Quantitative Biology Bootcamp

Michael Schatz, Justin Kinney, Mickey Atwal

Aug 27, 2014
WSBS

Unsolved Questions in Biology

- What is your genome sequence?
- How does your genome compare to my genome?

- Where are the genes and how active are they?
- How does gene activity change during development?
- How does splicing change during development?

- How does methylation change during development?
- How does chromatin change during development?
- How does is your genome folded in the cell?
- How do proteins bind and regulate genes?

- What virus and microbes are living inside you?
- How do your mutations relate to disease?
- What drugs and treatments should we give you?

- ***Plus thousands and thousands more***

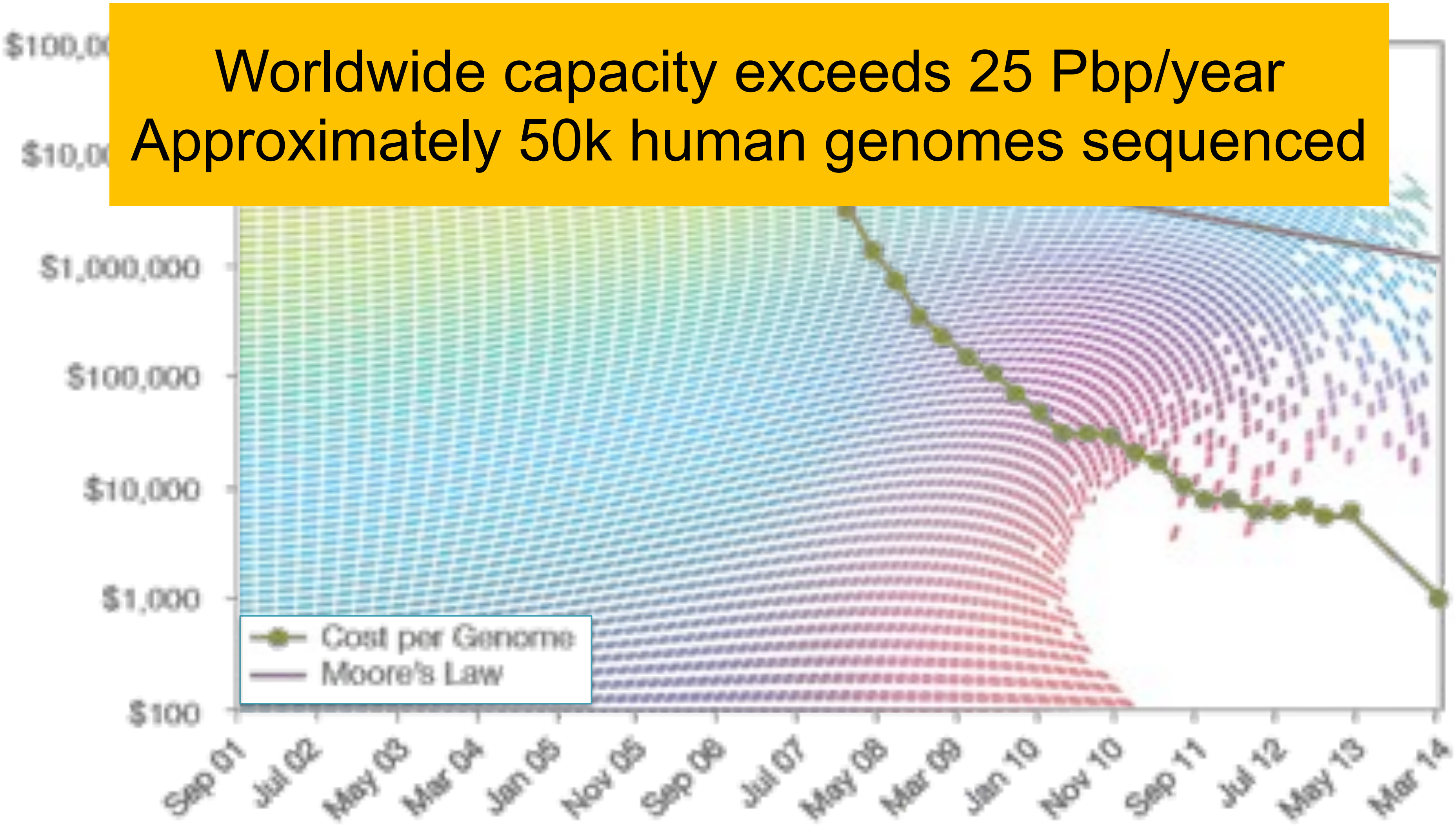
Data types across the NIH

Genomic
Other 'omic
Imaging
Phenotypic
Exposure
Clinical
Complexity
Courtesy of NHGRI

Phil Bourne, Associate Director of Data Science for NIH
http://www.slideshare.net/pebourne/wiki-mania080914

Cost per Genome

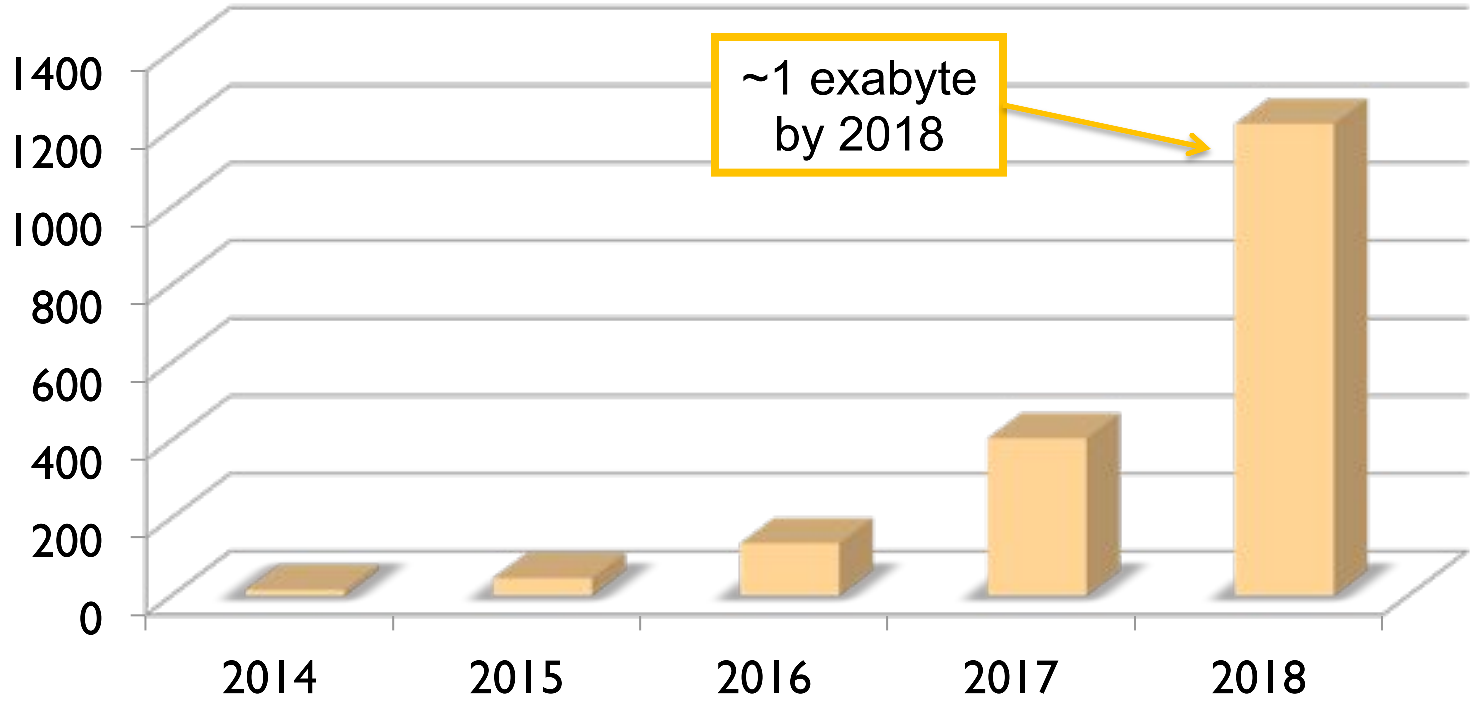
Worldwide capacity exceeds 25 Pbp/year
Approximately 50k human genomes sequenced



http://www.genome.gov/sequencingcosts/

DNA Data Tsunami

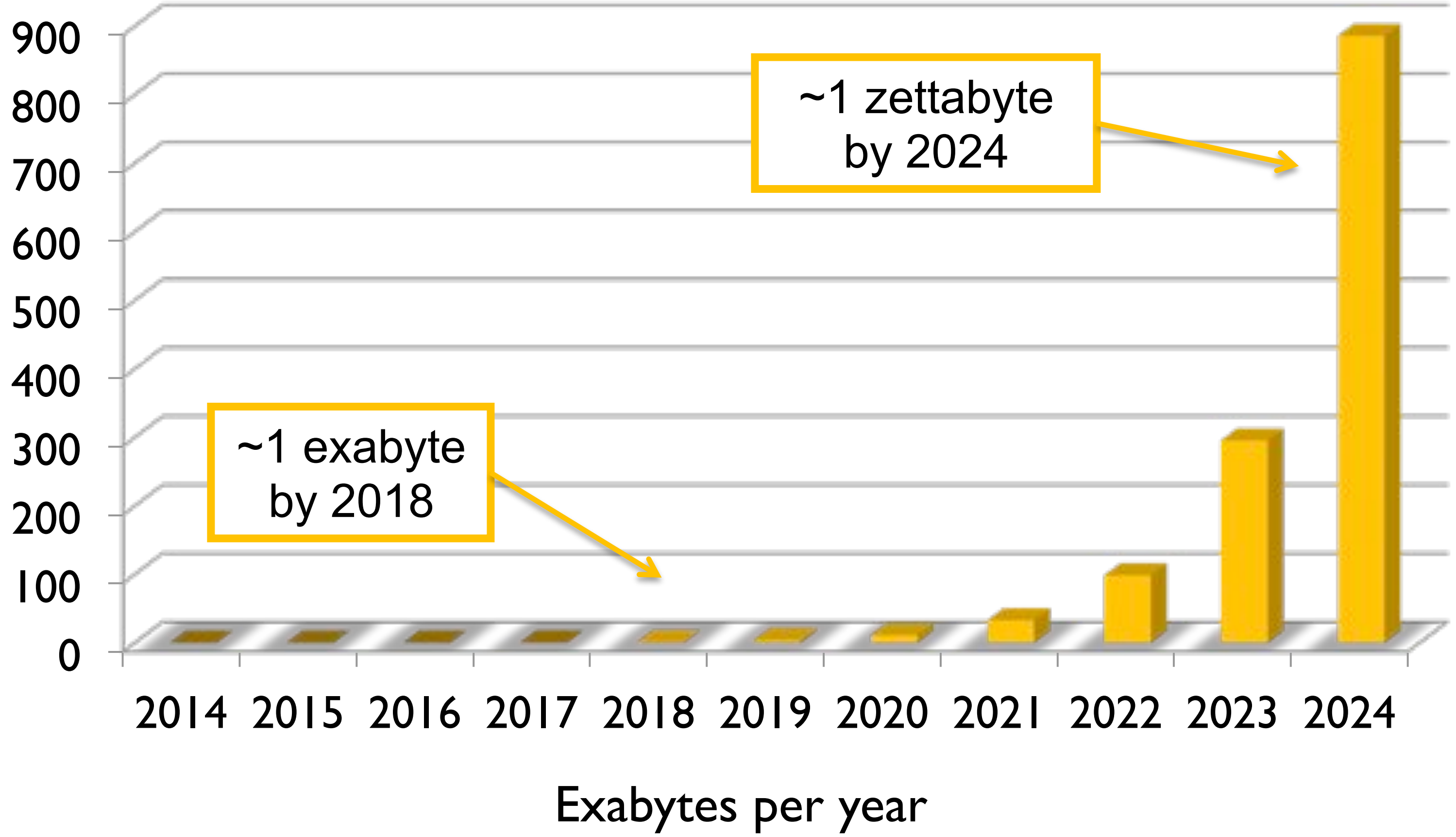
Current world-wide sequencing capacity is growing at ~3x per year!



Petabytes per year

DNA Data Tsunami

Current world-wide sequencing capacity is growing at ~3x per year!



~1 zettabyte
by 2024

~1 exabyte
by 2018

How much is a zettabyte?

Unit	Size
Byte	1
Kilobyte	1,000
Megabyte	1,000,000
Gigabyte	1,000,000,000
Terabyte	1,000,000,000,000
Petabyte	1,000,000,000,000,000
Exabyte	1,000,000,000,000,000,000
Zettabyte	1,000,000,000,000,000,000,000

How much is a zettabyte?

100 GB / Genome
4.7GB / DVD
~20 DVDs / Genome

X

10,000,000,000 Genomes

=

1ZB Data
200,000,000,000 DVDs

150,000 miles of DVDs
~ ½ distance to moon

YouTube

Both currently ~100Pb
And growing exponentially

Unsolved Questions in Biology

- What is your genome sequence?

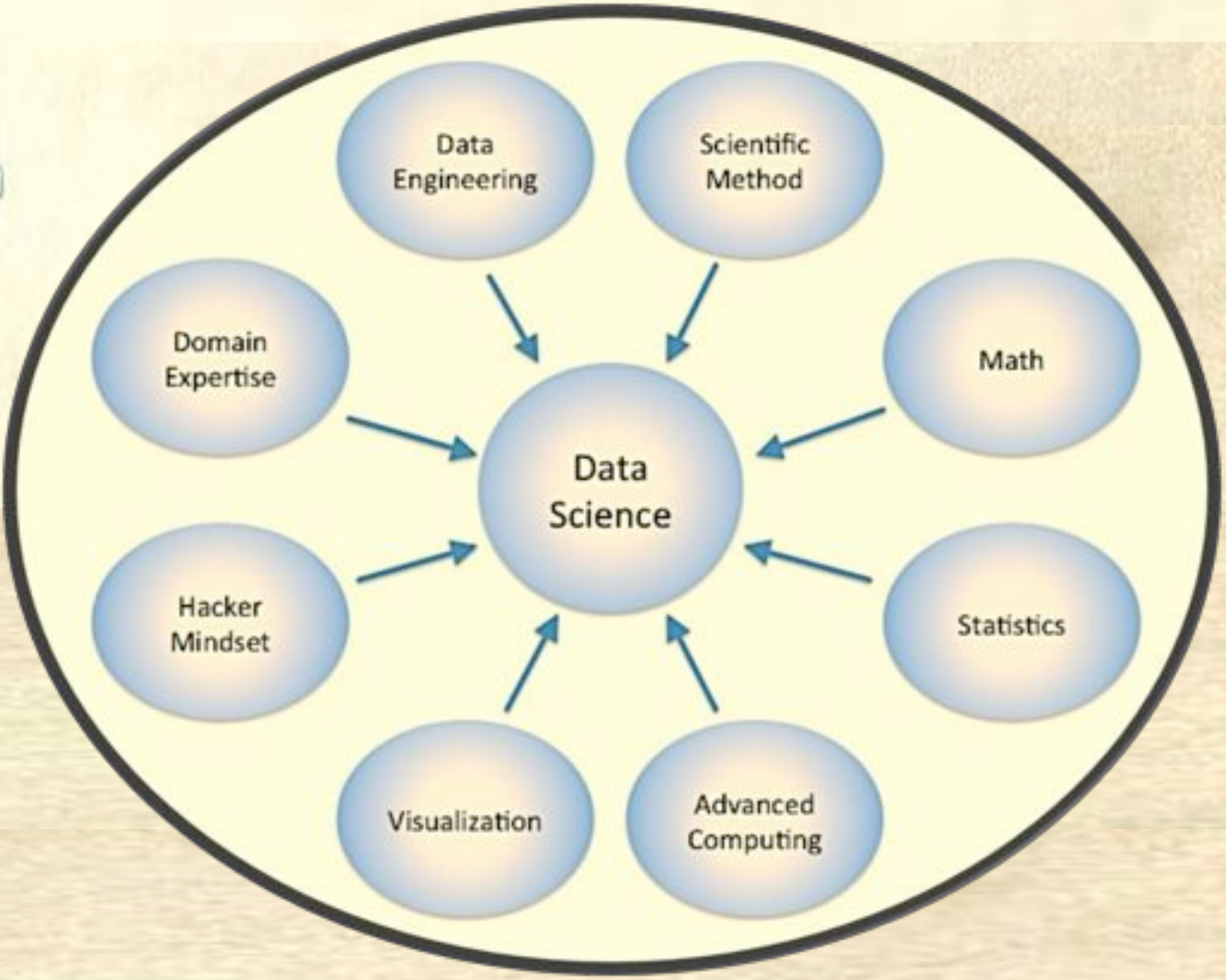
The instruments provide the data, but none of the answers to any of these questions.

What software and systems will?

And who will create them?

- ***Plus thousands and thousands more***

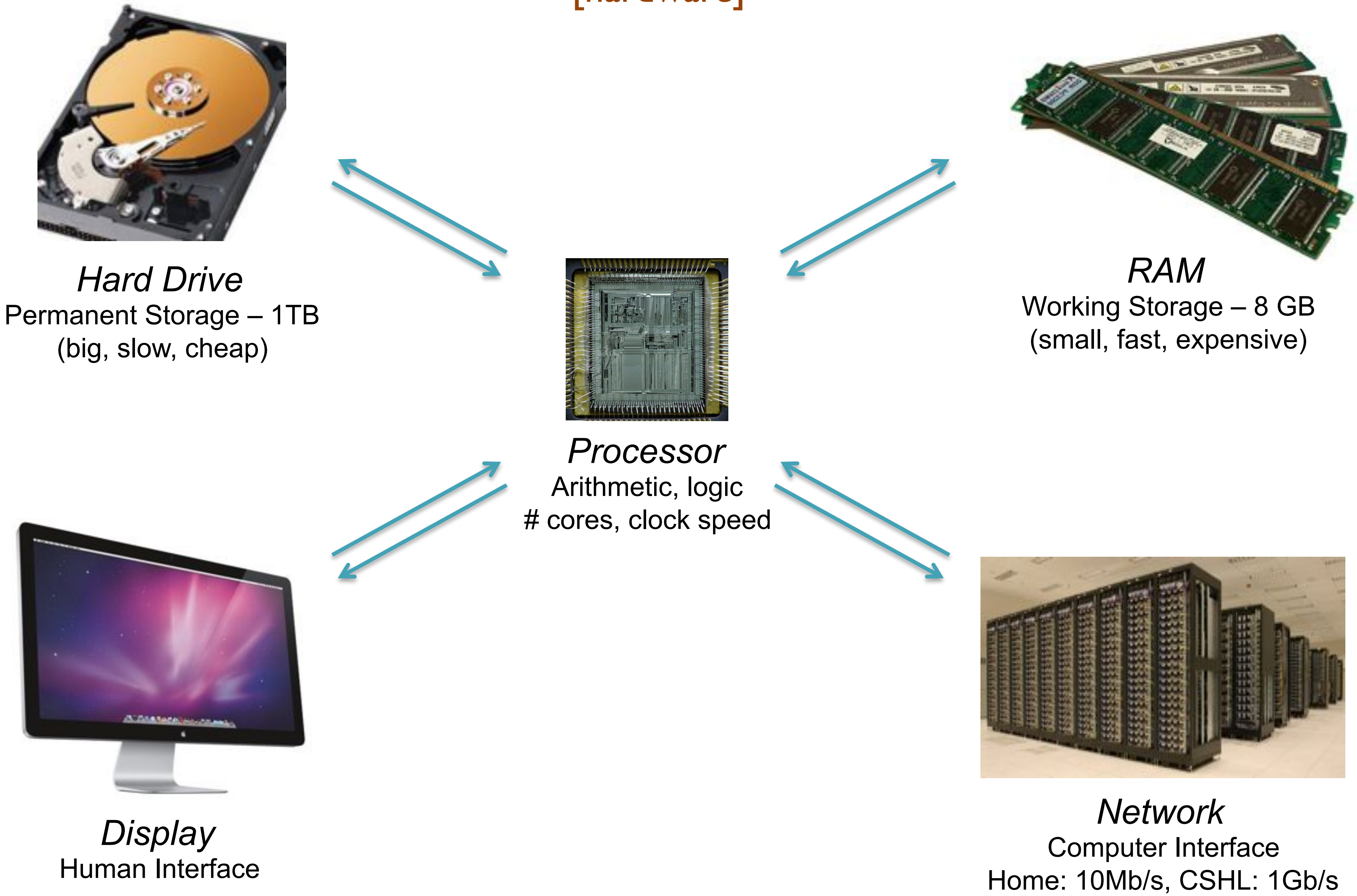
Who is a Data Scientist?



http://en.wikipedia.org/wiki/Data_science

What is a computer?

[hardware]



Hard Drive
Permanent Storage – 1TB
(big, slow, cheap)

RAM
Working Storage – 8 GB
(small, fast, expensive)

Processor
Arithmetic, logic
# cores, clock speed

Display
Human Interface

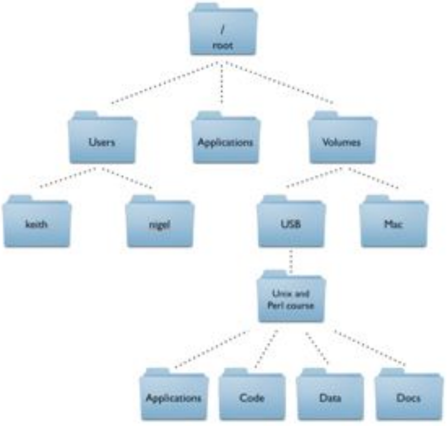
Network
Computer Interface
Home: 10Mb/s, CSHL: 1Gb/s

What is a computer?

[software]

Office Applications

Presentations, Documents
Simple statistics and plots

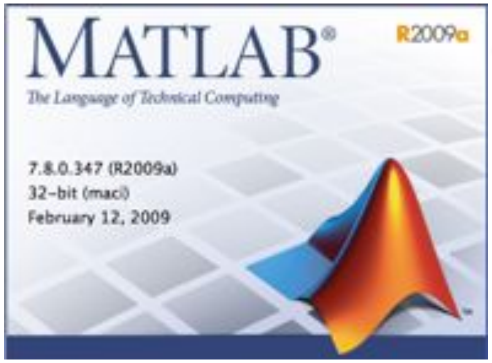


Files / Data

Papers, sequences, measurements

Operating System

Mission Control
Windows, Mac, Unix, iOS



MATLAB® R2009a

The Language of Technical Computing

7.8.0.347 (R2009a)
32-bit (maci)
February 12, 2009

Scientific Applications

Specialized Analysis
Commercial

```
time_t time1 = clock(); // Measure time from here
for (int i = 0; i < 100; i++) { // Do the test 100 times
    NSEnumerator *enumerator = [array objectEnumerator];
    NSString *str;
    while ((str = [enumerator nextObject])) {
    }
}
time_t time2 = clock(); // Measure time from here
for (int i = 0; i < 100; i++) { // Do the test 100 times
    for (NSString *str in array) {
    }
}
time_t time3 = clock(); // Measure time from here

for (int i = 0; i < 100; i++) { // Do the test 100 times
    for (int j = 0; j < [array count]; j++) {
        NSString *str = [array objectAtIndex:j];
    }
}
time_t time4 = clock(); // Measure time from here

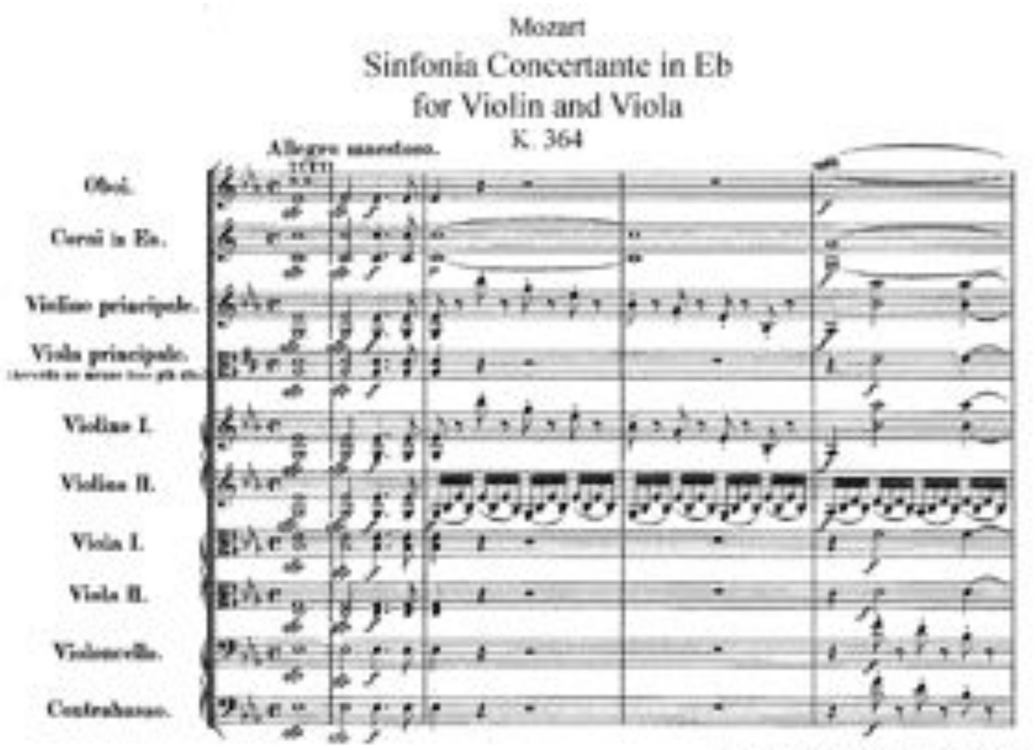
double t1 = (((double)(time2-time1))/CLOCKS_PER_SEC)*1000;
double t2 = (((double)(time3-time2))/CLOCKS_PER_SEC)*1000;
double t3 = (((double)(time4-time3))/CLOCKS_PER_SEC)*1000;
printf("NSEnumerator: %0.f ms\n", t1);
printf("Fast enumeration: %0.f ms\n", t2);
printf("For-loop: %0.f ms\n", t3);

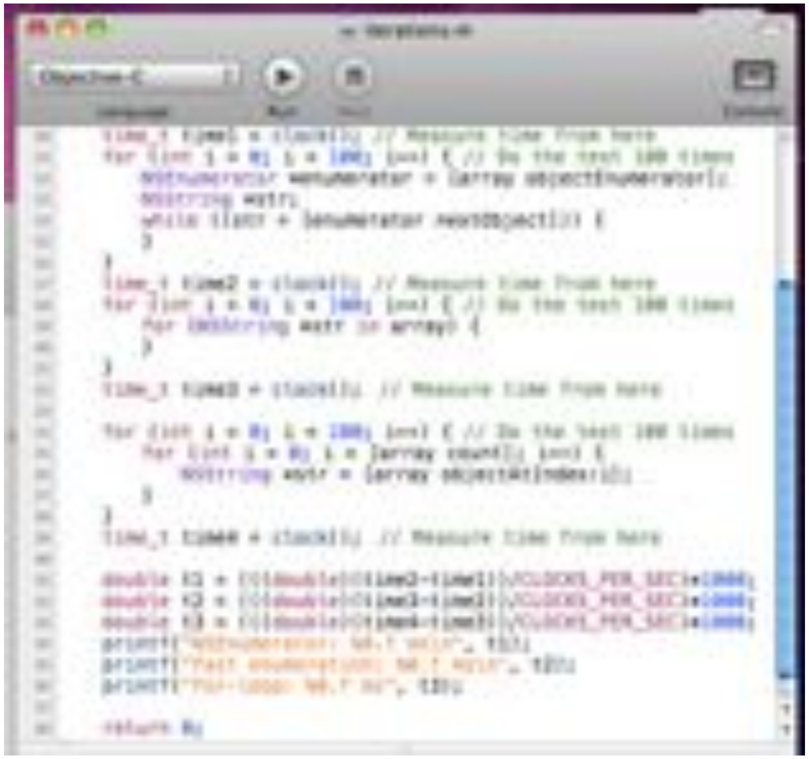
return 0;
```

Code / Scripts

Research Applications
Academic

Programming 101





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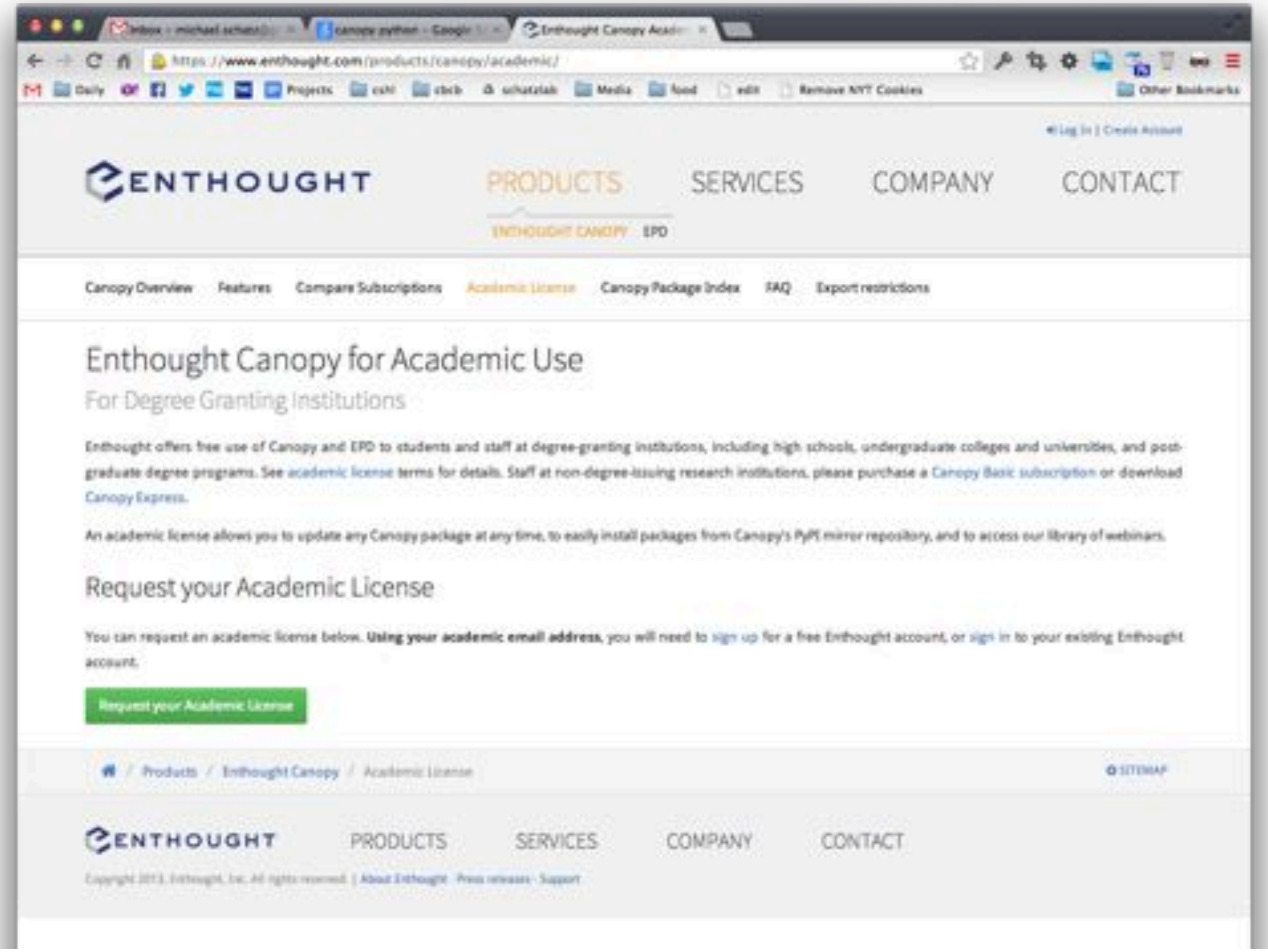
    printf("Fast enumeration: %0.f ms\n", t2);
    printf("For-loop: %0.f ms", t3);

    return 0;
```

A software program is like sheet music for the orchestra inside your computer
Static, written representations of an active process

Programming with Python



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