Introduction to Arduino Workshop

Arduino Platform - LEDs, switches, light, temperature and colour

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Internet of Things Sydney Meetup

Arduino Platform

Hardware and Software Overview

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Arduino

- Open source hardware and software platform
- It’s free!
- Easy to program
- Low cost hardware
- Many physical form factors

Hardware

- ATmega micro-controller from Atmel
- Arduino Uno
- Arduino Pro and Pro mini
- Lilypad and Flora (wearable)
- Funnel IO
- Mega + Due 32bit ARM CPU
- Yun and Tre - Linux

What can it really do?

- Great prototyping platform
- Research
- Art
- Drone
- Commercial products
- 3D printers

Arduino Board

- Connects via USB
- Power from USB or plug
- Digital inputs/outputs
- Analogue inputs
- PWM outputs - pulse width modulation
- Reset button

ATmega328

- High performance low power RISC
- 16 MHz up to 16 mips
- 32K Flash (2K used for bootloader), 1K EEPROM, 2K SRAM
- SPI and 2 wire serial interfaces
- External interrupts, timers, pulse width modulation
- Harvard architecture

Shields

- Plug on top of Arduino
- Many available
- Can make your own
- Can be stacked

IDE

- IDE open source and cross platform
- Projects are called sketches
- Many open source sketches and libraries available

Installing IDE

- Install IDE
- Install USD drivers

Programming

- C/C++ language based on wiring
- GCC under the hood
- Write code and compile in IDE
- Upload compiled code via USB
- Can monitor serial port
- Uploaded program is in non volatile memory

Overview of IDE

- Code editor
- Create new sketch
- Compile sketch
- Upload sketch
- Serial monitor
- Help and examples

Prototyping

- Breadboards
- Serial port

Digital Outputs

Turning on a LED

Circuit Basics

- Ground and power
- Potential difference required for current to flow
- Conductors and resistors

Circuit Basics

- Voltage measured in volts
- Current measured in amps
- Resistance measured in ohms

Digital Inputs/Outputs

- Digital pins on Arduino are dual purpose
- Digital logic and voltage on = 5V off = 0V
- Can be set to be input or output via pinMode

Variables

- Declare by <datatype> <variable name>; eg int i;
- Data types include boolean, char, byte, int, long , float, double, string and array.
- int 16 bits, long 32 bits, float 32 bits
- Strings are nul terminated ‘\0’

Setup Function

- Used for initialisation
- Run when program loaded or board reset
- Best place to place calls to pinMode

LEDs

- Light emitting diodes
- Current will only flow in one direction
- Emits light with current applied
- Don’t connect directly to power source use in series with a resistor

Resistors

- Resistors limit current flowing through them
- Value and tolerance indicated by colour bands
- Resistor values for LEDs
- For RGB or LED digits you need multiple resistors.

Loop Function

- Place main code here
- Set digital output via digitalWrite
- Output 13 is connected to led on board

Debugging via Serial Port

- Use Serial.begin to set speed
- Use Serial.print or Serial.println to output
- Use serial monitor in IDE to view

Test Program

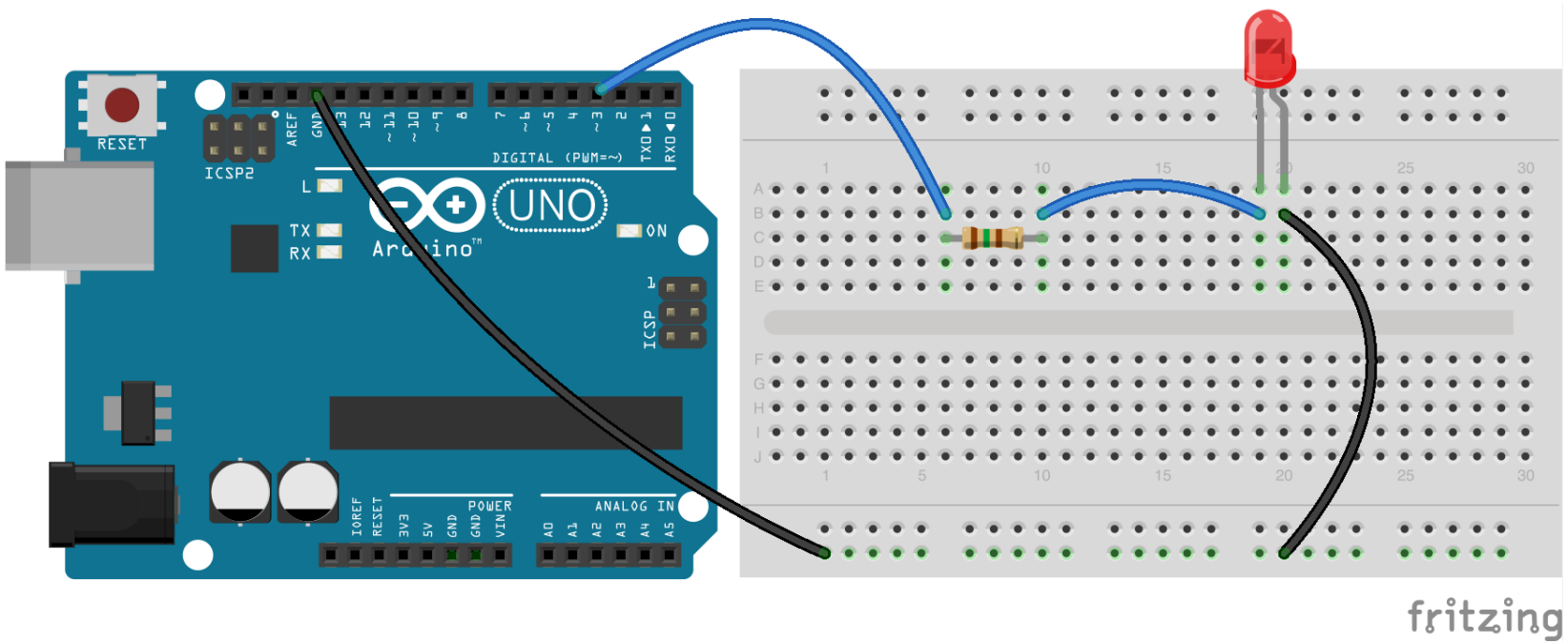
- Set output mode in setup function
- Turn on pin 13 LED in loop function
- Verify
- Upload

Breadboards

- Tracks under board
- Separated into 2 or 4 sections with optional power/ground sections
- Standard 0.1” spacing (imperial) so most through hole components can plug straight in

LED Circuit

- Add LED and resistor to breadboard
- Connect to Arduino
- Change pin no to 3


RESET
ICSP2
AREF
GND
DIGITAL (PWM=~)
TXD
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TX
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ICSP
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IOREF
RESET
3V3
5V
GND
GND
VIN
A0
A1
A2
A3
A4
A5
fritzing

LED Circuit

Blink

- Make led blink by calling delay

Digital Inputs

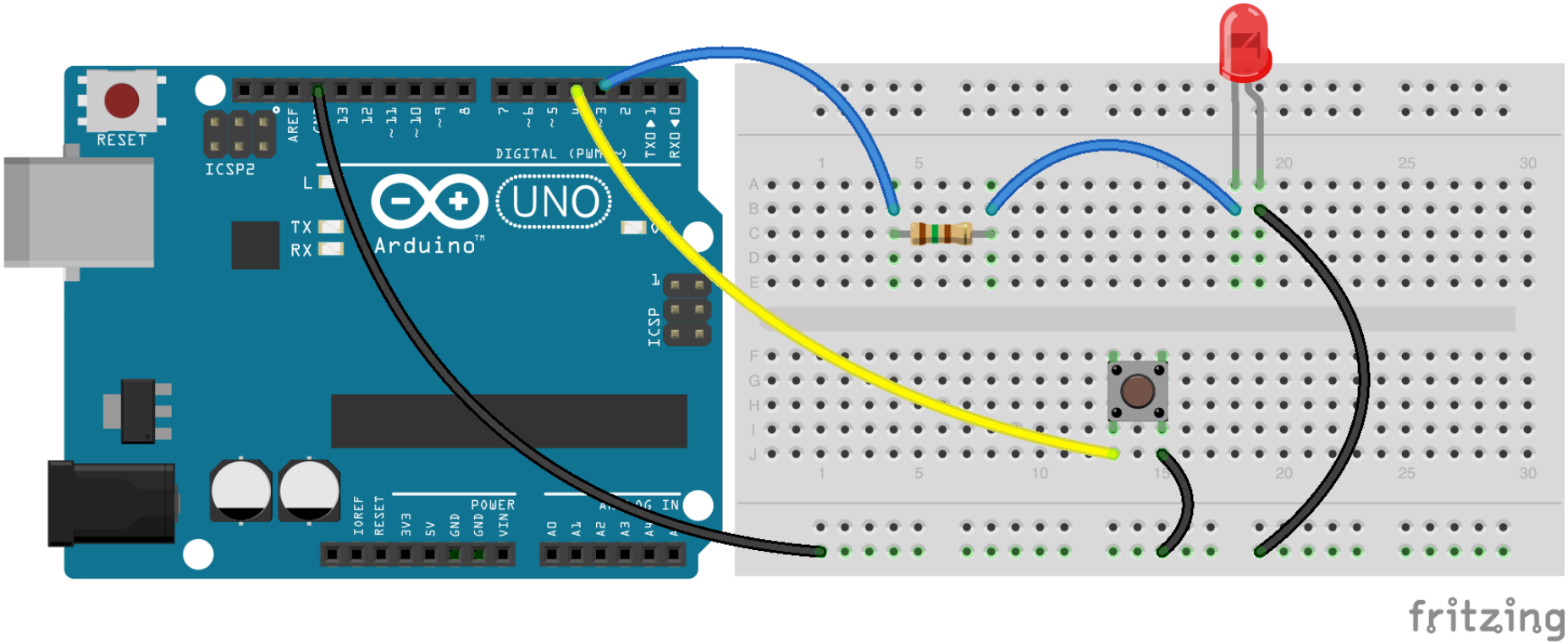
Connecting switches

Digital Inputs

- Some logic as inputs; high (5V) or low (OV)
- Simplest digital input switch
- Call pinMode to set as digital input as input
- Call digitalRead to see if switch is high or low

Connect Switch

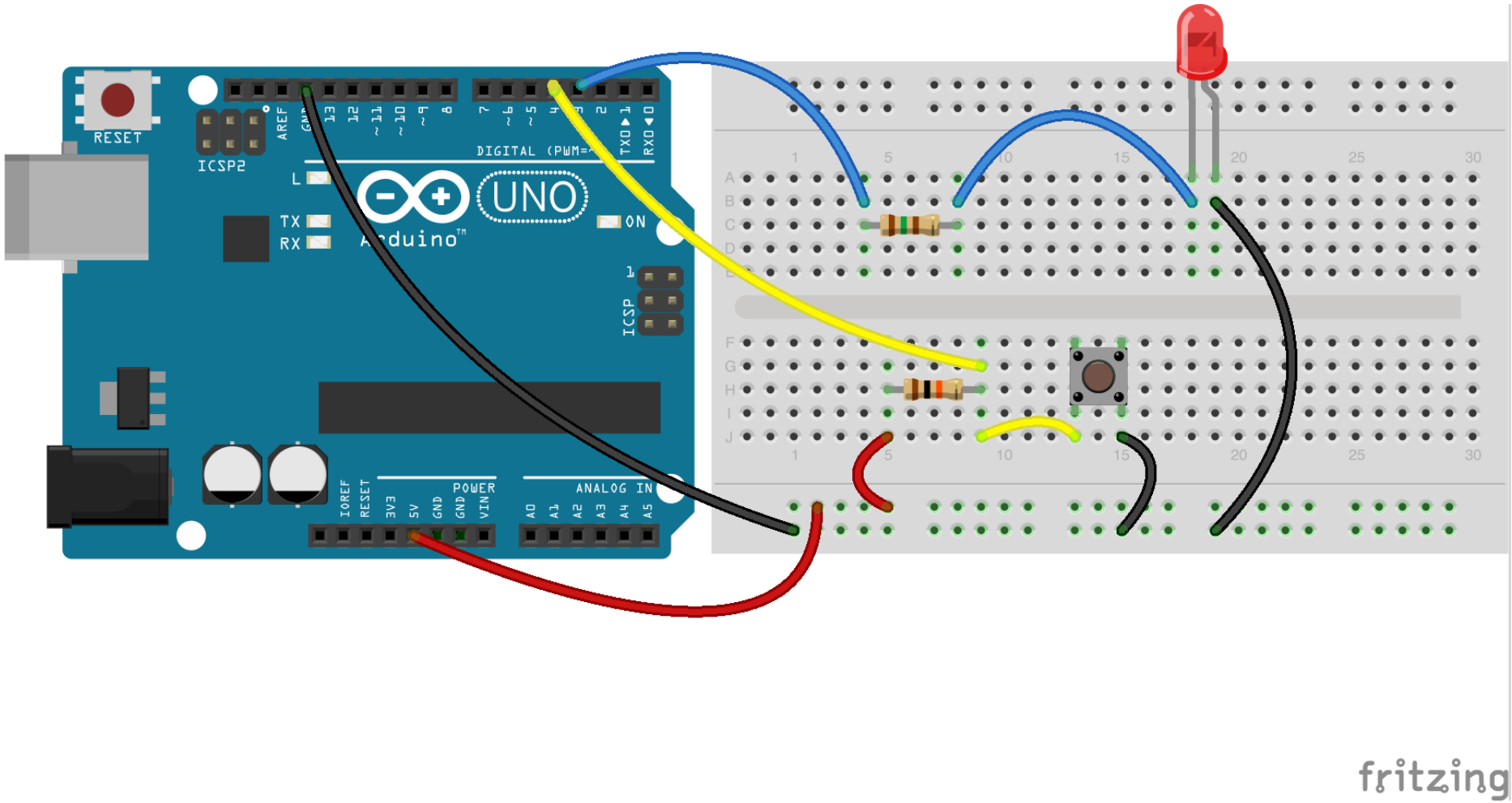
- Wire up push button on breadboard
- Change code to light led when switch is pushed



Switch Circuit

Floating Inputs

- Floating input issue
- 3 values hi, low and unconnected
- Solved by using pull up resistors



Switch Circuit 2

Internal Pullup Resistors

- Set mode to input
- digitalWrite to HIGH to turn on
- digitalWrite to LOW to turn off

Switch Issues

- Switches can bounce and give on and off values while switching
- Noise can give false results
- Use millis function to delay reading of value
- Can count on/off switches

Analogue Inputs

Connecting sensors

Reading Inputs

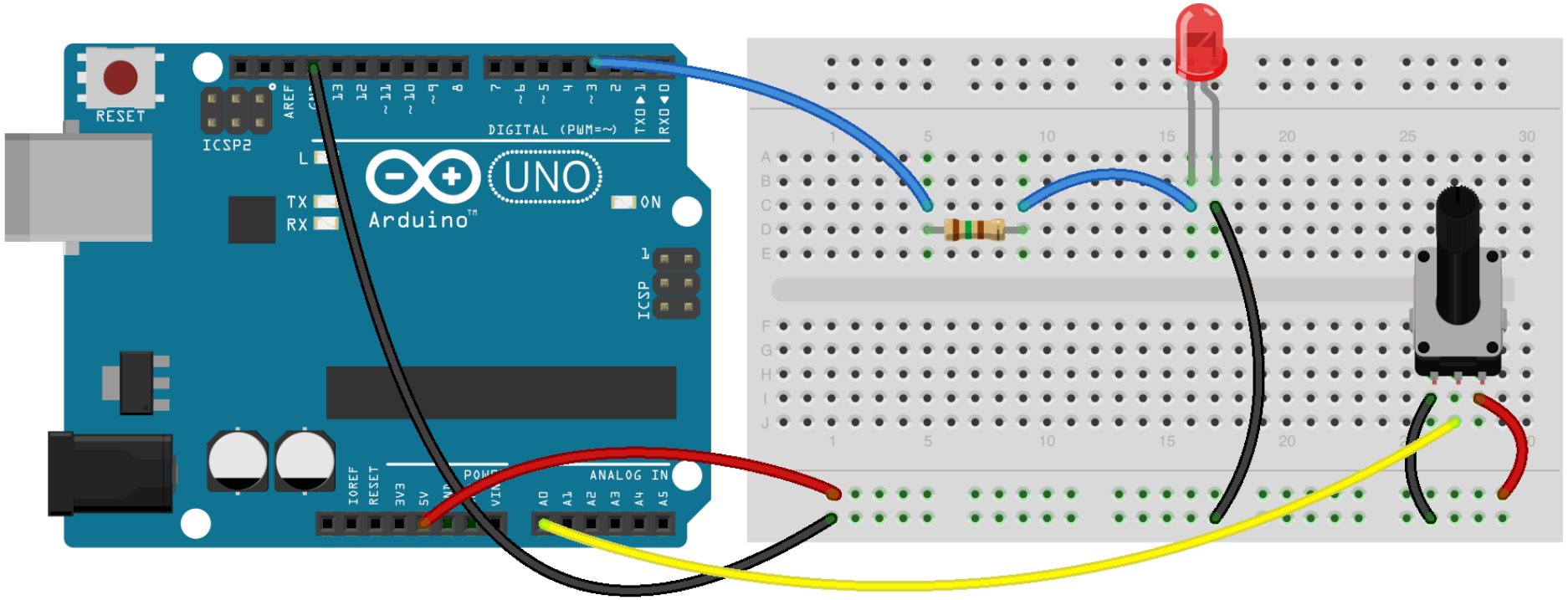
- Can read values via analogRead
- Result is in range 0 to 1023 (10 bits)
- 0V = 0 and 5V =1023

Potentiometer

- Variable resistor
- Different physical forms
- Usually three connections

Analogue Input

- Read potentiometer value
- Set led flash rate based on value



Potentiometer Circuit

Voltage Divider

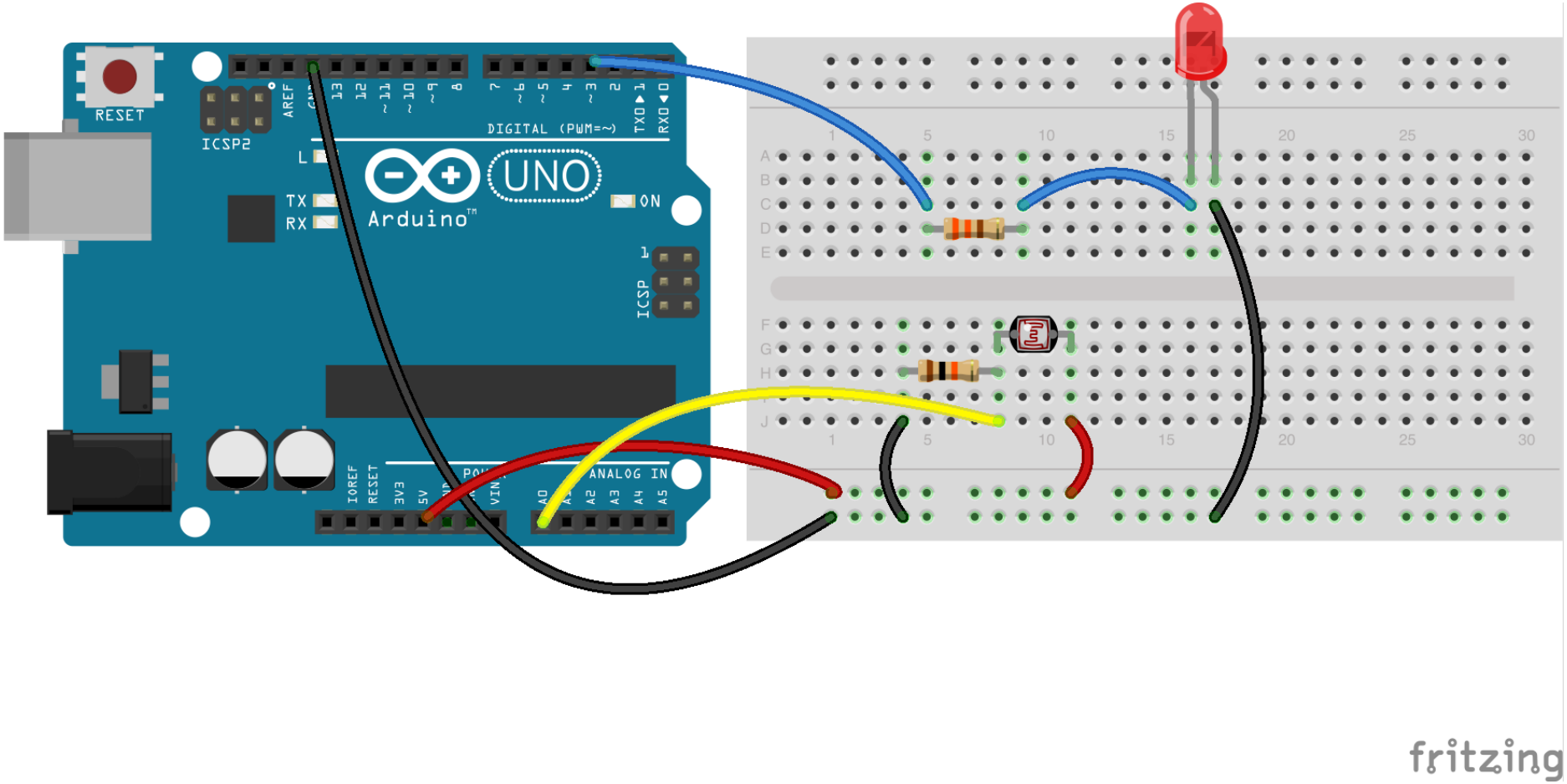
- Output voltage is a fraction of the input voltage. Use two resistors (one can be variable).
- $V = 5 \times R2/(R1+R2)$

Divider Examples

R1	R2	Voltage
100 Ohms	25 Ohms	1
100 Ohms	50 Ohms	1.67
100 Ohms	100 Ohms	2.5
100 Ohms	200 Ohms	3.33
100 Ohms	10K Ohms	4.95

LDR

- Light dependant resistor (high resistance)
- Set flash rate based on value of LDR


RESET
ICSP2
DIGITAL (PWM=~)
UNO
Arduino™
TX
RX
ON
ICSP
ANALOG IN
fritzing

LDR Circuit

Pulse Width Modulation

Controlling brightness of a LED

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Analogue Outputs

- No true analogue outputs
- Can simulate via pulse width modulation
- Square wave duty cycle
- Pins 3,5,6,9,10,11
- Set via analogWrite

Pulse Wave Modulation

- Square wave
- x% high and (100-x)% low
- Measure via oscilloscope

Functions

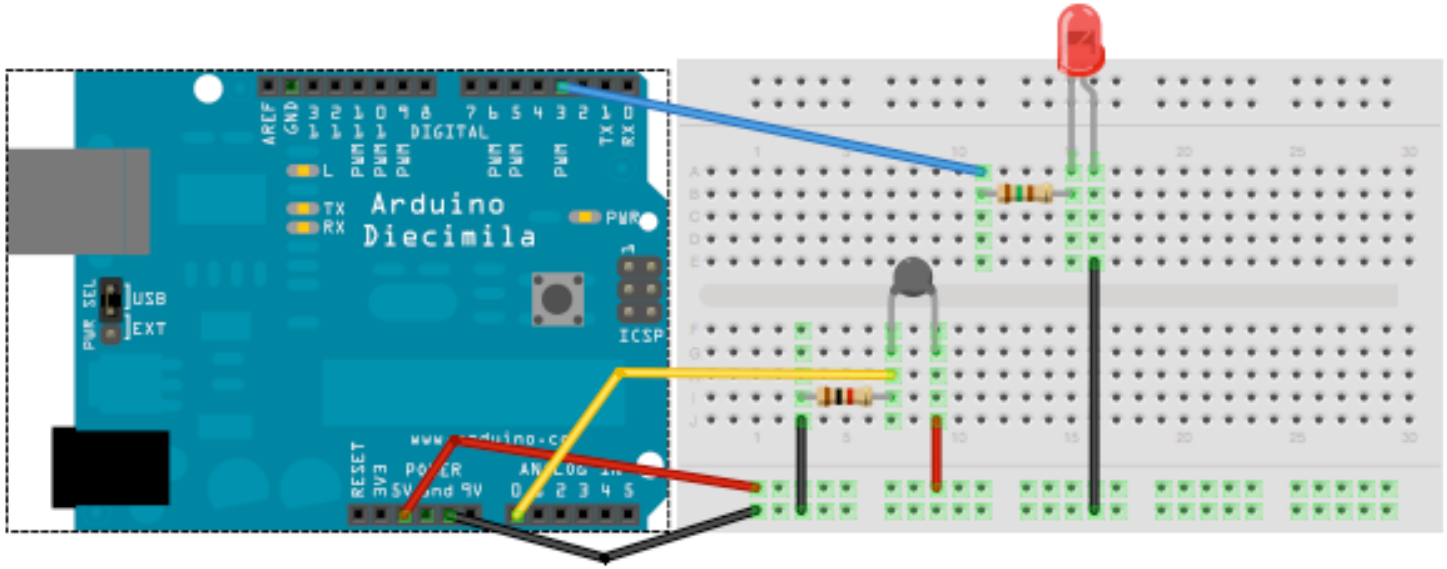
- Functions take 0 or more parameters
- Can optionally return a value
- <returntype> <name>(<paramaters>)

PWM LED

- Wire up LED to digital output
- Use delayMicroseconds for short delays
- Write fadeIn and fadeOut function using delay and analogueWrite to fade in and out

Thermistor

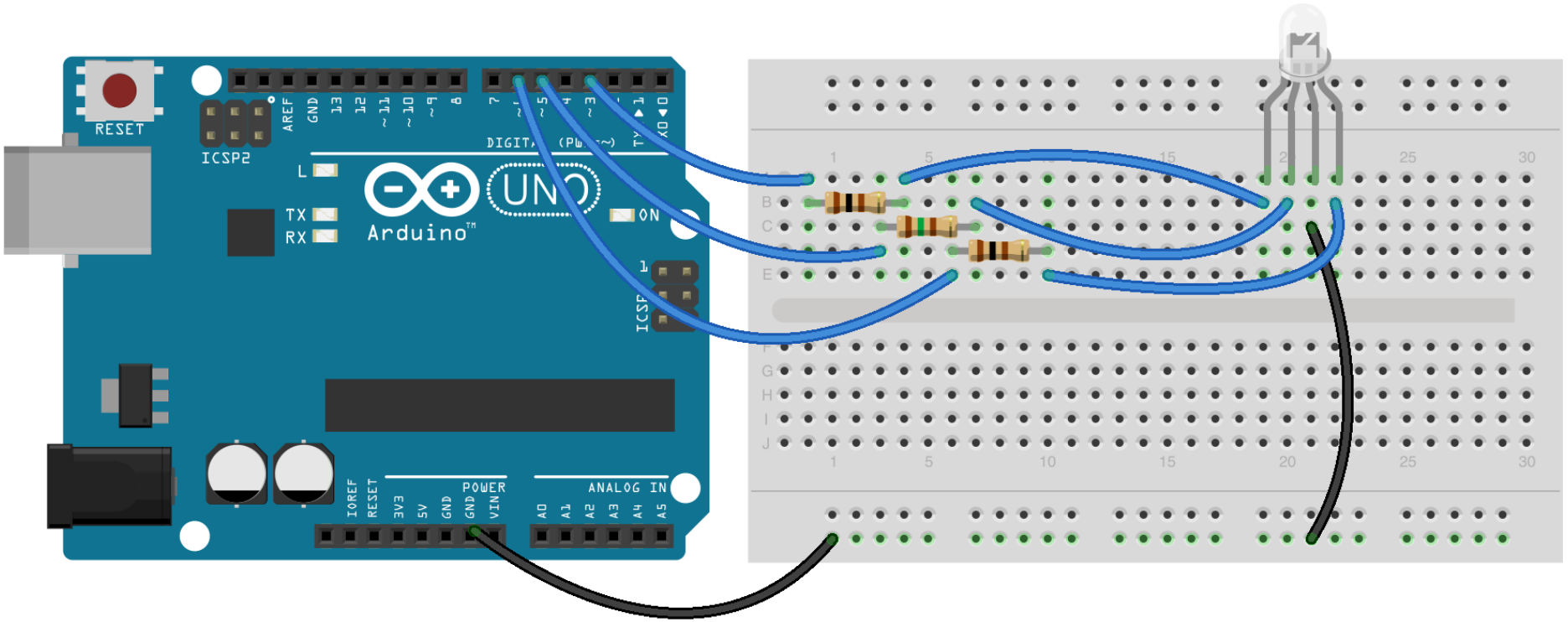
- Thermistors are temperature sensitive resistors
- Wire up thermistor and PWM led based on current temperature



Thermistor Circuit

Colour Mixing

- Wire up RGB 3 using 3 resistors
- Common (longest leg) is ground
- Be creative!



Colour Circuit

Fritzing

Turning your design into a real prototype

Resources

Finding out more information

Arduino Sites

- Arduino (http://ardunio.cc)
- Tinker It! (http://tinker.it)
- Lady Ada (http://ladyada.net)
- Seeed Studio (http://www.seeedstudio.com)

Electronic Components

- Spark fun (http://www.sparkfun.com)
- Little Bird Electronics (http://http://littlebirdelectronics.com)
- Freetronics (http://www.freetronics.com)
- Element14 (http://www.element14.com/)
- Electric Goldmine (http://www.goldmine-elec-products.com/)
- Digikey (http://www.digikey.com/)

Other Sites

- Make magazine (http://makezine.com/)
- Evil Mad Scientist (http://evilmadscientist.com)
- NYC Resistor (http://nycresistor.com)

Other Software

- Frizing (http://www.fritzing.org/) - helps make your own wiring diagrams and shields
- KiCad - make your own schematics and PCBs