Physics 281 – Computational Physics

• (1st 3 weeks) **Computer programming (coding)**
  • We will use **Python**
• (rest of semester) **Use programming to do physics**
  • Solve physics problems that can’t be solved “analytically” (with pen and paper)
  • Use computers to deal with data (too much data to handle without computers)
A problem you can solve analytically: 
Mass on a linear spring

\[ \frac{d^2y}{dt^2} = -(k/m)y \]
Solution is a sine wave

A problem you can’t solve analytically: 
Mass on a **nonlinear** spring

Not a sine wave! This curve was obtained by numerically integrating \( F=ma \).
It is a simulation of the physics.
None of these pictures came from experiment – they are all simulations
Experimental data you cannot write in a lab notebook
You need computers to analyze data like this

- AFM scan of the surface of a glass (Carnegie-Mellon U nanolab)
- Single event in a high-energy physics experiment (ATLAS collaboration, CERN)
- Two-dimensional colloidal crystal (C.E. Cash et al PRL 2018, Harvey Mudd College)
Physics before computers
(simplified)
Physics in the age of computers
(still simplified)

Computational physics: simulations or "computer experiments"

A working physicist needs to be able to make computers do whatever s(he) wants – this is programming (coding).

Experiment
- Computer data handling and analysis

Theory
- Computer tools for theory
Why Python?

Java

class HelloWorld {
    static public void main( String args[] ) {
        System.out.println( "Hello World!" );
    }
}

C++ (ISO)

#include <iostream>
int main()
{
    std::cout << "Hello World!" << std::endl;
}

C (ANSI)

#include <stdio.h>
int main(void)
{
    puts("Hello World!");
}

Python

print('Hello World!')

Source: [https://helloworldcollection.github.io/](https://helloworldcollection.github.io/)
I learned it last night! Everything is so simple!
Hello World is just 'print "Hello, world!"

I dunno...
Dynamic typing?
Whitespace?
Come join us!
Programming is fun again!
It's a whole new world up here!
But how are you flying?

I just typed
import antigravity
That's it?

... I also sampled everything in the medicine cabinet for comparison.
But I think this is the Python.

https://xkcd.com/353/