PHYS 2020

LECTURE 1
Bits, Bytes, UNIX, LINUX and C

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Binary Numbers

- There are 10 types of people in this world: Those who understand binary numbers and those who don’t.
- Computers use numbers to the base 2.
- To humans this seems very inefficient
- We count 1, 2, 3, 4, 5,…
- They count 0, 1, 10, 11, 100, 101, 111, 1000,…
To put my age in binary I need to write: 101101.
It is inefficient and unflattering!

So why do computers use binary numbers?

It can be done in electronics!
A switch can be on or off.
A current flows in a circuit or it doesn’t

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**Basic Computers**

- Computers can add (+), subtract(-), multiply(∗), divide(/) and compare (c.f.) – that is all!

- Every thing else we do with them is made up of a subset of those functions.

- I know this is true because I once did a course in digital electronics and we learnt how to make circuits, using only on and off switches, that performed these functions. It was really good fun, but these days I use a computer language to tell the computer how to use those circuits.
And Now to Tell the Computer How to Add, Subtract, Multiply and Divide

- I find that my attention span is just not up to building a circuit each time I want to multiply two large numbers.
- So, I use a programming language.
- In fact I use many, depending on my needs.
- I am completely agnostic about which computer language reigns supreme!

What Is a Computer Language?

- A computer language is written in words and symbols which humans can easily read and write.
- It has an associated compiler, which is a computer program that reads the words and symbols and translates it into binary instructions that turn switches on and off to make circuits +, -, *, /, c.f.
The Compiler*

- Some history:
  - USA, 1942, ENIAC. To program this baby you needed to rewire it by hand!
  - By the early 1950s computer programming had evolved to entering code by turning switches on and off rather than rewiring.
  - In 1951 Grace Hopper developed the first compiler, which allowed the computer to be programmed using words and symbols rather than binary ones and zeros.

*Reference book for this course: C all-in-one Desk Reference for Dummies by Dan Goodkin.

Programming Languages

- FORTRAN was the first major computing language and was developed in the 1950s.
- The name stands for FORmula TRANslatinon as this language was designed for mathematical calculations e.g. good for science.
- Other languages were designed for other purposes e.g. COBOL for business.
Programming Languages

- In 1968 Niklaus Wirth developed Pascal. It was designed as a teaching tool because it didn’t allow poor programming structures (such as the GOTO statement).
- Inspired by Pascal, Dennis Ritchie at Bell Labs developed C in 1972. (He was working on a language called B at the time.)

Why Learn C?

- C was used to write the UNIX operating system.
- LINUX and Mac OS/10 are also written in C, and are based on UNIX.
- Therefore C is automatically available on many computers. Windows C compilers are easy to install and can be found free on the Internet.
- C is the “Latin” of the computer world: many other languages such as C++, Perl, Java, and Python are based on C. These are easy to learn once you know C.
- It does not matter too much which programming language you learn first. The concepts are the same in most languages and are readily translatable.
UNIX and LINUX

- These operating systems have a hierarchical directory structure—like the roots of a tree.

![Directory Structure Diagram]

Moving Around in LINUX*

- **pwd** Where am I
- **ls** what is in this directory
- **cd newdir** change to new directory called newdir. Note: unless newdir is in the current directory you must specify a path, such as `/home/mariac/data/ngc4945/galaxy.txt`
- **cd ..** Change up one directory
- **.** Short for “the directory I am in now.”
- **~** short for “my home directory.”

*I use UNIX and LINUX interchangeably, as they are almost identical.
Some more LINUX

- `finger` who else is on this computer?
- `cp` fileone filetwo copy file named fileone to file named filetwo
- `mv` moves the file rather than copies it
- `more` filename.txt print the contents of filename.txt to the screen, one part at a time.

Creating a text file

- On windows use maybe word, but don’t forget to save as a text file!
- On UNIX use VI, VIM, Emacs, Textedit, nedit…
Programming at Last