Microcontrollers

Career Day Submissions

Quick Overview

- Upcoming Events
- Project

Events

- B-Sides Orlando https://bsidesorlando.org/event/
  - 8AM - 6PM Saturday. Full Sail University. Orlando, FL
  - Lockpicking Village
  - Soldering Village
  - Social Engineering Village
  - Adults $25, Students Free
- Sunshine CTF

Career Day Planning

- How can Mrs Feldbush assign students to sessions for Career Day?
- Some presentations filled up (have to limit students)
- Some presentations didn't get as much interest (need to randomly assign students to fill)
- Students have ranked choice selection
- Preference given to Seniors and Juniors
-

CSV Files

- How do we easily process sheets from spreadsheets with programs
- Use library
  - Python can read / write complicated sheet data
  - Free and paid options
  - File format specific (ODT, .xls, .xslx, etc)
- Comma-Separated-Value
  - Table cells separated by commas
  - 1 line of data per row
  - Easy to process with standard input, output programs

Session Info File

Line 1 = Number of sessions

Line 2 = Max students per session

Line 3 = Min students per session

Lines 5 +

- Subject ID (unique number)
- Subject
- Teacher of Room
- Presenter

Student Selection File

Line 1 = Number of students

Line 3+

- Timestamp
- Student First Name
- Student Last Name
- Student Home room (Last FI)
- Student First period (Last FI)
- Student ID
- Grade
- 7 cols (1st col = highest choice, last col = lowest choice)

Output File

Line 1 = Number of students

Line 3+

- Student First Name
- Student Last Name
- Student Home room (Last FI)
- Student First period (Last FI)
- Student ID
- Grade
- 8 cols (1st session subj id, 1st session teacher, 2nd session subj id, 2nd session teacher, …)

Rubric / Evaluation

- Did your program work
  - Min students per session OK
  - Max students per session OK
  - Each student has 4 sessions
- Quantitative evaluations
  - Num students going to sessions not picked
  - Num students got their 1st pick
  - Num students got their 2nd pick
  - Num Jrs/Srs going to sessions not picked
  - Num Jrs/Srs got their 1st pick
  - Num Jrs/Srs got their 2nd pick

Getting Started

WestSchoreCS Club Github

Craft some sample challenge data

Evaluation Criteria

- Is output file format correct?
- Evaluate sessions
  - Min number of students enrolled?
  - Max number of students not exceeded?
  - Students haven't signed up for 2 periods of same session?
- Evaluate students
  - Everyone signed up for 4 sessions?
- Score students
  - 4 top choices. 7 + 7 + 7 + 7 / 28 * 100 = 100.0
  - 1st choice, 2nd choice, 4th choice, 7th choice. 7 + 7 + 6 + 4 = 24 / 28 * 100.0 = 85%
  - 3rd choice, 5th choice. 5 + 3 + 1 + 1 = 10 / 28 = 35%
- Shows scores for each grade level

My bad solution

- Assign all the students randomly
- What to improve?
  - Everything

```
Average score all students: 10.7380952380952 35
Average score 7th grade: 10.785714285714286
Average score 8th grade: 10.714285714285715
Average score 9th grade: 9.57142857142857
Average score 10th grade: 10.500000000000002
Average score 11th grade: 11.857142857142858
Average score 12th grade: 11.000000000000002
```

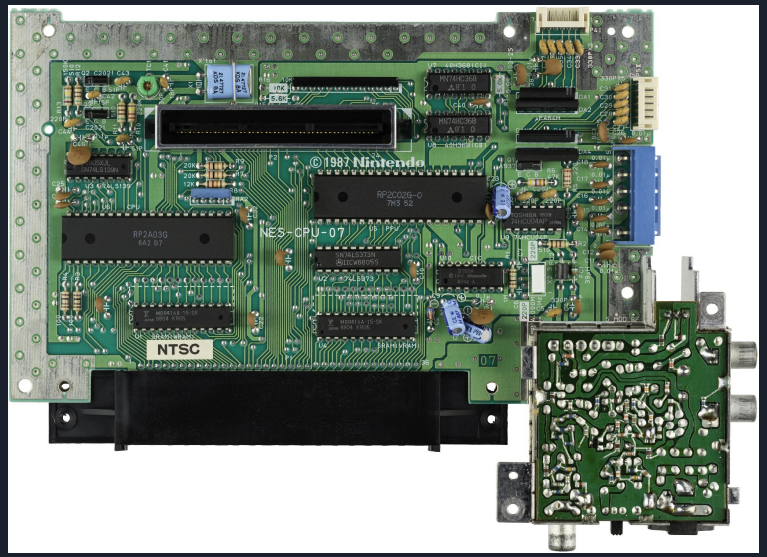
My better solution

- Order students by grade 12th first, sevies last
- Each student pick 1 class, random period
- Students that failed to pick a class, get random one (sessions wont overfill)
- Downgrade students from high pick to lower pick to fill empty sessions
- Downgrade students to fill empty sessions
- Improvements:
  - Didn't use timestamps
  - No smart period selection

```
Average score all students: 91.05357142857156
Average score 7th grade: 88.21428571428571
Average score 8th grade: 89.82142857142857
Average score 9th grade: 91.64285714285714
Average score 10th grade: 87.21428571428571
Average score 11th grade: 93.82142857142857
Average score 12th grade: 95.60714285714286
```

Microprocessor Systems

- Nintendo Entertainment System (NES)
- 1.79 MHz 8-bit CPU MOS 6502 family
- 2KB Work RAM (for programs)
- Ricoh 2CO2 Picture Processing Unit (PPU)
  - 256 Bytes OAM memory - sprites
  - 28 bytes RAM color memory
- 2KB VRAM for PPU
- CIC
- Resistors, buffers, caps, crystals, etc

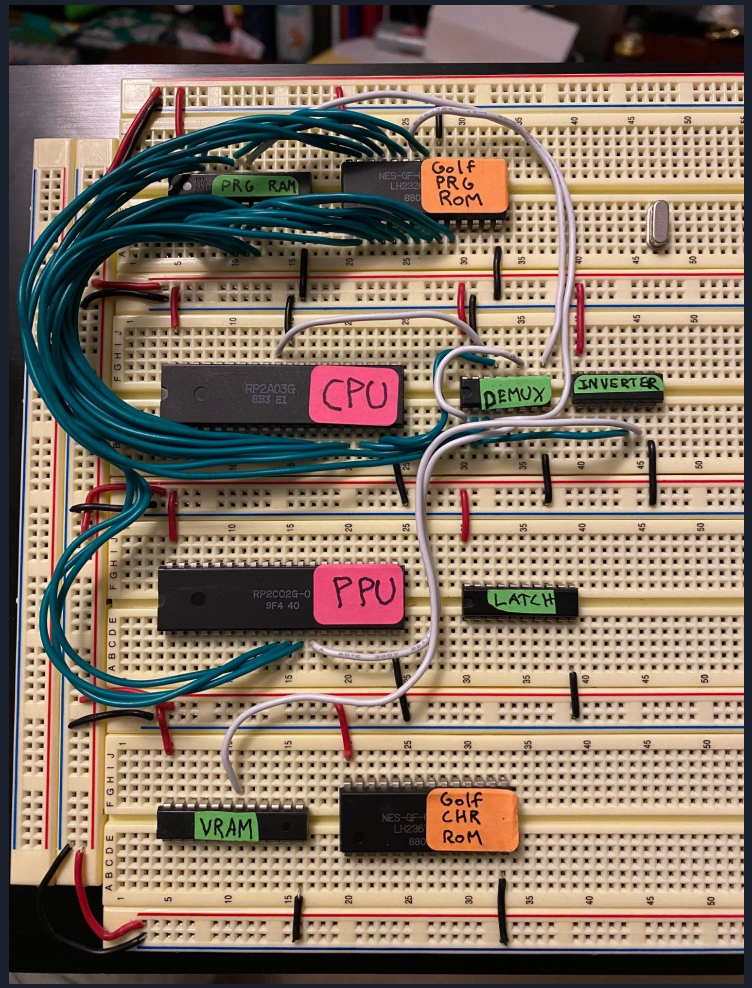


How much work to breadboard a NES?

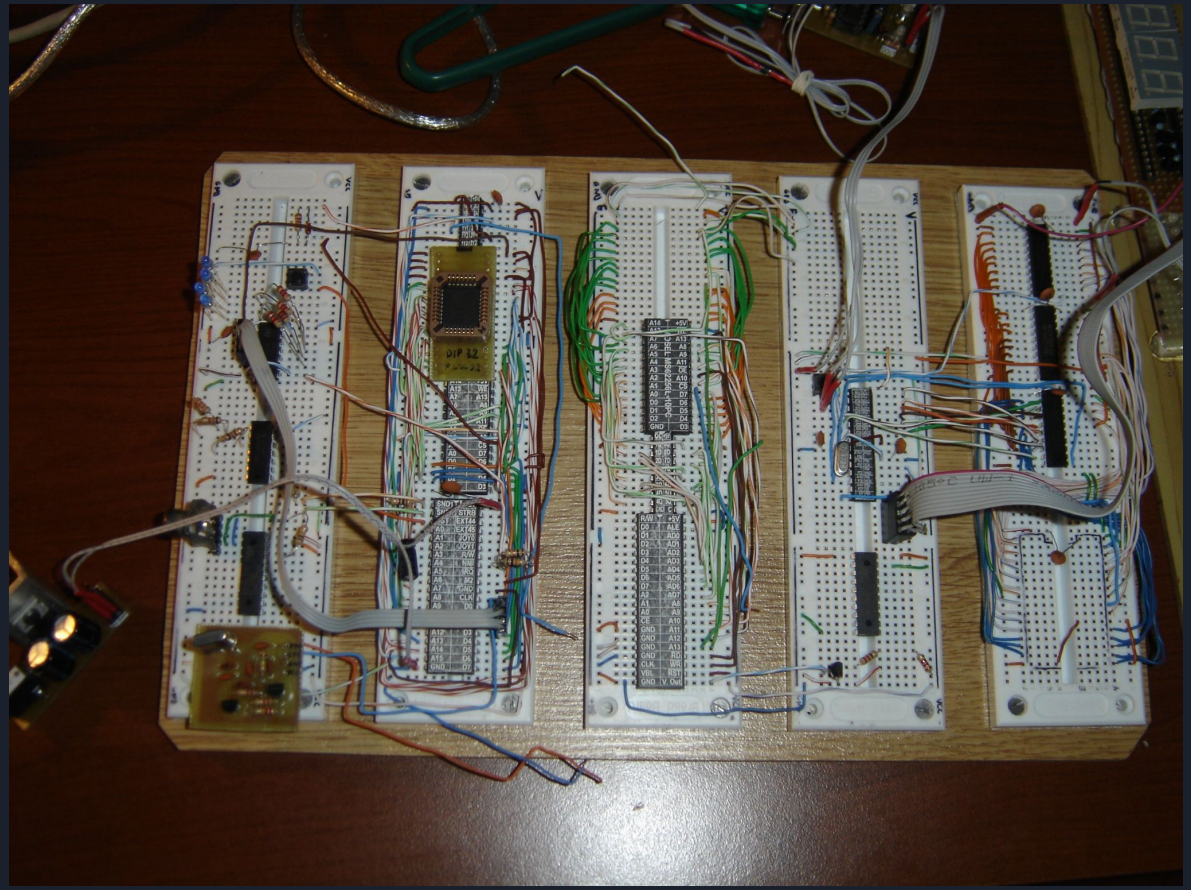
NES Breadboard

- CPU Parallel memory bus can address 64KB
  - 16-bit address bus
  - 8 bits for the data
- Components on BUS
  - CPU
  - PPU
  - VRAM
  - Work RAM
  - Program ROM
  - Characters ROM

Wait, PPU, VRAM, CHR ROM not even hooked up yet…

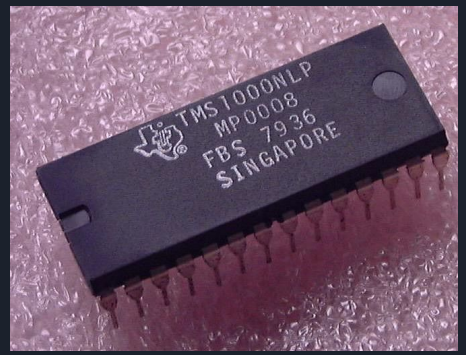


NES Protoboard



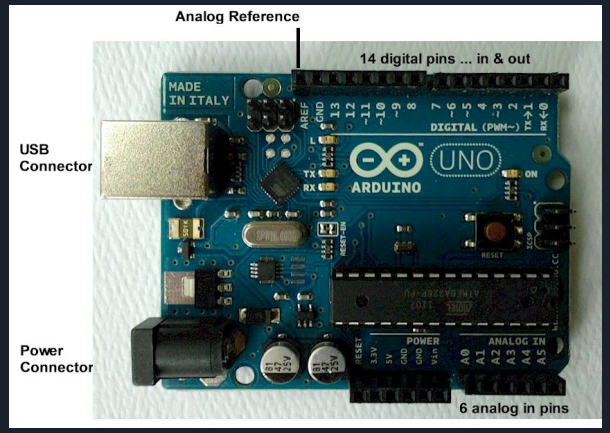
Microcontrollers

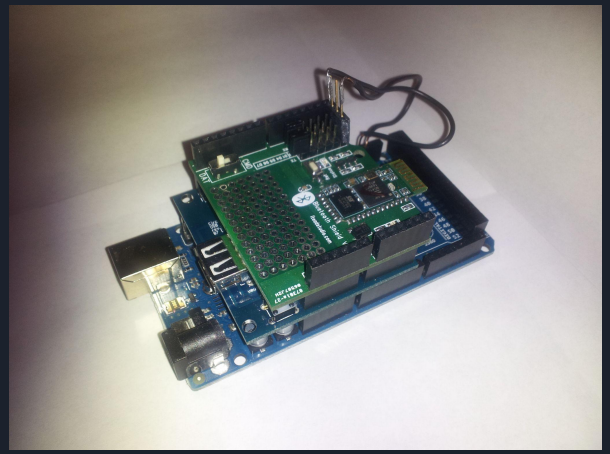
- Integrate CPU, RAM, and ROM into a single Integrated Circuit (IC)
  - Think of all those wires i don't have to connect now…
- Sometimes can have oscillator (crystal) integrated
- Can have (General Purpose Input Output) GPIO pins
  - Control LEDs, motors, chip select signals
  - Buttons, switches
- Serial peripherals - Use 2 or 3 wires to send address / data information
  - I2C - slow, many devices on one bus
  - SPI - faster, 1 device, but can add more
- Much easier to design / prototype a system with microcontroller
- Texas Instruments - TMS1000 - first microcontroller, 1970s



Arduino

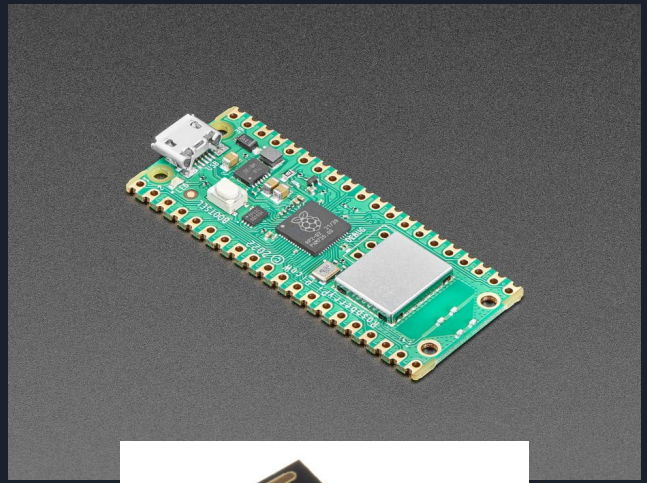
- Italian company / group
- Wanted a simple, low-cost platform for non-engineers to create digital projects
  - Simple API - Wiring
  - Simple HW - Dev kit with everything needed to get started
    - Circuit programming / debugging
    - Some LEDs
    - Easy to power
- Shields - add on circuits
  - USB Host
  - SD Card
  - Bluetooth / LoRa radio

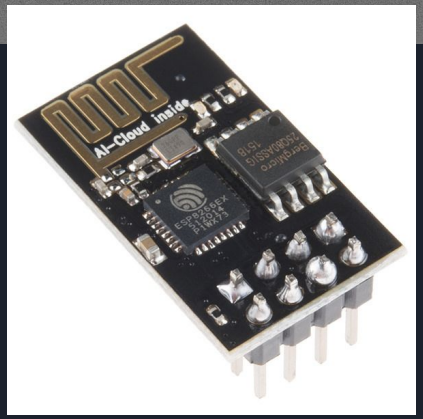




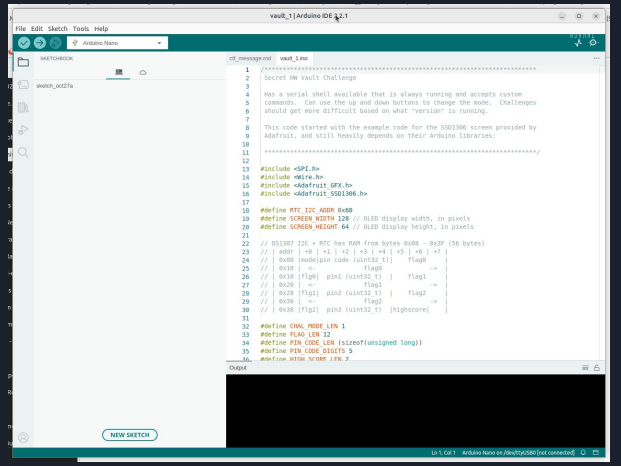
Arduino Evolution

- Started with ATmega AVR 8-bit microcontrollers
- Open source - caused many clones
  - Different CPUs. x86, ARM, Parallax, PIC, TI, ESP32
- IDE Plugins
  - Allow other vendors to add support to Arduino IDE
  - Adafruit
- Raspberry Pi Pico W
  - $6 for microcontroller with WiFi





Intro to Arduino



- Arduino IDE for development
  - Comes with compiler tools built in
  - Comes with serial terminal program built in
  - Can program / reprogram Arduino boards
  - Works in Windows or Linux
- C language
- Wiring API

Blinky Tutorial: https://docs.arduino.cc/built-in-examples/basics/Blink/

First Time Using Arduino

- Look at installation instructions
- Linux user: sudo usermod -a -G dialout <username>
  Then logout and log back in
- When you run Arduino program
  - Tell it what type of board you are using
  - Tell it what port the board is on
- Always use a current limiting resistor with the LEDs

Attributions

- NES Motherboard Gallery: https://hackaday.io/project/18301/gallery#442bdea578a372abe684822ad46d6045
- NES architecture: https://www.copetti.org/writings/consoles/nes/
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