CLASS 3 DIGITAL I/O, ANALOG OUTPUT

PLAN FOR CLASS 3

Review

- Blog review
- AMA, Class 2, partial quiz review
- Look ahead plan for class 5 (Jeff out)

New

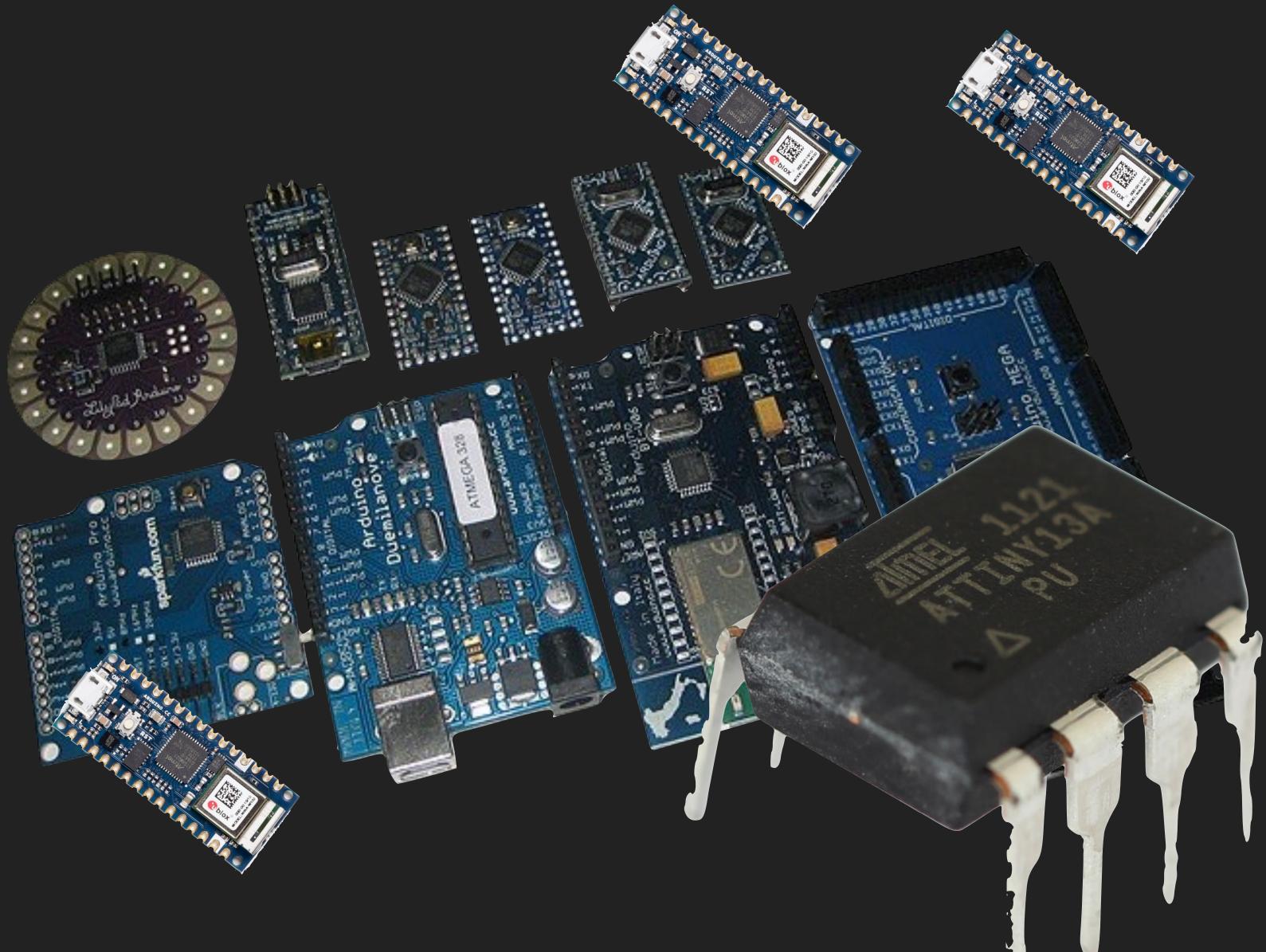
- Microcontrollers
- Sensors
- Programming terms and environment
- Digital Input and Output
- Analog Input

Bonus (if time) soldering demo

iz review ass 5 (Jeff out)

l environment t

MICROCONTROLLERS CAN BE LOTS OF DIFFERENT THINGS (Reminder)



SENSORS

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)

convert something in the world (smell, light, mass, motion,

PROGRAMMING TERMS AND ENVIRONMENT

An IDE (Integrated Development Environment) 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 (a big 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 & LANGUAGE Learn how data is handled Variables, types Learn how to organize code Functions (objects) Order of operations **Understand "scope"** Learn flow control for, if/then, while Learn operators ► = , ==, ! , && , ||

- Learn the syntax and reserved words
- case matters, semicolons matter, etc.





Type code in!!!You'll learn faster

You'll learn faster than cut-n-paste

PCOMP ENVIRONMENT Most development environments will have similar elements

I.D.E.

•	Blink Arduino 1.8.13	
Ø¢		ø
Blink	5	
1.	/*	
24 25 26 27 28 29 30 31 32 33	<pre>// the setup function runs once when you press reset or power the board // initialize digital pin LED_BUILTIN as an output. pinMode(LED_BUILTIN, OUTPUT); pinMode(12, OUTPUT); // the loop function runs over and over again forever // the loop function runs over and over again forever // the loop function runs over and over again forever // digitalWrite(LED_BUILTIN, 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 LO digitalWrite(12, LOW); // turn the LED on (HIGH is the voltage level) delay(1000); // wait for a second</pre>	
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	ploading.	
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LIBRARIES

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		facchinm Merge pull request	#369 from per1234/up 60f0d0b	7 days ag
		bootloaders	Removed Genuino Micro and set to repla	ce it with A
		cores/arduino	Merge pull request #345 from Vitve4/pr_	344
		extras	Remove Genuino Occurrences	
		firmwares	Added support to Genuino boards (driver	rs, boards.
		libraries	Wire: apply last suggested comment from	n @matthi
		variants	Added SERIAL_PORT_MONITOR define to	o Arduino E
	Ľ	boards.txt	Update platform specification URLs in co	onfiguration
	Ľ	platform.txt	Update platform specification URLs in co	onfiguration
	ß	programmers.txt	Add ATmega32U4-compatible Arduino as	s ISP progi

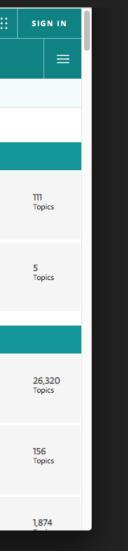


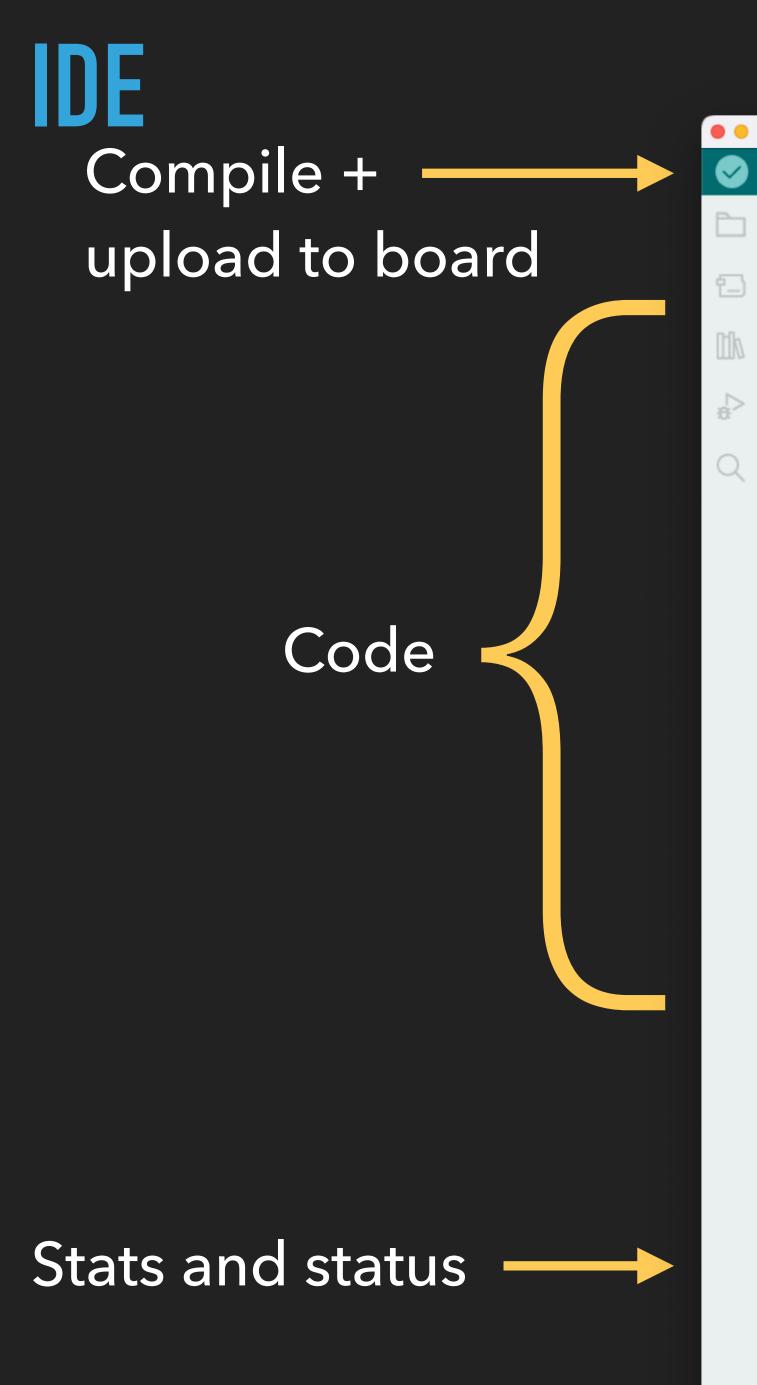
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PROF	ESSIONAL	EDUCATION	STORE		Q Search on Arduino.co		::
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Emerg	gency Resp	onse					
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+	Moderators:	s dedicated to educ mario-r, Theresed		arents helping childr	ren learn STEAM remotely	19 Post:	s
Using	Arduino						
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€ €	🜵 Arduino NANO 33 loT 🛛 🝷
Class 3 De	emo.ino
1	<pre>const int blueButton = 4, //it's a nic</pre>
2	greenButton = 3,
3	yellowButton = 2 ,
4	pot = A7,
5	fsr = A6,
6	blueLED = 5;
7	
	<pre>void setup() {</pre>
9	<pre>// put your setup code here, to run o</pre>
10	<pre>pinMode(blueButton, INPUT);</pre>
11	<pre>pinMode(yellowButton, INPUT);</pre>
12	<pre>pinMode(greenButton, INPUT);</pre>
13	<pre>pinMode(blueLED, OUTPUT);</pre>
14	<pre>Serial.begin(9600);</pre>
15	
16	//flash the LED to show the program i
17	<pre>for (int i=0; i<10; i++) { diside life i= (1); i= (1)</pre>
18	<pre>digitalWrite(blueLED, i%2==0); //Ex delew(100);</pre>
19	delay(100);
20	}
	}
22	usid loop() (
23	<pre>void loop() { outputForPlotter();</pre>
24	
	<pre>delay(100); }</pre>
20 .	ſ
	//output data in a format that will plo
	void outputForPlotter() {
30	Serial.print("B:");
31	if (digitalRead(blueButton)) Serial.p
32	<pre>else Serial.print("0,");</pre>
33	
34	<pre>Serial.print("G:");</pre>
35	if (digitalRead(greenButton)) Serial.
36	<pre>else Serial.print("200,");</pre>
37	
38	<pre>Serial.print("Y:");</pre>
39	if (digitalRead(yellowButton)) Serial
40	else Serial.print("400,");
Output	Serial Monitor
	2264 bytes to flash (102 pages)

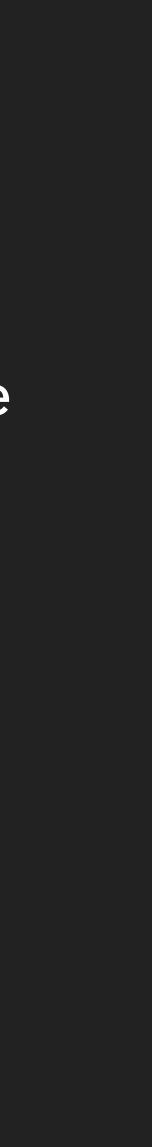
Write 12264 bytes to flash (192 pages)

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done in 0.083 seconds	

Verify 12264 bytes of flash with checksum. Verify successful done in 0.010 seconds CPU reset.

Demo | Arduino IDE 2.0.0 √ .©.. ... ice idea to label things semantically. Avoid magic numbers. once: is starting Extra credit: what's happening here???? lot nicely .print("100,"); l.print("300,"); al.print("500,"); ≣× 6 pages) 92 pages)

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





Library Manager*

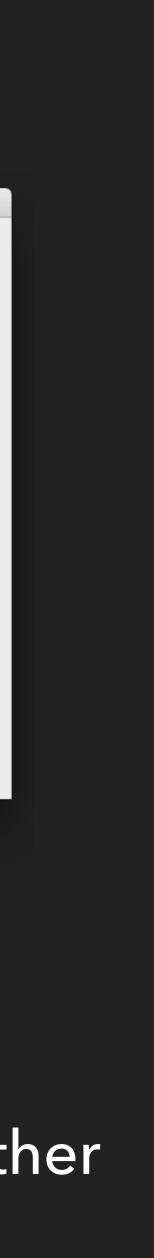
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by A Help ease	uino SigFox for MKRFox1200 Arduino per library for MKRFox1200 board and ATAB8520E Sigfox module This library allows some high level operations on Sigfox mod e integration with existing projects e info	ule, to
by A This Ardu	uino Uno WiFi Dev Ed Library Arduino Version 0.0.3 INSTALLED In Bilbrary allows users to use network features like rest and mqtt. Includes some tools for the ESP8266. Use this library only Jino Uno WiFi Developer Edition. E info	y with
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Install software modules for additional functionality

Board Manager*

Arduino AVR Boards Built-In by Arduino version 1.8.3 INSTALLED Boards included in this package: Arduino Yun, Arduino Uno, Arduino Explora, Arduino Iteirmila, Arduino Kano, Arduino Mega, Arduino MegaADK, Arduino LinyPadUSB, Arduino Linypad, Arduino Pro, Arduino ATMegaNG, Arduino Robot Control, Arduino Robot Motor, Arduino Gemma, Adafruit Circuit Playground, Arduino Yun Mini, Arduino Industrial 101, Linino One. Online Help More Info Select version Control Install Arduino MiFi Rev2, Arduino Nano Every. Online Help More Info Boards included in this package: Arduino NiFi Rev2, Arduino Nano Every. Online Help More Info Carduino SAM Boards (32-bits ARM Cortex-M3) Close	Arduino AVR Boards Built-In by Arduino version 1.8.3 INSTALLED Boards included in this package: Arduino Yún, Arduino Uno, Arduino Explora, Arduino Emerila, Arduino Kega, Arduino Mega, Arduino BT, Arduino LivpadUSB, Arduino Liupad, Arduino Moro, Arduino Megad, Arduino Robot Motor, Arduino BT, Arduino IIVpadUSB, Arduino Uilypad, Arduino Industrial 101, Linino One. Online Help More Infe Select version Install Arduino WiFi Rev2, Arduino Nano Every. Online Help More Infe Select version Install Arduino NiFi Rev2, Arduino Nano Every. Online Help More Infe Select version Close Arduino NiFi Rev2, Arduino Nano Every. Online Help More Infe	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 Miri, 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 Select version Install Arduino Uno WiFi Rev2, Arduino Nano Every. Online Help More Info Seards included in this package: Arduino Uno WiFi Rev2, Arduino Nano Every. Online Help More Info	Arduino AVR Boards Built-In by Arduino version 1.8.3 INSTALLED Boards included in this package: Arduino Yún, Arduino Uno, Arduino Ioscimila, Arduino Nano, Arduino Mega, Arduino BE, Arduino Esplora, Arduino Esbera, Arduino Esbera, Arduino Esbera, Arduino Esbera, Arduino Esbera, Arduino Robot Control, Arduino Robot Motor, Arduino BT, Arduino IliyPadUSB, Arduino Online Leip Online Help More Info Select version O Install Arduino WiFi Rev2, Arduino Nano Every. Online Help More Info Arduino SAM Boards (32-bits ARM Cortex-M3) Close		Boards Manager
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Install hardware definitions to talk to other microcontrollers



SUPPORT In addition to PCOMP syllabus

Forums (lots!)

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	Arduino			
Emergency Response				
Covid-19 Projects	Home	Explore our Q	uestions	Ask Question
This board is dedicate Last post: Today at 02:18 p	Quodiono	arduino-uno serial esp82	66 arduino-mega programming	
	Users		ino-nano c++ power more tags	Active Hot Week Month
Remote Learning This board is dedicate Moderators: mario-r, Th Last post: Nov 04, 2020, 0	🗷 Jobs	0 1 20 votes answer views	Reading and Writing to a JSON Arduino? arduino-ide http json	I File on the Desktop from answered 17 mins ago Majenko + 88.2k
Using Arduino		0 2 17	Where to store critical data in p ESP8266	ower outage situation on
Installation & Trout For problems with Ar		votes answers views	esp8266 eeprom spiffs littlefs	modified 18 mins ago ocrdu 449
Last post: Today at 05:29 p	F	0 1 22 votes answer views	possible to preform VIO from tw esp32?	vo cameras/imu's on a dual-core
Tutorials for new peo			esp8266 wifi raspberrypi imu	camera modified 25 mins ago Community + 1
		0 1 26	Cannot compile F() macro with	-
Avrdude, stk500, Be Problems related to u		votes answer views	esp8266 c++ c string	answered 41 mins ago timemage 21
		0 2 24 votes answers views	How can I add a potentiometer game controller?	and more buttons to my custom
			button potentiometer arduino-pro-r	micro digital analog

Examples (lots!)

01.Basics

02.Digital

03.Analog

05.Control

06.Sensors

07.Display

08.Strings

09.USB

04.Communication

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 SOU SOU SOU SOU SOU SOU SOU SOU SOU SO	
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 IO Arduino Adafruit LED Backpack Library Adafruit Motor Shield V2 Library Adafruit MQTT Library Adafruit NeoPixel	

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 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 SimpleKalmanFilter SparkFun Micro OLED Breakout Tasker TimeLord TinyWireM U8g2 U8g2_for_Adafruit_GFX uTimerLib WiFiNINA_Generic WiFiWebServer

INCOMPATIBLE

▲

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SUPPORT

New 2.0 IDE adds:

- Code completion (Yay!)
- In-circuit debugging (to be explored...)
- More serial plotting features

• •	•	😞 Class 3 Demo Arduino IDE 2.0.0	
	€ €	🖞 Arduino NANO 33 loT 👻	۰Q۰
Ph	Class 3 De	emo.ino	
	1 2	<pre>const int blueButton = 4, //it's a nice idea to label things semantically. Avoid magic numbers. greenButton = 3,</pre>	
1_)	3	yellowButton = 2,	
ութ	4	pot = A7, fsr = A6,	
	6 7	blueLED = 5;	
÷	8 9	<pre>void setup() { // put your setup code here, to run once:</pre>	
2,57	10	pinMode(blueButton, INPUT);	
\sim	11	pinMode(yellowButton, INPUT);	
Q	12	<pre>pinMode(greenButton, INPUT);</pre>	
	13	<pre>pinMode(blueLED, OUTPUT);</pre>	
	14	<pre>Serial.begin(9600);</pre>	
	15		
	16	//flash the LED to show the program is starting	
	17	<pre>for (int i=0; i<10; i++) {</pre>	
	18	<pre>digitalWrite(blueLED, i%2==0); //Extra credit: what's happening here????</pre>	
	19	delay(100);	
	20	}	
	21	}	
	22		
	23 24	void loop() {	
		<pre>outputForPlotter(); dolow(100);</pre>	
	25 26	delay(100);	
	20	ſ	
		//output data in a format that will plot nicely	
		void outputForPlotter() {	
	30	<pre>Serial.print("B:");</pre>	
	31	<pre>if (digitalRead(blueButton)) Serial.print("100,");</pre>	
	32	<pre>else Serial.print("0,");</pre>	
	33		
	34	<pre>Serial.print("G:");</pre>	
	35	<pre>if (digitalRead(greenButton)) Serial.print("300,");</pre>	
	36	<pre>else Serial.print("200,");</pre>	
	37		
	38	<pre>Serial.print("Y:");</pre>	
	39	<pre>if (digitalRead(yellowButton)) Serial.print("500,");</pre>	
	40	else Serial.print("400,");	
	Output	Serial Monitor	≣ 6
		(2264 bytes to flash (102 pages)	

```
[======= ] 33% (64/192 pages)
[=======] ] 66% (128/192 pages)
[======] 100% (192/192 pages)
done in 0.083 seconds
Verify 12264 bytes of flash with checksum.
Verify successful
done in 0.010 seconds
CPU reset.
```

Write 12264 bytes to flash (192 pages

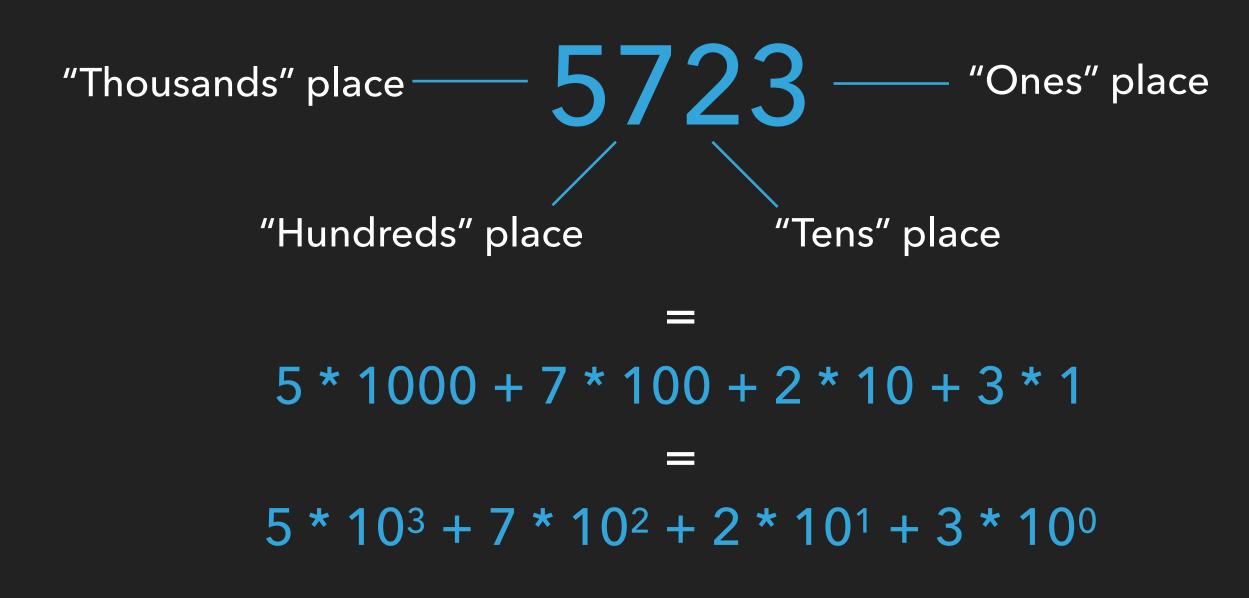






BINARY DECIMAL Review

"Place-value" number systems You have some number of symbols (e.g. '0'-'9') You assemble those symbols to represent a value. The place of the symbol determines its contribution to the total



In other words, the "place value" of the symbol is: the number of possible symbols raised to the power of it's place in the string of symbols

BINARY **1 COIN, 2 STATES:**



Heads

Tails

BINARY 2 COIN, 4 STATES:



ΗH

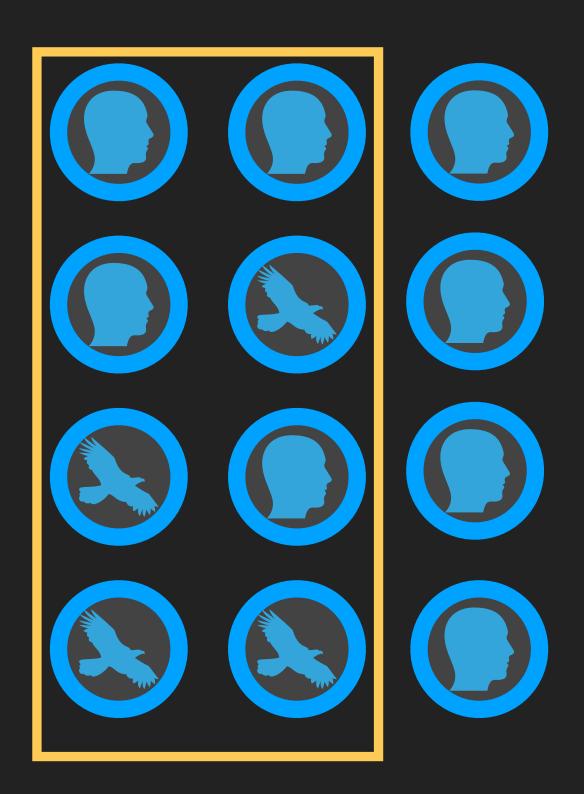
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TH

ТТ

BINARY Each additional coin doubles the number of possible states.

With 3 coins there are 8 states:

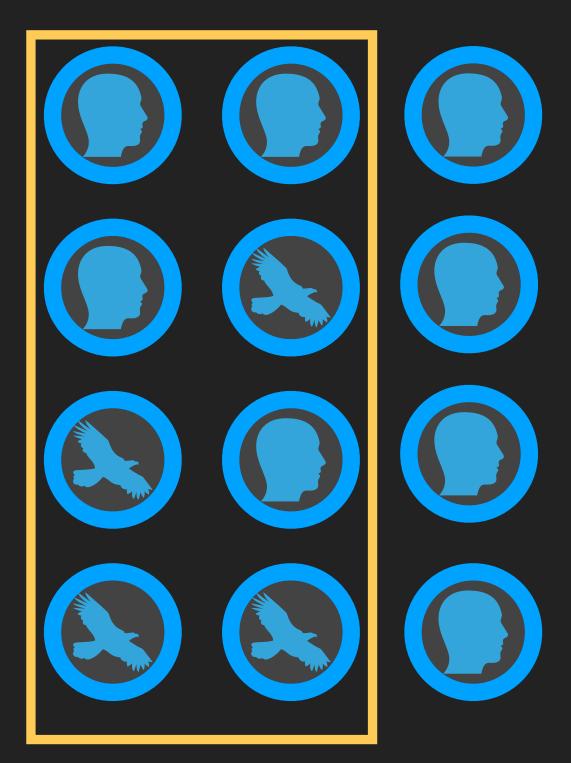


Previous states, plus Heads



Previous states, plus Tails

BINARY Put another way, the number of states is: number of coins 6



Previous states, plus Heads

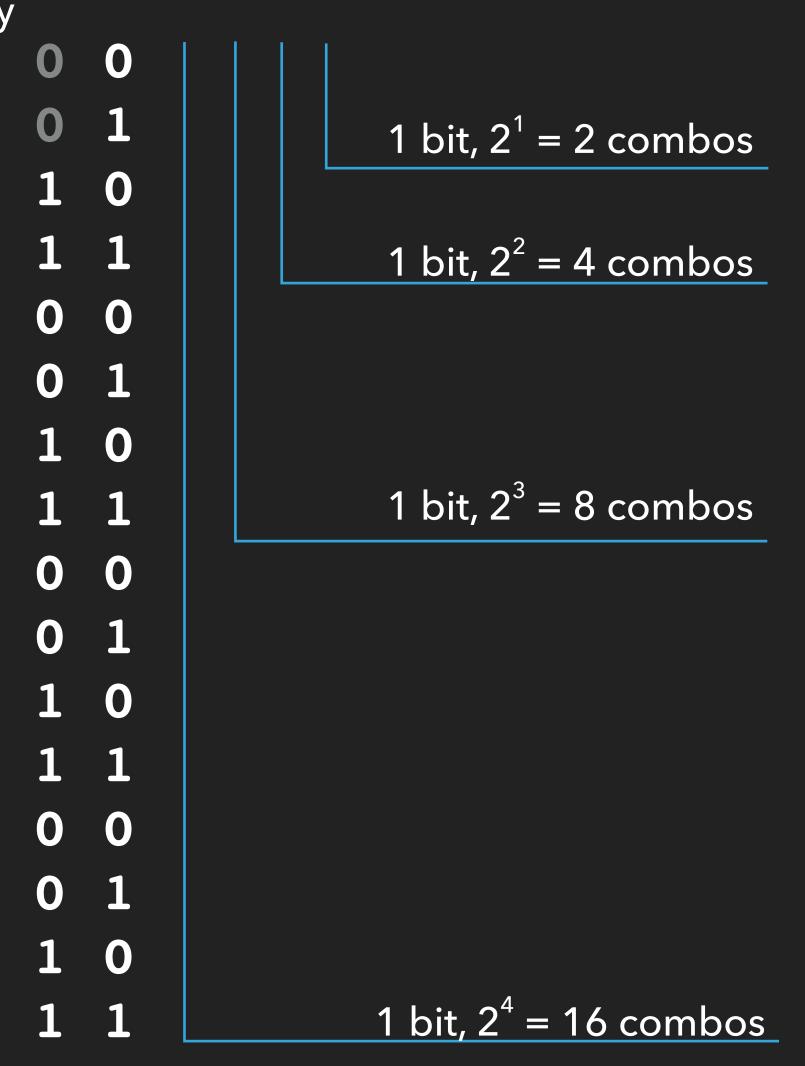




Previous states, plus Tails

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

	р.	
Decimal	Bir	nary
0	0	0
1	0	0
2	0	0
3	0	0
4	0	1
5	0	1
6	0	1
7	0	1
8	1	0
9	1	0
10	1	0
11	1	0
12	1	1
13	1	1
14	1	1
15	1	1



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, $2^{10} = 1024 \text{ combos} = [0...1023]$



BOOLEAN / BINARY LOGIC

1 == HIGH == TRUE

0 == LOW == FALSE

HOW A MICROCONTROLLER TOUCHES THE WORLD

