
Engineering Technology (ENGR 101)

Introduction to Arduino

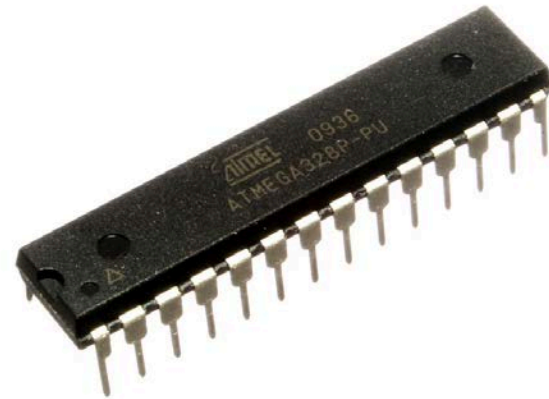
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Victoria University of Wellington

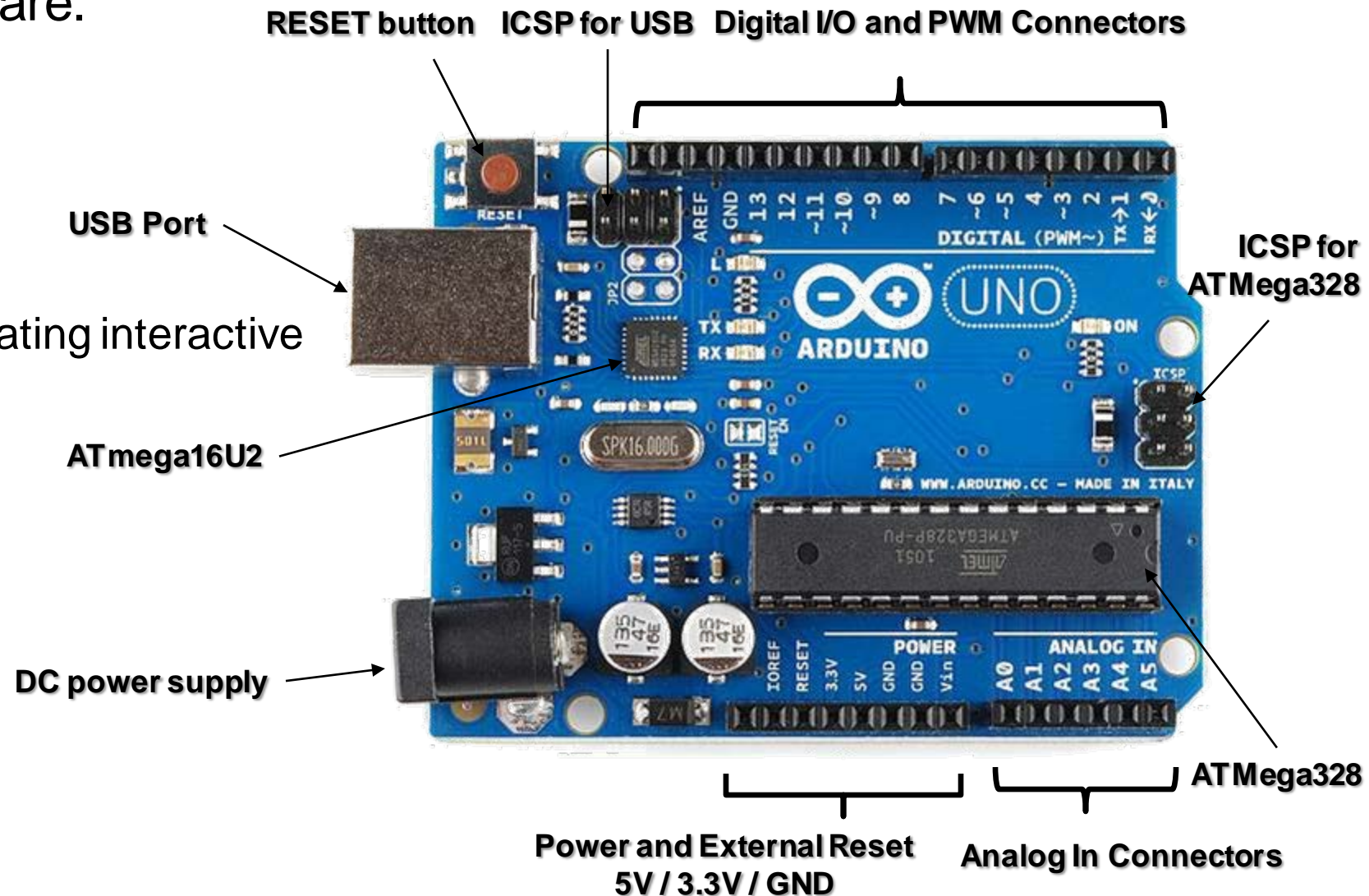
What is processor?

- A processor is an integrated electronic circuit that performs the calculations that run a computer.
- A processor performs arithmetical, logical, input/output (I/O) and other basic instructions



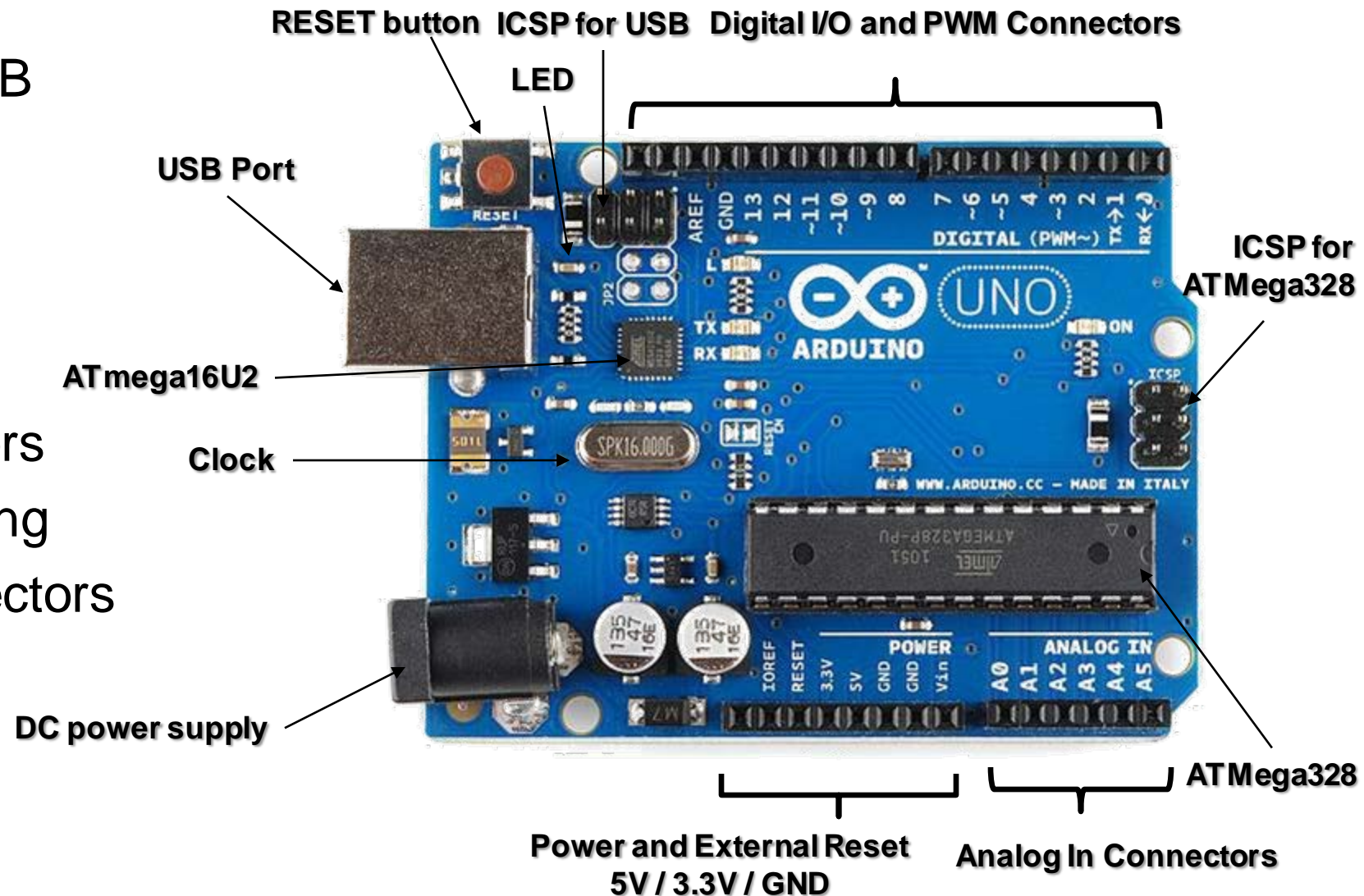
What is Arduino?

- Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software.
- It's intended for
 - artists,
 - designers,
 - hobbyists,
 - and anyone interested in creating interactive objects or environments.
- <http://www.arduino.cc/>



Arduino Components

- ATmega328: the processor programmed by the user
- ATmega16U2: handles USB communication
- USB port.
- EEPROM memory
- Flash memory
- Input and Output Connectors
- ICSP pins for reprogramming
- Power regulator and connectors
- Reset button
- LED
- Clock



Application Code and Firmware

- Two types of code executing on a simple microcontroller

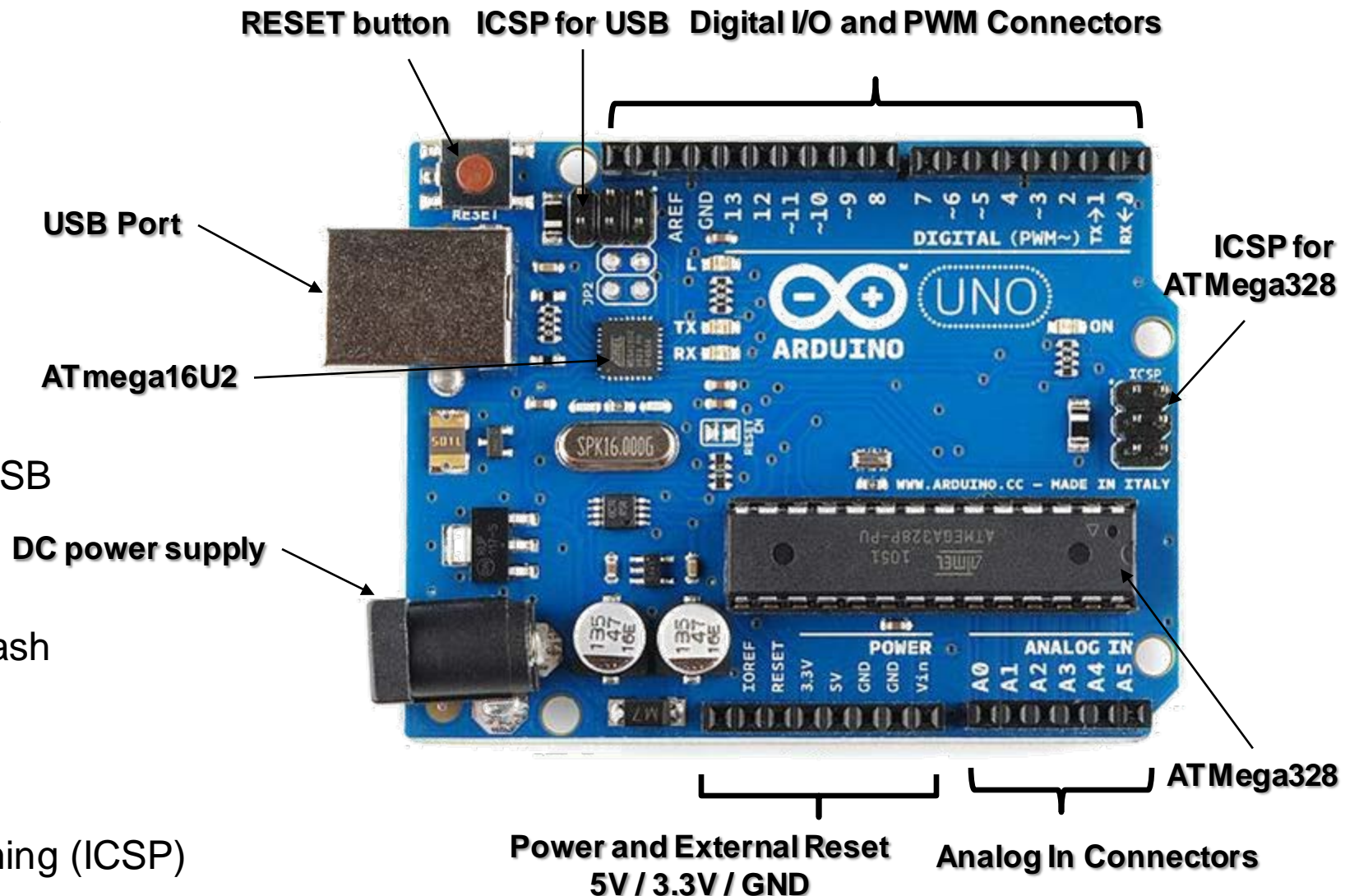
1. Application code

- ✓ Executes main functionality
- ✓ **We write this code**
- ✓ Stored in Flash memory
- ✓ Uploaded via USB

2. Firmware

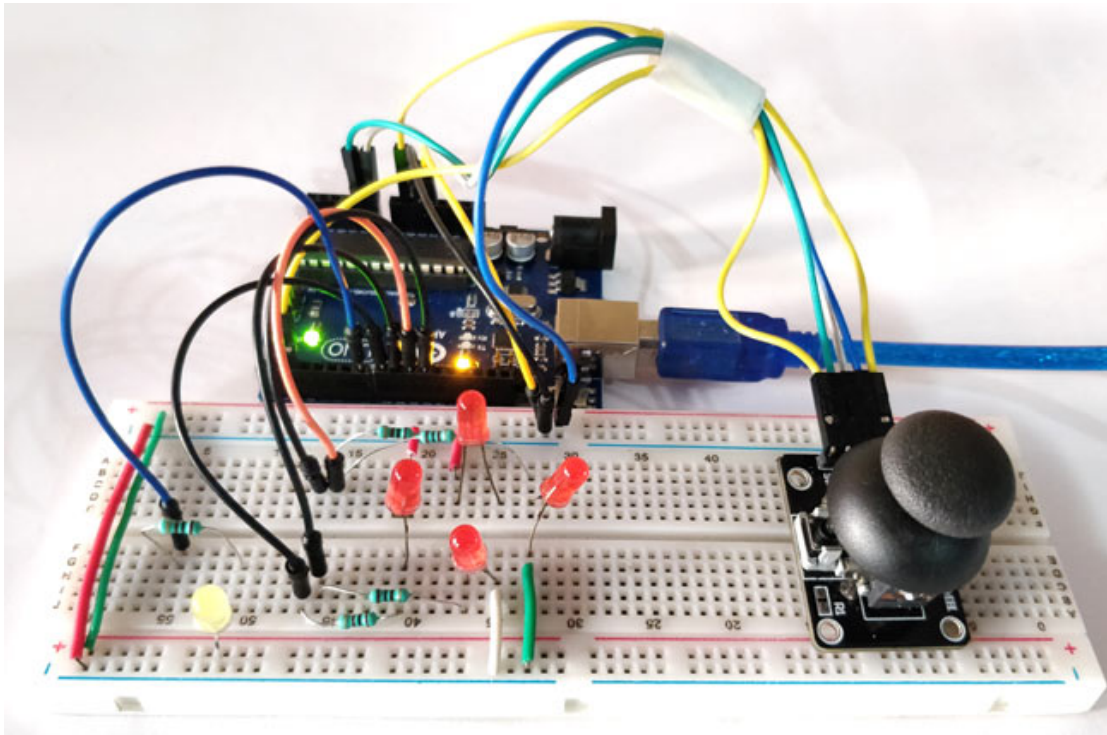
- ✓ Low-level code:
- ✓ Manages the system and USB
- ✓ Not user programmable
- ✓ Bootloader is fixed
- ✓ Other firmware stored in Flash memory
- ✓ Reprogrammed through ICSP and the bootloader

- In-Circuit Serial Programming (ICSP)



Connecting to the world

- Can connect sensors, actuators, and other electronics to the IO connectors.



Arduino Shields

- Special-purpose circuit boards:
 - Specialised functionality
 - Extends the Arduino
 - Easy to attach
 - Good libraries provided

Buttons and Joystick Shield



Shield mounted on the Arduino



Micro SD Shield



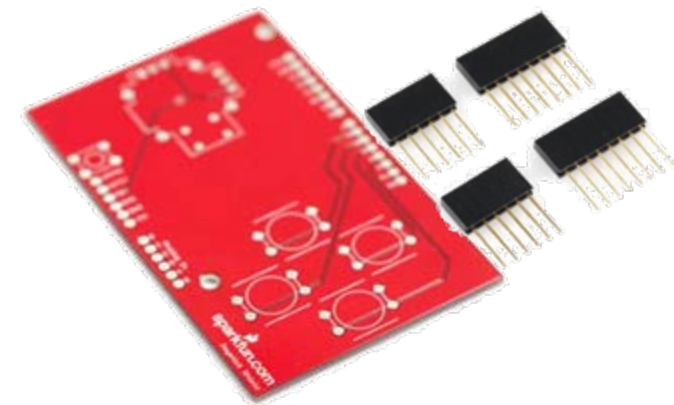
MP3 Trigger Shield



LCD Shield



PCB: Build your own shield!



Arduino Uno Specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (6 PWM)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Pseudocode

- A plain language description of the steps in an algorithm or another system

```
1 Repeat
2   Turn the built in LED on
3   Wait for one second
3   Turn the built in LED off
4   Wait for one second
```

Pseudocode

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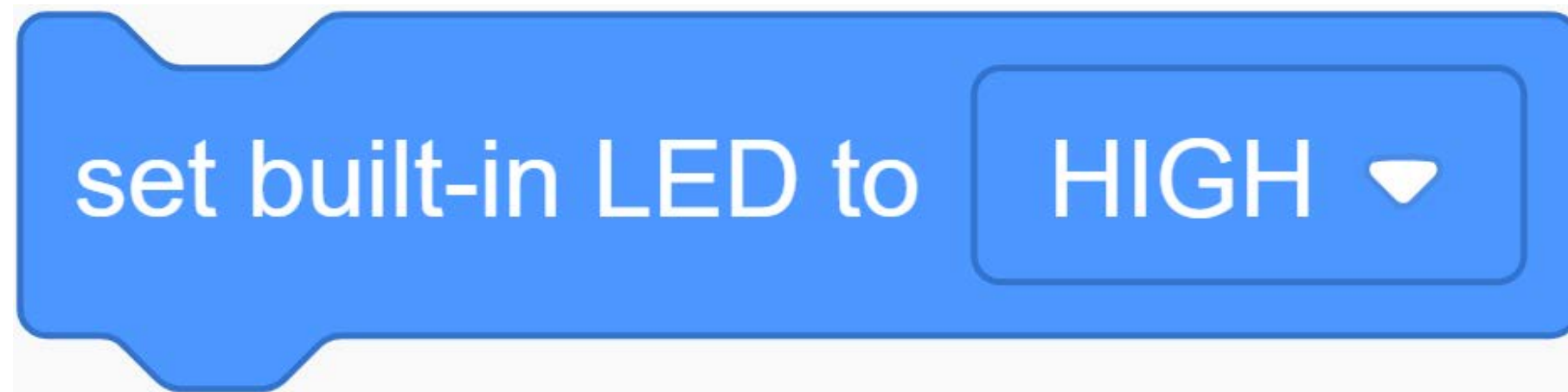
Programming language for Arduino

- At first, programming language in Arduino it might look cryptic.

```
void setup() {  
    pinMode(LED_BUILTIN, OUTPUT);  
}  
void loop() {  
    digitalWrite(LED_BUILTIN, HIGH);  
    delay(1000);  
    digitalWrite(LED_BUILTIN, LOW);  
    delay(1000);  
}
```

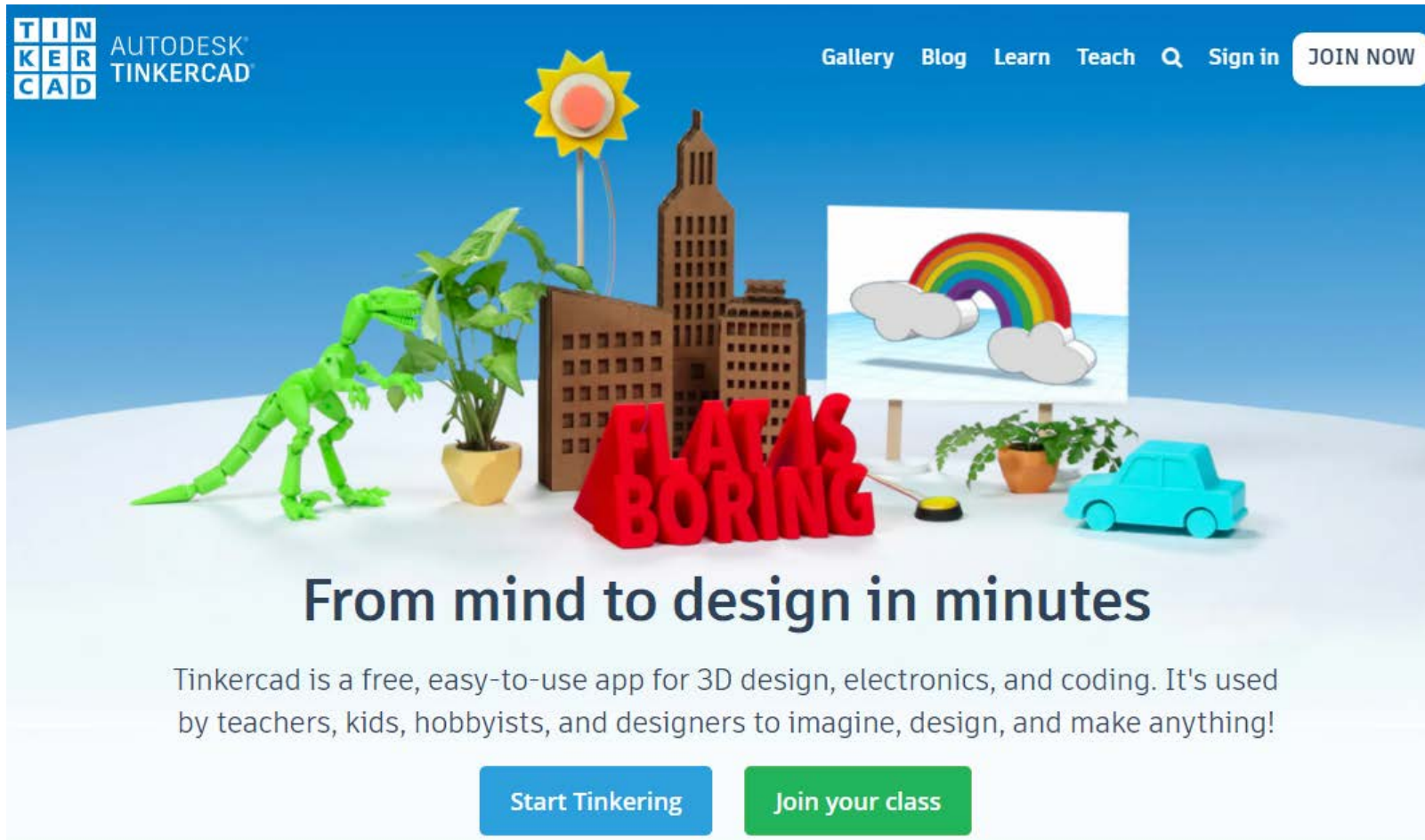
- We can use graphical programming
 - You can learn programming fundamentals
 - You do not need to worry about syntax

Graphical programming



Using the Simulator

- AUTODESK, Tinkercad: <https://www.tinkercad.com/>

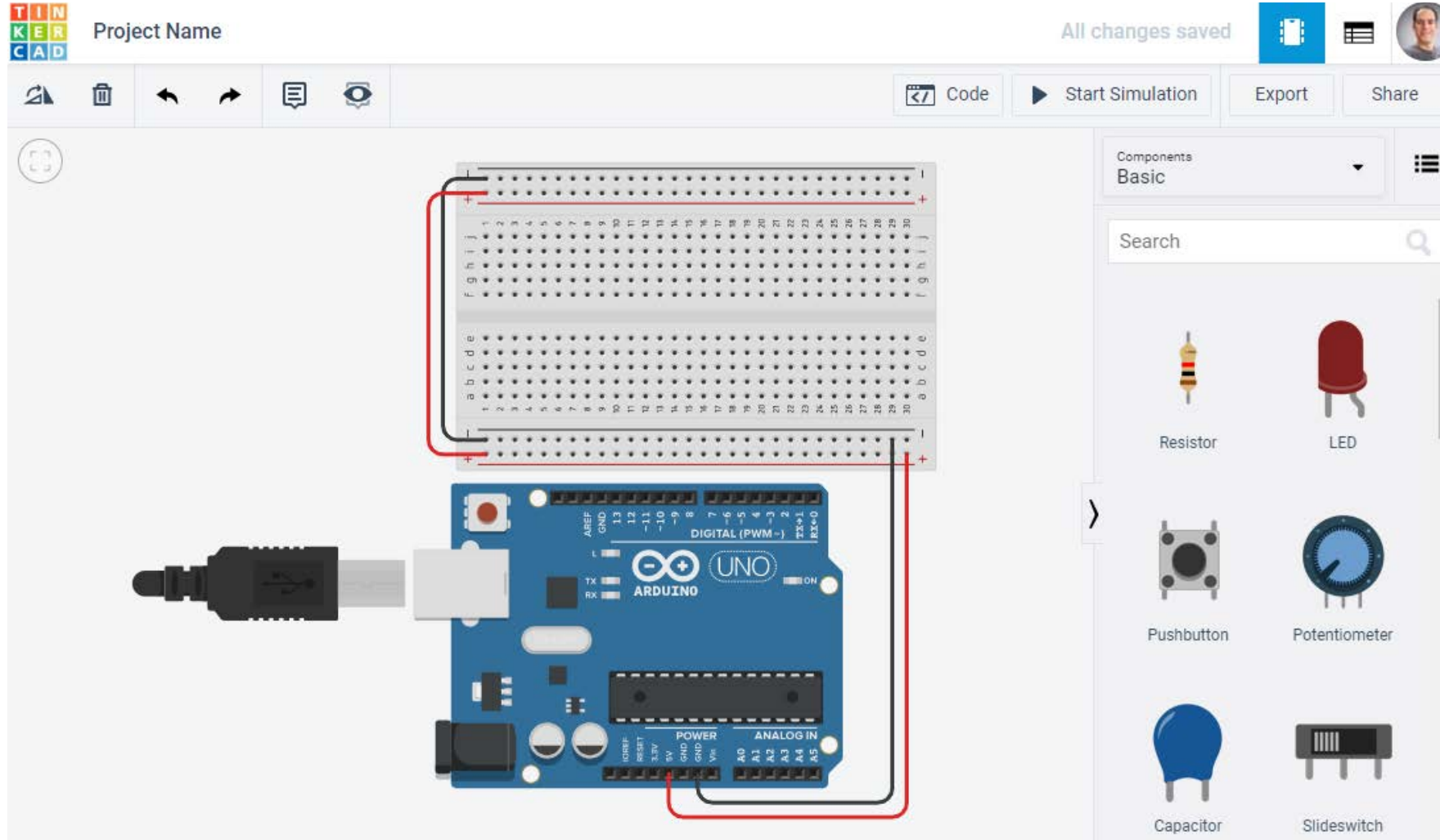
A screenshot of the Tinkercad website's main banner. The background is a bright blue sky with a white ground plane. In the center, there are several 3D models: a green dinosaur, a potted plant, a yellow sun on a stick, a brown skyscraper, a white screen displaying a rainbow, a red car, and a broom. The text 'FLAT IS BORING' is written in large, red, 3D block letters. At the top left is the Tinkercad logo, and at the top right are navigation links: 'Gallery', 'Blog', 'Learn', 'Teach', 'Sign in', and a 'JOIN NOW' button.

From mind to design in minutes

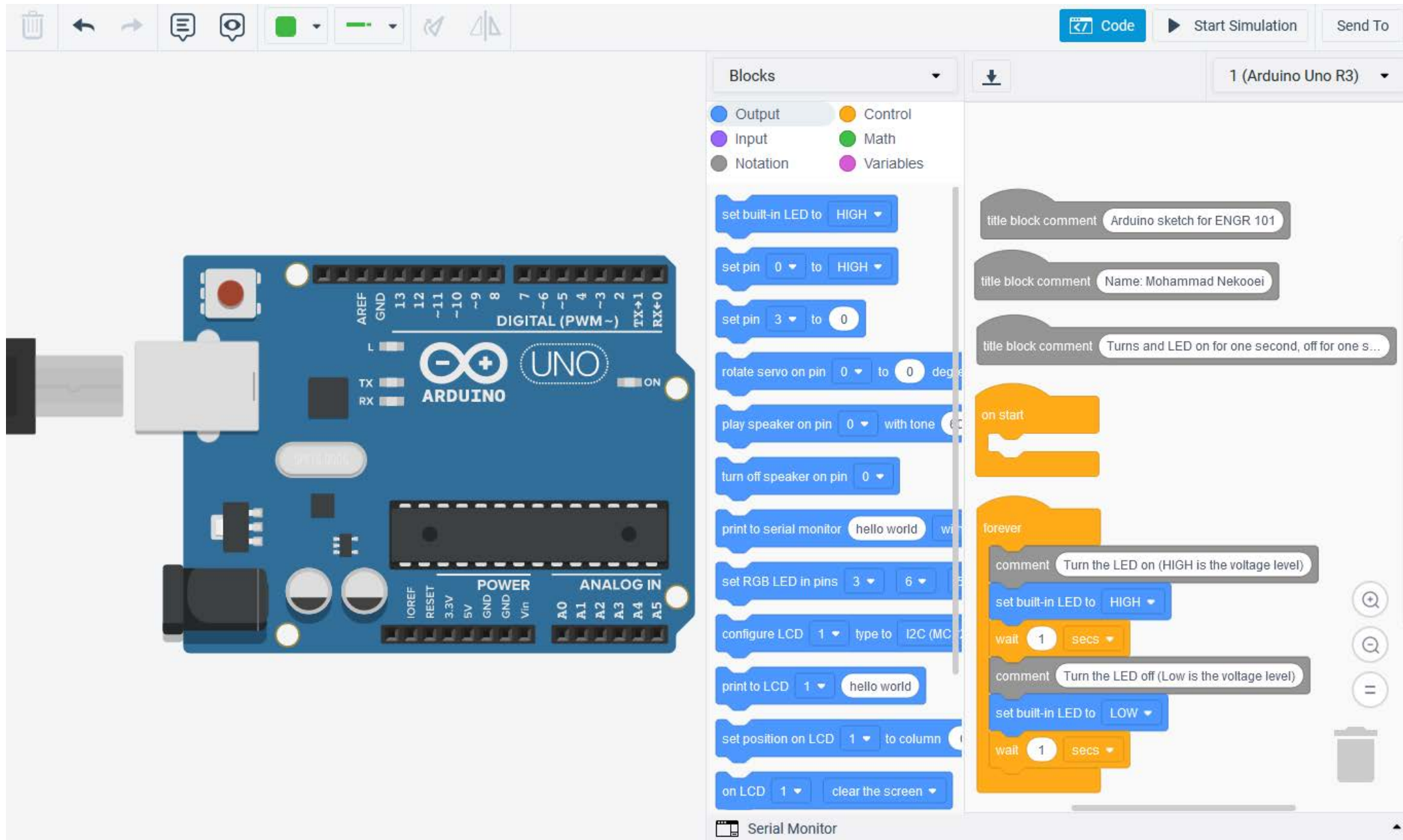
Tinkercad is a free, easy-to-use app for 3D design, electronics, and coding. It's used by teachers, kids, hobbyists, and designers to imagine, design, and make anything!

[Start Tinkering](#) [Join your class](#)

Using the TinkerCad Simulator



Graphical programming in TinkerCad



The screenshot displays the TinkerCad graphical programming environment. On the left, a 3D model of an Arduino Uno R3 board is shown with a USB Type-C cable connected. The central workspace contains a palette of blocks categorized by function: Output (blue), Input (purple), Notation (grey), Control (orange), Math (green), and Variables (pink). The main workspace is populated with a sequence of blocks: 'set built-in LED to HIGH', 'set pin 0 to HIGH', 'set pin 3 to 0', 'rotate servo on pin 0 to 0 degrees', 'play speaker on pin 0 with tone', 'turn off speaker on pin 0', 'print to serial monitor hello world', 'set RGB LED in pins 3 6', 'configure LCD 1 type to I2C (MC)', 'print to LCD 1 hello world', 'set position on LCD 1 to column', and 'on LCD 1 clear the screen'. The right side of the workspace features a script for controlling an LED, starting with an 'on start' block, followed by a 'comment' block: 'Turn the LED on (HIGH is the voltage level)', a 'set built-in LED to HIGH' block, a 'wait 1 secs' block, another 'comment' block: 'Turn the LED off (Low is the voltage level)', a 'set built-in LED to LOW' block, and a final 'wait 1 secs' block. The top right corner includes buttons for 'Code', 'Start Simulation', and 'Send To'. The bottom left corner shows the 'Serial Monitor' icon.

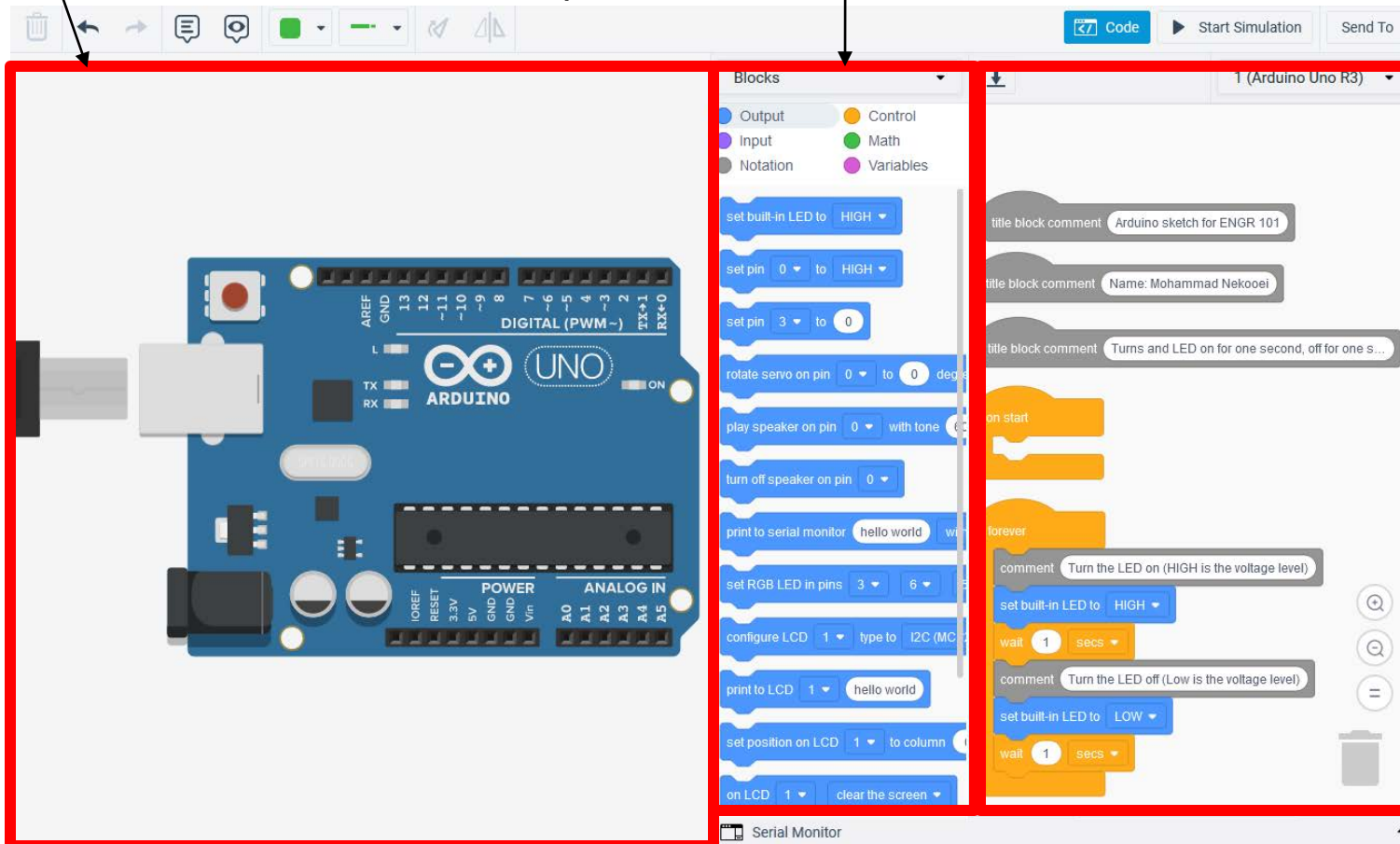
Graphical programming in TinkerCad

Designing area: designing digital circuits and connecting different components to Arduino

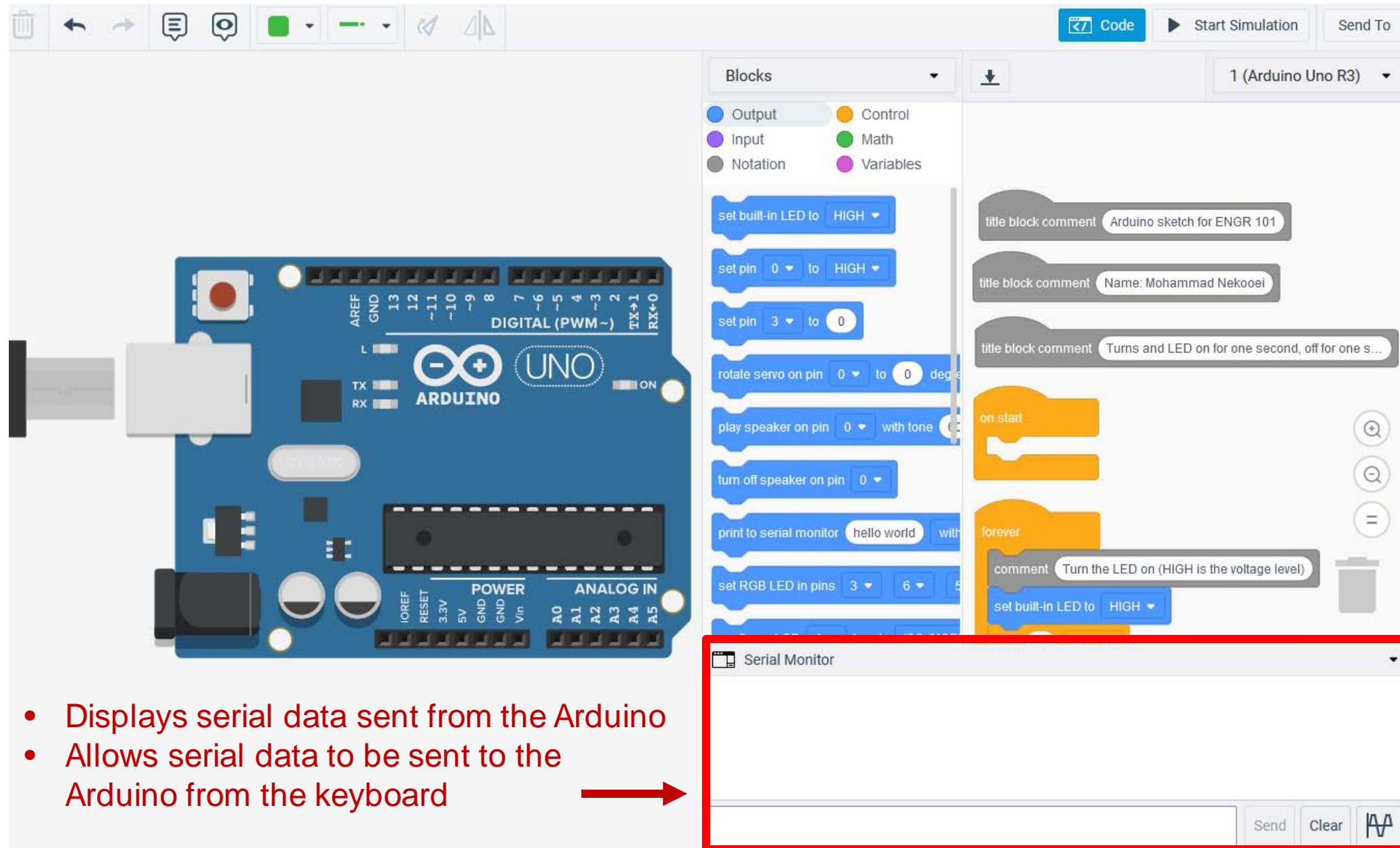
Programming blocks: they are like puzzle pieces

- We have functions, variables, conditionals and Boolean expressions and more in different colours and shapes

Programming area: Connecting the block together



Serial Monitor in TinkerCad



The screenshot displays the TinkerCad environment. On the left is a 3D model of an Arduino Uno R3 board. The central workspace contains a block-based code editor with the following blocks:

- set built-in LED to HIGH
- set pin 0 to HIGH
- set pin 3 to 0
- rotate servo on pin 0 to 0 degrees
- play speaker on pin 0 with tone
- turn off speaker on pin 0
- print to serial monitor hello world with
- set RGB LED in pins 3, 6, 5

The right sidebar shows a 'Blocks' palette with categories: Output, Input, Notation, Control, Math, and Variables. Below the code editor are several title block comments:

- Arduino sketch for ENGR 101
- Name: Mohammad Nekooei
- Turns and LED on for one second, off for one s...

The Serial Monitor window at the bottom is highlighted with a red border and contains the text:

```
Serial Monitor
```

At the bottom right of the Serial Monitor window are buttons for 'Send', 'Clear', and a refresh icon.

- Displays serial data sent from the Arduino
- Allows serial data to be sent to the Arduino from the keyboard

