# An overview of the Python programming ecosystem

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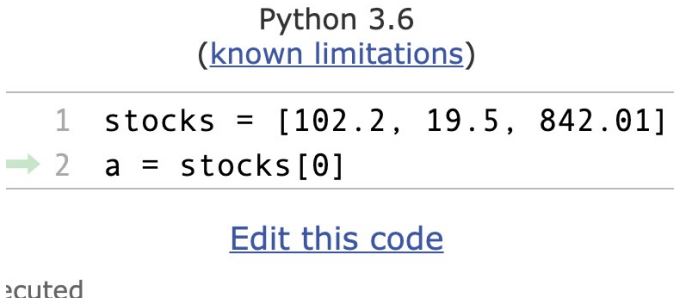
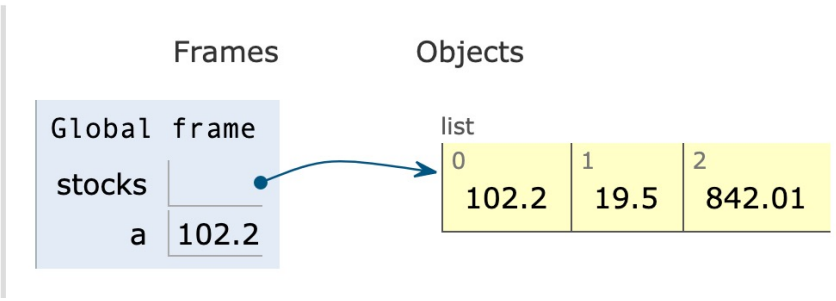
# Executing programs

- Computers don't inherently understand Python or any other programming language
- A programmer has to create a program in some language X, called an interpreter, that understands statements in language Y (Python's interpreter is written in the C language)
- We'll use three interfaces to access a Python interpreter:
  - pythontutor.com (no setup and visualizes Python executions)
  - The UNIX commandline to run Python .py files and to interact
  - Jupyter notebooks, a browser interface for code and notes
- We'll even learn to execute code on a remote cloud computer

# Python tutor http://pythontutor.com/

- Type/execute code without installing software on your laptop
- Visualizes the state of the Python interpreter
- Really nice interactive tool for learning Python (and other langs)



# Python from the commandline

- The commandline is built in to Macs / unix machines
- Python interpreter installed with Anaconda

```
beast:~ $ python
Python 3.8.8 (default, Apr 13 2021, 12:59:45)
[Clang 10.0.0 ] :: Anaconda, Inc. on darwin
Type "help", "copyright", "credits" or "license" for
more information.
>>> print("Hello, World")
Hello, World
>>> stocks = [102.2, 19.5, 842.01]
>>> a = stocks[0]
>>> print(a)
102.2
>>>
```

*Interactive*

```
beast:~ $ cat t.py
stocks = [102.2, 19.5, 842.01]
a = stocks[0]
print(a)
beast:~ $ python t.py
102.2
beast:~ $
```

*batch*

# Python within a Jupyter notebook

- Interactive execution for code, notes, data, visualizations
- Installed automatically with Anaconda
- The Python interpreter keeps running in the background so we can interactively try different code snippets
- This will likely be your primary data science development environment

## Simple notebook

A demonstration of notebooks

```
[1]: stocks = [102.2, 19.5, 842.01]
     a = stocks[0]
```

Show **a** by referencing variable:

```
[2]: a
```

```
[2]: 102.2
```

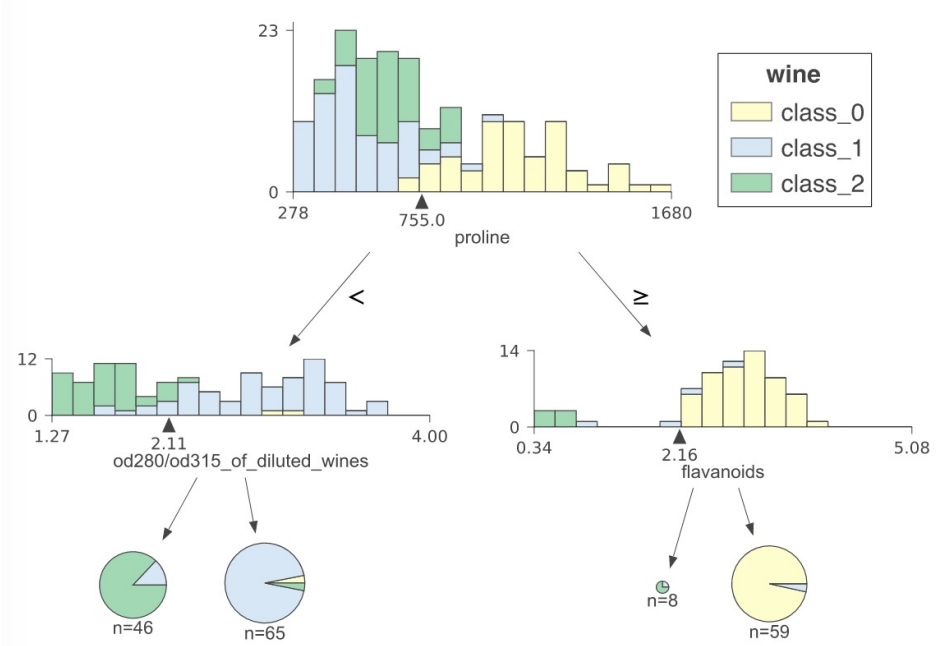
```
[3]: stocks
```

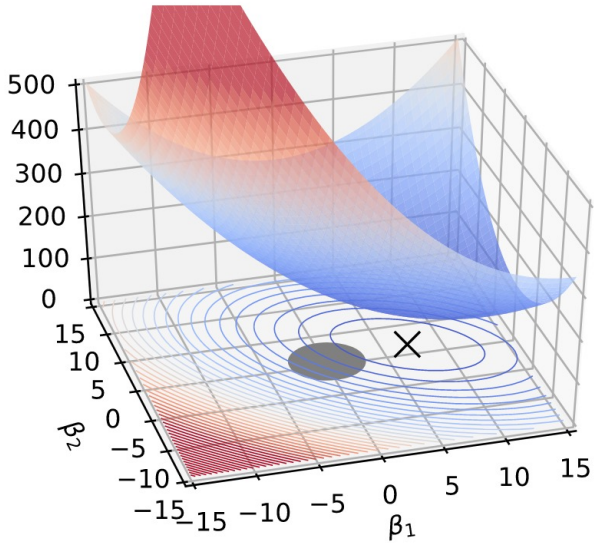
```
[3]: [102.2, 19.5, 842.01]
```

# Python libraries make us more productive

- Libraries provide repertoire of existing functionality we can leverage to boost productivity
- You'll use **matplotlib**, **numpy**, **pandas**, and **scikit-learn** extensively throughout the MSDS program
- The application programmers interface (API) is huge for these libraries and it takes a while to learn them, but they are very powerful
- Google / stack overflow will be your friends here as you learn
- Never ask what the parameters are to a library function; you must be independently functional so look it up yourself

# Sample functionality



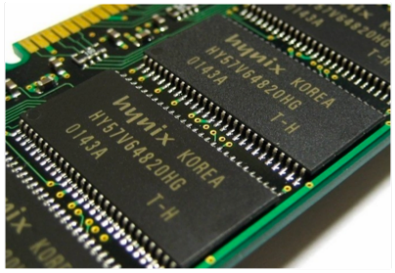

| | bedrooms | bathrooms | latitude | longitude | price |
|---|---|---|---|---|---|
| **0** | 3 | 1.5000 | 40.7145 | -73.9425 | 3000 |
| **1** | 2 | 1.0000 | 40.7947 | -73.9667 | 5465 |
| **2** | 1 | 1.0000 | 40.7388 | -74.0018 | 2850 |
| **3** | 1 | 1.0000 | 40.7539 | -73.9677 | 3275 |
| **4** | 4 | 1.0000 | 40.8241 | -73.9493 | 3350 |

# Getting to know your computer

A programmer's perspective

# Computer components

- Processor (*CPU*)
- Memory (*RAM*) code+data
- Nonvolatile Storage (*disk*)
- *Network*
- CPU executes code and operates on data in RAM, saving results on disk
- Can send and receive data across the network


# Processor

iMac (Retina 5K, 27-inch, Late 2014)
Processor 4 GHz Quad-Core Intel Core i7
Memory 32 GB 1600 MHz DDR3

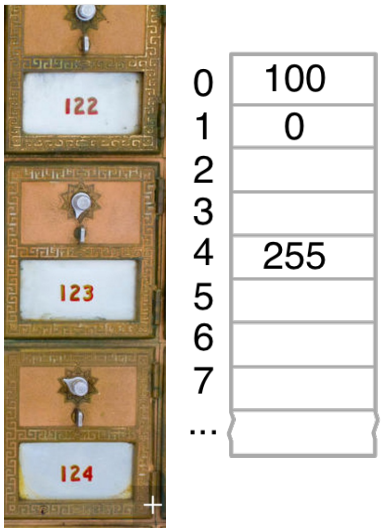
Mac mini (M1, 2020)
Chip Apple M1
Memory 16 GB

- Performs five principal operations:
  - load small chunks of data from memory into the CPU
  - perform arithmetic computations on data in the CPU
  - store small chunks of data back to memory
  - jump to a new location (this is how we loop)
  - jump to a new location if condition is true
- Each instruction does a tiny amount of work but CPU can execute billions of them per second
- E.g., **total = cost + tax** might take 2 loads, 1 add, and 1 store

iMac (Retina 5K, 27-inch, Late 2014)
Processor 4 GHz Quad-Core Intel Core i7
Memory 32 GB 1600 MHz DDR3

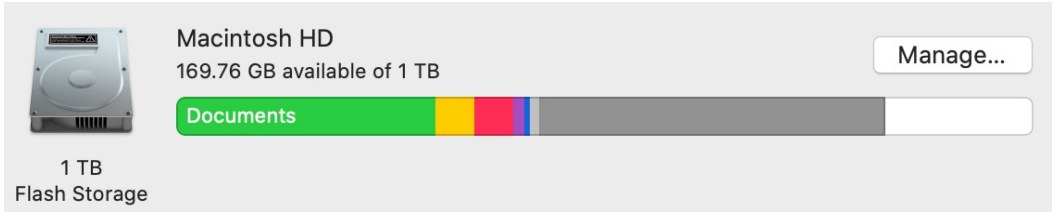
# Memory

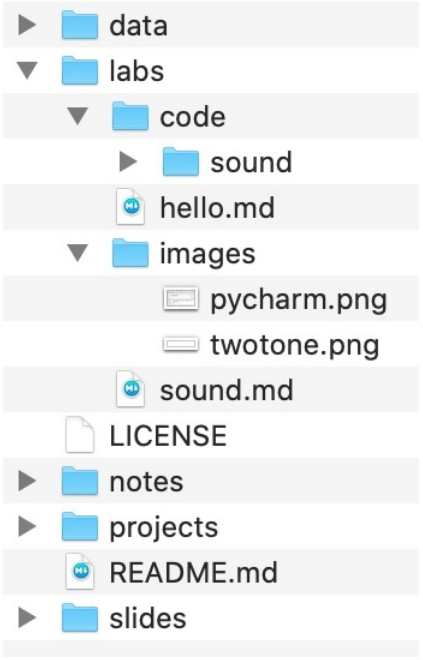
- RAM is much faster but usually much smaller than the disk and all RAM data is lost when the computer powers off
- Think of memory as your working or scratch space and the disk as your permanent storage
- Memory is broken up into discrete cells of a fixed size called a *byte* that can hold a number between 0 and 255 (8 bits)
- Cells have integer addresses just like mailboxes
- CPUs can read/write data at specific memory locations
- Everything from actual numbers to music to videos is broken down and stored as a sequence of bytes



# Disk/SSD (nonvolatile) storage

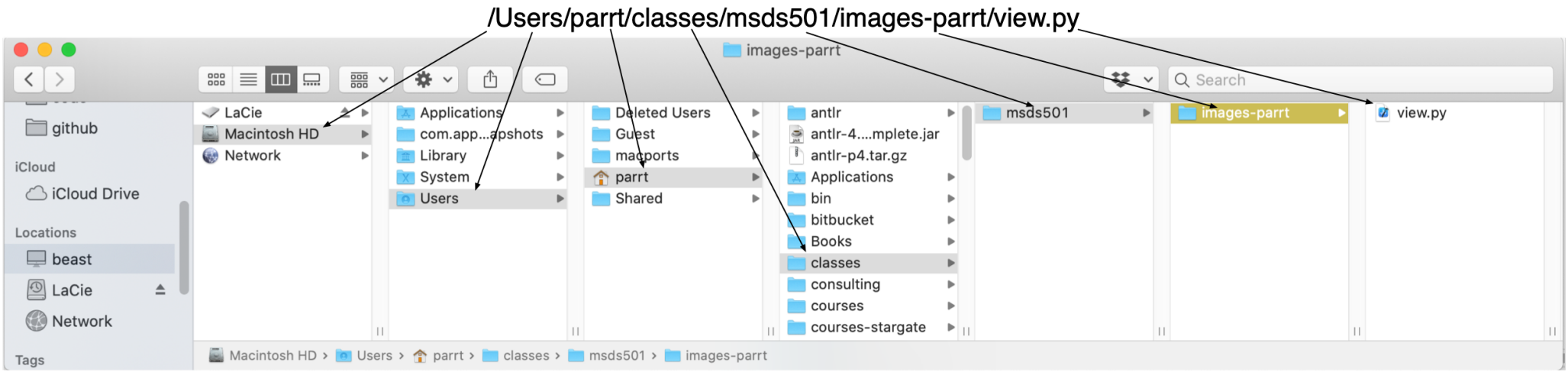
- *Files* hold data meant to be treated as a unit such as **ladygaga.mp3** or **sales.csv**
- *Directories* (folders) group files and other (sub-)directories
- Disk is a tree of folders with files in the leaves
- Executing programs have a *current working directory* and file specs (paths) are relative to that



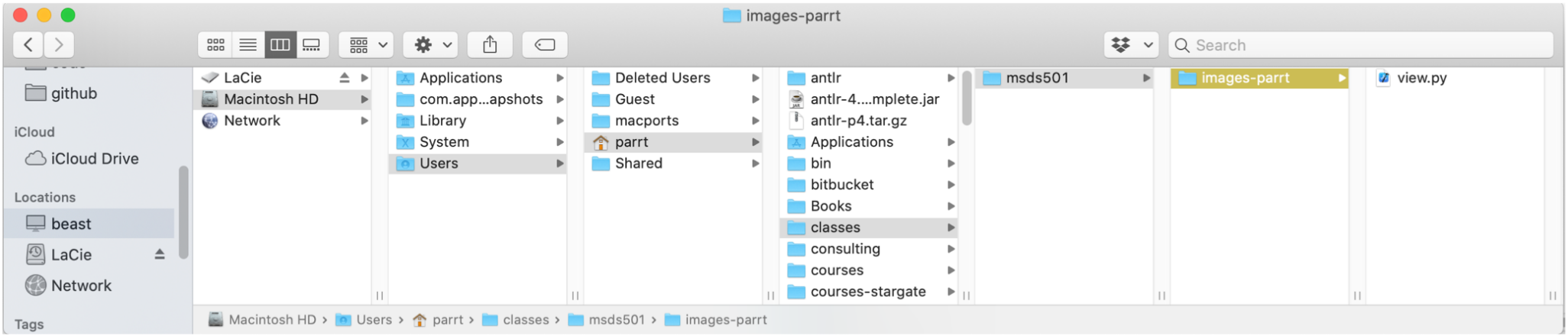
# Paths to directories and files

- *Path* is slash-separated sequence of dir names, optionally followed by a file name
  - The *root* is a single slash "/" and absolute paths start with "/"
  - Shorthand for your user home directory is "~" such as **/Users/parrt**
- *Relative paths* do not start with "/" or "~" and are relative to current working directory



# Path examples

- The **parrt** dir you see is **/Users/parrt** or **~parrt** or just **~**
- If current working directory is **parrt** then **msds501** dir is **classes/msds501** relative to that
- If current working directory is **images-parrt**, path to **view.py** is just **view.py**

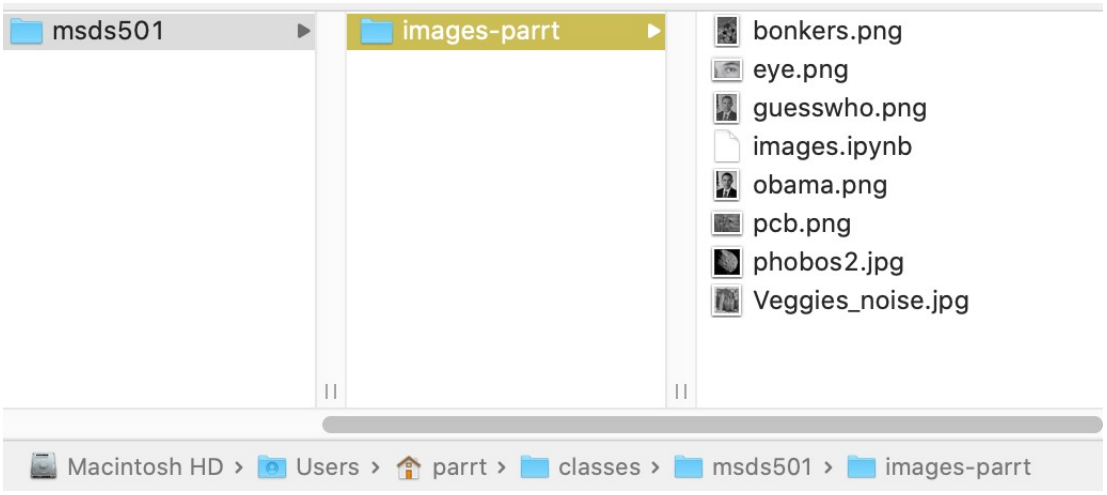


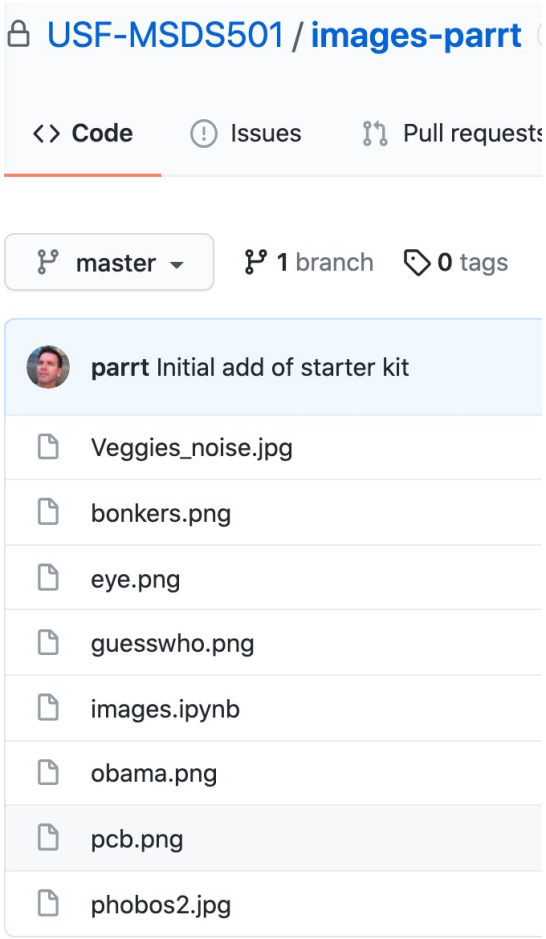
# The shell / terminal / command line

- Before GUIs, the terminal was all we had and what we used to examine files, check the state of the machine, execute programs, transmit files to other computers, etc.
- The terminal is running a "shell", a command interpreter that is another simple language, but one designed with commands to control your computer
- **echo** is like **print**
- **cd** changes directory
- **ls** lists files in directory

# Git / github

- Git = version control for a *repository*, which is represented by a directory with your code, data
- Git tracks changes made to files in repo dir
- Github = website that hosts git repositories
- We push/pull from laptop to github to share code

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# Summary

- Programming in Python is about way more than just typing in grammatically correct code
- It's about conjuring up sequences of instructions that perform a specific task then coding that up in Python but…
- There's an entire ecosystem we have to deal with:
  - Machine CPU/RAM capabilities
  - Libraries
  - Commandline
  - Git
  - Github
  - Notebooks, script files
  - Cloud computing / distributed computing