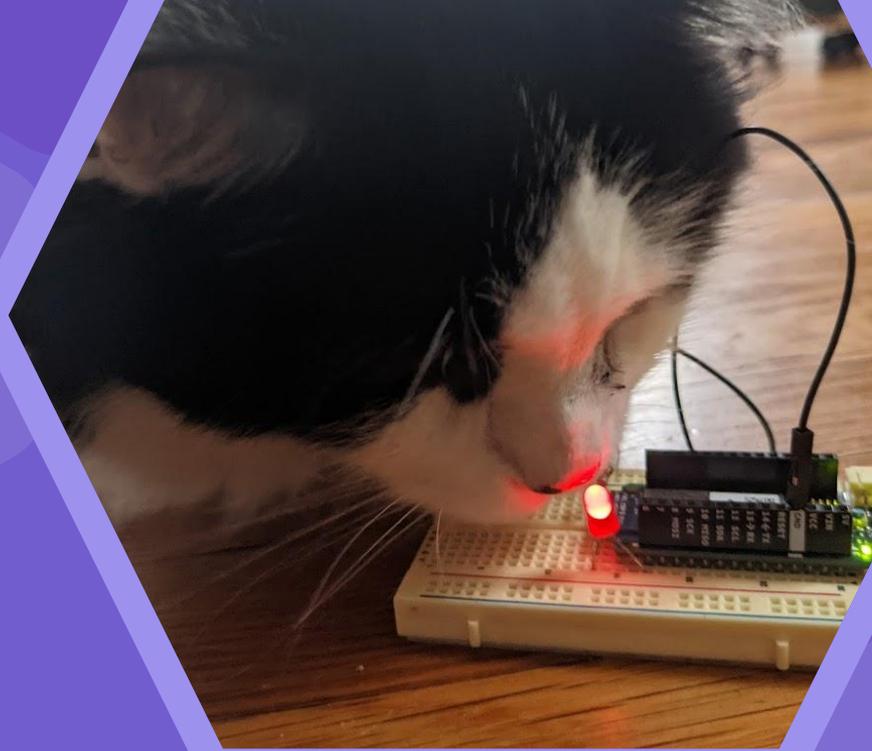


CSCI 1600: Real-time and Embedded Systems





Not counting laptops and phones, estimate the number of computers in this classroom

Class estimates/examples:

TVs

Podium control

Motion sensors

HVAC system, fire alarms, purifier

Speakers

Projector

Smartwatches

Wireless headphones

Switch

Keycard

Lecture capture cameras



What are some other examples of embedded systems you can think of?

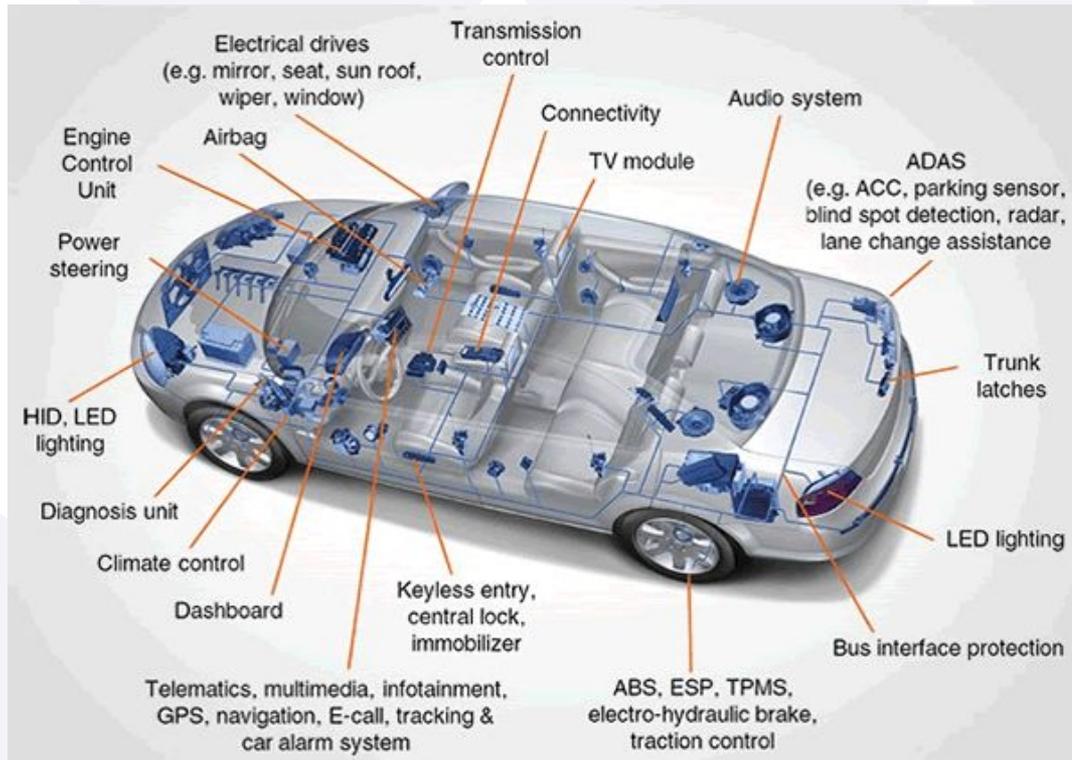
Some examples



Images creative commons. For credits, see last slide



*How many different
embedded systems can you
think of that make up a car?*



Thomas Scannel, "Automotive Connectivity Evolves to Meet Demands for Speed & Bandwidth", 2017

Some products are made up of **distributed** embedded systems



*Choose a device we
mentioned.*

Discuss:

- *How does the device interface/interact with the outside world (sensors, buttons, displays, other devices)?*
- *What sorts of constraints are put on its design (size, cost, safety)?*

Embedded systems

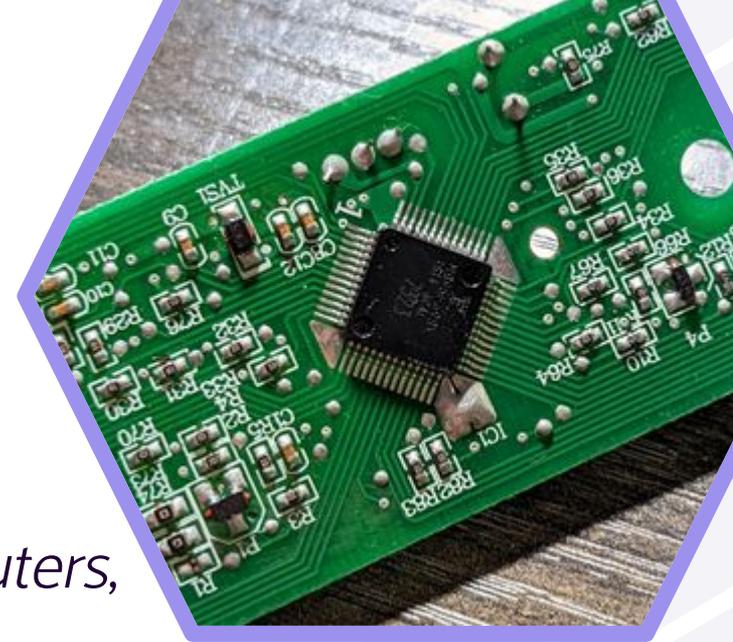
Controlled by a **microcontroller**

CPU, memory, IO in one chip

Contrasted with *general-purpose computers*,

embedded systems:

- Are made for a specific purpose
- May be less “visible”
- Interface with the physical world
- Have timing constraints that affect correctness (**real-time systems**)





Challenges

Constraints

Memory space

Form factor

Power

No OS*/standard API or architecture

Engineering

Safety

Software/hardware design process

Cost at scale

Real-world interactions

Interface with peripherals

Peripheral failure

Communication protocols

Harsh environments

Verification & Validation

Timing analysis

Modeling physical properties

HW *and* SW testing and debugging



Roadmap of the class

Background, hardware
concepts

Engineering
process

Safety,
security, and
correctness



Theory, case studies
Examples and interactive work
Hands-on labs

How microcontrollers
work

Applications

Your cool
embedded
project!

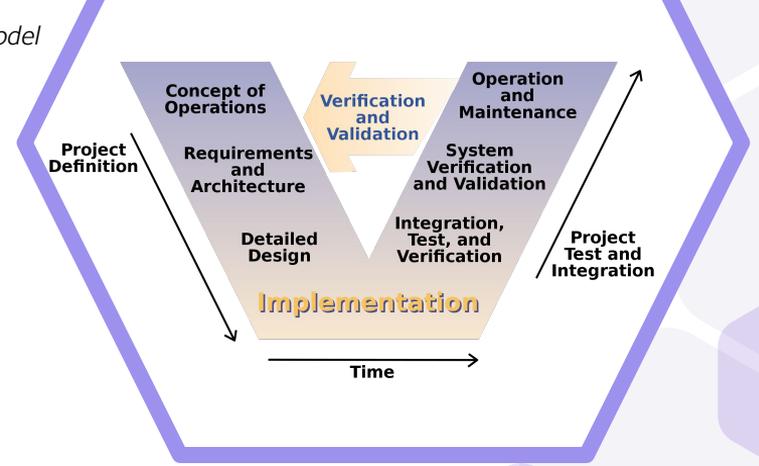


Throughout the class

How design, implementation, verification/validation connect

How HW influences SW and the other way around

Societal impacts of embedded technology

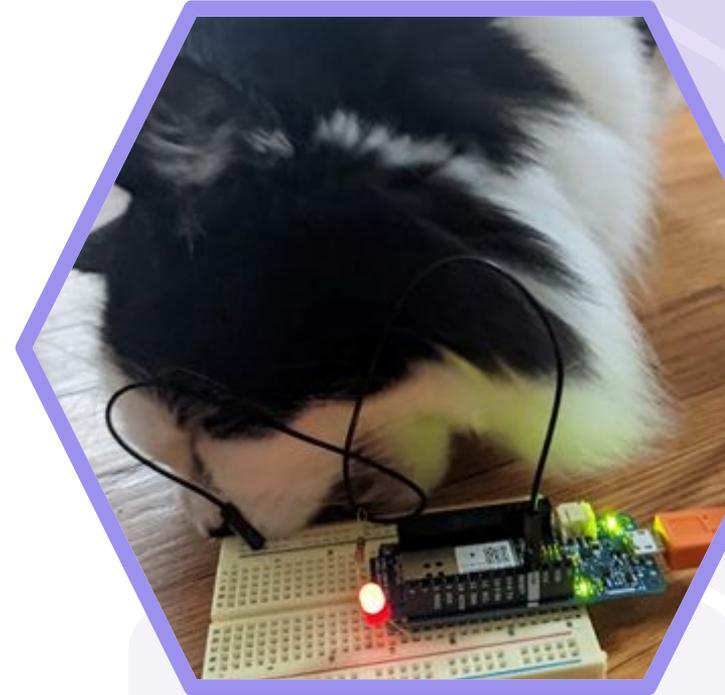


Embedded Systems...

are everywhere

have many different applications

have interesting design challenges





Course structure

Homeworks

...prepare you for...

Concepts presented in lecture

...prepare you for...

Hands-on experience in lab

further assessed in
Group project



Logistics

Website: brown-cs1600.github.io

Waitlist: through HWO (please drop the class if you know you won't take it!)



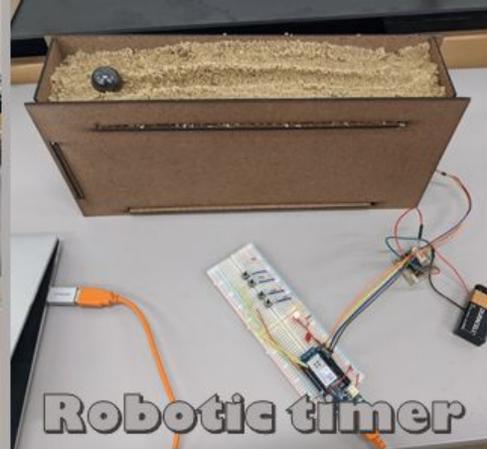
Music visualizer



Looping pedal



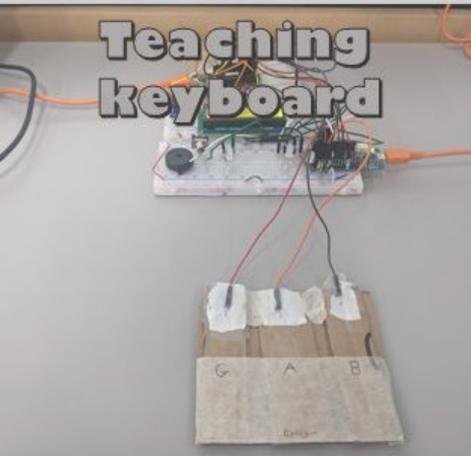
Drink mixer



Robotic timer

Incredible work on your projects, CS 1600! We want to brag about you!

- Arun, Jason, Stephen, and Prof. Zizyte



Teaching keyboard



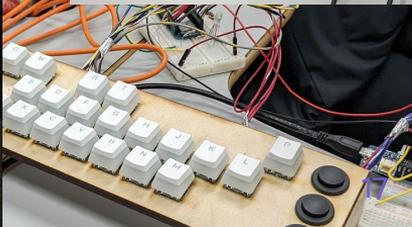
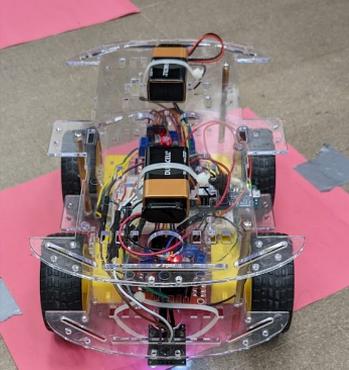
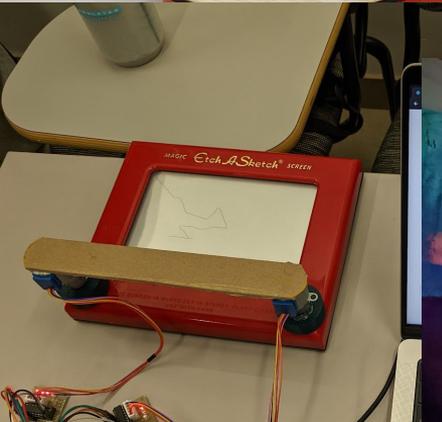
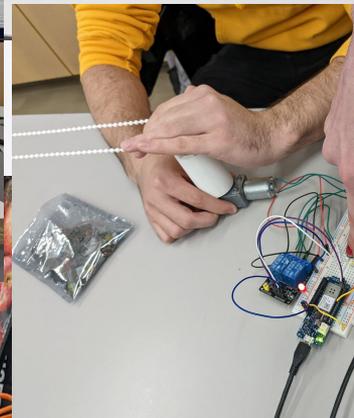
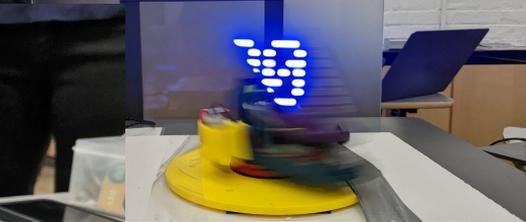
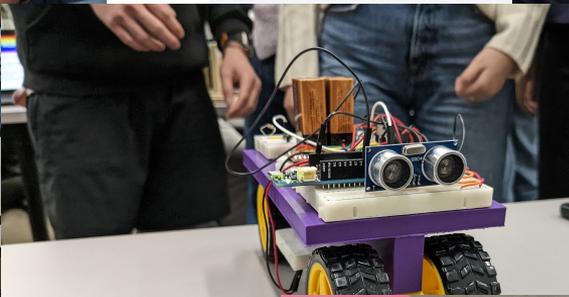
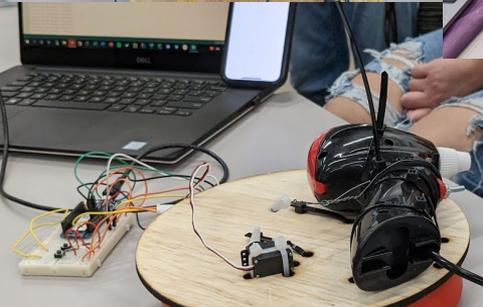
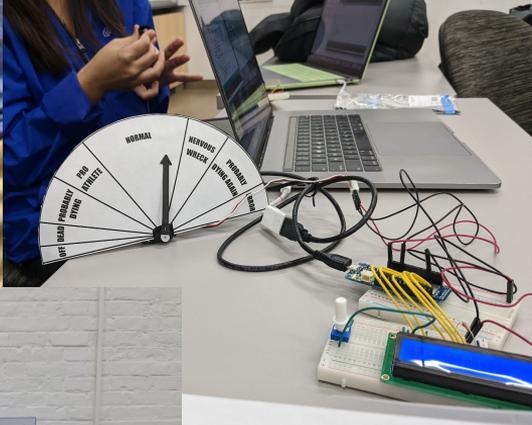
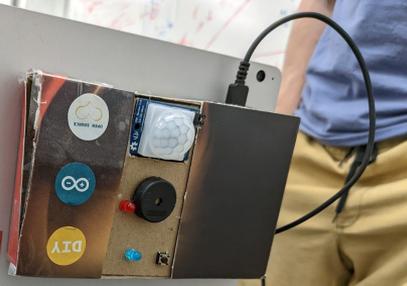
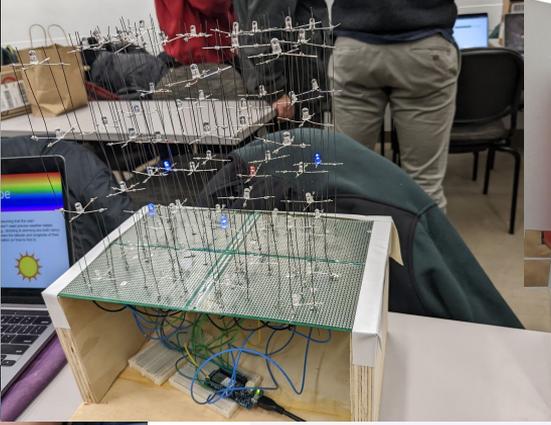
Laser tag



Sapling Sprinter game



Egg scrambler





DE&I

Engineering involves working **with people** to create artifacts that will be used **by people**

Your work impacts others

Course has a major participation and teamwork component → inclusion and respect

I want to hear how I can do better, too



Ways you can give me feedback

E-mail

In person (after class, in office hours)

Anonymous form

Via TAs (anonymous or not)

DE&I, accessibility, culture issues: department and university-wide resources

→ **Feedback only works if I follow up on it**



Think about the classroom practices that have enabled your learning in the past. Where do you see room for a similar practice in this class?





What is one community guideline that would help your learning that you would like to see in the syllabus?



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