micro:bit

JavaScript meets microcontroller

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Agenda

- What is micro:bit?
- Not only JavaScript
- Setting up your environment
- Programming
- Resources
- Demo 🙀

What is micro:bit?

BBC's take on STEM

- BBC tries to promote Science, Technology, Engineering and Mathematics (STEM)
- Targeting 11-12 years old children
- Transformation from consumer to designer/developer/producer
- Organized in Microbit Educational Foundation
  - 20+ partners

A little history lesson

- Developed by BCC
- Introduced in 1981
- Featured in BBC's *The Computer Programme*
- Heavily used in schools in UK
- Manufactured by Acorn
  - Acorn later designed Acorn Risc Machine
  - And later changed its name to ARM
- BASIC as main programming language

Hardware

- 16 MHz ARM Cortex-M0 (32 bit)
- 256 KB flash + 16 KB memory
- 2.4 LE Bluetooth
- MicroUSB port
- 5×5 LED array (display)
- 1 reset button + 2 user buttons
- 3-axis accelerometer
- 3-axis magnetometer
- 3× I/O ports (0-2), 3V and GND with crocodile clip)
- Edge connector Power-Width Modulator (PVM) and General-Purpose I/O (GPIO)
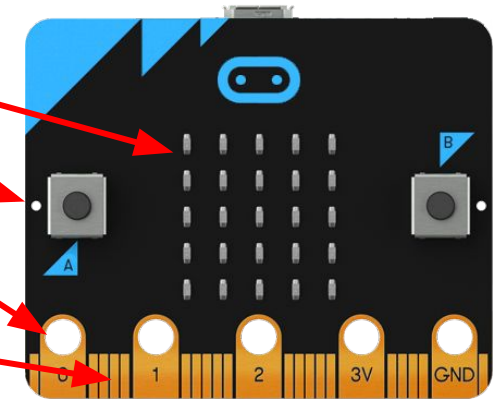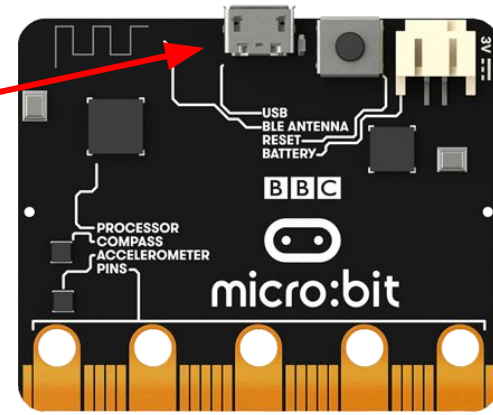
Block programming

- Web based development environment
- Simple blocks instead of text
- Blocks for
  - Loops and branches
  - Reacting to events (pressing a buttons, etc.)
  - Writing to the display (5×5 LEDs)
- Built-in simulator
- Community contributed blocks
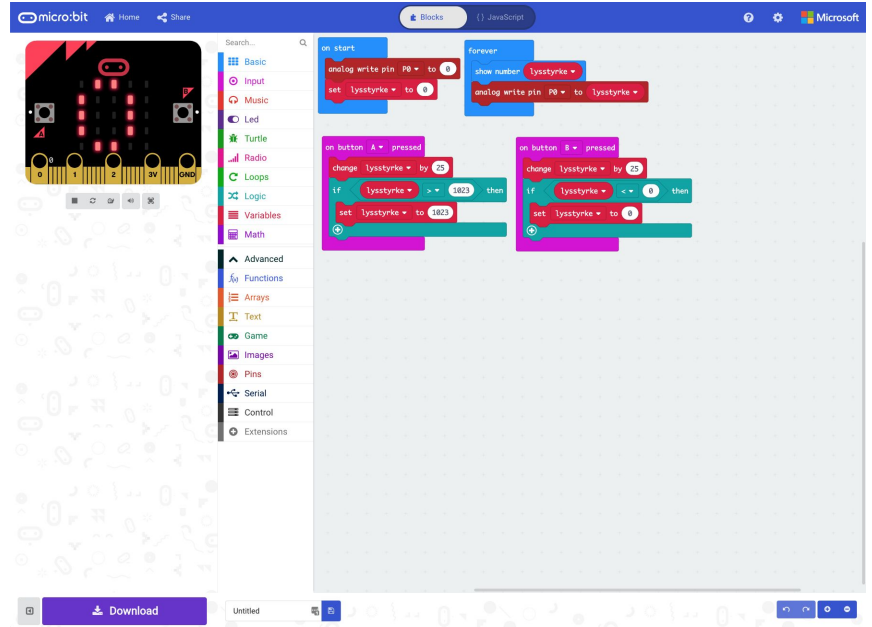
3rd party kits

- Educational kits
  - Resistors, battery pack, LEDs
- Robotics kits
  - Motor drivers, motors
- Game console kits
  - Joystick, buttons
- IoT kits
  - Sensors
- Many home brew projects
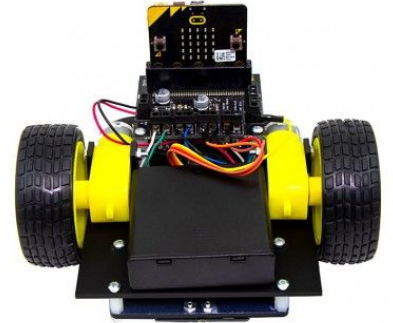
DR ultrabit

- Danmark's initiative to promote STEM
- Target: 4. - 6. grade (9 - 11 years)
- 90 % of all 4. graders received a kit in 2018!
- Curriculum/projects adapted to Danish schools (or at least translated from English)
- TV programmes (channel DR ultra)
- 15+ partners
- Financially supported by Industriens Fond
- Running for at least three years

- micro:bit (of course!)
- Crocodile bites
- Battery pack
- Red, green and yellow LEDs
- Buzzer
- Copper tape

Not only JavaScript

MicroPython

- MicroPython is a special edition of Python
- Originally targeting IoT devices
- Compiles Python 3.4 and some Python 3.5 to ARM, Arduino, ESP8266, ESP32, and micro:bit
- Threads are supported
- Some standard modules are implemented
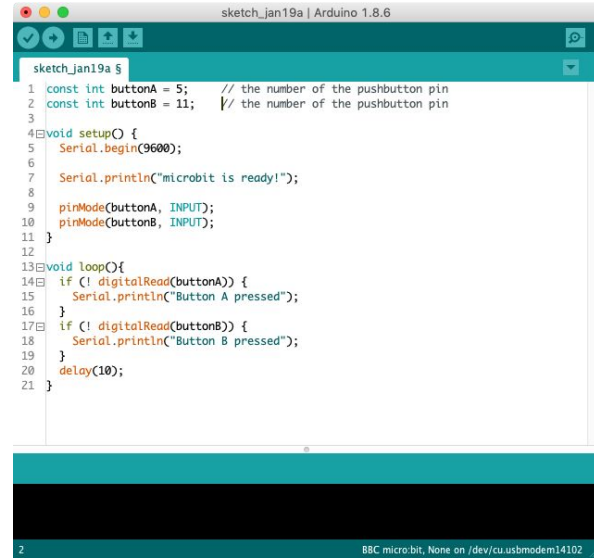- Only a limited set of data types are supported
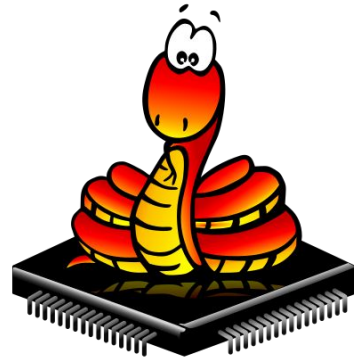
```python
from microbit import *

intensity = 0

while True:
    if button_a.is_pressed():
        intensity += 25
        if intensity > 1023:
            intensity = 1023
    if button_b.is_pressed():
        intensity -= 25
        if intensity < 0:
            intensity = 0
    display.scroll(intensity)
    pin0.write_analog(intensity)
```
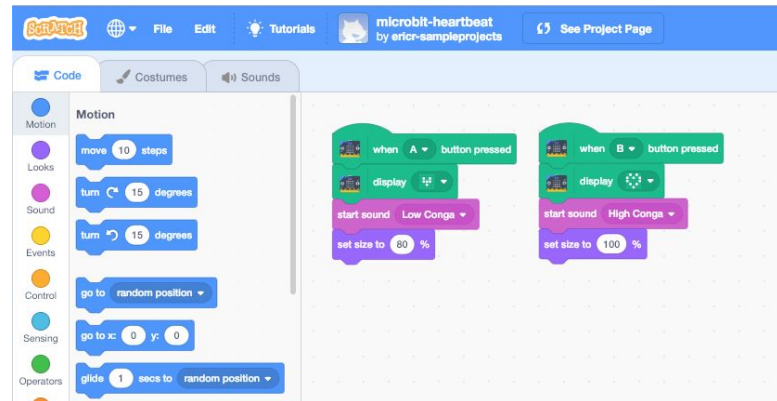
And a few others

- C++ is officially supported
  - Using either GCC or ARMCC as toolchain
  - Direct access to runtime library
- Arduino
  - C/C++ and runtime
- Pascal, Lisp, Forth and Ada are alternative languages
- Scratch 3 (block programming for kids) can be used
- Simulink (block programming for Matlab users)
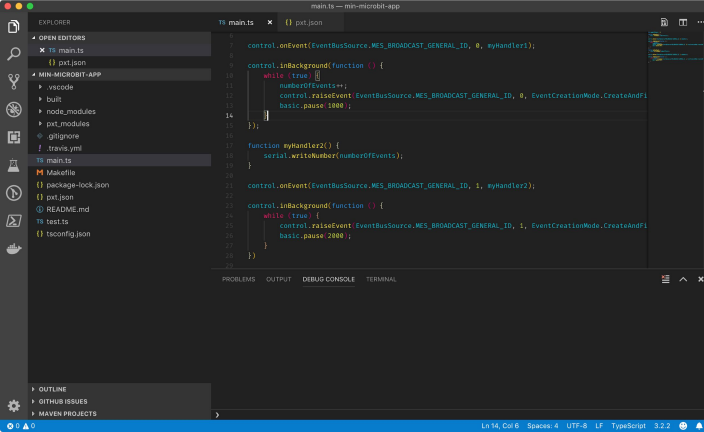
Setting up your environment

Programming Experience Toolkit (pxt)

- Provided by Microsoft
- Easy to install (for node users)
  - `npm install -g pxt`
- Command-line interface
- Tight integration with Visual Studio Code
  - Terminal �to Run Task
- Includes a simulator (but is hard to get to work)
- Much of the runtime library is written in C++

A new project

- Creating a new project
  - `mkdir my-microbit-app && cd my-microbit-app`
  - `pxt target microbit` - set platform
  - `pxt init` - create a skeleton project with VSCode integration
  - `pxt npminstallnative` - install basic packages
- Building your project
  - `pxt build`
- Run on a real device
  - `pxt deploy`
- Start simulator and run app
  - `pxt serve`
  - `pxt run`

Programming

Static TypeScript

- Subset of TypeScript v2.6
  - Most rookie code is plain JavaScript □
- The usual types including strings and arrays
- `any` is not supported
- Generic functions cannot be values
- pxt compiles static TS to ARM assembler
  - Take a look in `built/binary.hex`

A rich runtime library

- The core library includes a number of modules
  - `basic` - the most common functions
  - `input` - various input functions (buttons, gestures, …)
  - `control` - spawning threads and manipulation of events
  - `music` - play tones using a set of attached headphones
  - `serial` - write strings and numbers to the serial port (useful when debugging
  - `console` - the usual logging function
  - `led` - control the 5×5 display

```
basic.forever(function () {
    led.toogle(3, 3)
    basic.pause(1000)
})
```



```
let freq = 440
for (let i = 0; i < 5; i++) {
    freq = i * freq
    music.playTone(freq, 1000)
}
```

Input and output

Register a handler to process input events

```
input.onButtonPressed(Button.A, function () {
    intensity += 25
    if (intensity > 1023) {
        intensity = 1023
    }
})
```

Output through plain function calls

```
basic.showNumber(intensity)
pins.analogWritePin(AnalogPin.P0, intensity)
serial.writeNumber(intensity)
```

Multitasking and events

- `control.inBackground()` spawns a new thread
- `basic.forever()` executes the same thread indefinitely
- Thread runs until it gives up the CPU - cooperative multitasking
  - Calling `basic.pause()` will release the CPU
- I/O events interrupts any running thread
  - So you won't miss `input.onButtonPressed()`

- `control.raiseEvent()` emits an event
- `control.onEvent()` registers an event handler
- You can listen for system events
- Or create your own events

Urs Steiner, https://www.flickr.com/photos/stoneysteiner/

Multitasking and events - example

```
let numberOfEvents = 0;

control.onEvent(EventBusSource.MES_BROADCAST_GENERAL_ID, 0,function () {
  basic.showNumber(numberOfEvents);
});

control.inBackground(function () {
  while (true) {
    numberOfEvents++;
    control.raiseEvent(EventBusSource.MES_BROADCAST_GENERAL_ID,
      0, EventCreationMode.CreateAndFire);
    basic.pause(1000);
  }
});

basic.forever(function () {
  serial.writeNumber(numberOfEvents);
  basic.pause(2000);
});
```
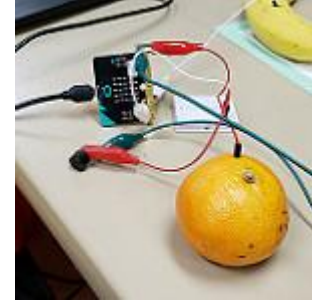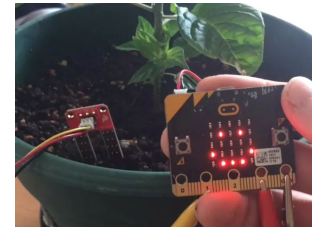
Resources

Resources

- Microbit Educational Foundation
  - https://microbit.org
- DR Ultrabit
  - https://www.dr.dk/om-dr/ultrabit
  - https://www.dr.dk/skole/ultrabit
- micro:mag
  - https://www.micromag.cc
- pxt
  - https://github.com/Microsoft/pxt
- Shops
  - https://raspberrypi.dk
  - https://elextra.dk

Abington Free Library, https://www.flickr.com/photos/abingtonroslynlibraries/

https://microbit.hackster.io/rypsmith/micro-bit-moisture-sensor-a6909c

Time for a demo