CLASS 3

DIGITAL I/O, ANALOG OUTPUT

PLAN FOR CLASS 3

Review

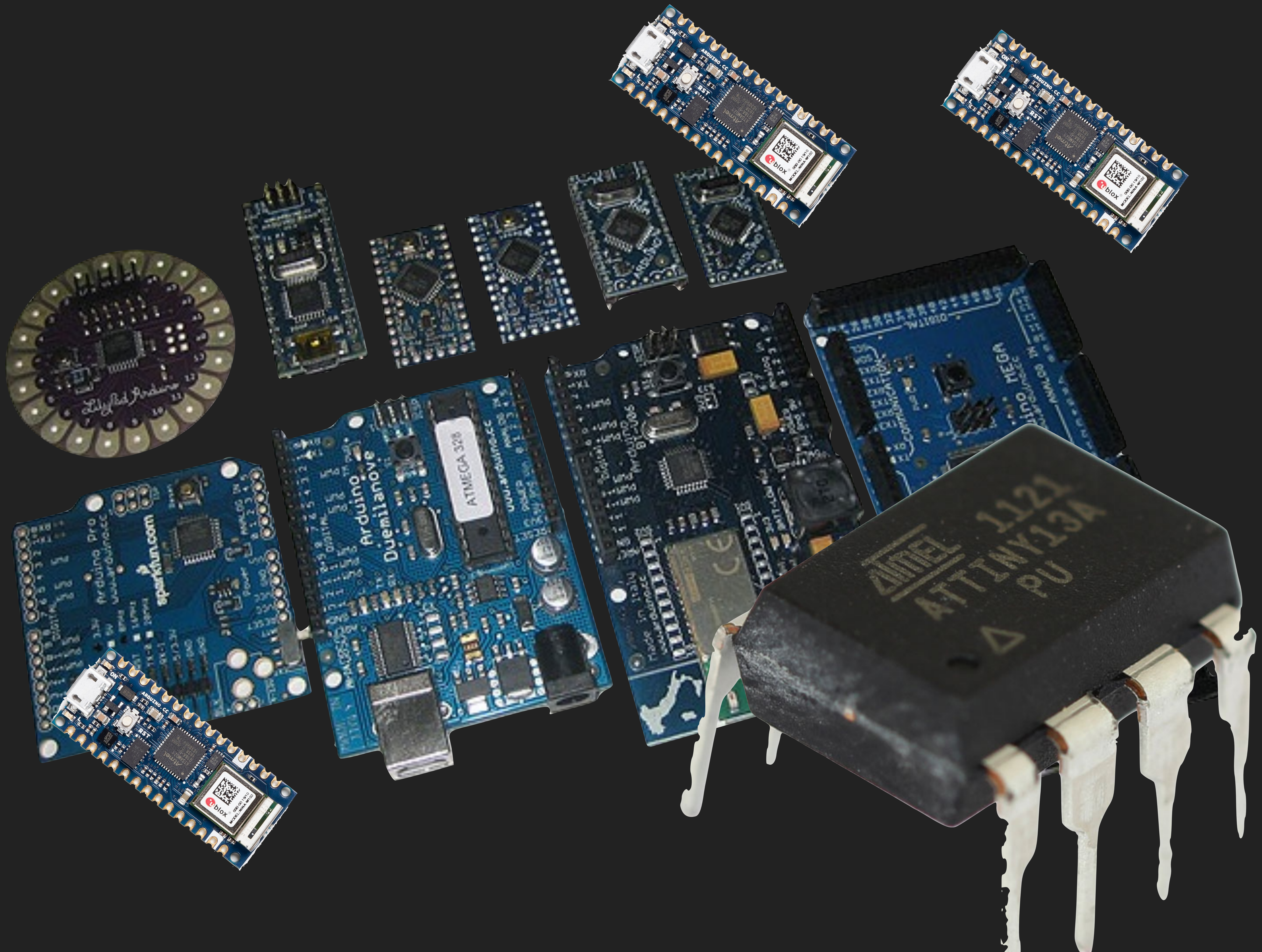
- AMA, Class 2, partial quiz review

New

- Microcontrollers
- Sensors
- Programming terms and environment
- Digital Input and Output
- Analog Input

Prep for Project 1 - form groups and brainstorm
Bonus (if time) soldering demo

MICROCONTROLLERS CAN BE LOTS OF DIFFERENT THINGS



SENSORS

convert something in the world (smell, light, mass, motion, etc.) into something the microcontroller can read

- Voltage (usually)
  - digital = two states (1-bit) above or below a threshold
  - analog = many states (2+ bits) mapped to many levels
- Digital data (covered later)

PROGRAMMING TERMS AND ENVIRONMENT

An **IDE** combines everything you need:

- text editor, compiler, libraries, uploader
- Arduino IDE has tools for specifying board, adding libraries, finding examples

Programming

- C / C++
- **typed** language (main difference from JS)
- generally, since we're "closer" to the machine, we need to be aware a bit more how it works (e.g. bits and bytes)

LEARNING A LANGUAGE

Learn the syntax

- case matters, semicolons matter, etc.

Learn how to organize code

- Functions (objects)
- Order of operations

Learn flow control

- for, if/then, while

Learn operators

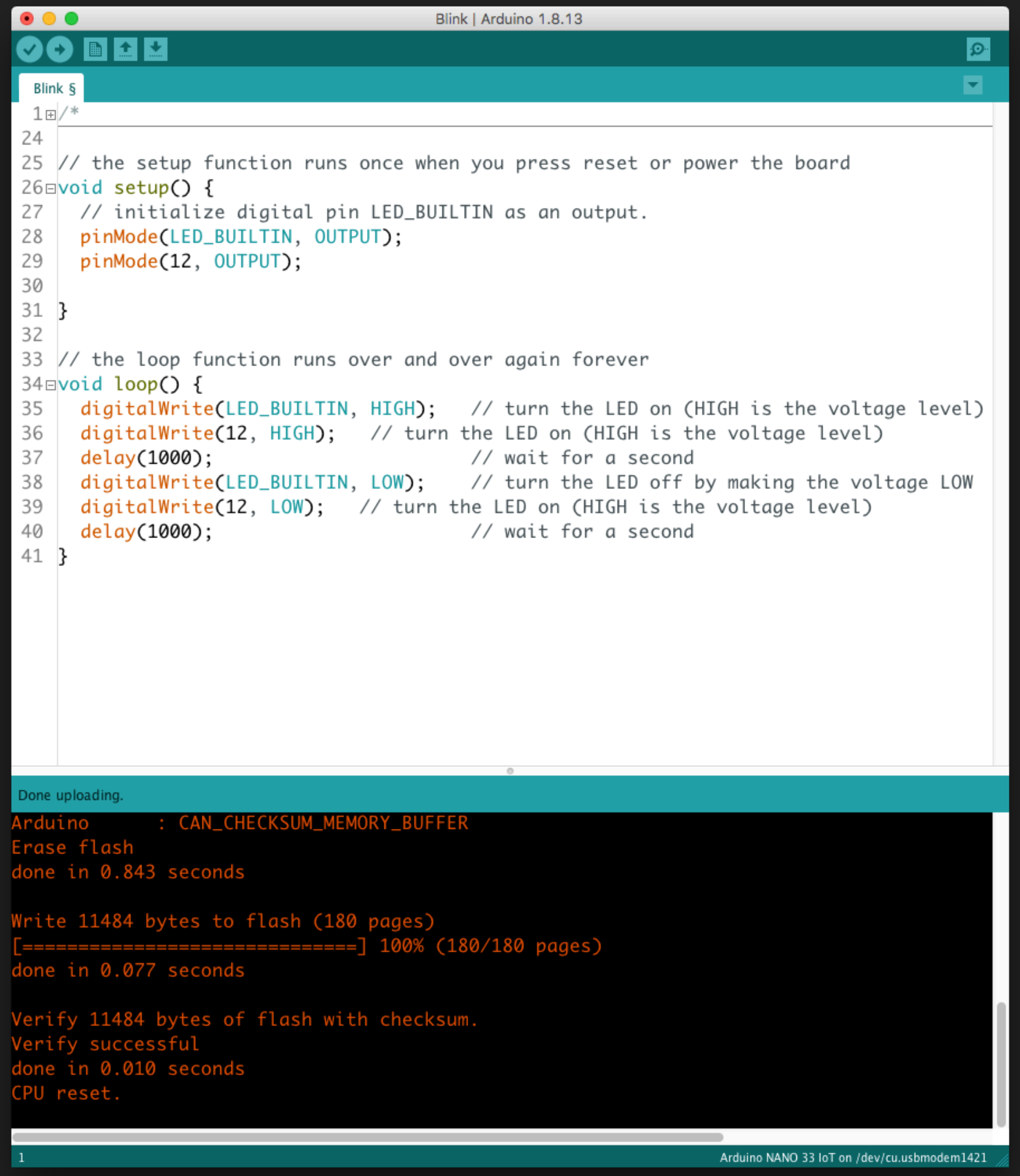
- = , ==, ! , && , ||

Learn other reserved words

PCOMP ENVIRONMENT

Most development environments will have similar elements

I.D.E.



Blink | Arduino 1.8.13

Blink §

```
/*

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
  pinMode(12, OUTPUT);

}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  digitalWrite(12, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  digitalWrite(12, LOW);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
}
```

Done uploading.

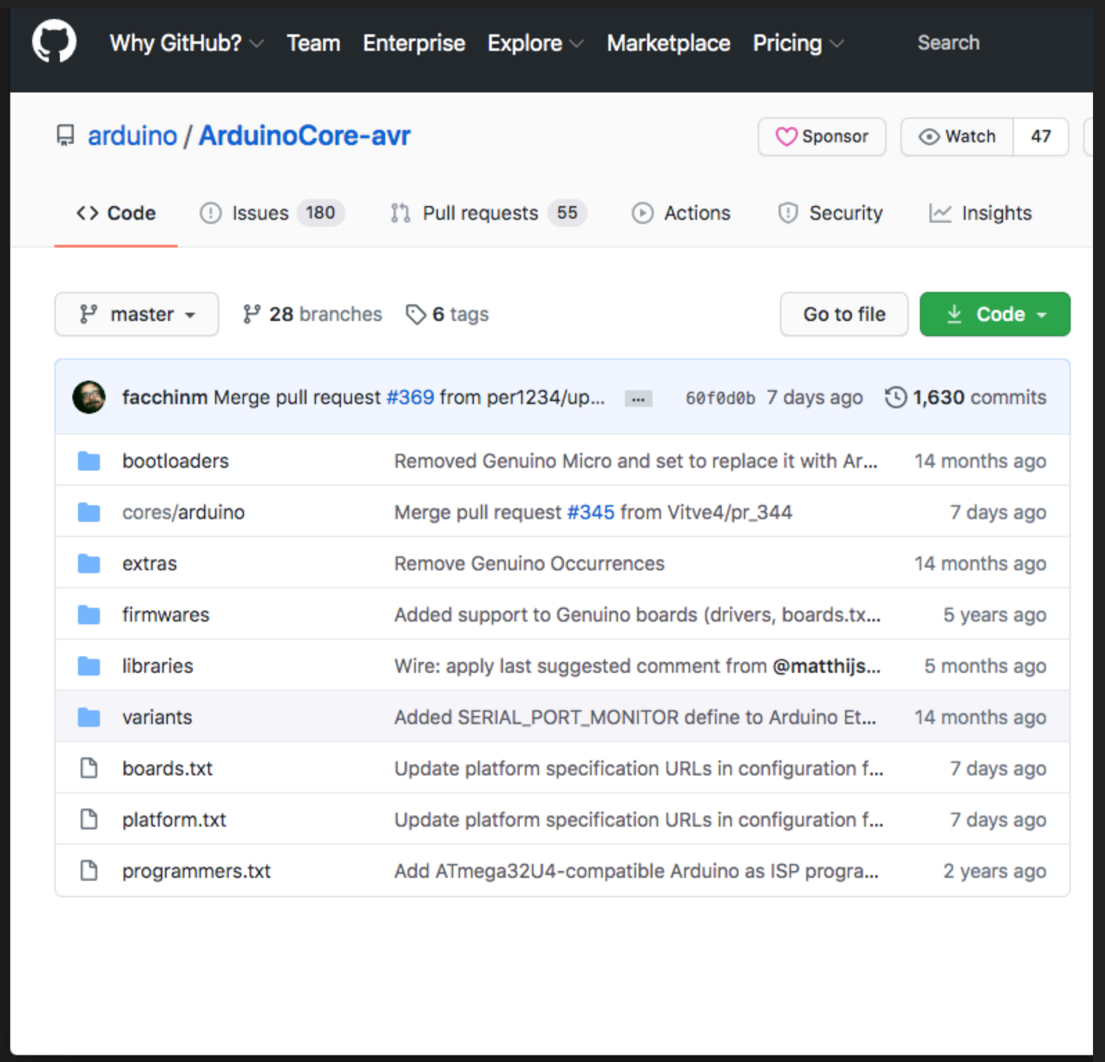
```
Arduino       : CAN_CHECKSUM_MEMORY_BUFFER
Erase flash
done in 0.843 seconds

Write 11484 bytes to flash (180 pages)
[==============================] 100% (180/180 pages)
done in 0.077 seconds

Verify 11484 bytes of flash with checksum.
Verify successful
done in 0.010 seconds
CPU reset.
```

1   Arduino NANO 33 IoT on /dev/cu.usbmodem1421

LIBRARIES



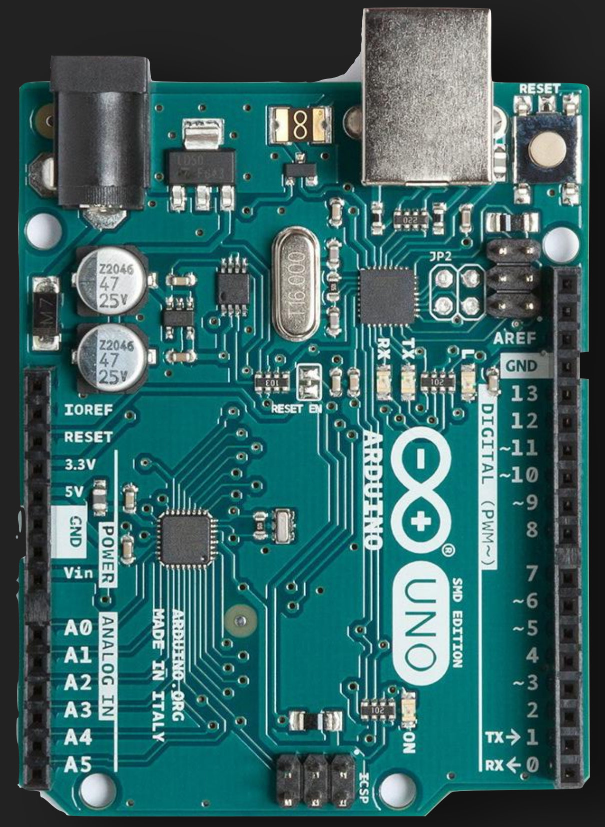
arduino / ArduinoCore-avr

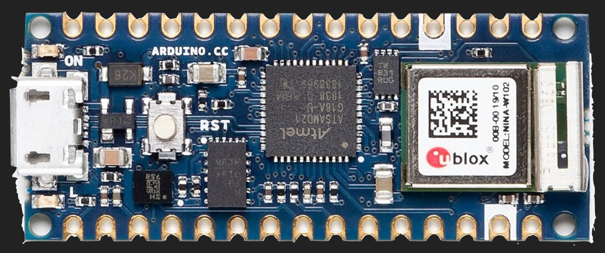
28 branches   6 tags

facchinm Merge pull request #369 from per1234/up... … 60f0d0b 7 days ago   1,630 commits

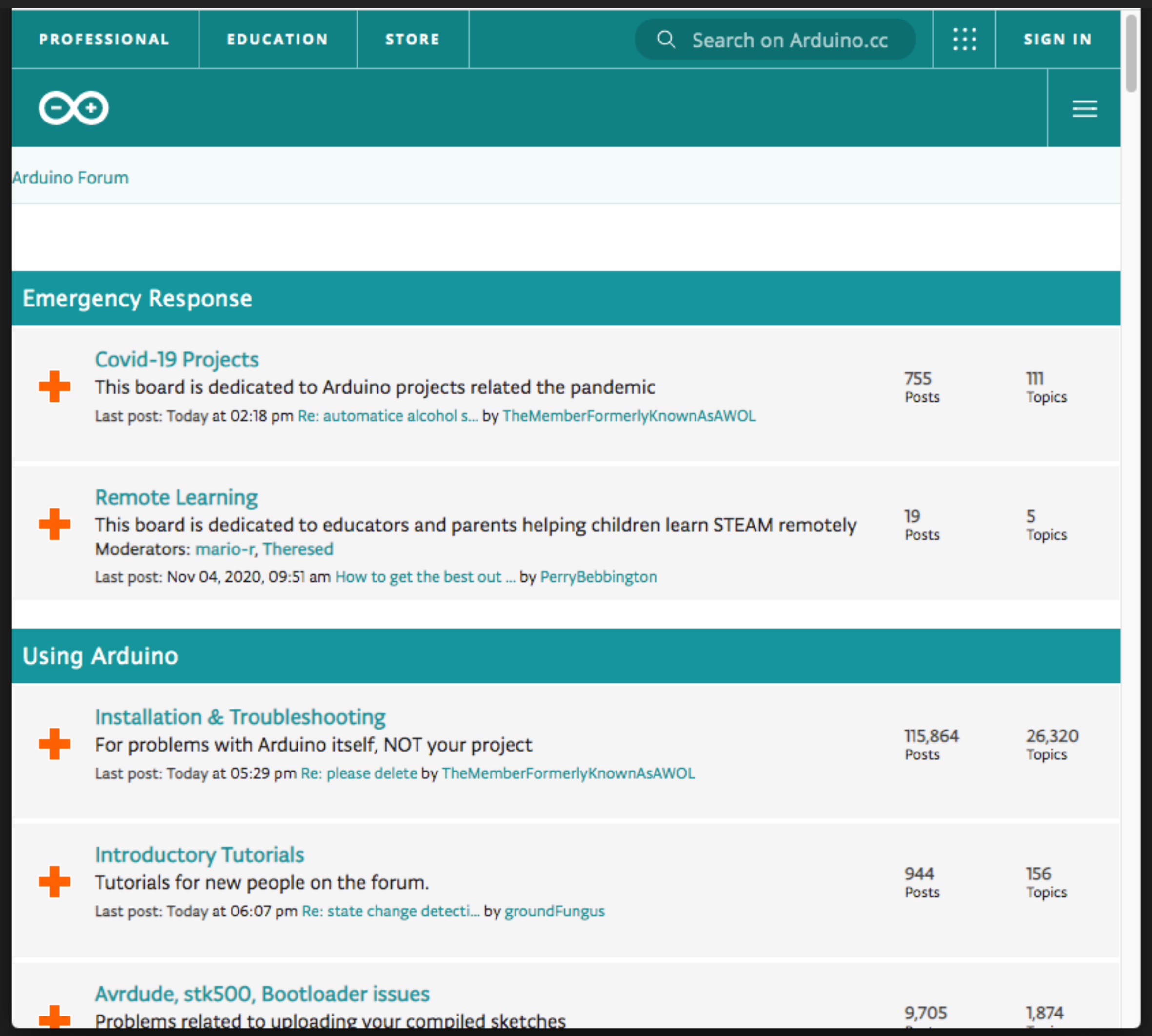
bootloaders	Removed Genuino Micro and set to replace it with Ar...	14 months ago
cores/arduino	Merge pull request #345 from Vitve4/pr_344	7 days ago
extras	Remove Genuino Occurrences	14 months ago
firmwares	Added support to Genuino boards (drivers, boards.tx...	5 years ago
libraries	Wire: apply last suggested comment from @matthijs...	5 months ago
variants	Added SERIAL_PORT_MONITOR define to Arduino Et...	14 months ago
boards.txt	Update platform specification URLs in configuration f...	7 days ago
platform.txt	Update platform specification URLs in configuration f...	7 days ago
programmers.txt	Add ATmega32U4-compatible Arduino as ISP progra...	2 years ago

HARDWARE





SUPPORT



Arduino Forum

Emergency Response

Covid-19 Projects
This board is dedicated to Arduino projects related the pandemic
Last post: Today at 02:18 pm Re: automatice alcohol s... by TheMemberFormerlyKnownAsAWOL
755 Posts   111 Topics

Remote Learning
This board is dedicated to educators and parents helping children learn STEAM remotely
Moderators: mario-r, Theresed
Last post: Nov 04, 2020, 09:51 am How to get the best out ... by PerryBebbington
19 Posts   5 Topics

Using Arduino

Installation & Troubleshooting
For problems with Arduino itself, NOT your project
Last post: Today at 05:29 pm Re: please delete by TheMemberFormerlyKnownAsAWOL
115,864 Posts   26,320 Topics

Introductory Tutorials
Tutorials for new people on the forum.
Last post: Today at 06:07 pm Re: state change detecti... by groundFungus
944 Posts   156 Topics

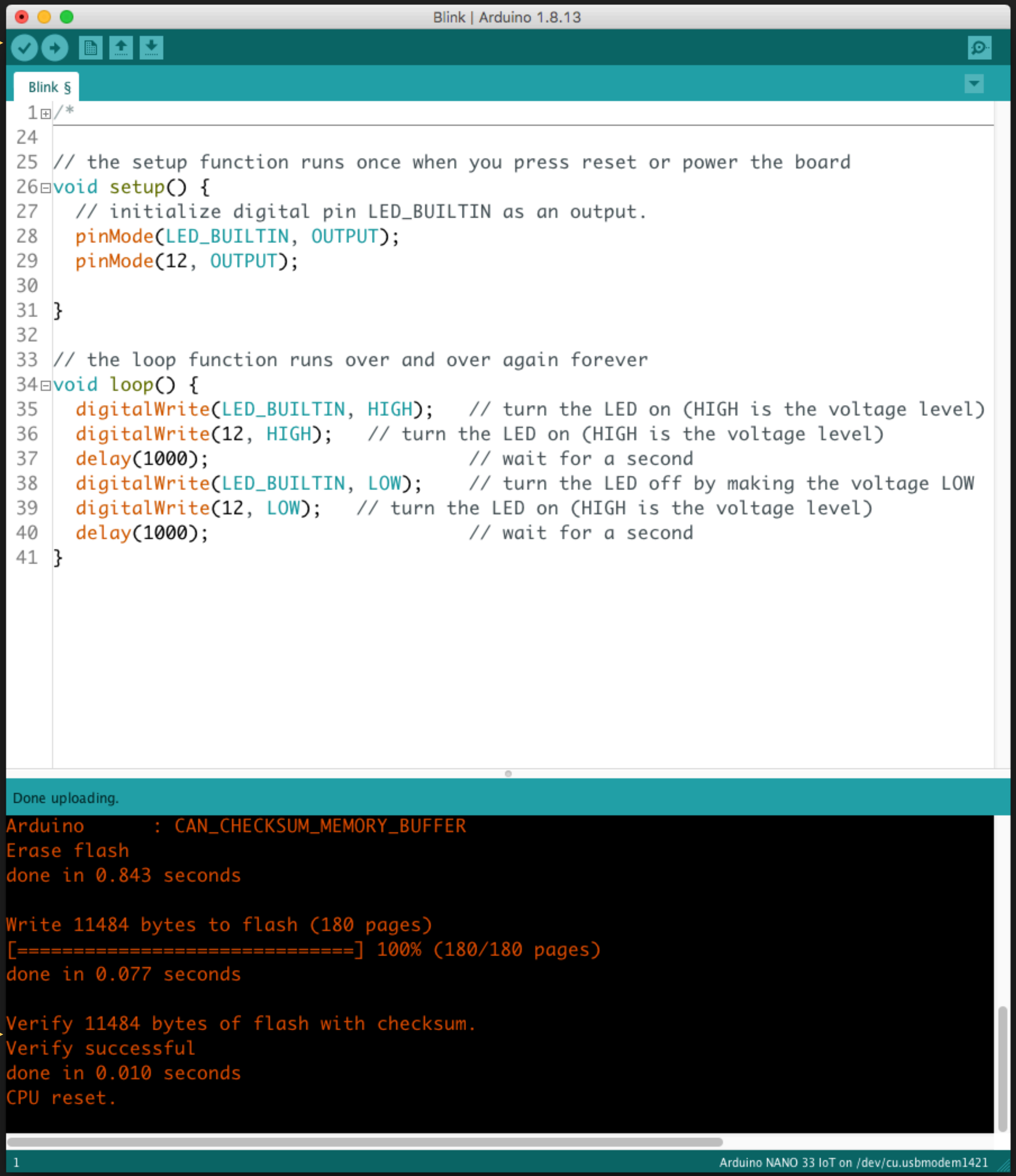
Avrdude, stk500, Bootloader issues
Problems related to uploading your compiled sketches
9,705   1,874

IDE

Compile + upload to board

Code

Stats and status



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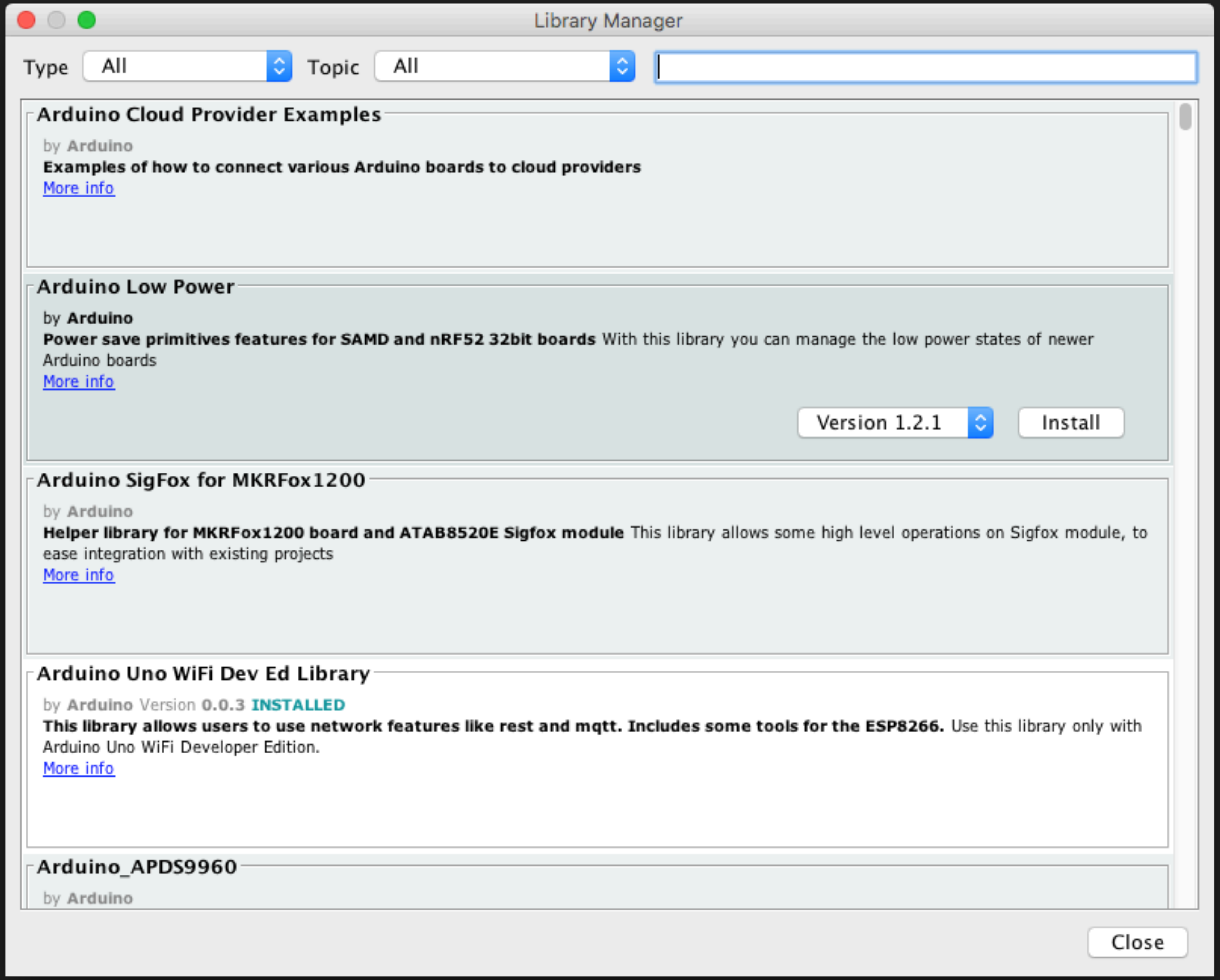
1

Arduino NANO 33 IoT on /dev/cu.usbmodem1421

Integrated Development Environment links your code with core libraries, compiler, and uploading tool chains.

IDE

Library Manager



Type: All   Topic: All

Arduino Cloud Provider Examples
by Arduino
Examples of how to connect various Arduino boards to cloud providers
More info

Arduino Low Power
by Arduino
Power save primitives features for SAMD and nRF52 32bit boards With this library you can manage the low power states of newer Arduino boards
More info

Version 1.2.1

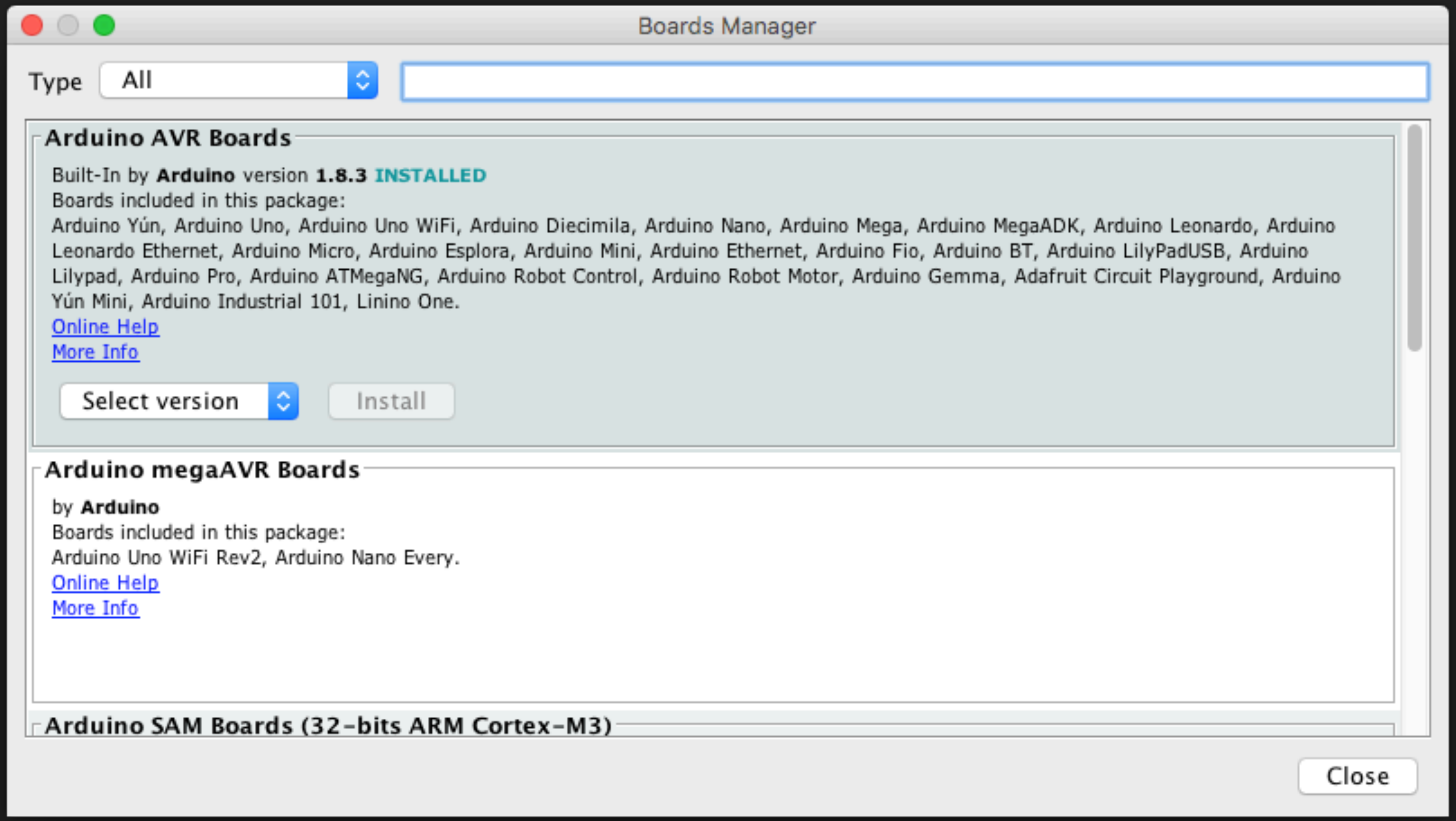
Arduino SigFox for MKRFox1200
by Arduino
Helper library for MKRFox1200 board and ATAB8520E Sigfox module This library allows some high level operations on Sigfox module, to ease integration with existing projects
More info

Arduino Uno WiFi Dev Ed Library
by Arduino Version 0.0.3 INSTALLED
This library allows users to use network features like rest and mqtt. Includes some tools for the ESP8266. Use this library only with Arduino Uno WiFi Developer Edition.
More info

Arduino_APDS9960
by Arduino

Install software modules for additional functionality

Board Manager



Type: All

Arduino AVR Boards
Built-In by **Arduino** version **1.8.3** INSTALLED
Boards included in this package:
Arduino Yún, Arduino Uno, Arduino Uno WiFi, Arduino Diecimila, Arduino Nano, Arduino Mega, Arduino MegaADK, Arduino Leonardo, Arduino Leonardo Ethernet, Arduino Micro, Arduino Esplora, Arduino Mini, Arduino Ethernet, Arduino Fio, Arduino BT, Arduino LilyPadUSB, Arduino Lilypad, Arduino Pro, Arduino ATMegaNG, Arduino Robot Control, Arduino Robot Motor, Arduino Gemma, Adafruit Circuit Playground, Arduino Yún Mini, Arduino Industrial 101, Linino One.
Online Help
More Info

Arduino megaAVR Boards
by **Arduino**
Boards included in this package:
Arduino Uno WiFi Rev2, Arduino Nano Every.
Online Help
More Info

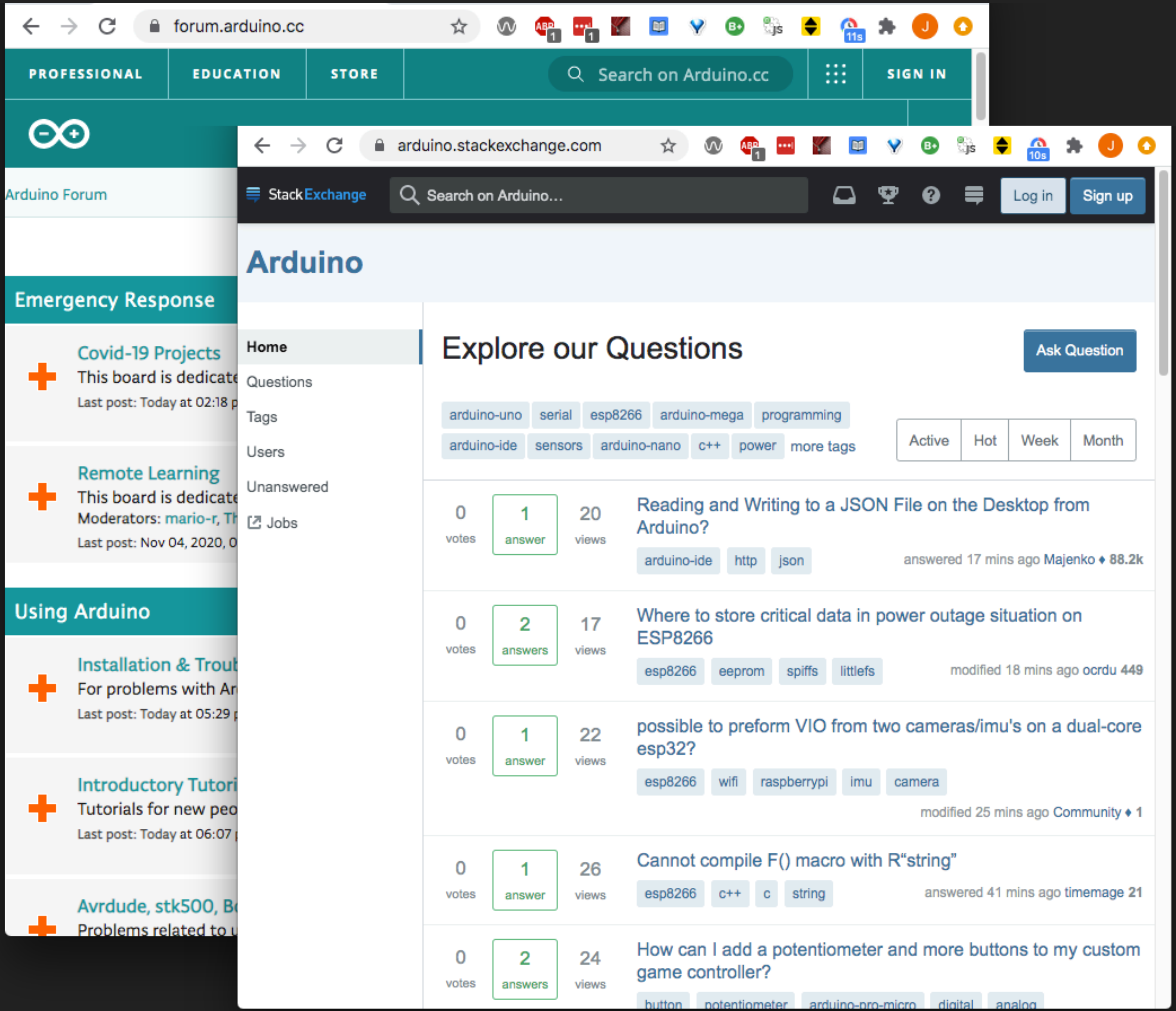
Arduino SAM Boards (32-bits ARM Cortex-M3)

Install hardware definitions to talk to other microcontrollers

SUPPORT

In addition to PCOMP syllabus

Forums (lots!)



forum.arduino.cc

PROFESSIONAL | EDUCATION | STORE | Search on Arduino.cc | SIGN IN

Arduino Forum

Emergency Response

Covid-19 Projects
This board is dedicate
Last post: Today at 02:18 p

Remote Learning
This board is dedicate
Moderators: mario-r, Th
Last post: Nov 04, 2020, 0

Using Arduino

Installation & Troub
For problems with Ar
Last post: Today at 05:29 p

Introductory Tutori
Tutorials for new peo
Last post: Today at 06:07 p

Avrdude, stk500, Bo
Problems related to u

arduino.stackexchange.com

StackExchange | Search on Arduino... | Log in | Sign up

Arduino

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Ask Question

arduino-uno | serial | esp8266 | arduino-mega | programming | arduino-ide | sensors | arduino-nano | c++ | power | more tags

Active | Hot | Week | Month

0 votes | 1 answer | 20 views
Reading and Writing to a JSON File on the Desktop from Arduino?
arduino-ide | http | json
answered 17 mins ago Majenko ♦ 88.2k

0 votes | 2 answers | 17 views
Where to store critical data in power outage situation on ESP8266
esp8266 | eeprom | spiffs | littlefs
modified 18 mins ago ocrdu 449

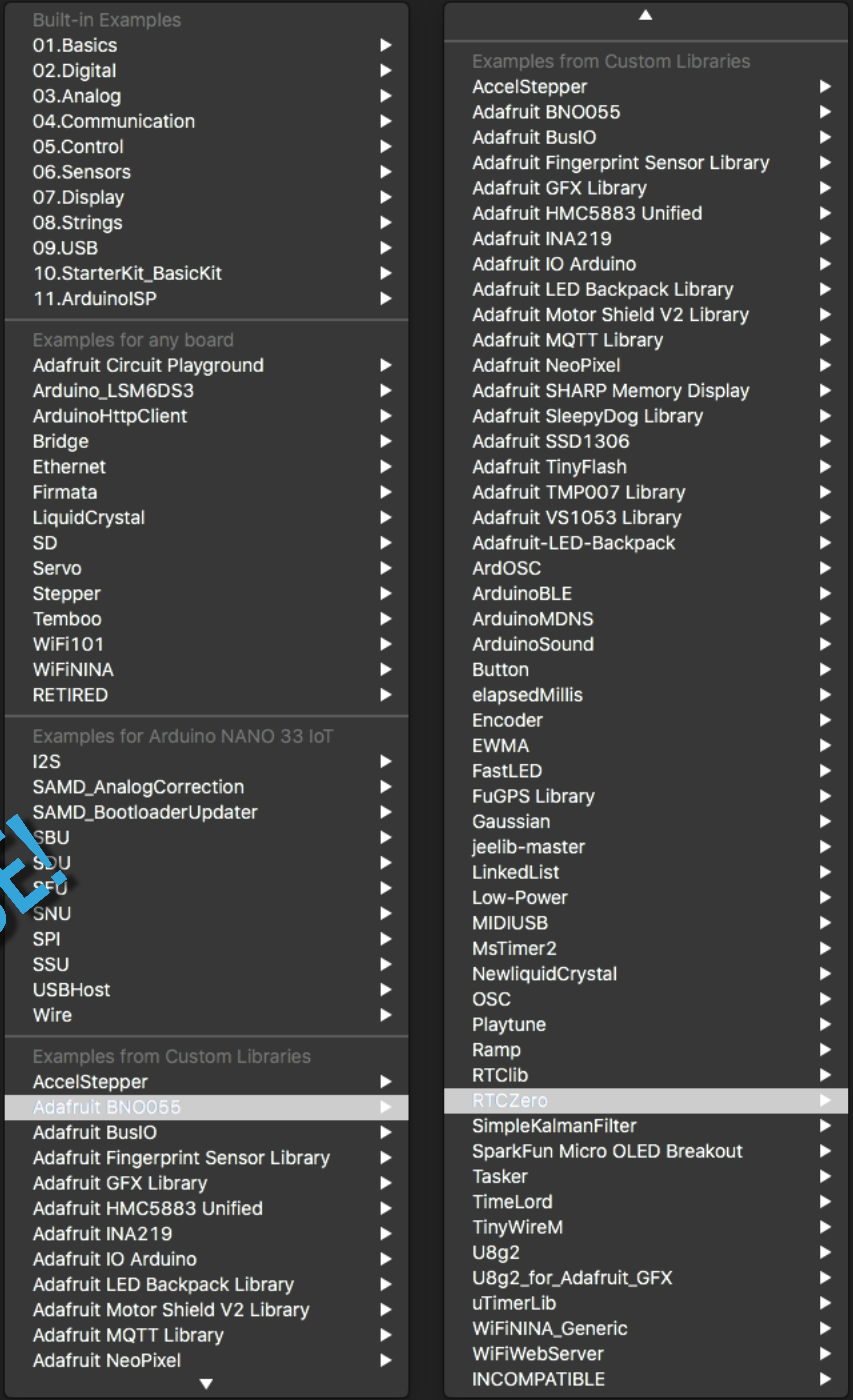
0 votes | 1 answer | 22 views
possible to preform VIO from two cameras/imu's on a dual-core esp32?
esp8266 | wifi | raspberrypi | imu | camera
modified 25 mins ago Community ♦ 1

0 votes | 1 answer | 26 views
Cannot compile F() macro with R"string"
esp8266 | c++ | c | string
answered 41 mins ago timemage 21

0 votes | 2 answers | 24 views
How can I add a potentiometer and more buttons to my custom game controller?
button | potentiometer | arduino-pro-micro | digital | analog

Examples (lots!)

IN IDE!



Built-in Examples
01.Basics
02.Digital
03.Analog
04.Communication
05.Control
06.Sensors
07.Display
08.Strings
09.USB
10.StarterKit_BasicKit
11.ArduinoISP

Examples for any board
Adafruit Circuit Playground
Arduino_LSM6DS3
ArduinoHttpClient
Bridge
Ethernet
Firmata
LiquidCrystal
SD
Servo
Stepper
Temboo
WiFi101
WiFiNINA
RETIRED

Examples for Arduino NANO 33 IoT
I2S
SAMD_AnalogCorrection
SAMD_BootloaderUpdater
SBU
SDU
SFU
SNU
SPI
SSU
USBHost
Wire

Examples from Custom Libraries
AccelStepper
Adafruit BNO055
Adafruit BusIO
Adafruit Fingerprint Sensor Library
Adafruit GFX Library
Adafruit HMC5883 Unified
Adafruit INA219
Adafruit IO Arduino
Adafruit LED Backpack Library
Adafruit Motor Shield V2 Library
Adafruit MQTT Library
Adafruit NeoPixel

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Adafruit IO Arduino
Adafruit LED Backpack Library
Adafruit Motor Shield V2 Library
Adafruit MQTT Library
Adafruit NeoPixel
Adafruit SHARP Memory Display
Adafruit SleepyDog Library
Adafruit SSD1306
Adafruit TinyFlash
Adafruit TMP007 Library
Adafruit VS1053 Library
Adafruit-LED-Backpack
ArdOSC
ArduinoBLE
ArduinoMDNS
ArduinoSound
Button
elapsedMillis
Encoder
EWMA
FastLED
FuGPS Library
Gaussian
jeelib-master
LinkedList
Low-Power
MIDIUSB
MsTimer2
NewliquidCrystal
OSC
Playtune
Ramp
RTClib
RTCZero
SimpleKalmanFilter
SparkFun Micro OLED Breakout
Tasker
TimeLord
TinyWireM
U8g2
U8g2_for_Adafruit_GFX
uTimerLib
WiFiNINA_Generic
WiFiWebServer
INCOMPATIBLE

BINARY

1 COIN, 2 STATES:

Heads

Tails

BINARY

2 COIN, 4 STATES:

HH

HT

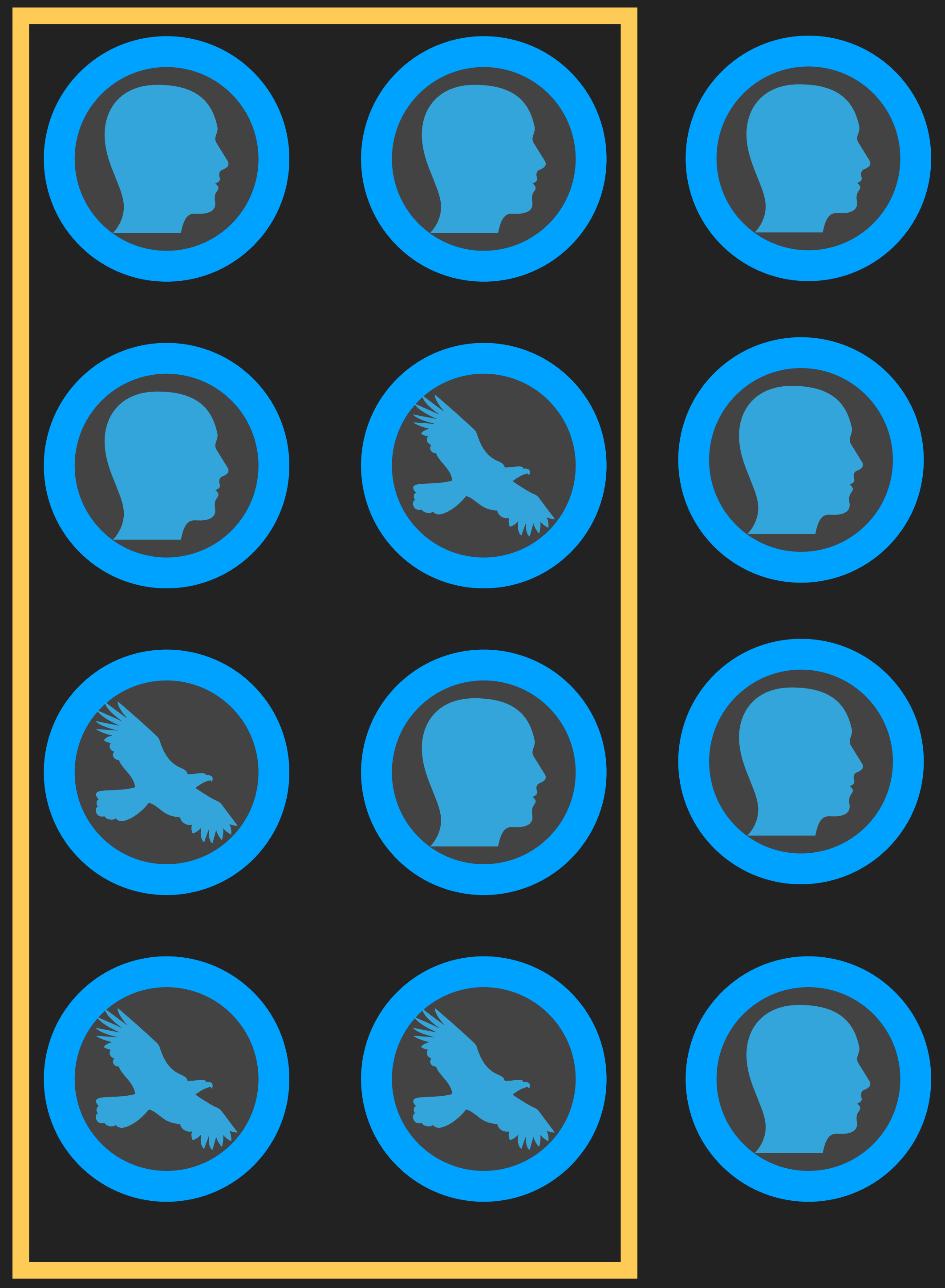
TH

TT

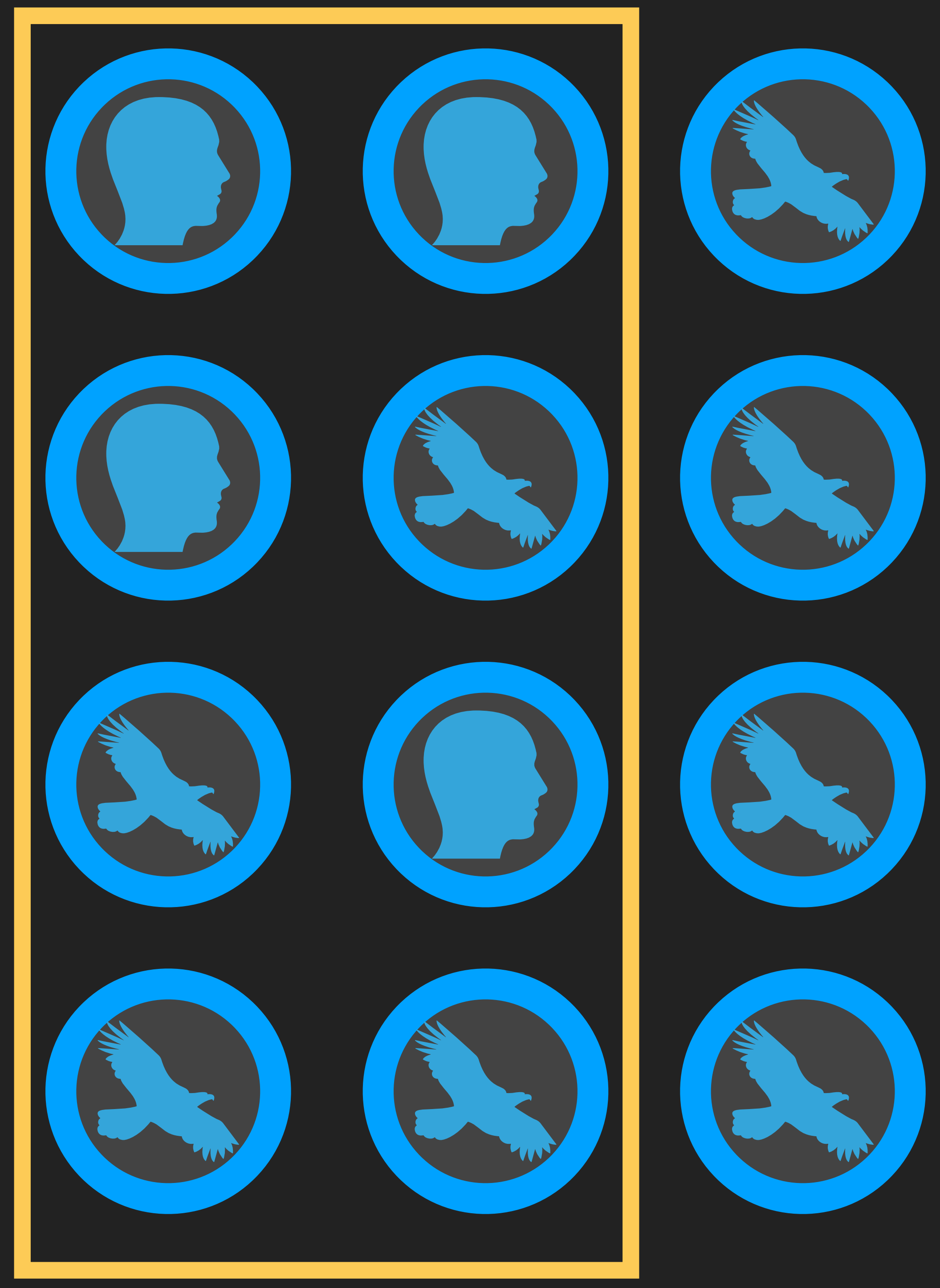
BINARY

Each additional coin doubles the number of possible states.

With 3 coins there are 8 states:



Previous states, plus Heads

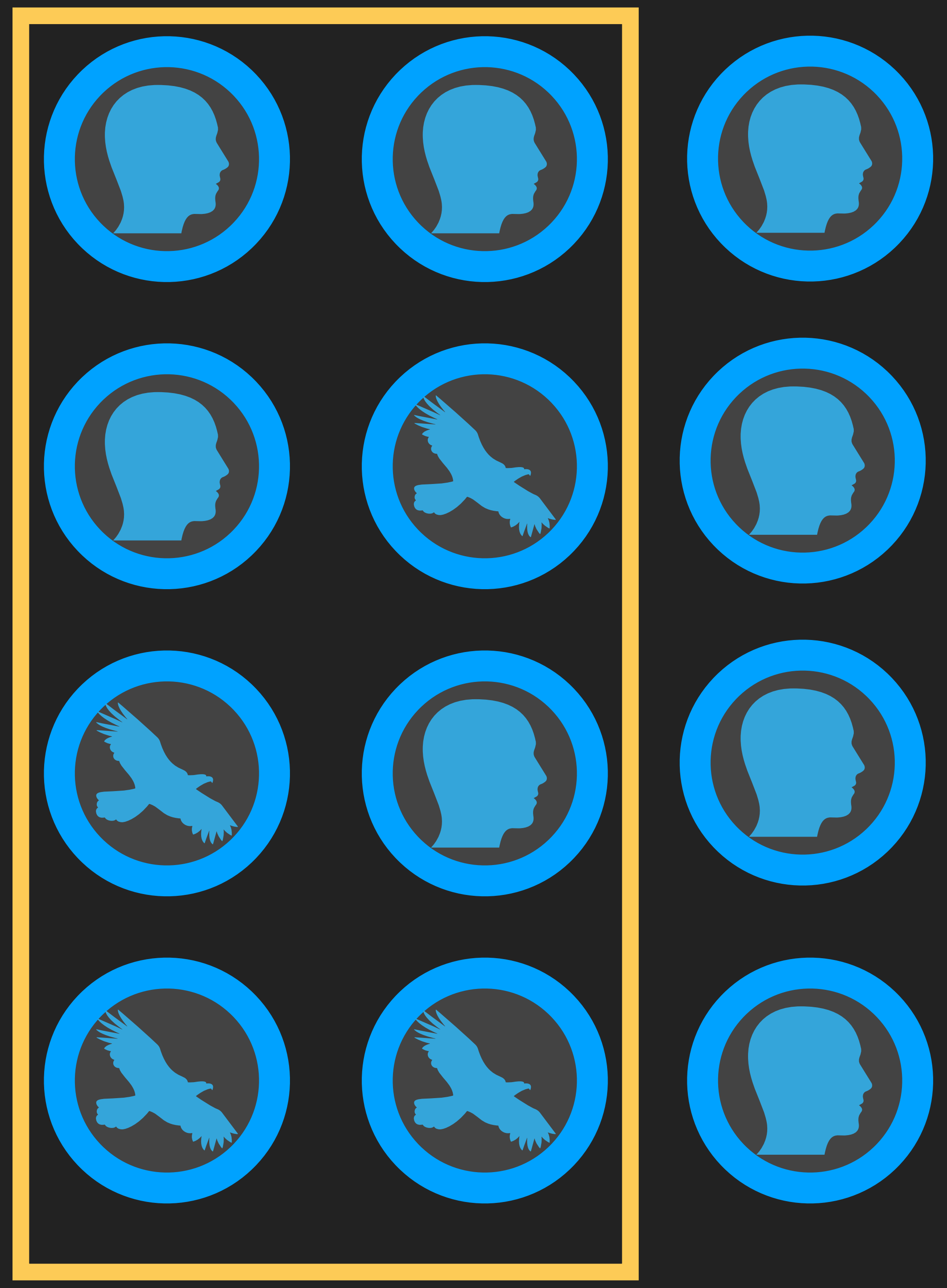


Previous states, plus Tails

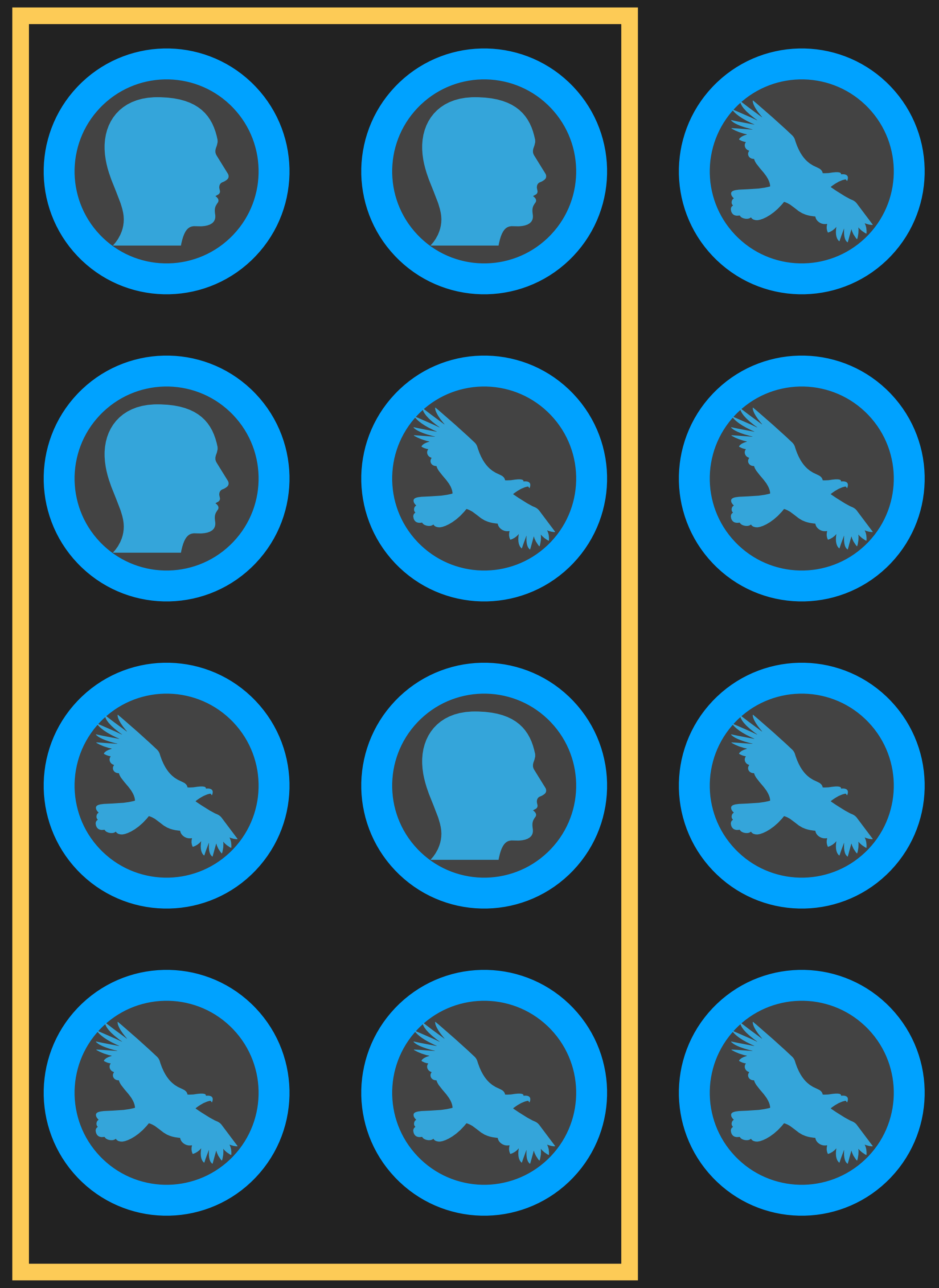
BINARY

Put another way, the number of states is:

$$2^{\text{number of coins}}$$



Previous states, plus Heads



Previous states, plus Tails

BINARY

Instead of coins, computers use bits, but the idea is the same.

Decimal	Binary			
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

1 bit, 2^1 = 2 combos

1 bit, 2^2 = 4 combos

1 bit, 2^3 = 8 combos

1 bit, 2^4 = 16 combos

BINARY

Microcontrollers like the Nano often have 8-bit PWM output resolution*:

8 bits, 2^8 = 256 combos = [0…255]

…and 10-bit analog input resolution*:

10 bits, 2^{10} = 1024 combos = [0…1023]

* by default