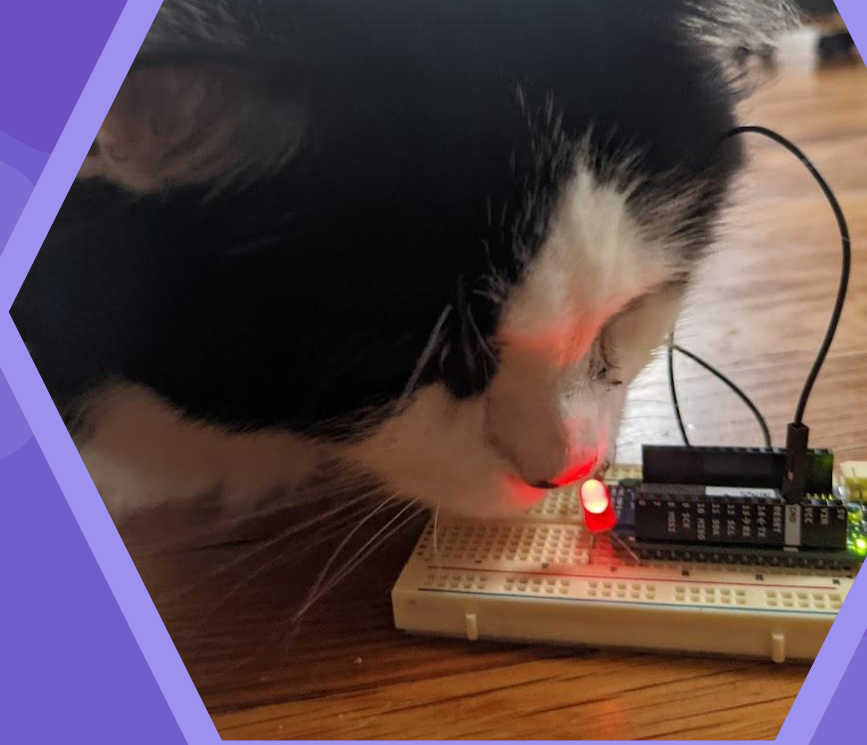
CSCI 1600: Real-time and Embedded Systems



Course staff

Filip!

Julian!

Ian!

Sahil!

Milda!

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

Class estimates/examples:

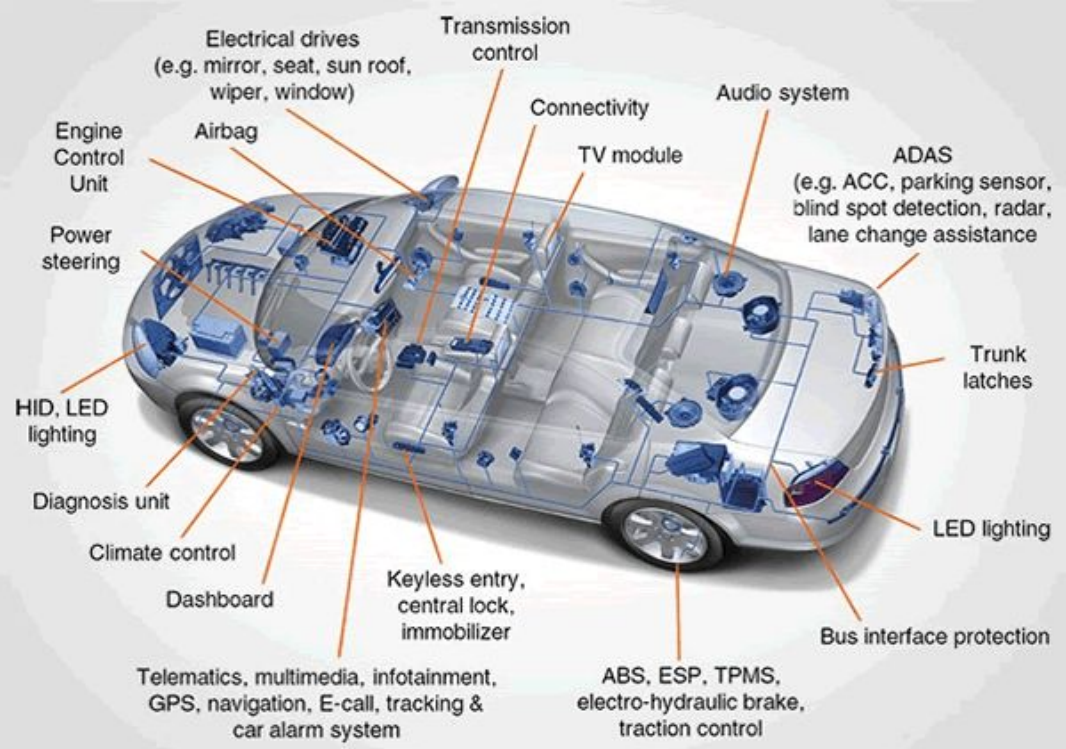
50? screen/speaker/project controllers
panel controller
smartwatches
fire alarm/sprinkler system
cameras
HVAC controllers
things hidden in the cart
possibly calculator
wifi router

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*

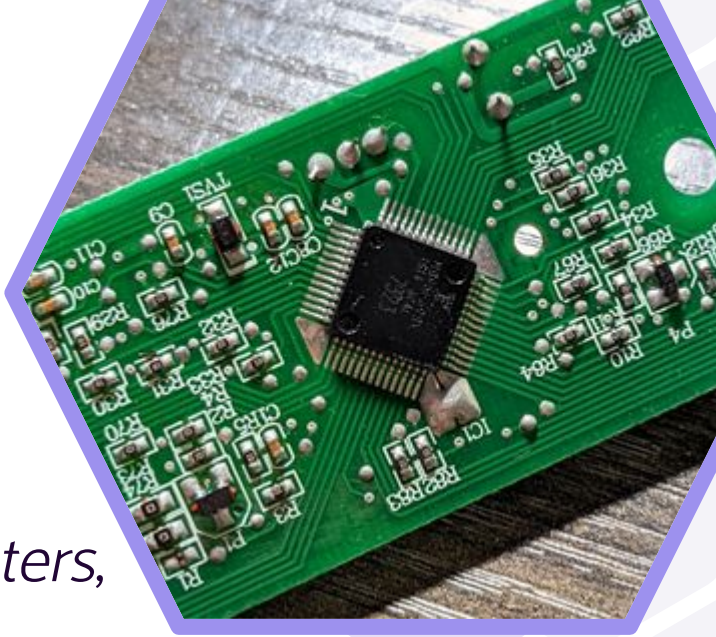
Some products are made up of **distributed** embedded systems

Choose a device we mentioned.

Discuss:

- *What is the device meant to do?*
- *What other devices does it communicate with?*
- *How does the device interface/interact with the outside world (sensors, buttons, displays)?*
- *What sorts of data does it process, and what computations does it have to do?*
- *Can it cause damage (to itself, its environment, people) if its software malfunctions?*

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

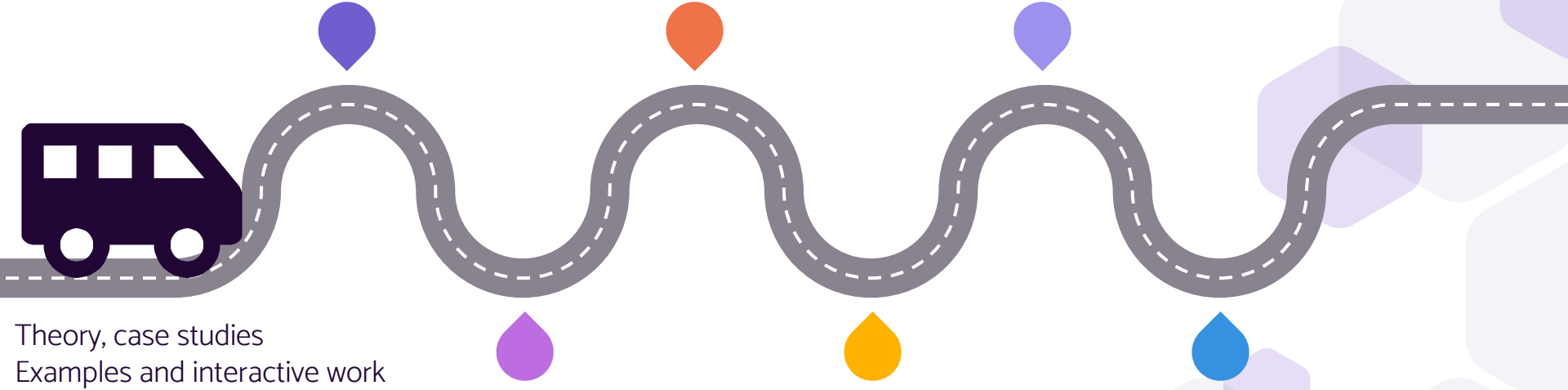
Verification & Validation
Timing analysis
Modeling physical properties
HW *and* SW testing and debugging

Roadmap of the class

Background, hardware concepts

Engineering process

Safety, security, and correctness



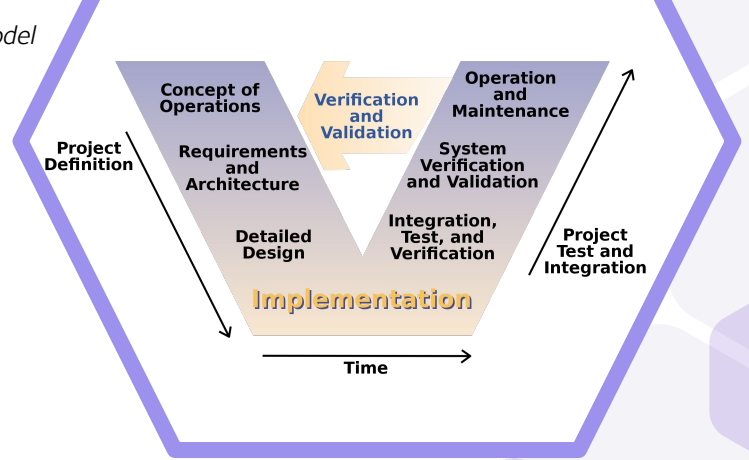
Theory, case studies
Examples and interactive work
Hands-on labs

How microcontrollers work

Applications

Your cool embedded project!

Image from http://en.wikipedia.org/wiki/V-Model



Throughout the class

How design, implementation, verification/validation connect

How HW influences SW and the other way around

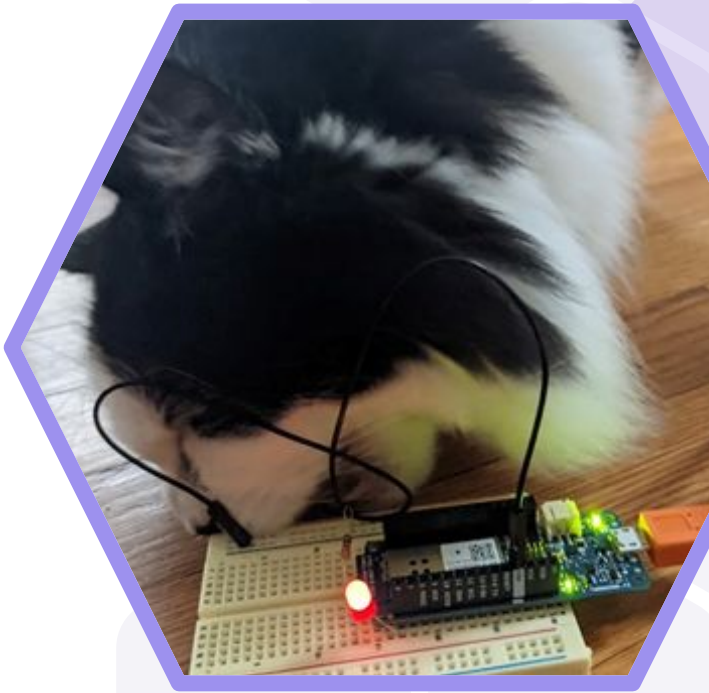
Societal impacts of embedded technology

Summary

Embedded is everywhere

Embedded is cool!

Embedded has interesting challenges



Course structure

Homeworks

...prepare you for...

Concepts presented in lecture

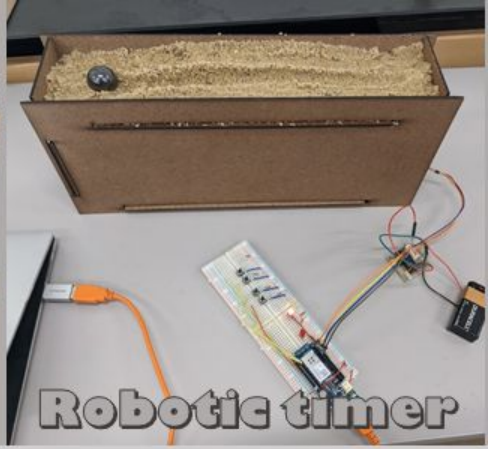
...prepare you for...

Hands-on experience in lab

further assessed in

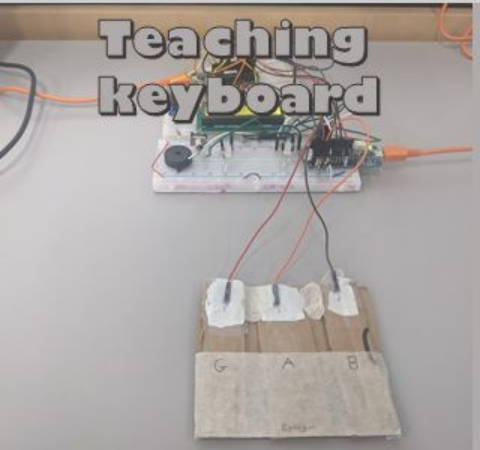
Group project

Website for details: brown-cs1600.github.io



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

- Arun, Jason, Stephen, and Prof. Zizyte



D E & 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**

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