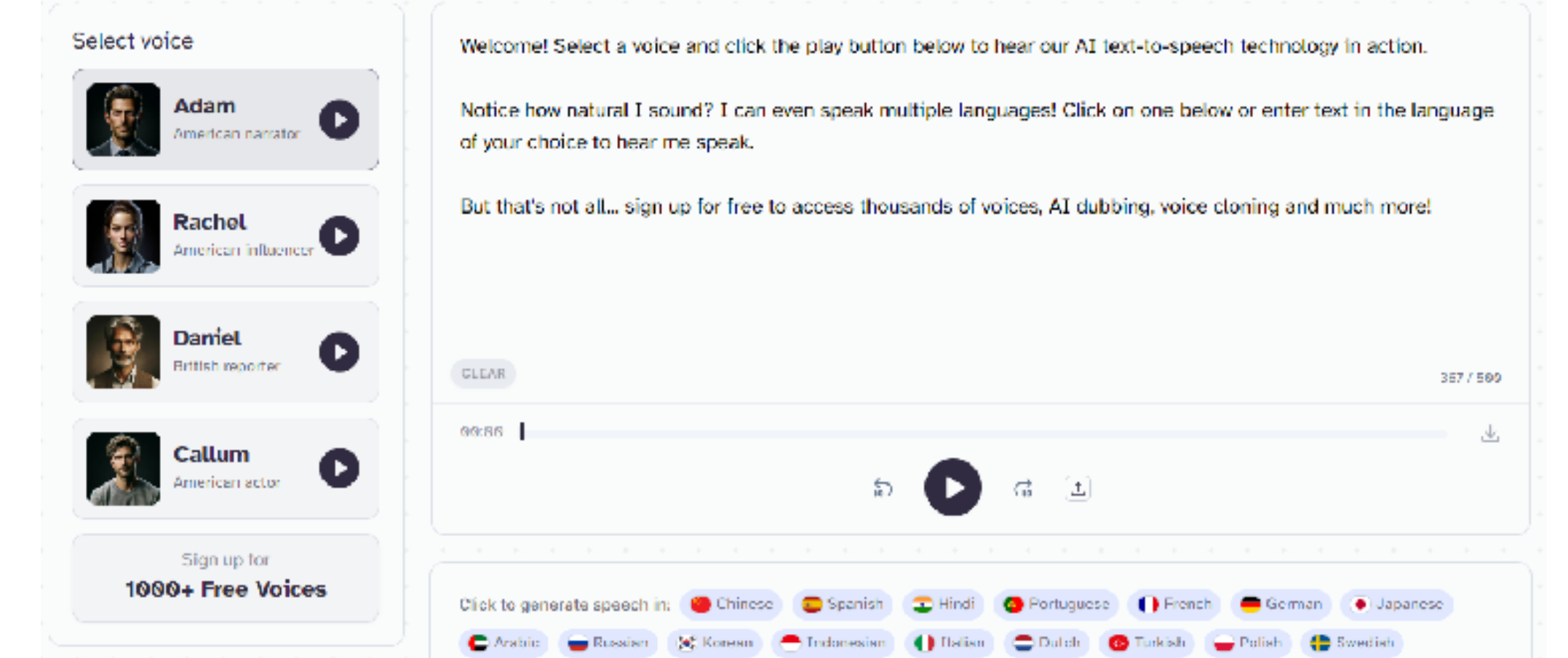
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Reference / Bibliography

1. Arduino https://www.arduino.cc/
2. AUTODESK Tinkercad https://www.tinkercad.com/
3. Eleven Labs https://elevenlabs.io/
4. Creative Commons BY-NC-ND-4.0 http://creativecommons.org/licenses/by-nc-nd/4.0/

Acknowledgement