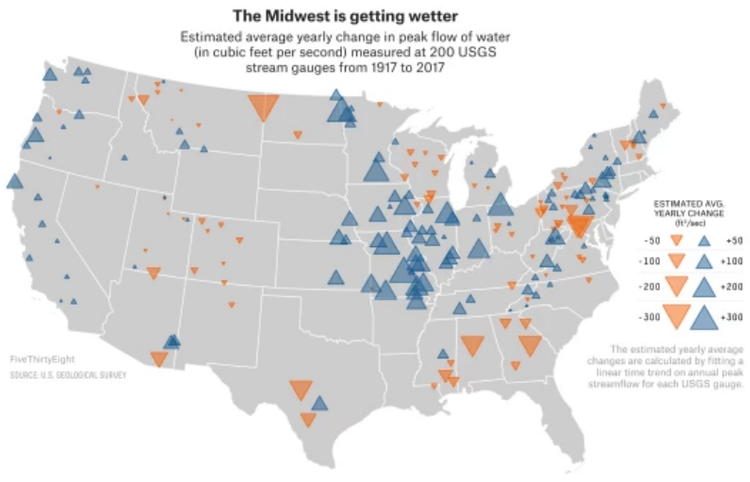
[301] Introduction

Tyler Caraza-Harter

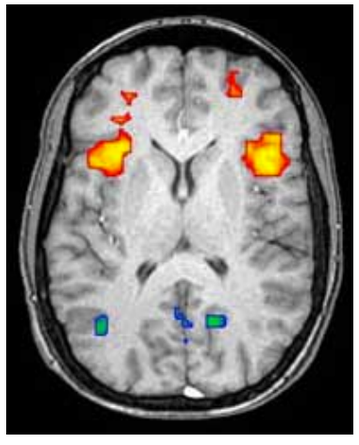
Welcome to Data Programming!

Data is exploding in many fields

- Journalism
- Biology, physics, chemistry
- Psychology, sociology, economics, business
- Engineering (mechanical, electrical, industrial, etc)

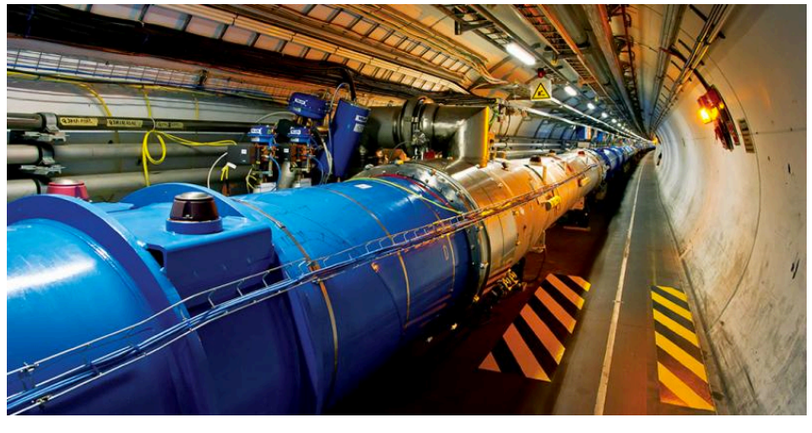


https://fivethirtyeight.com/features/the-midwest-is-getting-drenched-and-its-causing-big-problems/

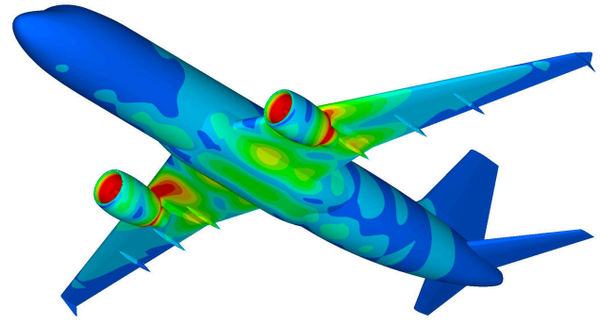


https://en.wikipedia.org/wiki/Neuroimaging

https://science.howstuffworks.com/life/genetic/gattaca-gaptacaz-adding-letters-the-genetic-alphabet.htm



https://home.cern/topics/large-hadron-collider



http://www.stressebook.com/finite-element-analysis-in-a-nut-shell/

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How can we gain insights from that data?

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- With computation

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Approach 1: human computation

https://en.wikipedia.org/wiki/Human_computer

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Approach 1: human computation

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Approach 2: machine computation

http://fortune.com/2015/11/15/intel-super-7/

Welcome to Data Programming!

CS 301 is about approach 2

- Faster, more reliable, can churn through more data

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CS 301 is about approach 2

- Faster, more reliable, can churn through more data
- Automate to save human effort

"Find the leverage in the world, so you can be more lazy!"

~ Larry Page

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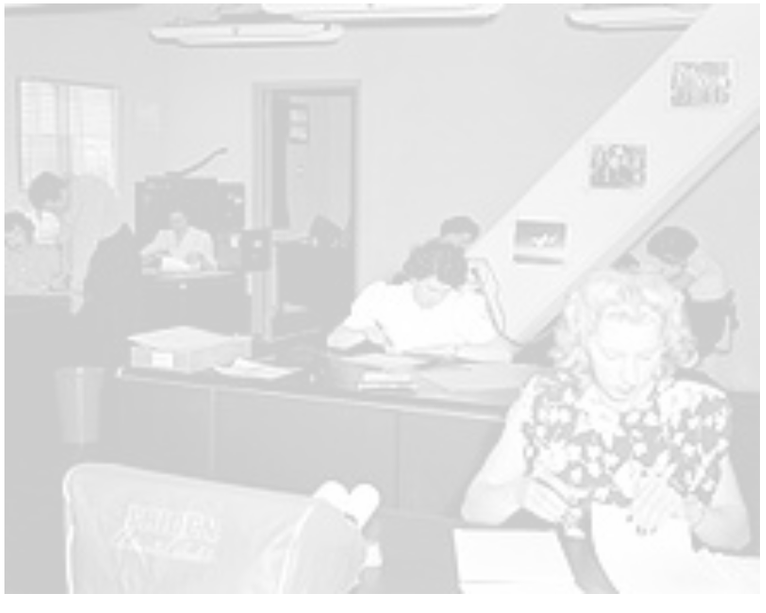
- Faster, more reliable, can churn through more data
- Automate to save human effort
- Requires being able to tell computers what to do!

society needs more domain experts in specific fields who can write code

Approach 1: human computation



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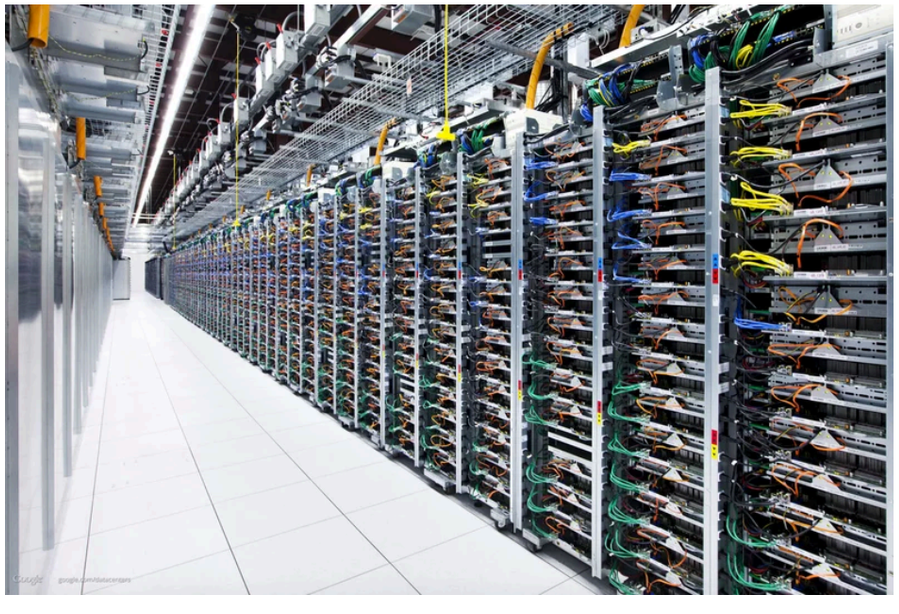
Approach 2: machine computation



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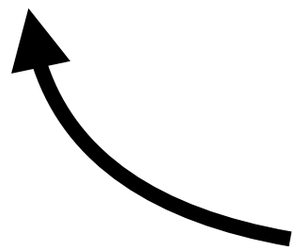

society needs more domain experts in specific fields who can write code

Goal: become "bilingual"

- Speak the language of X (biology, mech eng, journalism, etc)
- Speak the language of computing

Why CS 301?

Common approach to introductory CS courses

- Use a programming language like C++ or Java
- Teach CS students and other majors together
- Emphasis on theory
- Light on data

Why CS 301?

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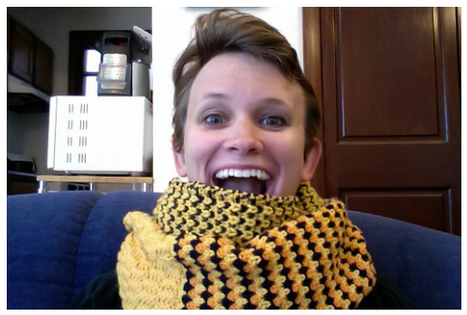
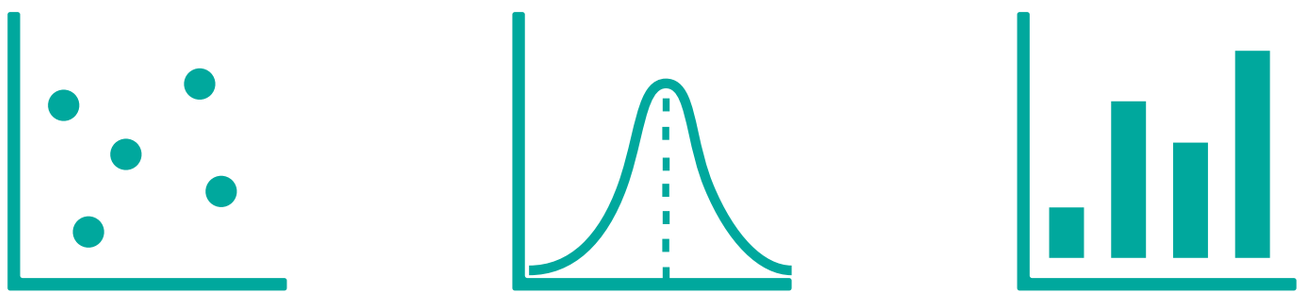
CS 301 approach

- Pioneered by Laura Hobbes LeGault
- Use Python (powerful but ~~easy~~ easier to learn)
- Goal: bring more programming into other fields
- Practical, minimal theory
- Emphasis on data, simulation, analysis, plotting





Today's Topics

Introductions

- Who am I? Who are you?

Course overview

Computer hardware basics

Website

Who am I?

Tyler Caraza-Harter

- Email: tylerharter@gmail.com
- Just call me “Tyler”

Long time badger

- Did undergrad, masters, and PhD at UW-Madison
- 2nd time teaching CS 301

Work in industry

- Worked at Microsoft on SQL Server and Cloud
- Other internships/collaborations:
  Qualcomm, Google, Facebook, Tintri

Open-source projects

- OpenLambda project (Python-based platform)
- PivotLibre project (preferential-voting tool)

Who are You?

Year in school?

- 1st year? 2nd? Junior/senior? Grad student?

Area of study

- Natural science, social science, engineering, other?

How many have programmed before?

- Any language? Python? Taken a class?

Survey (counts for participation)

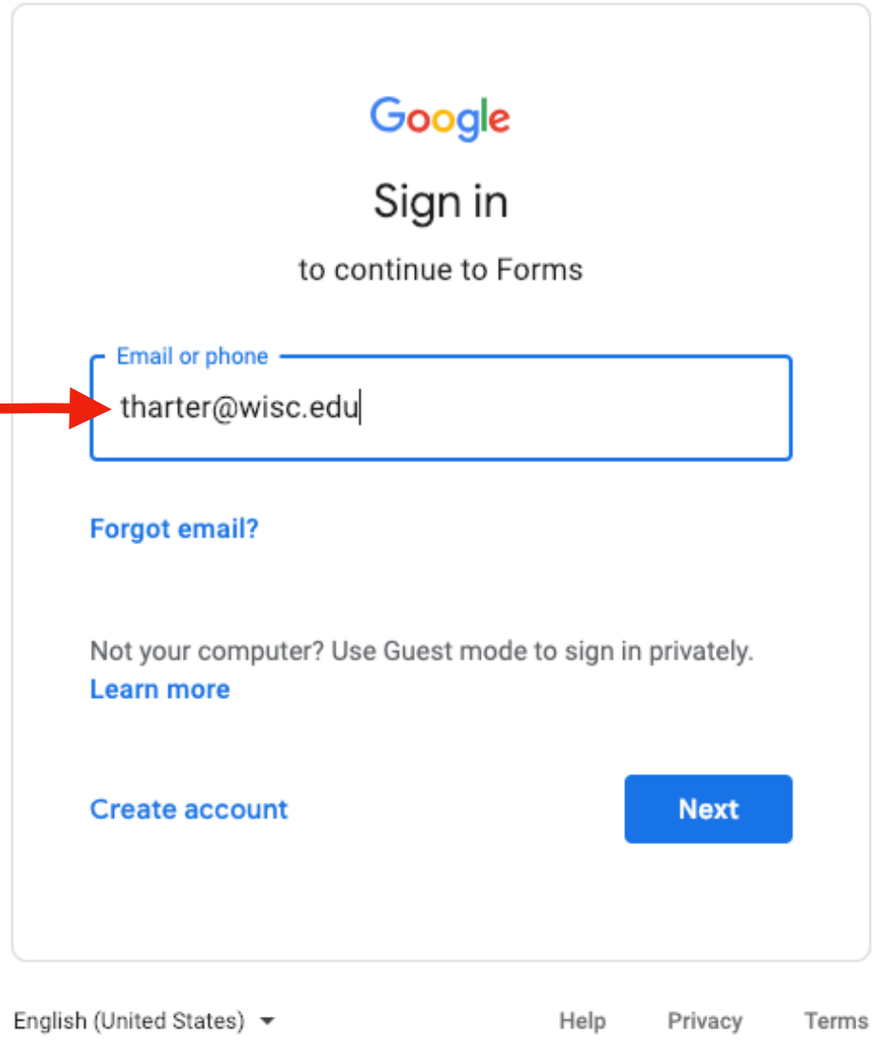
Please help us get to know you (not anonymous):

https://goo.gl/forms/WtWRjr7qFt4jYfEV2

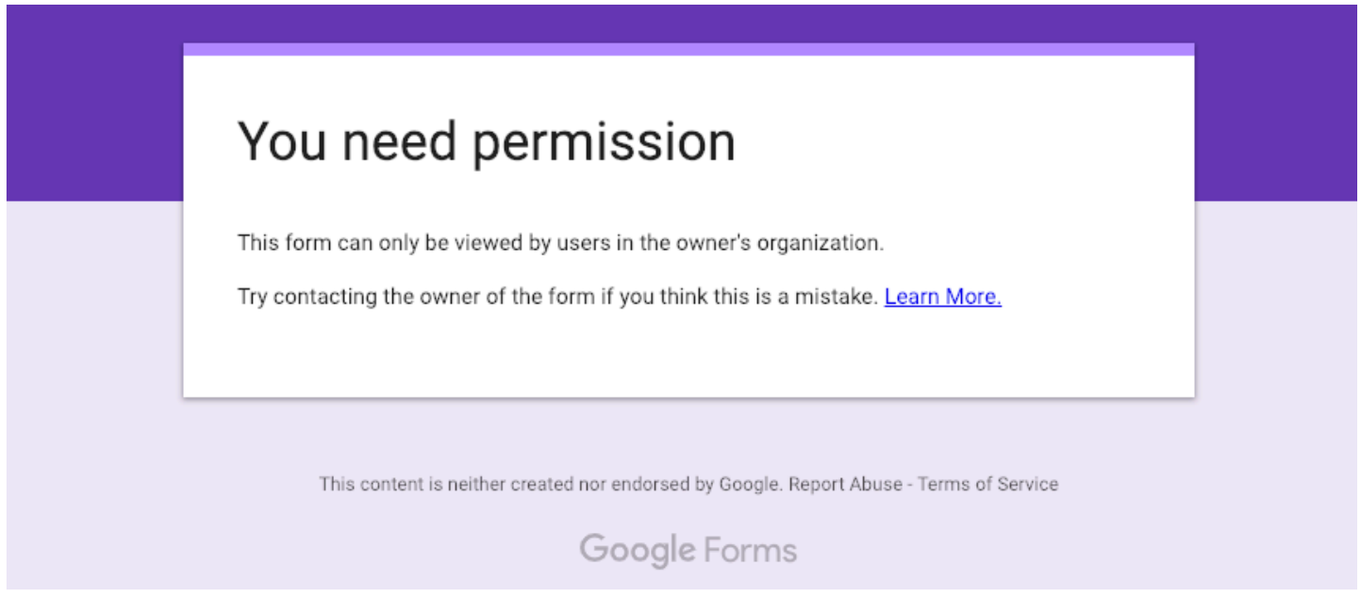
Purposes:

- gauge class interest/experience
- determine who on waitlist is attending (please finish by 4pm today!)
- correlate experience with later scores

be sure to use your campus email!!!



Survey: Common Technical Issues



if you see this, it means you're signed in via Gmail instead of your campus email

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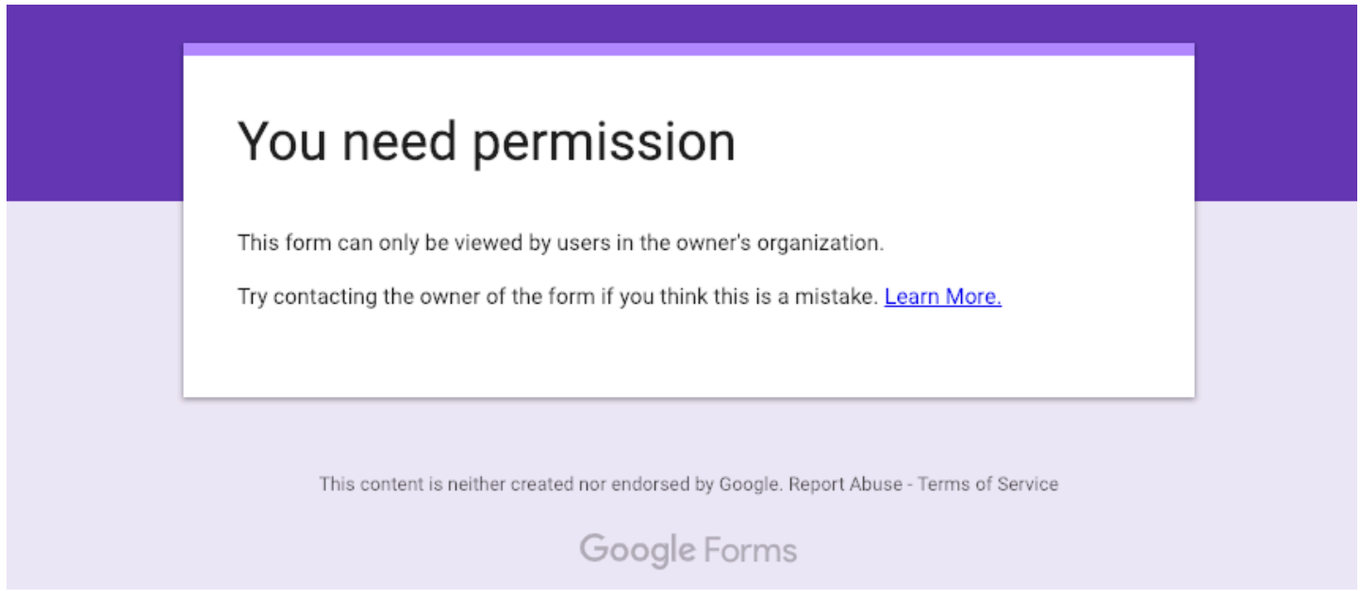

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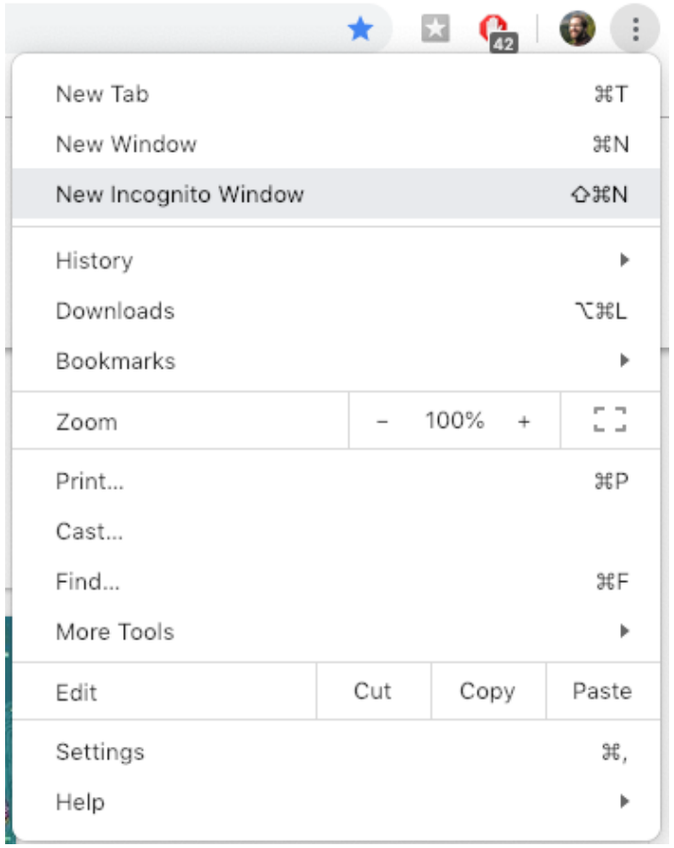
if you were automatically signed into gmail without being asked, consider clearing cookies or using an Incognito Window (in Chrome)



Three types of students...

1. Lazy CS senior

"*I am a senior CS student, this class was very easy for me*" [from F18 course eval]

Comment: drop this course and take something that challenges you.
You're not the target audience, and we'll make zero effort to make 301 interesting to you.

2. Mandatory participants

"*Make it significantly easier. None of [us] will ever code again...*" [from F18 course eval]

Comment: we're working with the assumption that your future careers WILL involve writing code in the future. 301 is challenging because our goal to prepare you for it.

3. Enthusiastic beginner

"*Good course, I think there is a good pace for this course, speaking as someone with zero programming experience coming into the class.*" [from F18 course eval]

Comment: this course is for you! Invest the time, and you'll walk away with a superpower (the ability to make computers work for you)

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301 Topics

Basic Python

- How to get data in/out of a program [I/O]
- How does program remember things [state]
- What is executed when [control flow]

Data structures

- How to organize lots of data? [data structures]

Popular data formats

- How to ingest tabular data, hierarchical data, web pages

Database basics

- Asking questions about data [querying]

Plotting

- Choosing and implementing visual communication

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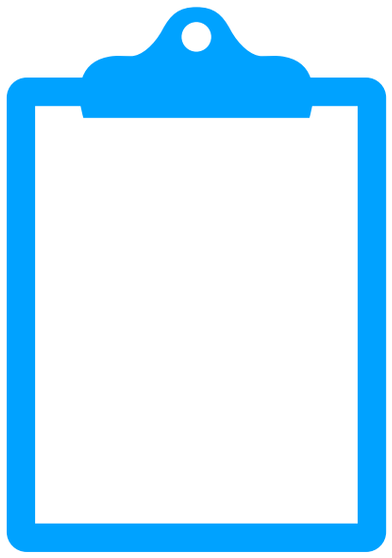
Lecture Style

general concepts



worksheet practice

live coding

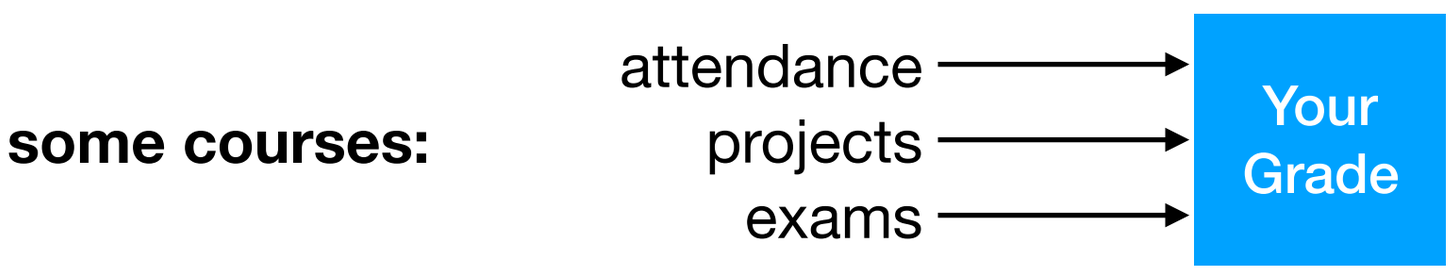
Your role

- do readings before or after
- feel free to bring your laptop along!
  (but avoid the temptation to get distracted)
- I love to get questions

Lecture Attendance

Attendance isn't graded

- One student's suggestion for improvement (f18):
  "*I think one MAJOR thing to do is make lecture mandatory*"



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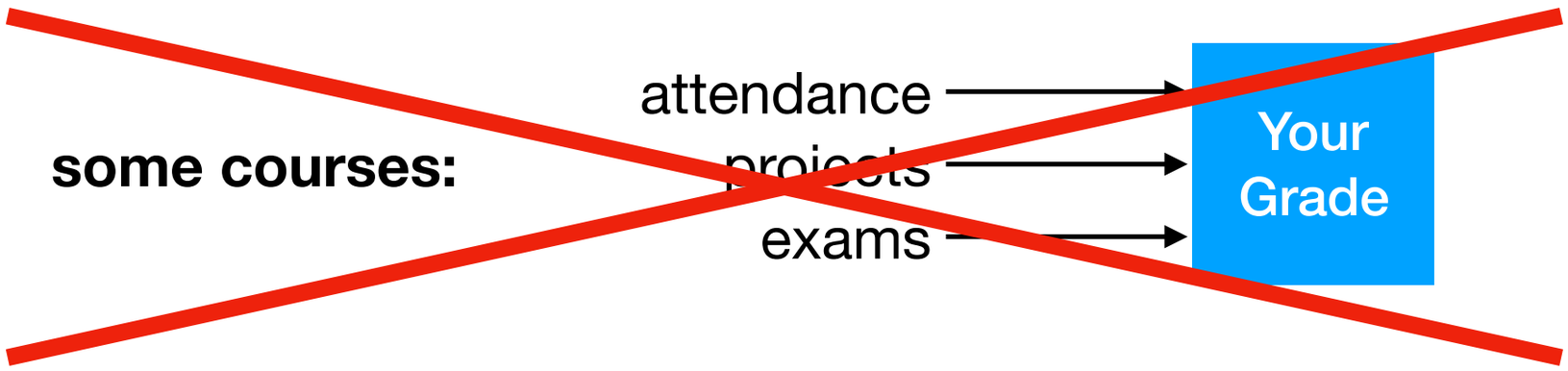

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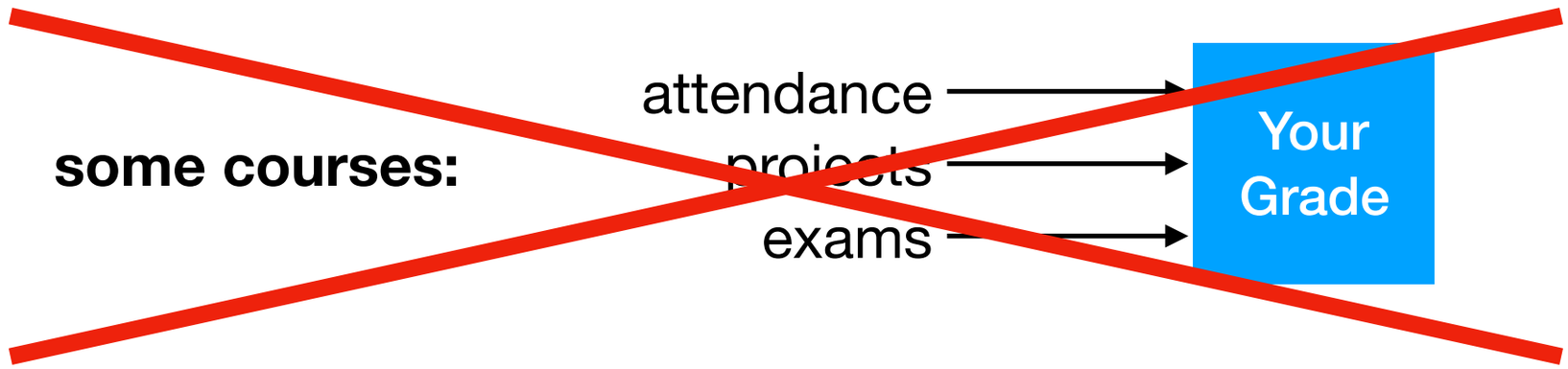

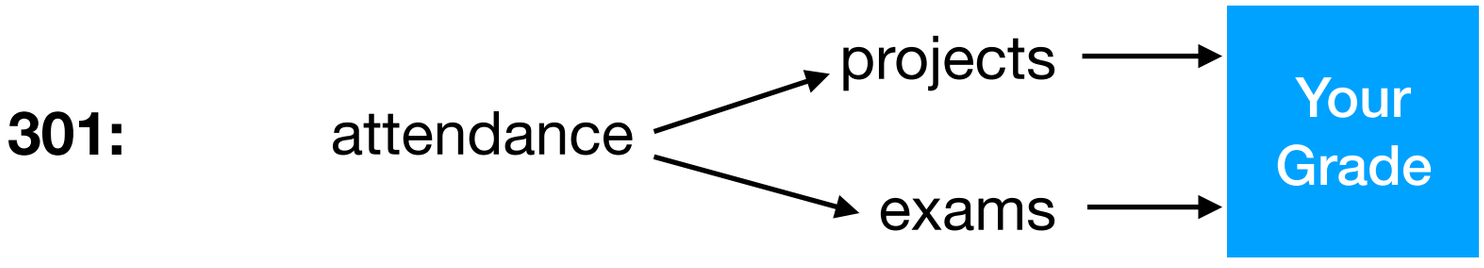

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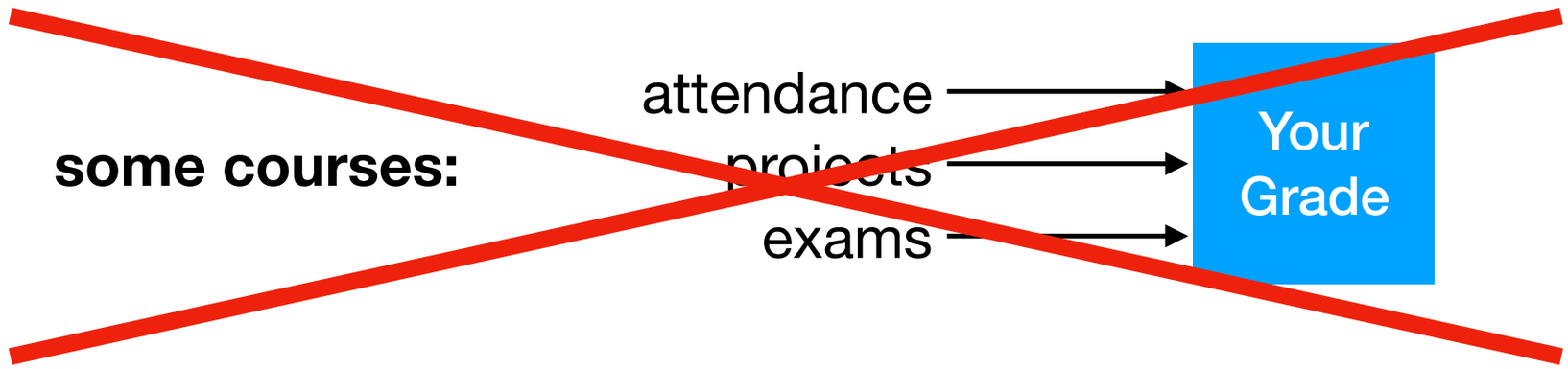
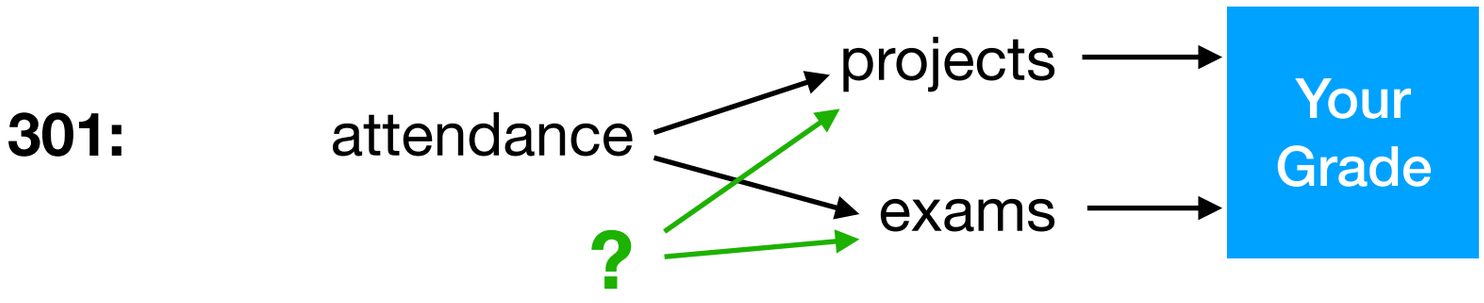


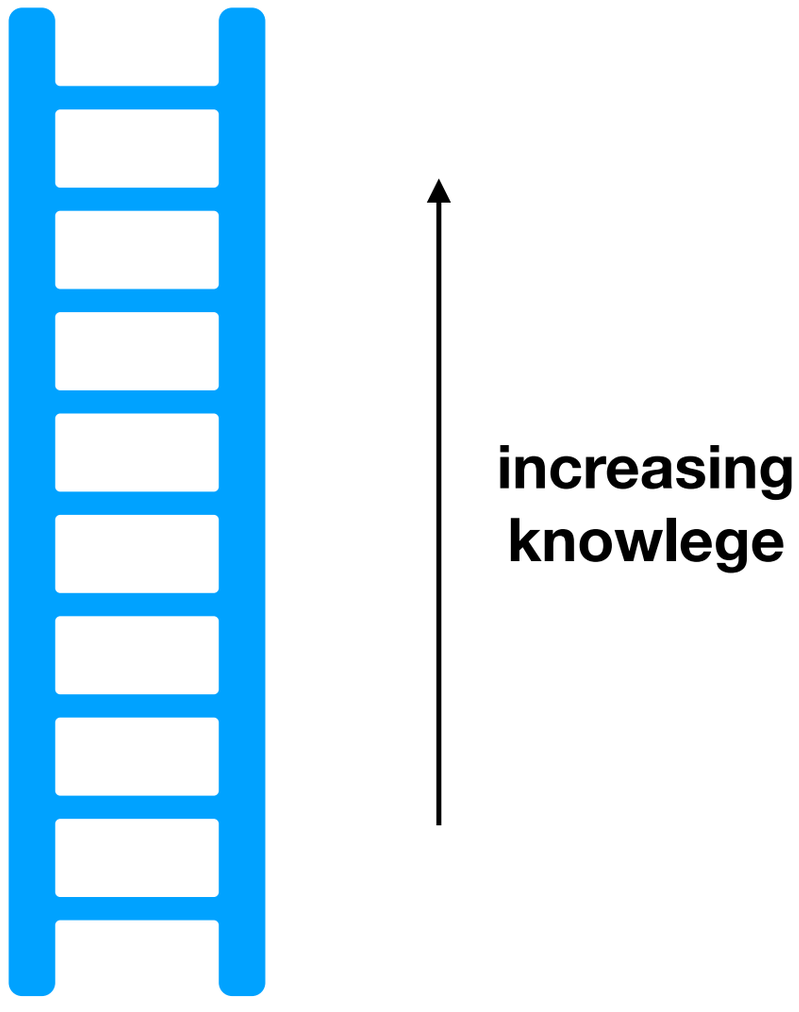


Tip: as a student, you can make anything mandatory for yourself you like! Think carefully about what you should, then practice following through.

Topic Progression

Programming knowledge builds

- For first couple months, trying to skip foundational knowledge will be problematic throughout the semester



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Computer hardware basics

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Labs

Format

- 75 minutes on Thu or Fri, leave when you're done
- typically: work through a practice document
- self guided, not graded
- **purpose: prep for project**

People

- pair with another student each time
- 1-2 TAs will be there to answer questions

Computers

- lab computers are provided (must have 2 students per computer)
- feel free to bring your own laptop

we will have labs this first week

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Readings (all free!)

Think Python, 2nd Edition

- Allen B. Downey
- Assumes no programming background
- It's very concise
- Get the 2nd edition, which is for **Python 3**!

Automate the Boring Stuff

- Al Sweigart
- Useful for some more advanced topics related to using data

CS 301 Notes

Course Notes

- 301 instructors
- Mostly for data science part of class

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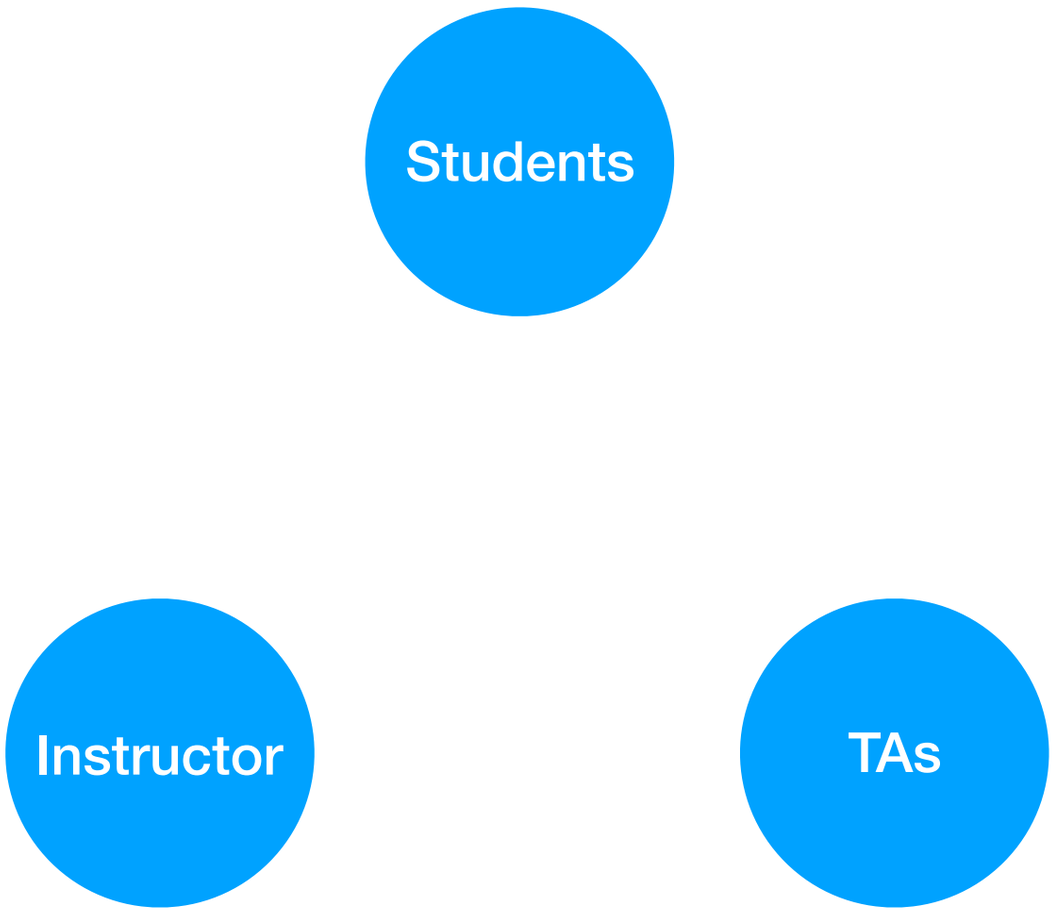
Communication is CS 301

Good communication is critical for a class of this size

- Who needs to communicate: students, TAs, instructors

Besides direct email, we'll use five communication tools

- Piazza
- Email lists
- Feedback Form
- Project Submission
- Canvas



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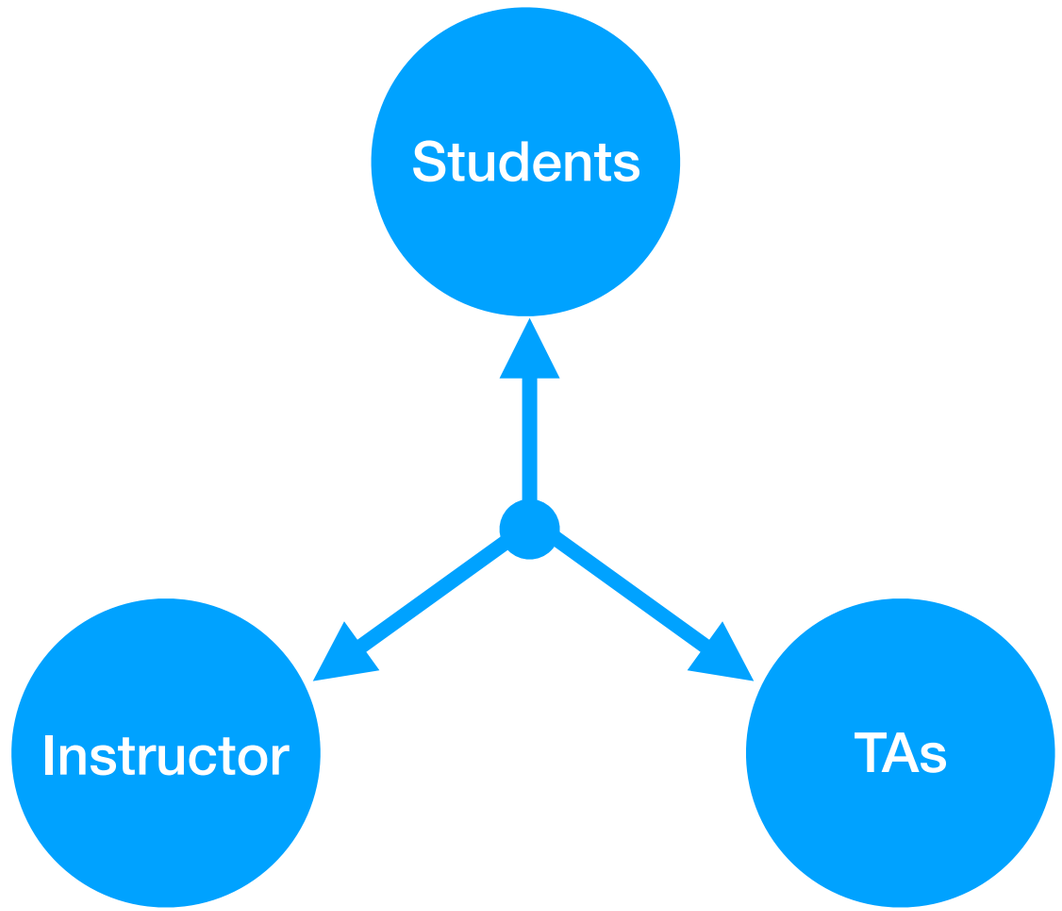

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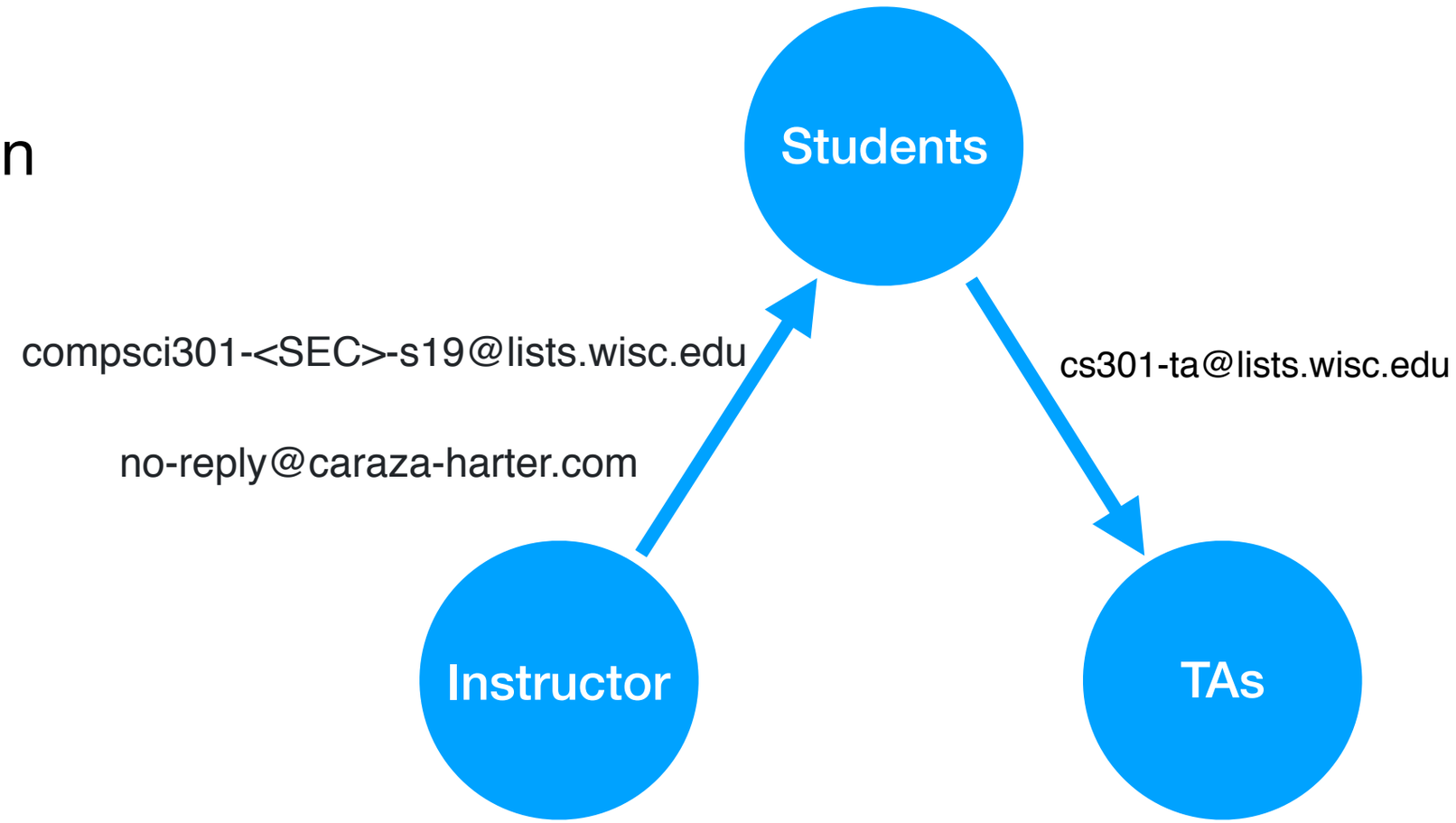

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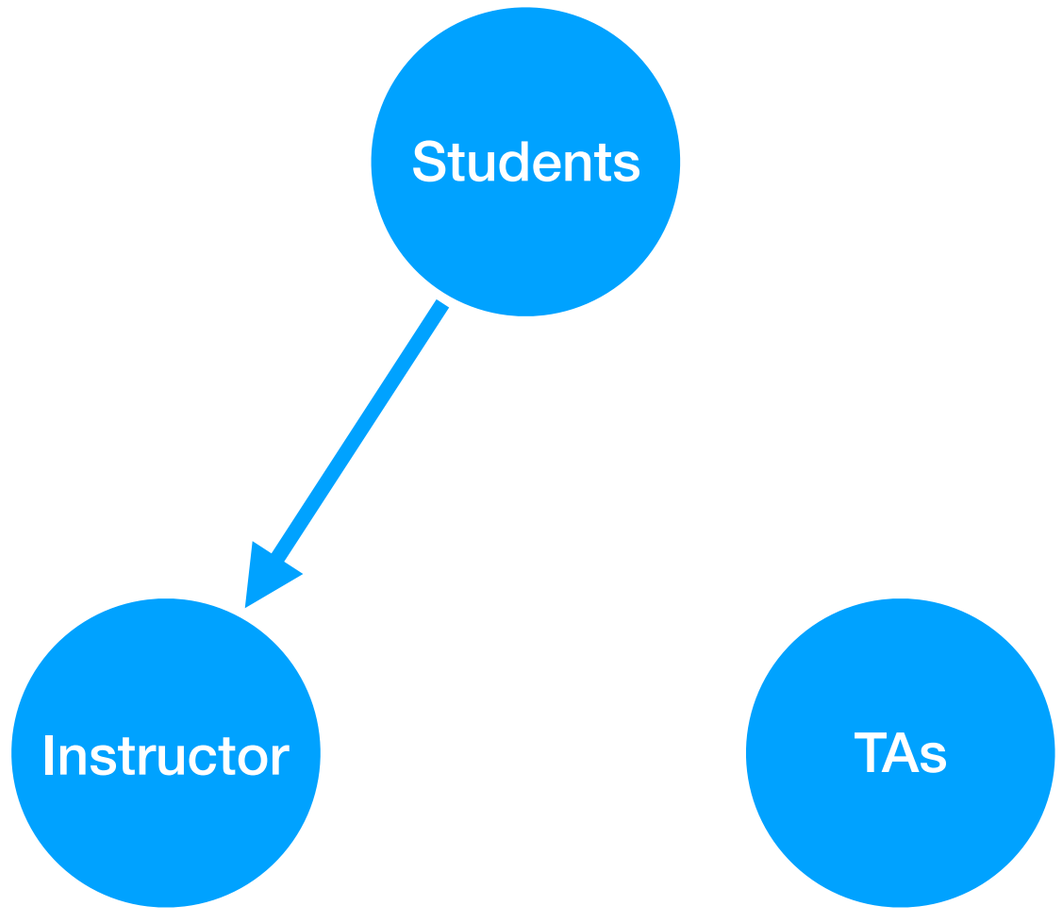

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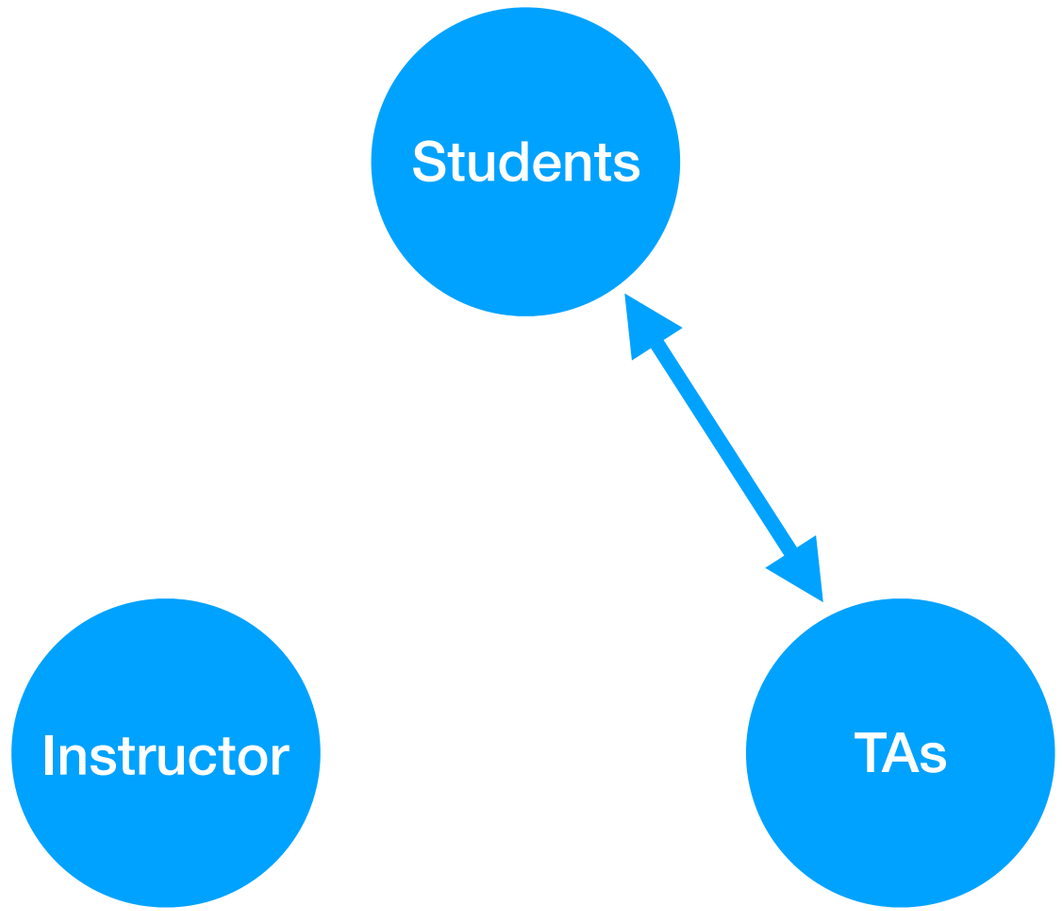

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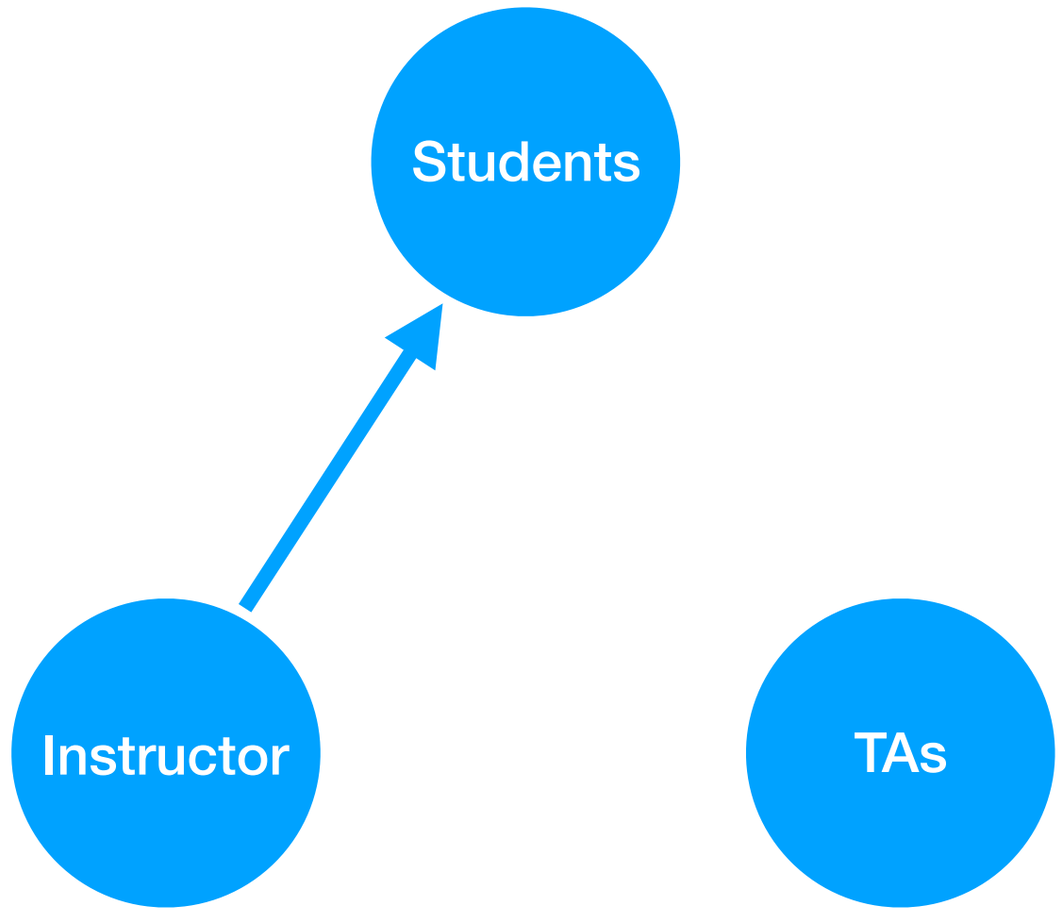

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Grades

49% - programming projects

- **10 projects**, not evenly weighted
- we'll share grading tests with you - avoid surprise
- learning to program is the most import part of the course

50% - exams

- 15% midterm 1 (evening)
- 15% midterm 2 (evening)
- 20% final
- finalized times coming soon

1% - participation

- filling surveys, following directions, other

At end of semester, we'll add up your total score, then set a curve to determine letter cutoffs.

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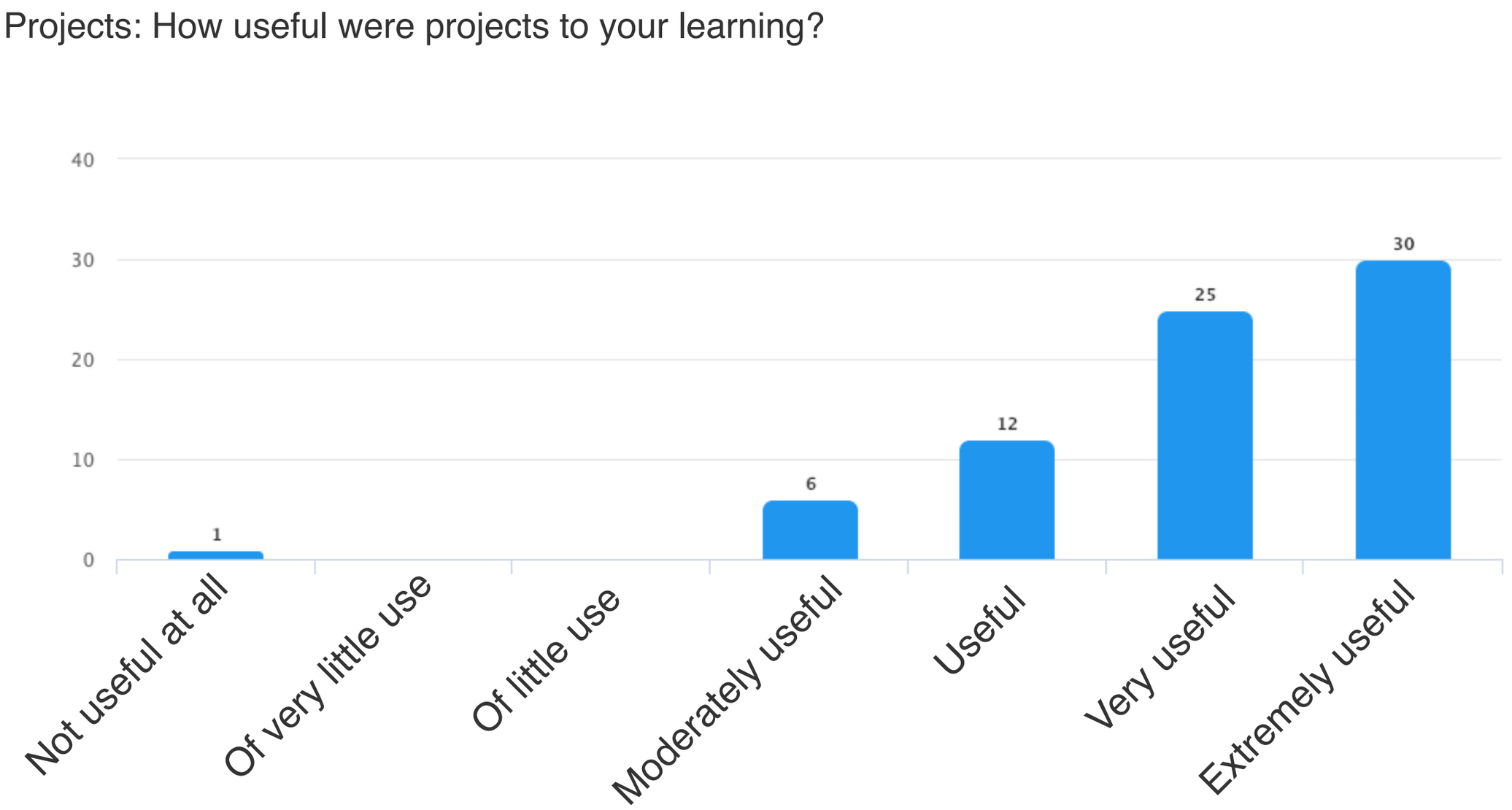
Prior student reaction to projects



Projects are the heart and soul of CS 301

Project Overview

Nearly all projects will relate to some dataset

Timeline

- Projects will be due most weeks, on Wed, at midnight
- You get 5 late days, use them wisely!
- Contact us about any issues

Getting help

- Piazza (don’t share substantial code) or email (do share code)
- Lab sessions
- Instructor or TA office hours
- CSLC (Computer Science Learning Center)

Pair Programming

You can optionally work in pairs of two

- Partnerships across sections allowed
- Switch partners between projects (or keep with same partner)

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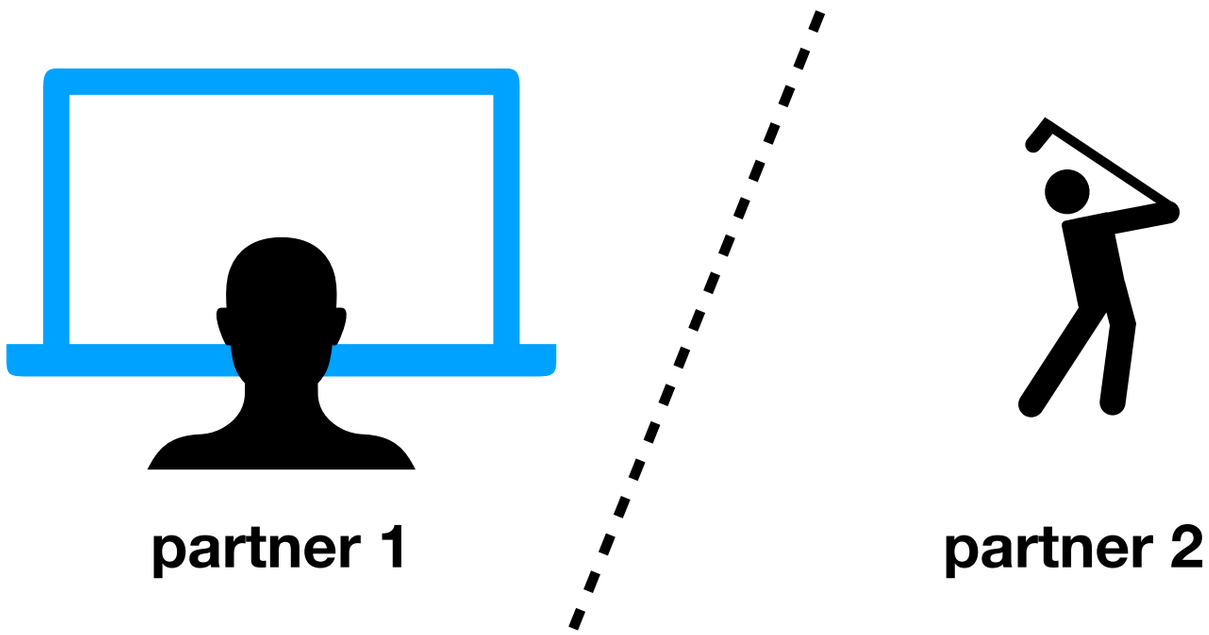

bad: partners don't share work

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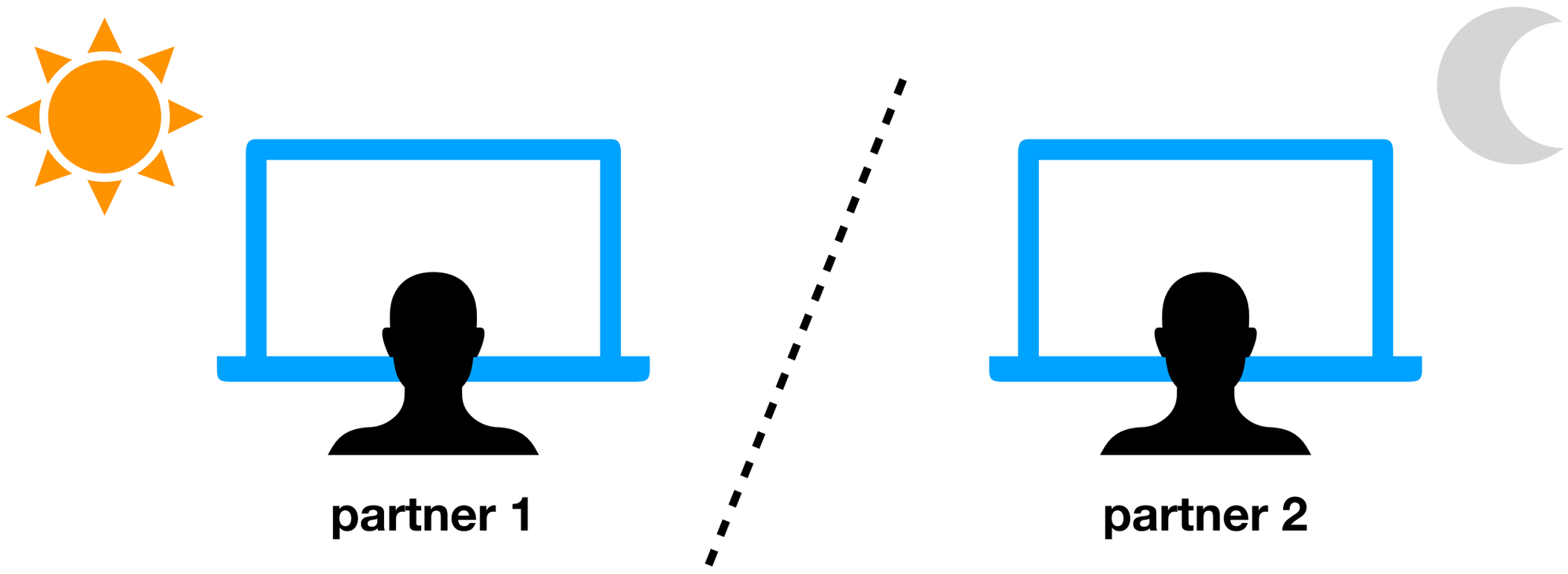

bad: working on different parts at different times

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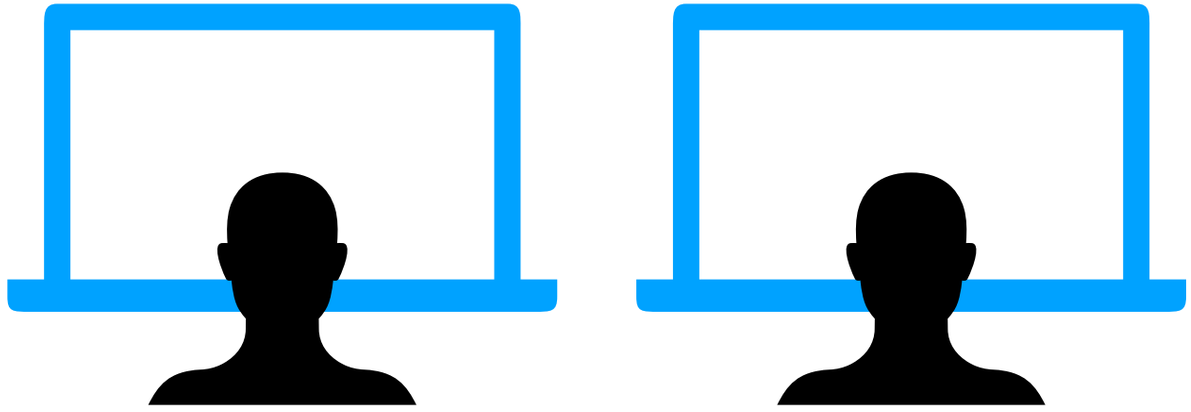

better: working alongside each other

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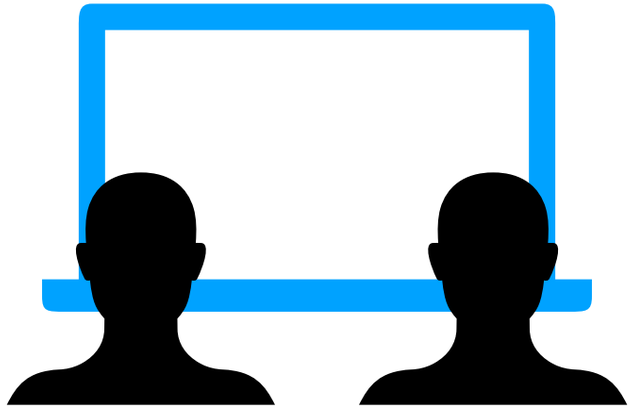

best: working on same computer

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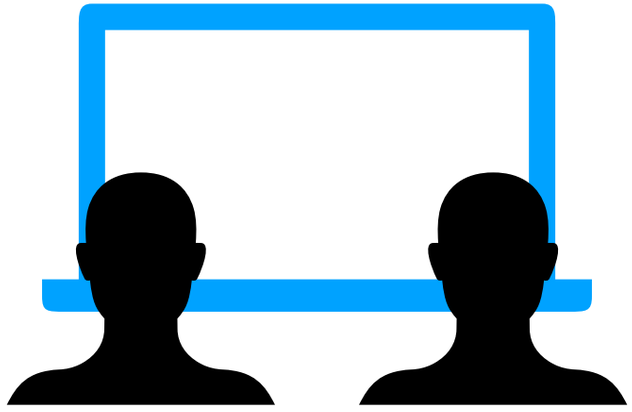
- Partnerships across sections allowed
- Switch partners between projects (or keep with same partner)



Suggestions

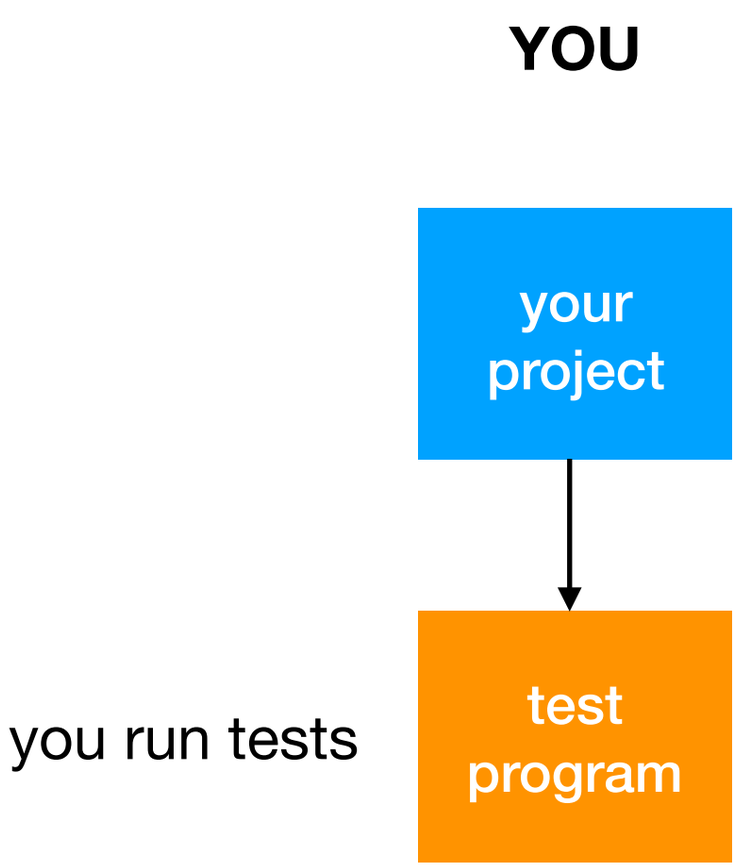
- Take turns coding (don't be greedy/aggressive!)
- One person types, other makes suggestions and thinks about design

Project Grading

YOU

your project

Project Grading



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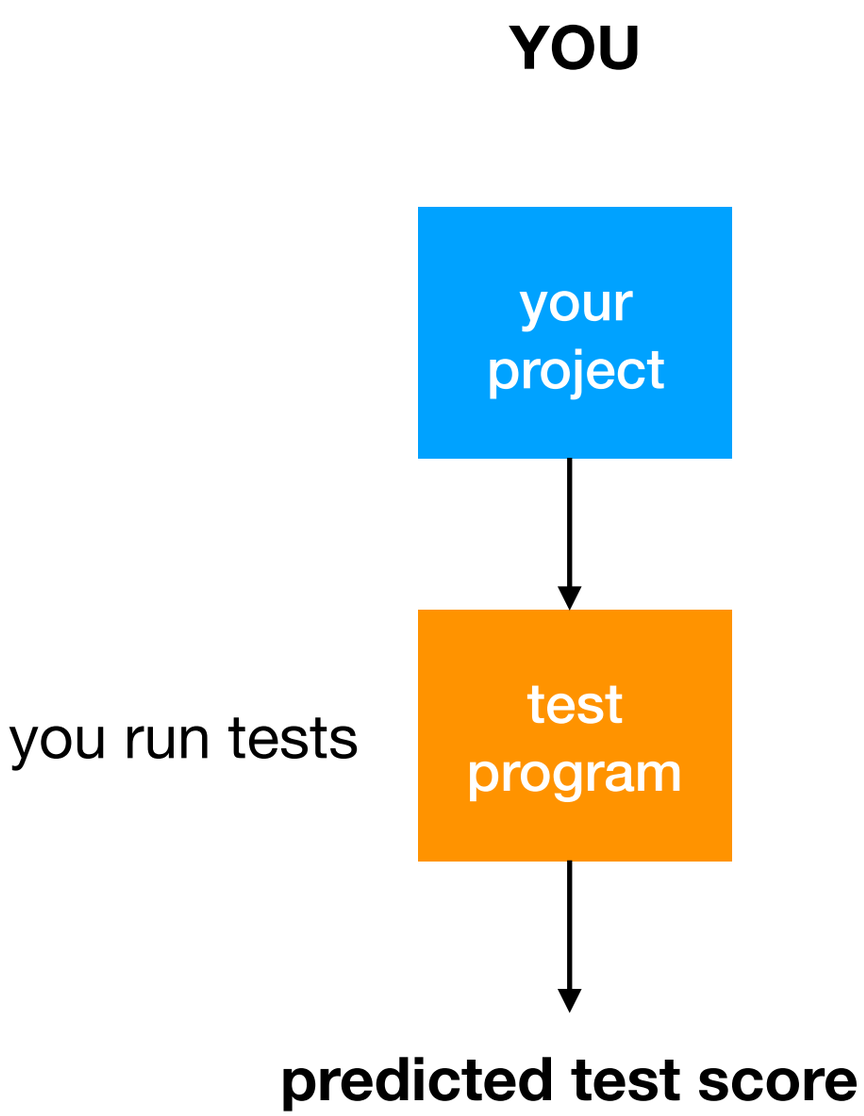

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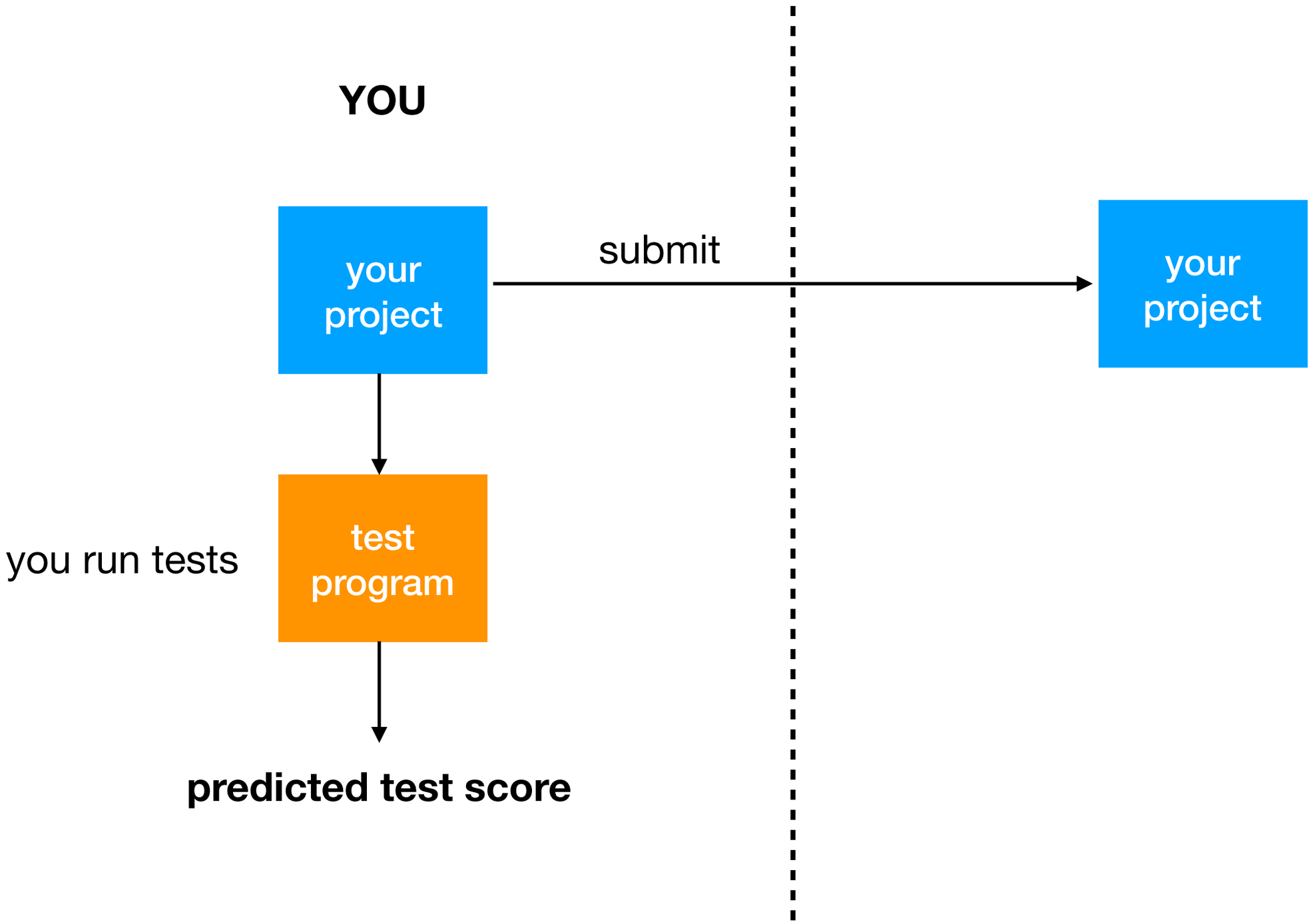

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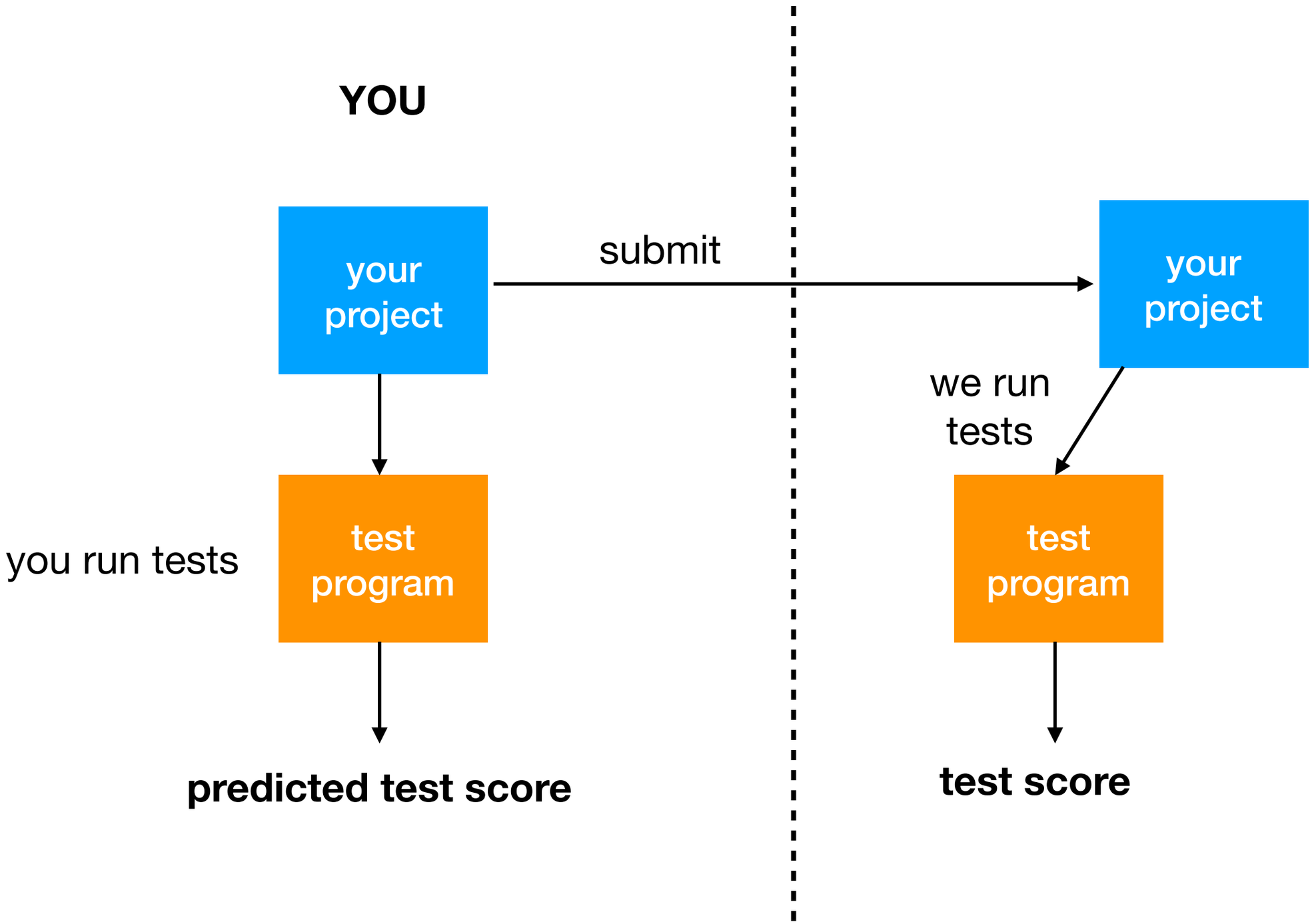

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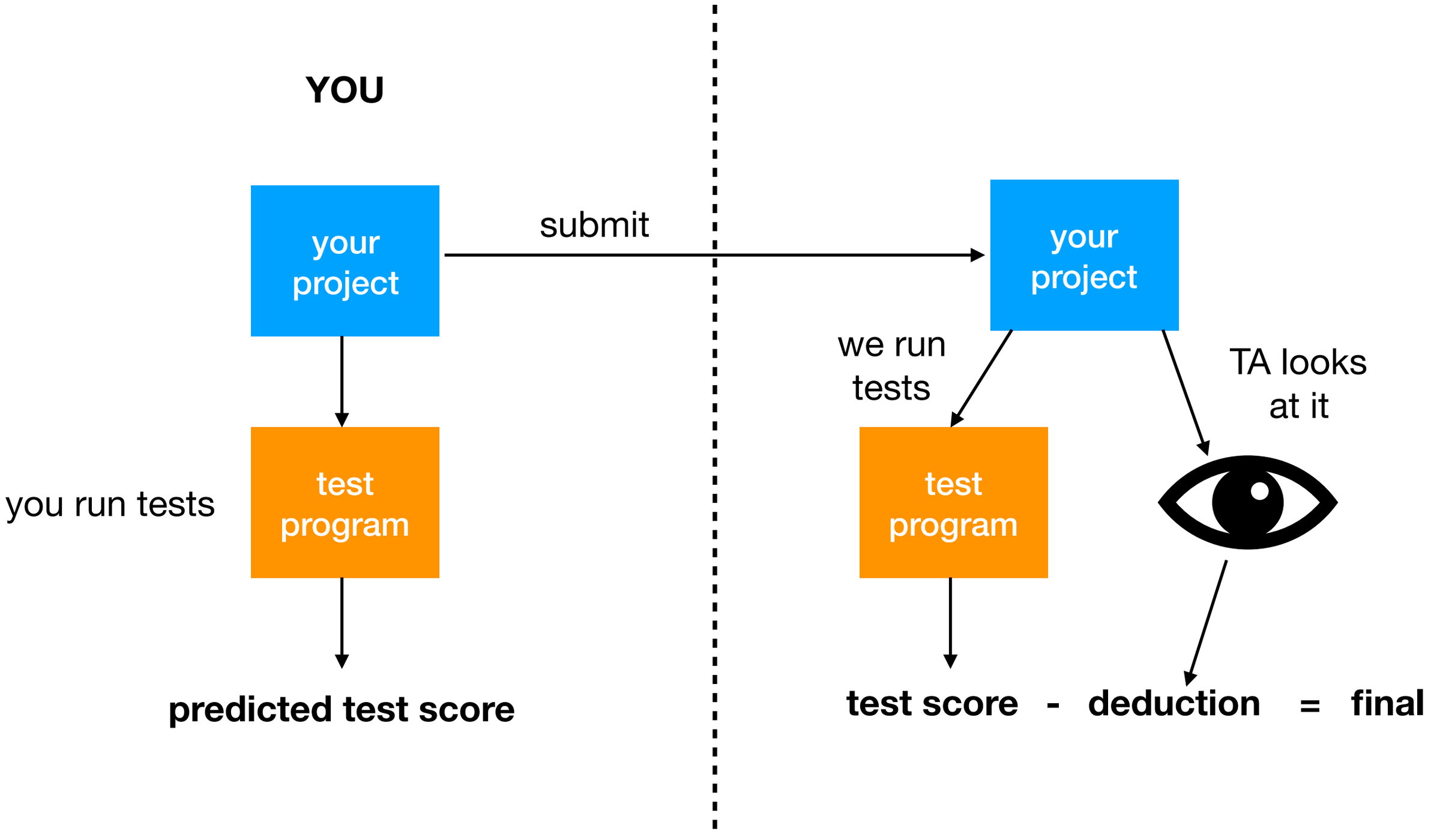
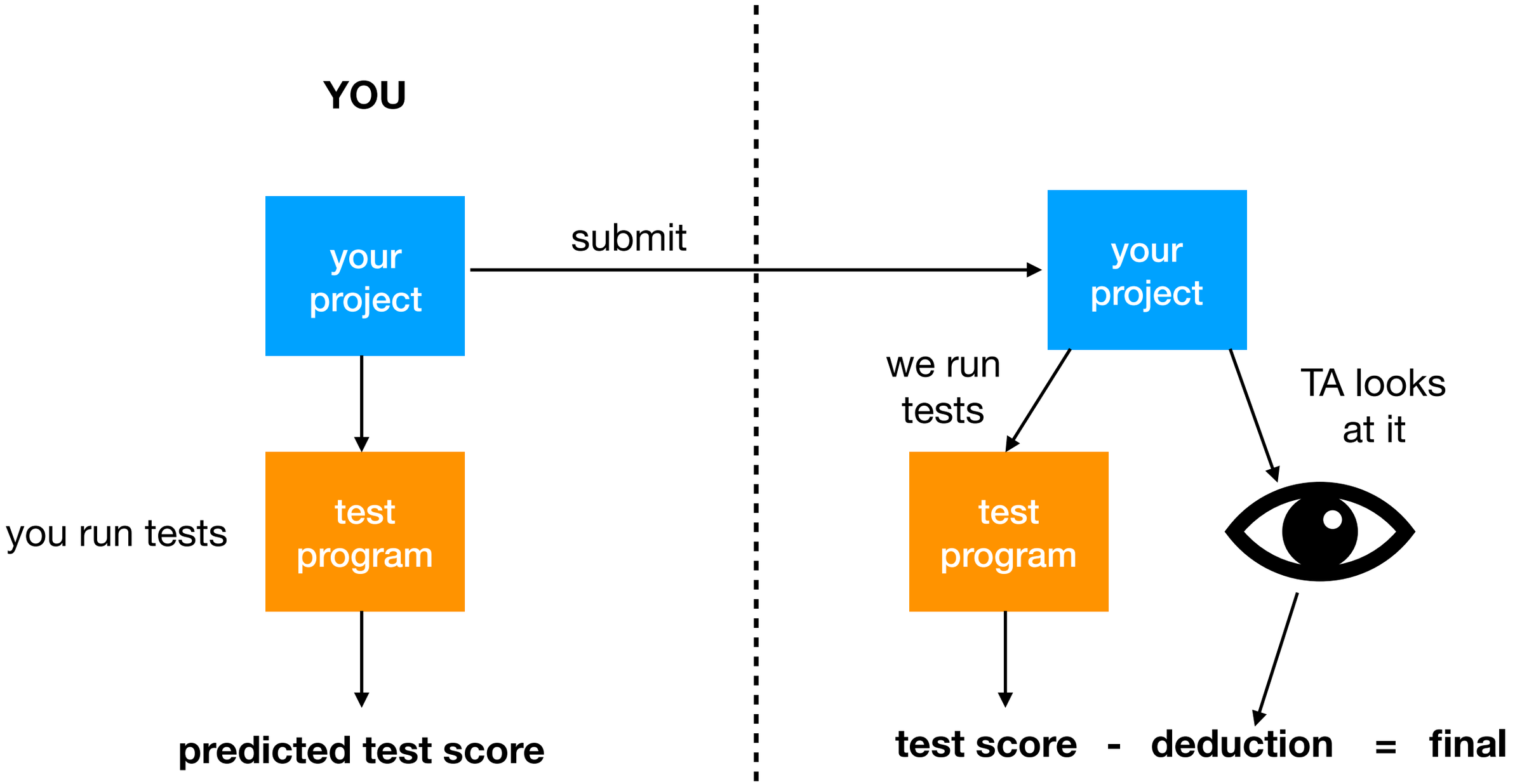


Project Grading

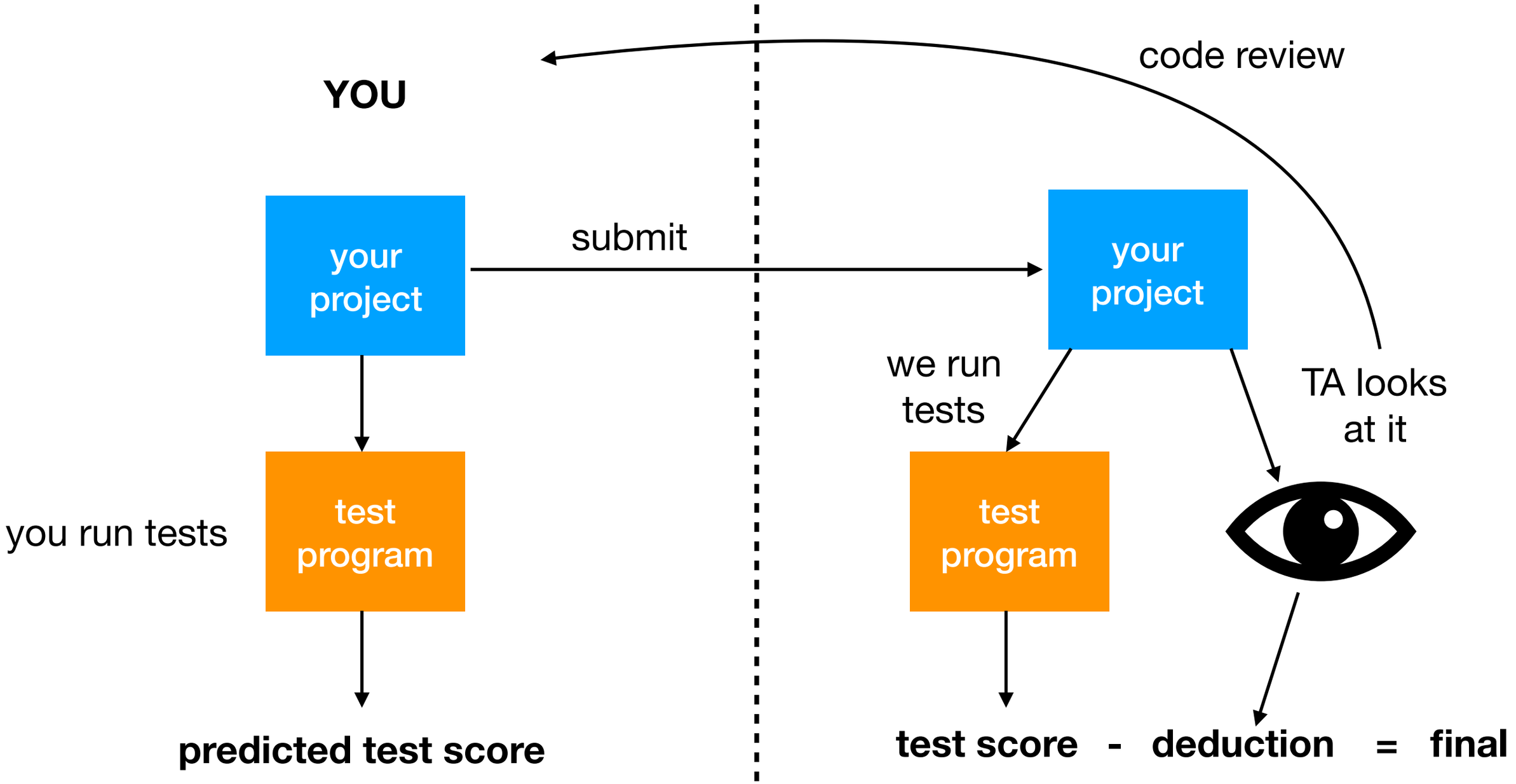


prediction will **usually** be accurate
(we'll be flexible if there are config issues or irregular bugs)

deduction will **usually** be zero
(don't cheat or try to defeat the tests)

Project Grading

feedback is mostly about how
to do things better or more simply
(valuable even if you score 100%)



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Today's Topics

Introductions

Course overview

- Learning objectives
- Lecture
- Lab
- Readings
- Class communication
- Grades
- Projects
- Exams

Computer hardware basics

Website

Exams

There will be two midterms and one final

- Check website for dates/locations
- One 8.5 by 11 in handwritten notesheet allowed only
- Exams will be multiple choice scantron

Contents

- cumulative
- ideally not much time pressure
- one goal: reward project partners doing more work over those slacking

Today's Topics

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- CPU
- Memory
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Input/Output

I/O (stands for input/output)

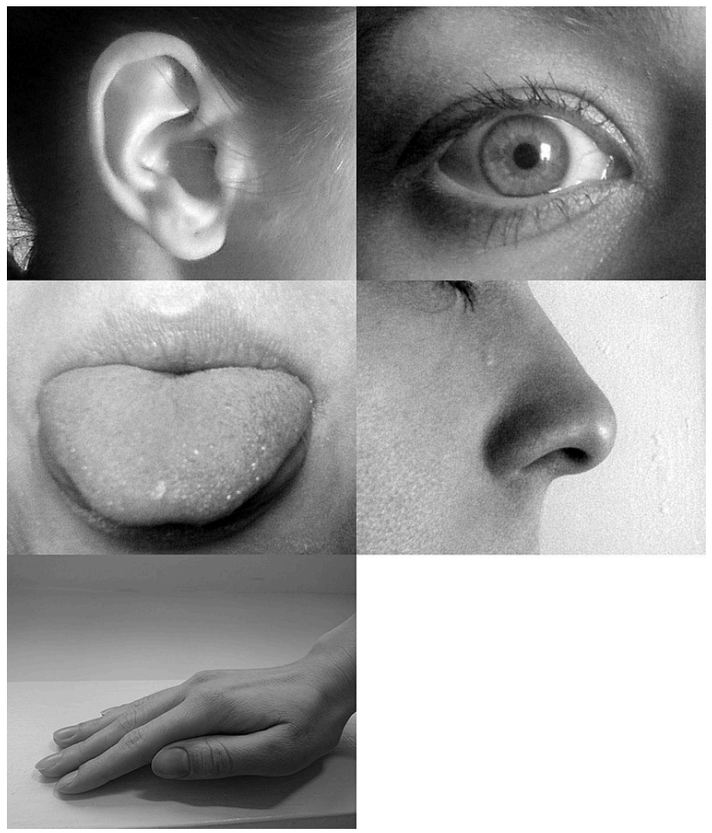
- What are examples for human?

Input/Output

I/O (stands for input/output)

- What are examples for human?

input: senses

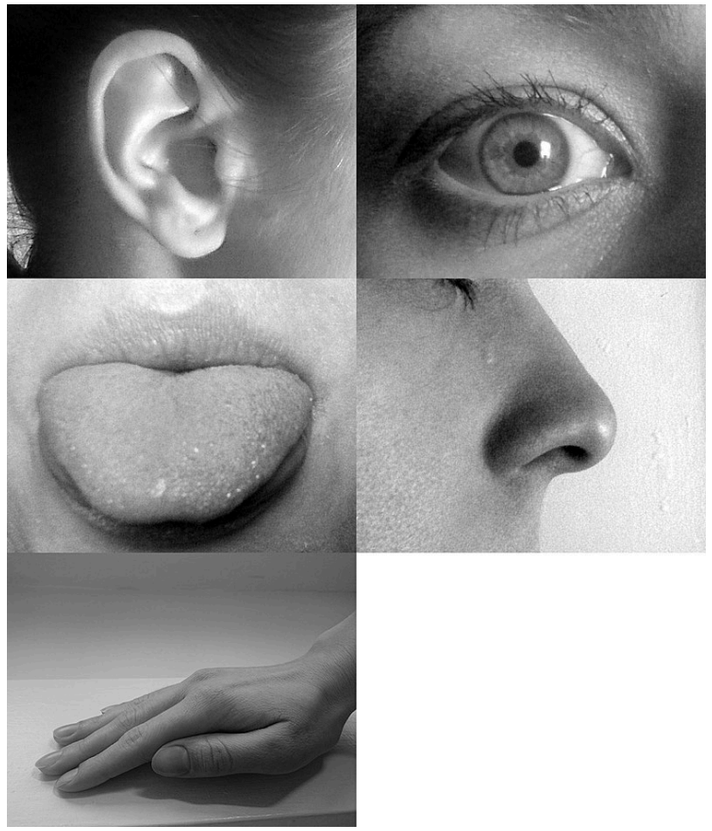


Input/Output

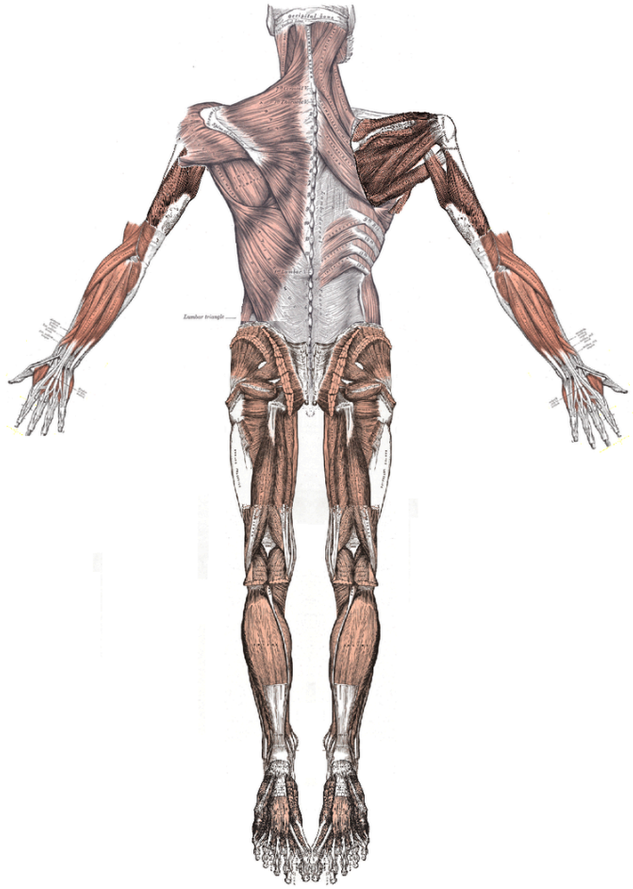
I/O (stands for input/output)

- What are examples for human?

input: senses



output: muscles

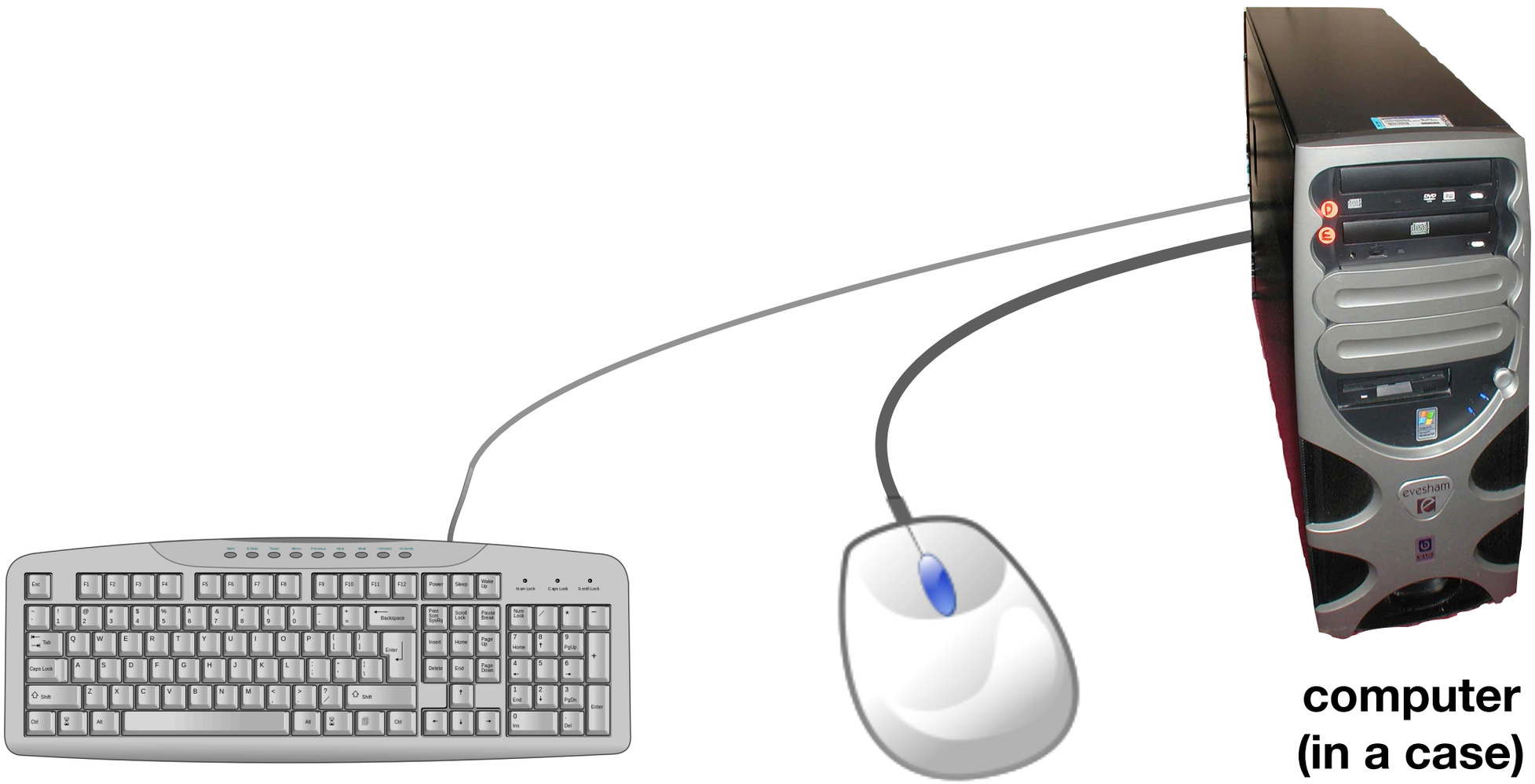


Computer Input/Output

what are some common compute inputs?

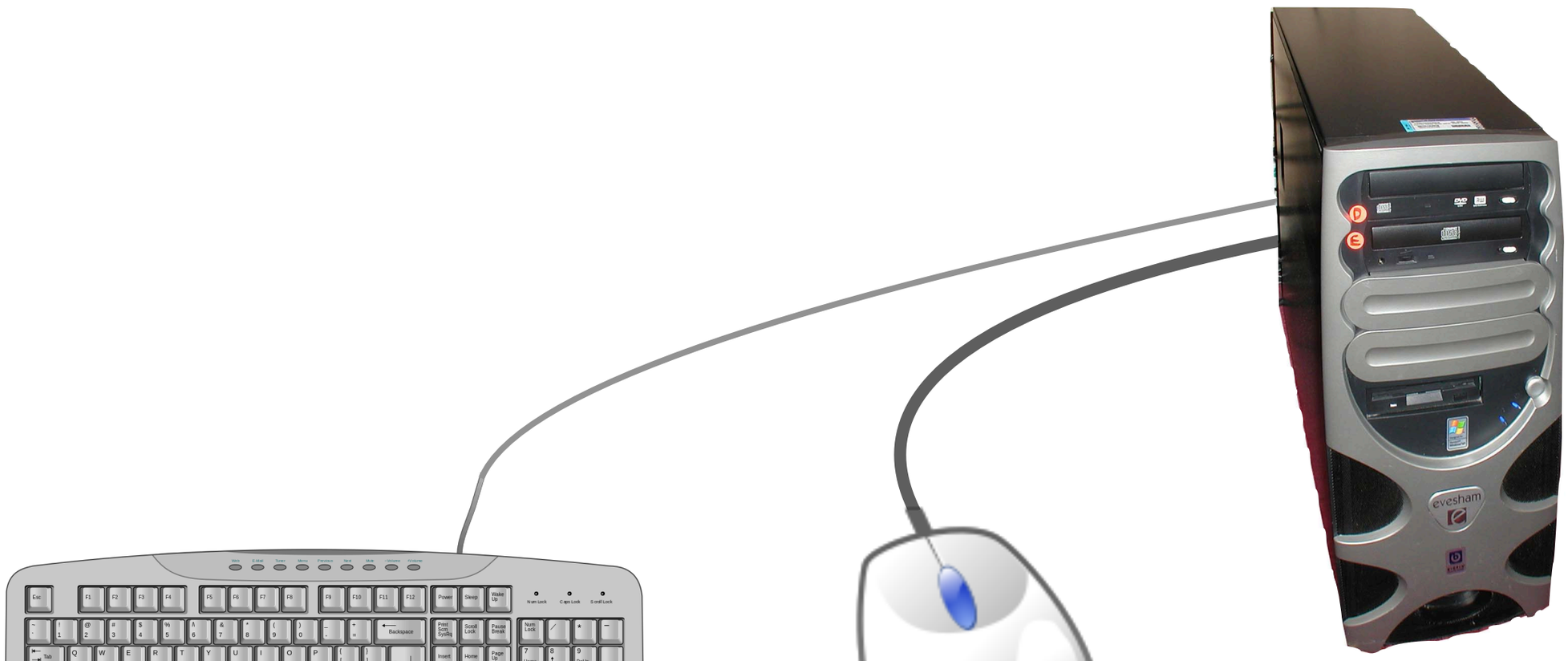
computer (in a case)

Computer Input/Output



Computer Input/Output

what are some common compute outputs?

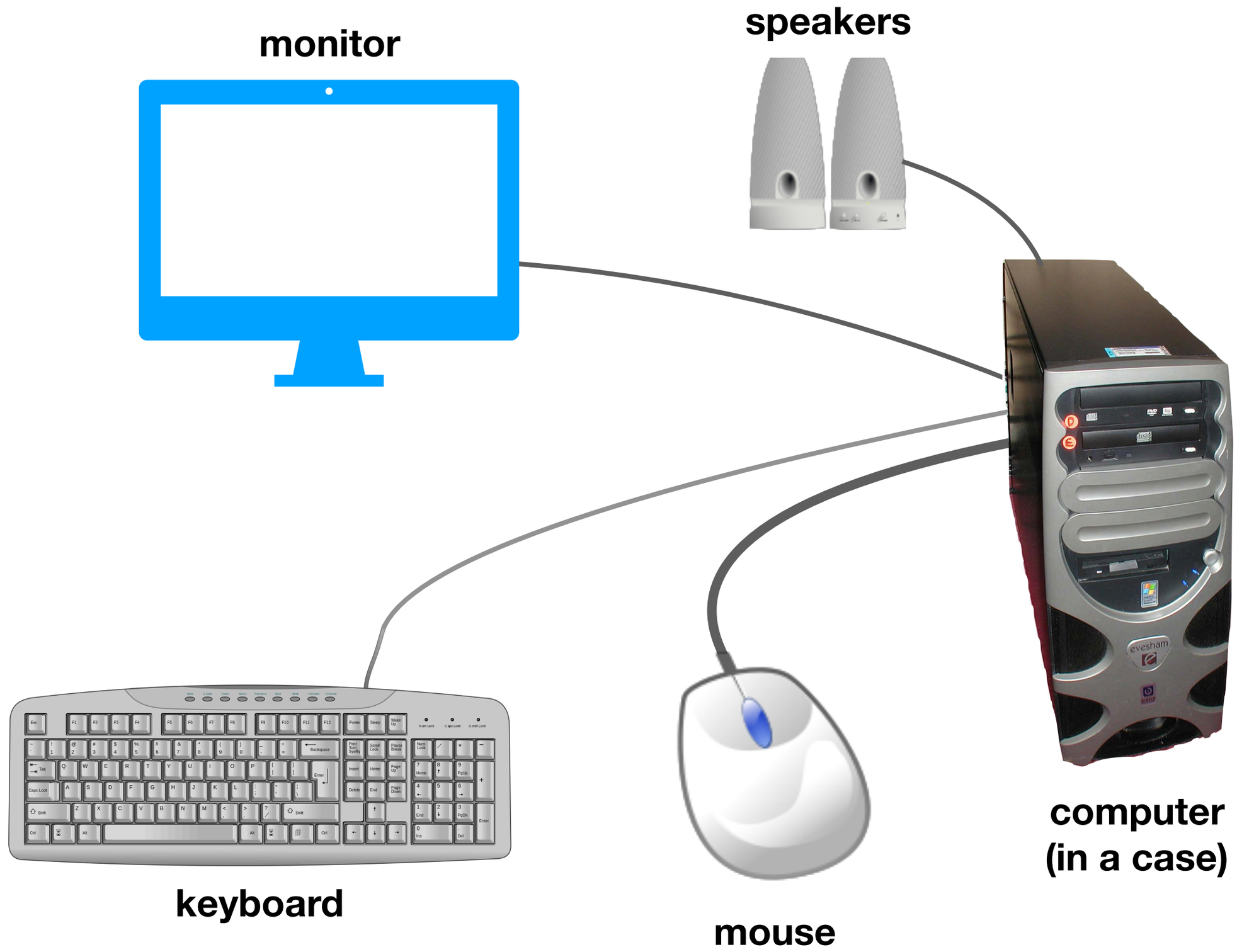


keyboard

mouse

computer (in a case)

Computer Input/Output



Computer Input/Output

I/O devices attach via “ports” (e.g. USB) in back of computer

monitor

speakers

computer (in a case)

keyboard

mouse

Computer Input/Output

monitor

speakers

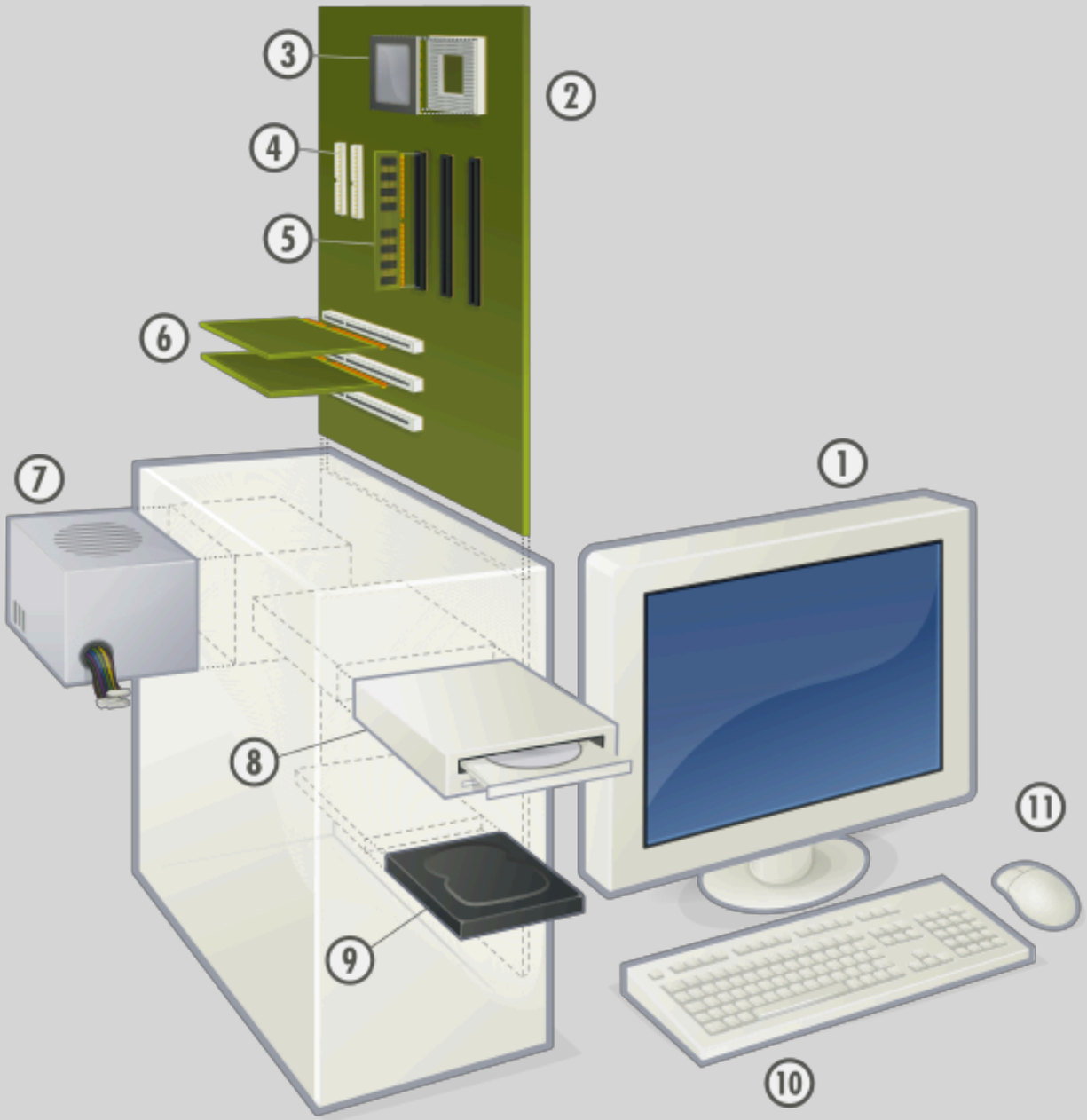
What's inside a computer case?

keyboard

mouse

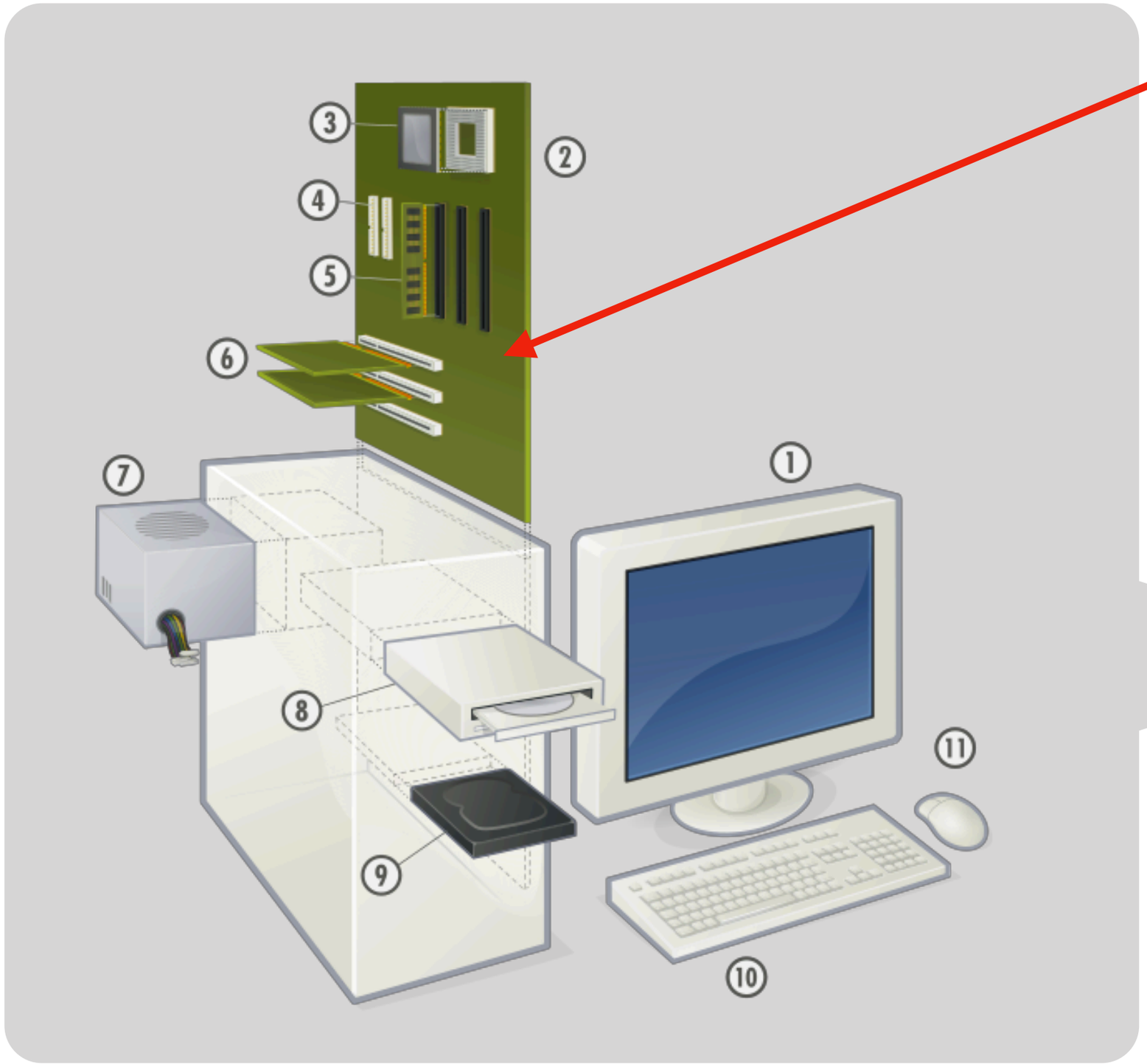
computer (in a case)

Computer Internals



https://commons.wikimedia.org/wiki/File:Personal_computer,_exploded_4.svg

Computer Internals



Motherboard: main circuit board to which other components connect, via sockets/slots

https://commons.wikimedia.org/wiki/File:Personal_computer,_exploded_4.svg

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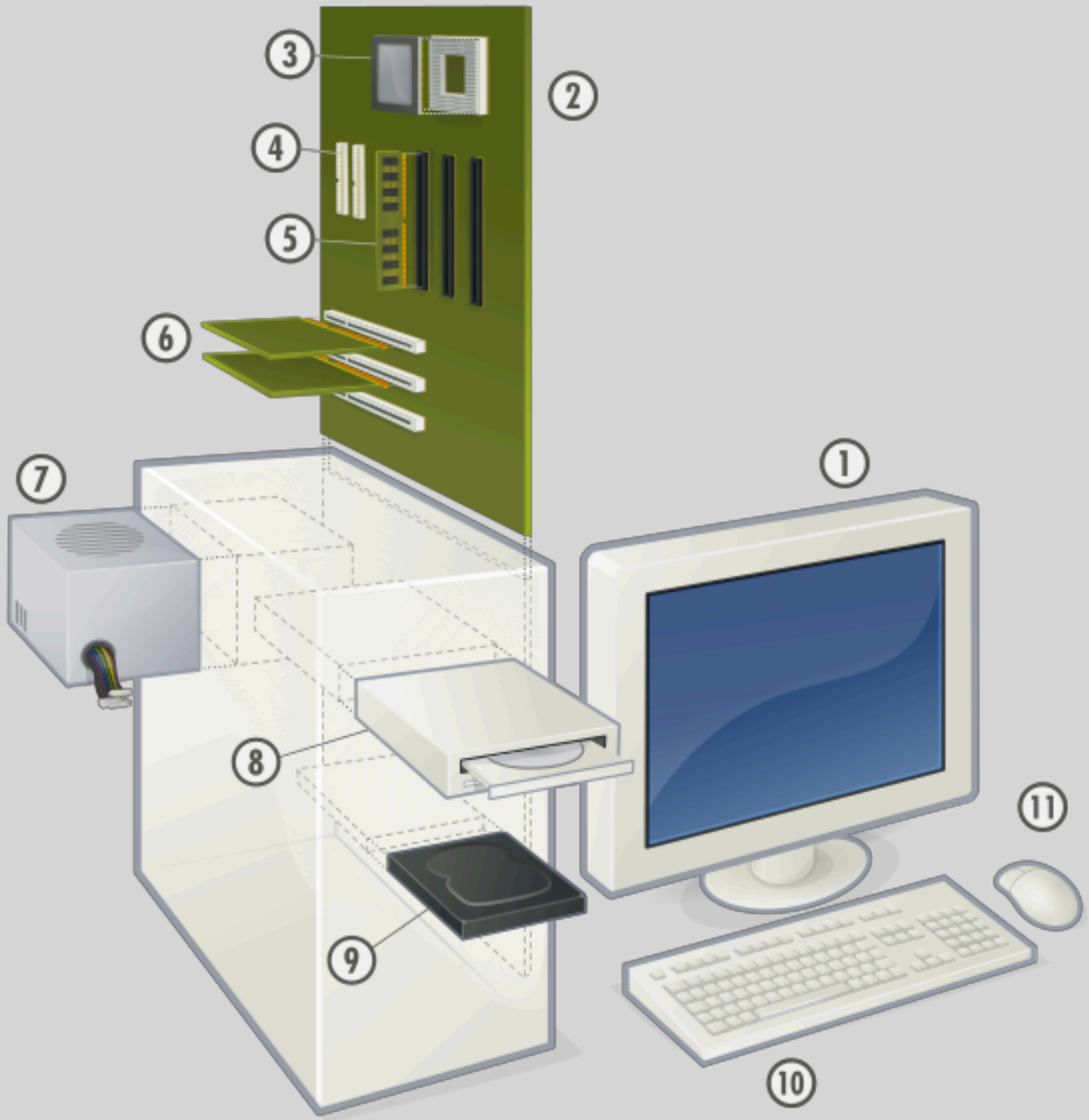
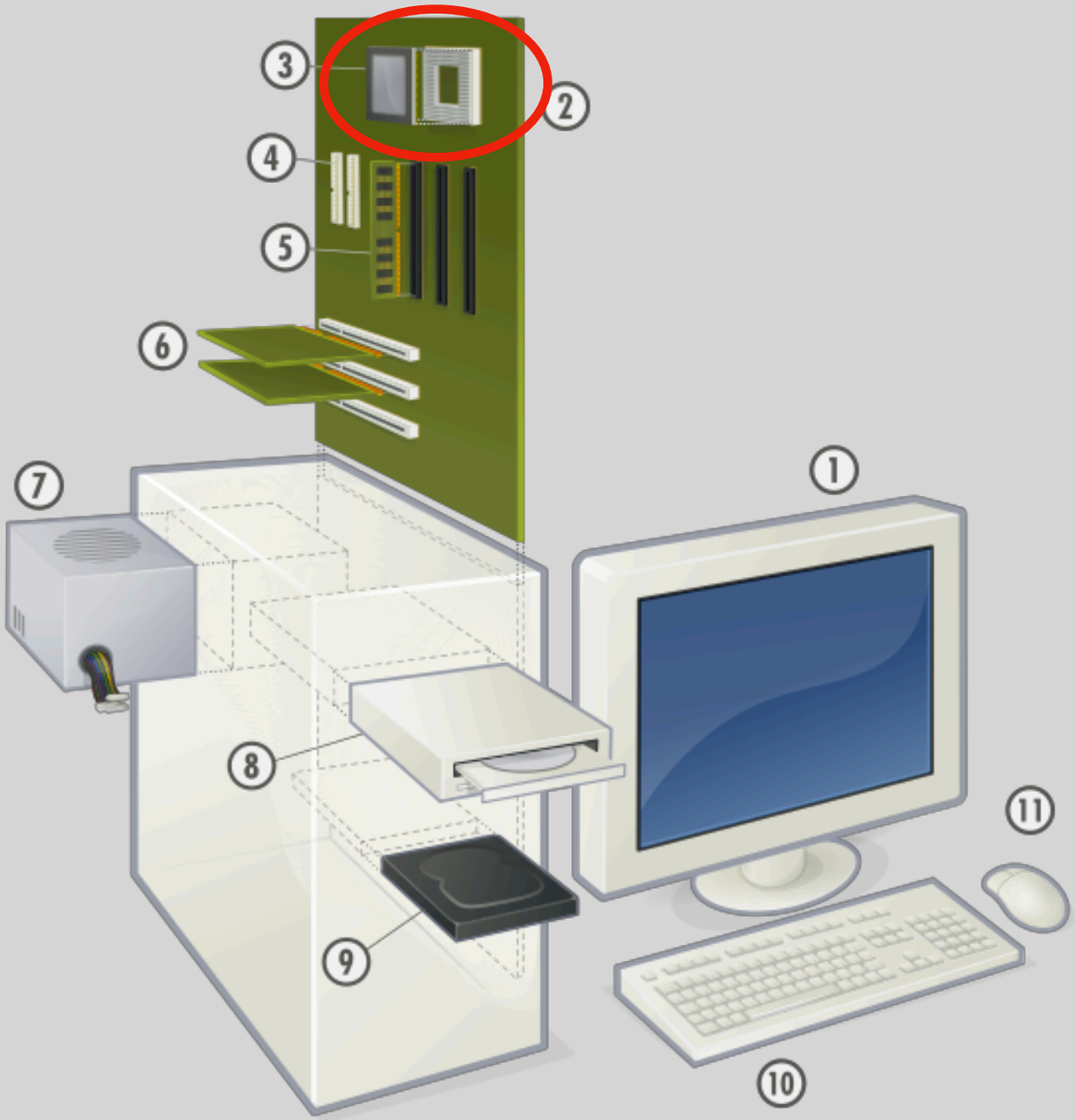
Central Processing Unit (CPU)



Central Processing Unit (CPU)



CPU

Responsible for computation

- Runs code
- Performs addition, other math
- Compares numbers, text
- Receives input, sends output
- Some compare it to a “brain”

Runs on a clock

- Typically a couple GHz (i.e., billions of ticks per second)
- High-speed makes CPUs hot, require fans/cooling

Computers often have multiple CPUs

- Motherboard may have multiple sockets
- Single chip may contain multiple CPUs
- Allows computers to do more things simultaneously

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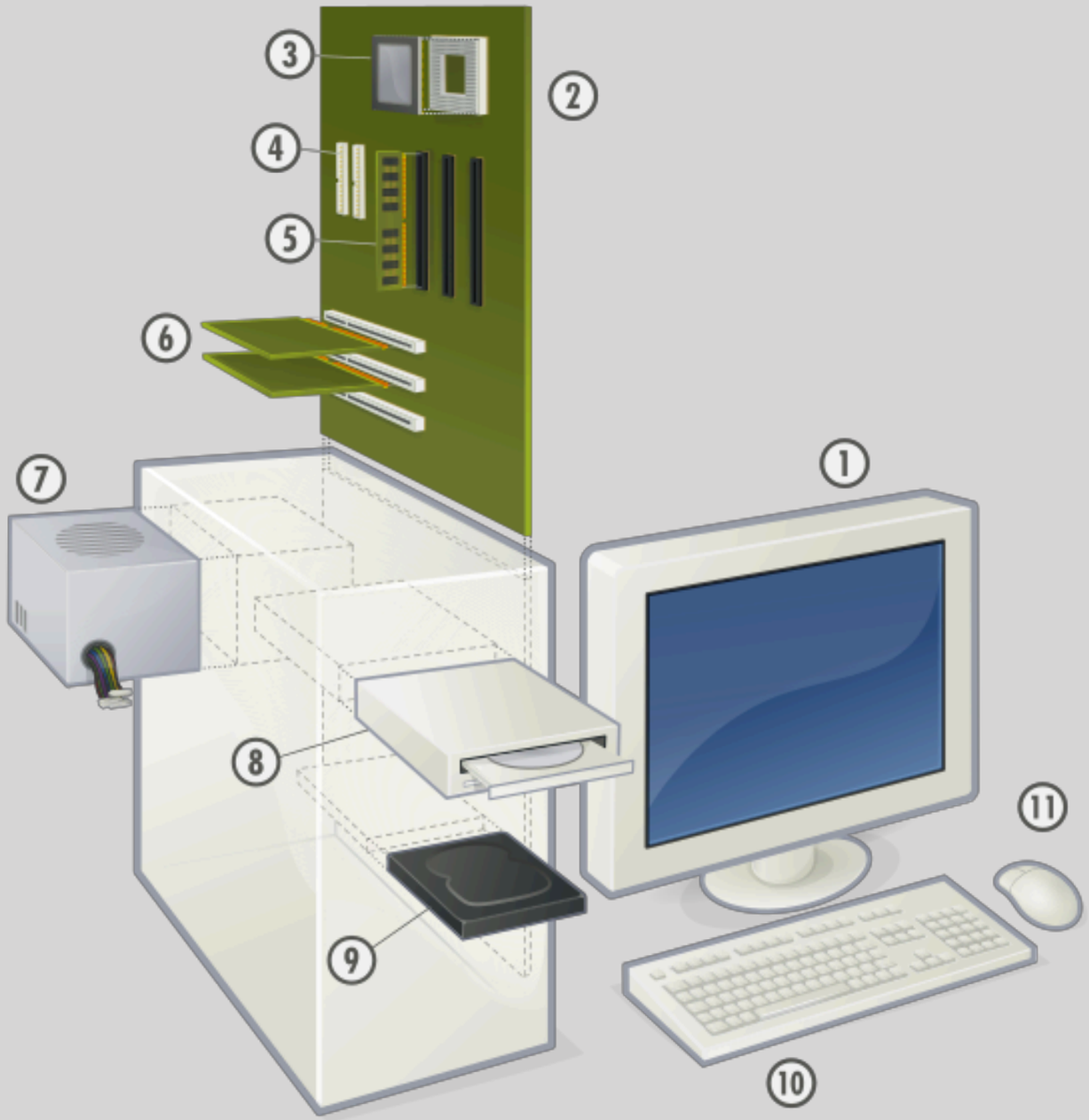
Random Access Memory (RAM)



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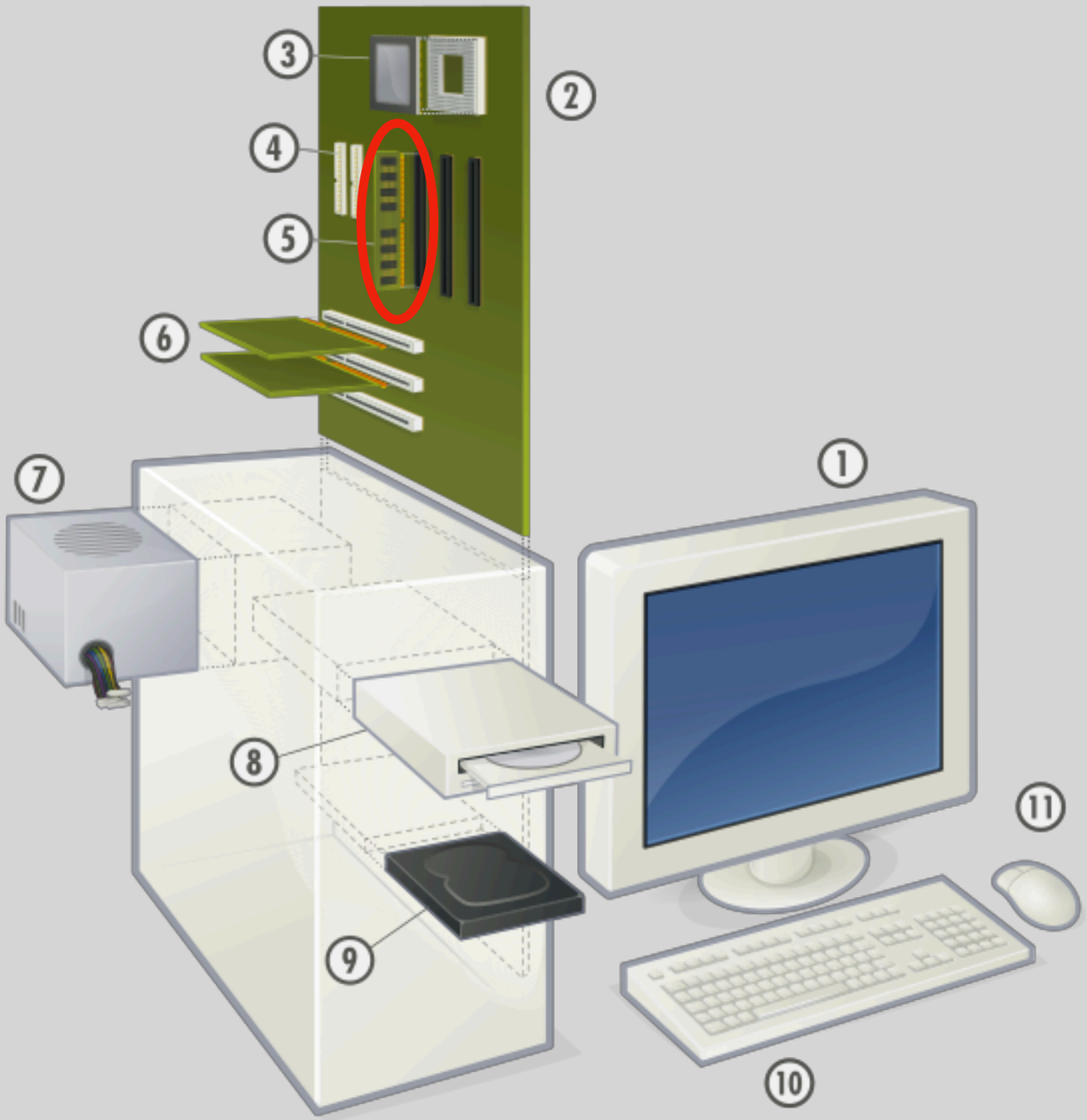

Memory

Memory stores data for short term

- RAM is most common form today (don't worry about specifics)
- CPU sends data to/from memory
- Accessing it is very fast
- It is "volatile" — meaning you lose this data when you power off your computer
- You don't save "files" in memory, otherwise they would be gone!

Stores bytes of data

- One byte ≈ one letter
- The text "hello" requires 5 bytes
- Typical personal computer has few to tens of gigabytes (billion bytes) of memory

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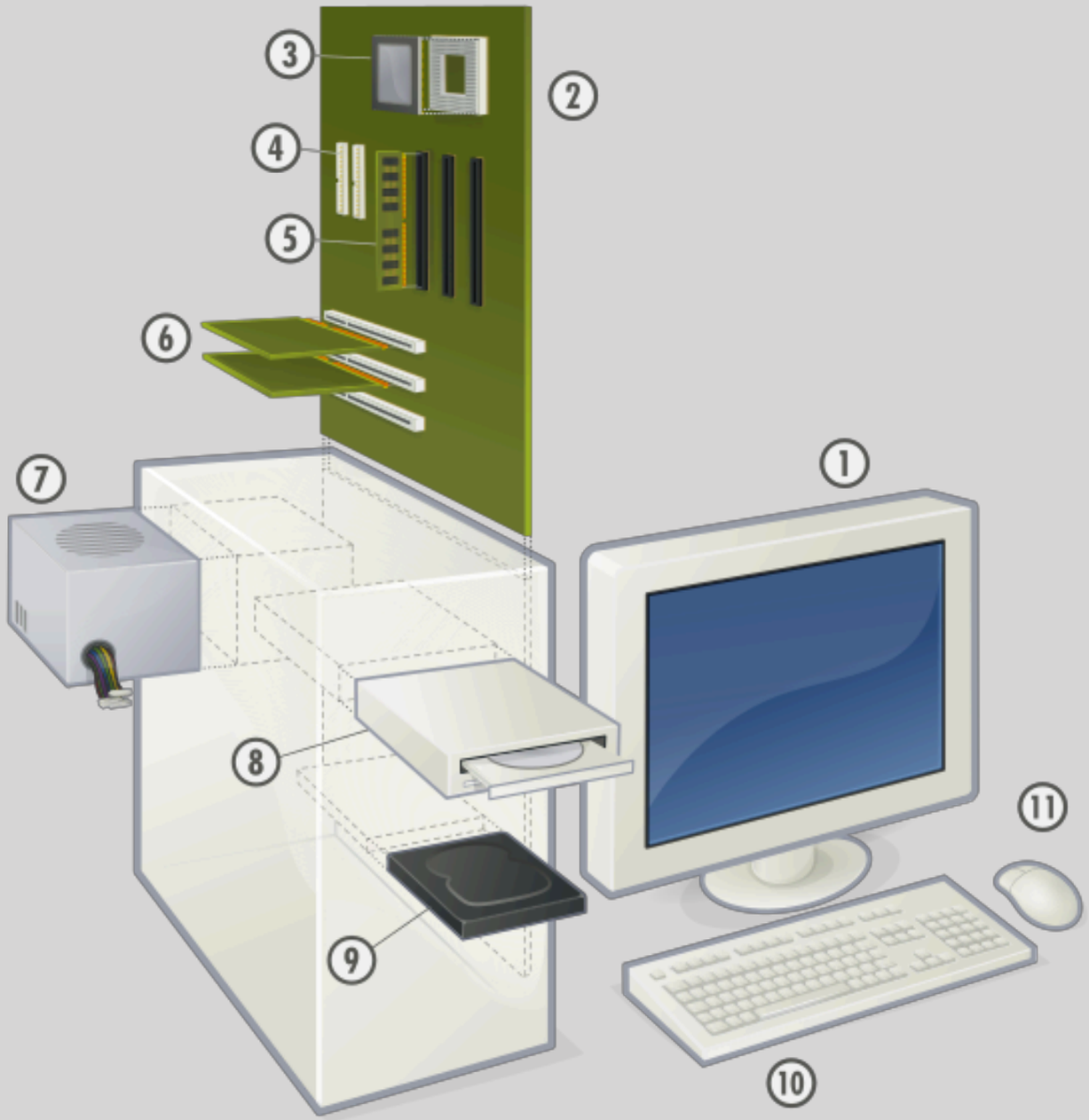
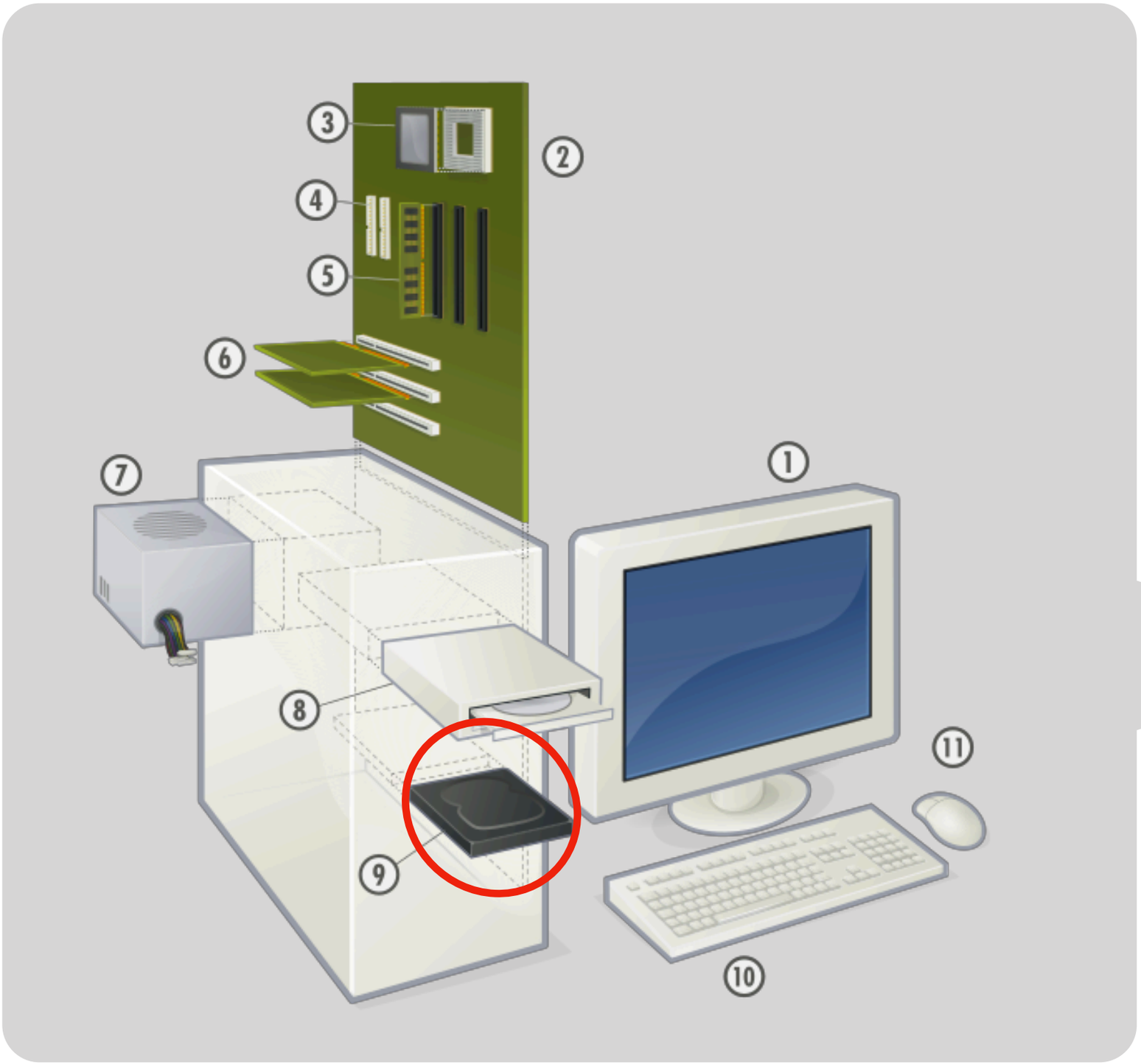
Storage Drives



Storage Drives



Storage Drives

Two common devices

- HDD (hard disk drive), has moving parts, cheap, slow
- SSD (solid state drive), no moving parts, expensive, fast
- Both much slower than RAM...

Storage devices used to save data after power down

- Persistant medium, in contrast to volatile RAM
- Typical capacity: hundreds of gigabytes

When you make a directory/folder or save a file, that data is ultimately getting recorded to your storage device

- Sometimes computers save to RAM first, and only to the device later; power down cleanly to avoid losing your data!!!

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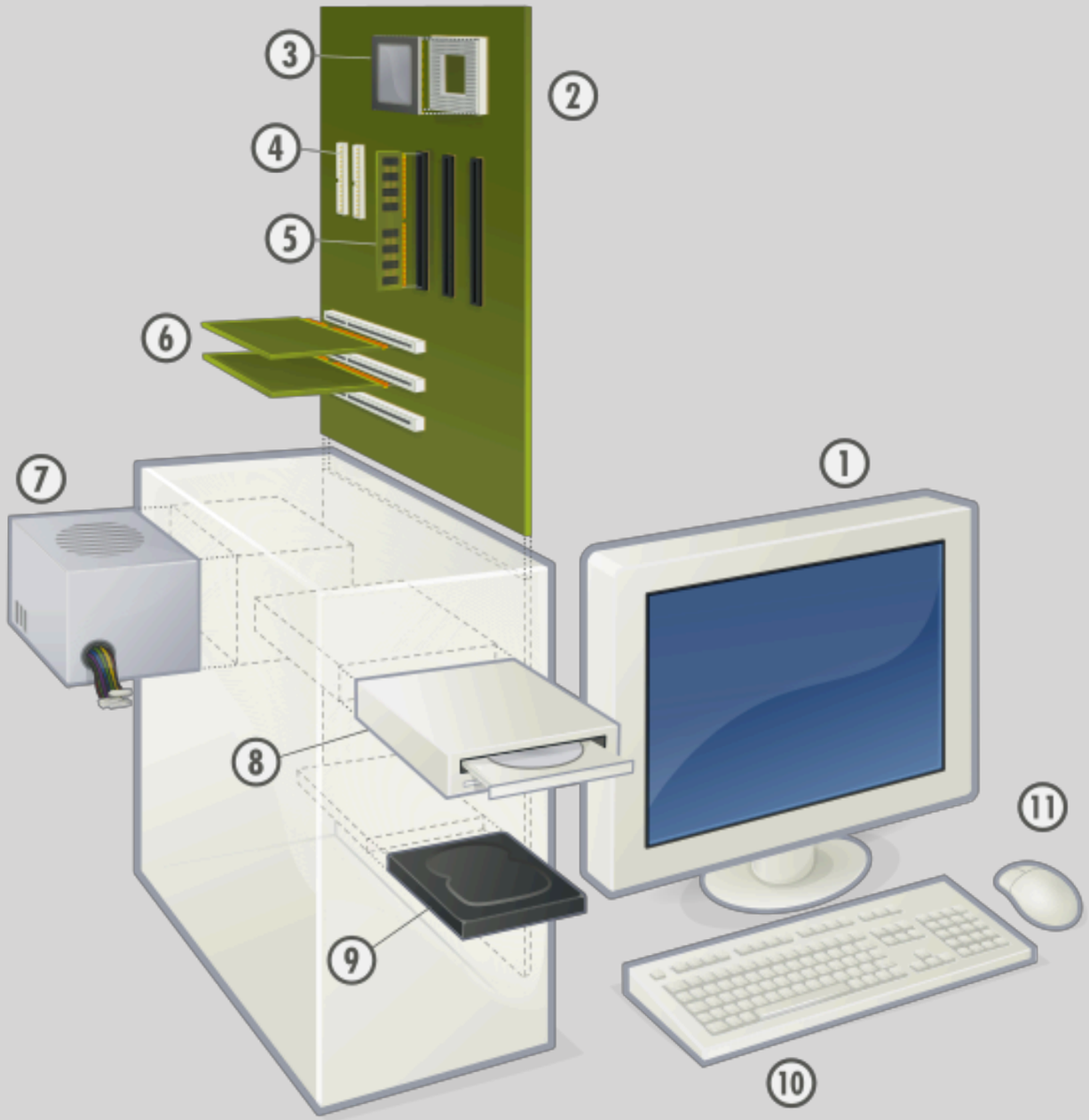
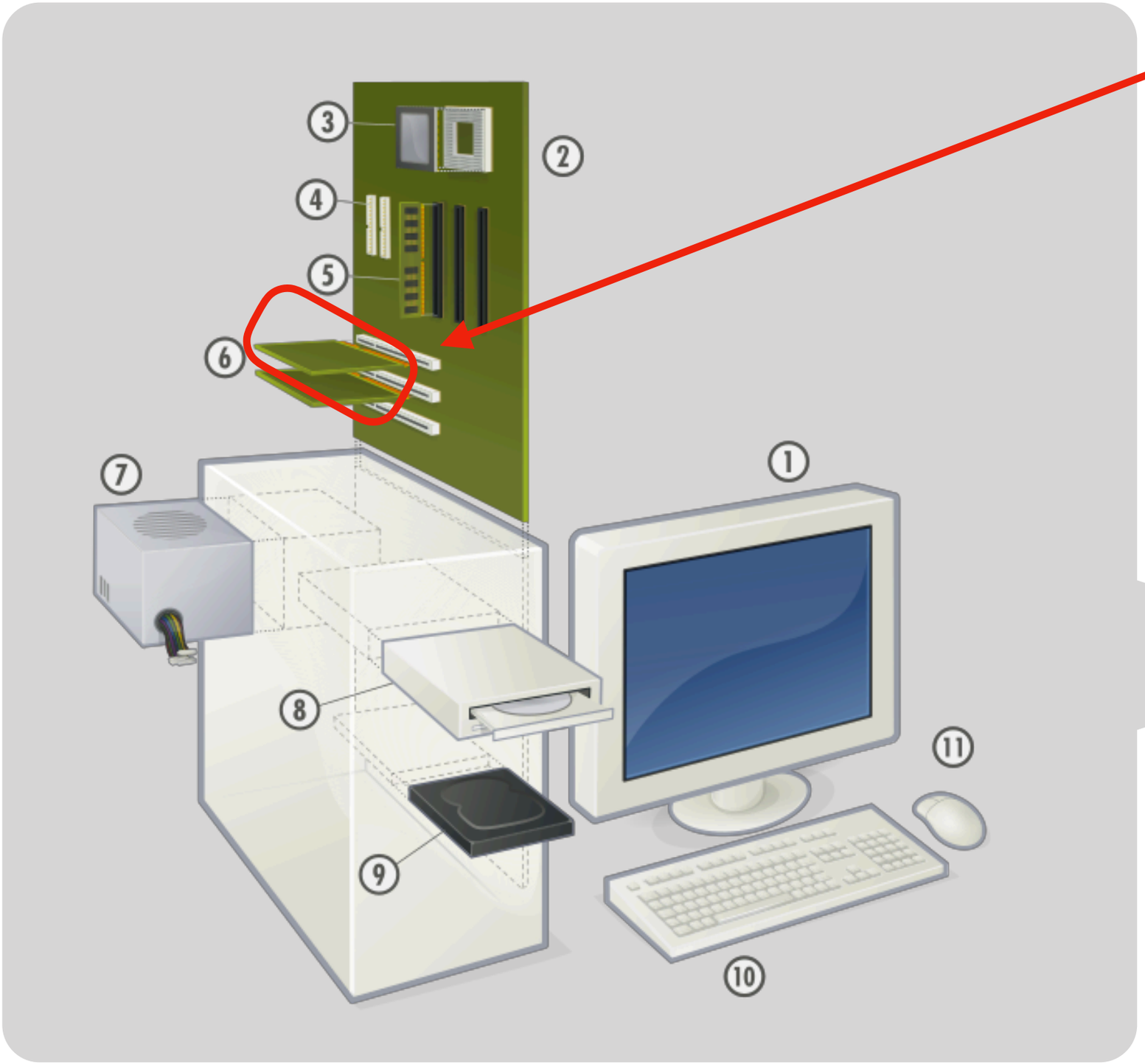
Network Interfaces



Network Interfaces



Network: often based on extension card or built into the motherboard itself

Networking

NIC (Network Interface Controller)

- Provides computer communication to other computers, and the Internet

Wired vs. Wireless

- Wired ethernet is common for cable-based connection
- Wi-Fi is common for radio-based wireless connection

Terminology

- **Server**: program/computer that runs, waiting for for incoming requests, to which it responds
- **Client**: program/compute that sends requests to a server

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Course Website

There are three lecture sections for 301 this spring. I'm teaching sections 2 and 3 and Caroline Hardin is teaching 1.

Shared website:
https://tyler.caraza-harter.com/cs301/spring19/home.html

Walk through…

Conclusion: five action steps for you

- take the **"Who are You?"** survey:
  https://tyler.caraza-harter.com/cs301/spring19/surveys.html

- read **syllabus** carefully:
  https://tyler.caraza-harter.com/cs301/spring19/syllabus.html

- sign into **Piazza**

- setup **Python** on your computer:
  https://tyler.caraza-harter.com/cs301/spring19/videos.html

- start **Project 1** (due next Wed):
  https://tyler.caraza-harter.com/cs301/spring19/projects.html