Lab 0

- Lab 0 – Submitting your work using GIT

- This is a very simple lab. You should be able to complete it within a few hours.

- If you cannot complete this, you are most likely not ready to take this class.

- Lab 0 is due FRIDAY at midnight (11:59PM)
Why Take CMPE-012/L

- Understanding the “machine model” of how a computer computes makes you a better coder.
  - You understand the limitations of the computational model
  - Some things you can do to take advantage of the hardware
  - Having knowledge of the low-level allows you to better code at a high level
  - You waste less time

- “Time is our most valuable nonrenewable resource, and if we want to treat it with respect, we need to set priorities.” — Albert-László Barabási
History of Computers
The History of Computers

The history of computers is interesting (or should be if you are in this class) and relevant to our professional lives.
Age of Excess Information

Images from “The Cartoon Guide to Computer Science” by Larry Gonick
What is Information?

What is information?

The modern definition comes from Claude Shannon, a Bell Labs engineer, amateur unicyclist, and founder of the science of information theory.
Information IS the Signal
How Do We Store Information

- In books...
- On audio and video disks...
- In paintings or drawings...
- On tape...
- In the human memory...
- How to build and deliver H-bombs
- In diagrams, etc!
Internal and External Signals

What do you mean, what does "gronk" mean? "Gronk" means "gronk!"

Anyway—what does "meau" mean?
Humans Invent Language

"GRONK"

The sky is blue...
The sky is blue and flecked with clouds...
The sky, clearing after yesterday’s rain, is blue and flecked with clouds...

"GRONK"

Gabriel Hugh Elkaim
Rules of Grammar and Logic

IF you come out AND APOLOGIZE, THEN we will NOT play you alive, UNLESS we change our MINDS...
Numbers

Numbers are precise... reliable... you can add, subtract and multiply numbers. "One plus one" makes sense, but as they say, you can't add grapes and reindeer.

Except in my grape and reindeer stew...

How many days in a month?

Simple! One, two, three, four, five, six, seven, eight, nine...

Ten...

Ahem! While I'm sure this question has an answer, the current generation of hardware seems inadequate to the task...

I say!
Tally Bone (20K+ years old)
Writing (Storage)

The Sumerians wrote on clay tablets, while the Egyptians used soft papyrus.

Chinese writing began with messages to the gods inked on tortoise shells.

They didn't ask the god of tortoises!

The Incas used a system of knotted cords.

HM! A floppy tablet!
Counting

I CALL THIS NUMBER "SMERO."

AND THEN—A HANDFUL OF HANDFULS OF HANDFULS.

That's $10 \times 10 \times 10 = 1000$. 

Gabriel Hugh Elkaim
Symbolic Number Systems

1 = ONE
\( \text{I} \) = TEN
\( \text{I} \) = HUNDRED
\( \text{I} \) = THOUSAND
\( \text{I} \) = TEN THOUSAND
\( \text{I} \) = HUNDRED THOUSAND

Then you just pile them up:

- Two hundred thousands
- Three ten thousands
- Six thousands
- One ten
- Nine units

Or 236,019

What's \( \text{III} \) times \( \text{III} \) ?

But for computation they stink...
Positional Number Systems

From which (for example):
- Two hundred thousands
- Three ten thousands
- Six thousands
- No hundreds
- One ten
- Nine units

or 236,019.
Our own Positional Number System

\[ \ldots 10^3 \ 10^2 \ 10^1 \ 10^0 \]

2 3 4 6

1 000's

\[ 1 \]

\[
100's\ 10's\ 1's
\]

Base 10
Ancient Positional Number Systems

$52_{60} = 50$

$5,45_{60} = 5 \times 60 + 45 = 300 + 45 = 345_{10}$. 
Any Base Positional Number System

- select base $b$
- Define a set of symbols for $0$ - $(b-1)$
- Ordered sequence of one or more digits: $d_i$

$$\text{number} = \sum_{p=0}^{n} d_p b^p$$

$$211_3 \rightarrow \left[1 \cdot 3^0 + 1 \cdot 3^1 + 2 \cdot 3^2\right] = 22_{10}$$
Calculation

Calculation
Alphabet

alphabetical order.

We choose to be still saddled with pictograms!

Whereas previously, only idiots with leisure could learn...

Does come before or after?
Much ado about Nothing

As far as calculation goes, the age of paper began in India, about 650 A.D.

The Indians had found a way to make cheap paper from palm leaves, and their mathematicians invented a way of using it...

I’ve discovered nothing!

1234567890
Paper and Pencil Calculation

"Al-Kwarizmi" or ALGEBRA, for short.

Gabriel Hugh Elkaim
The Renaissance

The RENAISSANCE.
Ballistics

Niccolo Tartaglia
1499 - 1557

→ 3 Body Problem

We're reaching the limits of paper!
Machine Calculation

John Napier (1552 - 1617)

William Schickard (1592 - 1635)

Blaise Pascal (1623 - 1662)

Gottfried Leibniz (1646 - 1716)
Industrial Revolution
Power Loom

Joseph Jacquard
1801

Power loom
Difference Engine

Charles Babbage
1792 - 1871

One more in 1991
The Analytical Engine

The Mill?

50 decimals

How did it know what to do?

The instructions to the mill would be read in on punchcards.
Computation on the Analytical Engine

A punchcard could do one of the following things:

- Input a number to the store
- Input a number to the mill
- Move a number from the mill to the store
- Move a number from the store to the mill
- Instruct the mill to perform an operation
- Output a number from either store or mill

Which may be summarized in this diagram:
The First Programmer

Ada Augusta
Lady Lovelace

Babbage's Law:
Computers are never built on time!

Ada - Military
US Census

NEIL HOFFRITT
1860–1929

1880 – 7 1/2 years
2 years

EACH CUP WAS WİRED TO A COUNTER, WHICH ADVANCED EACH TIME AN ELECTRIC PULSE ARRIVED.
Data Processing

2½ for 2½ yrs

Railroads

↓

IBM

This company is going somewhere!
The Switch

\[
\begin{align*}
\text{Battery or Power Source} &= \text{Light Bulb} = \text{Switch}
\end{align*}
\]
Better Switches

ELECTRO MECHANICAL
NEW

VACUUM TUBE
1,000,000 x SECOND
Switches to Logic

That is, patterns of switches can be arranged to add, to store, and even to embody logical relationships (whatever that means). Details later!

If I insert finger and flip this switch, then I am a dead engineer!
First Computers

Konrad Zuse (1910)
Z-1 (1939)

10²₅ + 10¹⁵ · 1 < 3 sec

Howard Aiken
Mark I

1200 ft³
Navy
Ballistics (again)

Big Bertha ~ 94 miles

Mauchly

John Mauchly

Eckert

J. Eckert
ENIAC / UNIVAC – 1957

1946

18,000 TUBES

500 MULTIPLICATIONS PER SECOND!

(IT ALSO NEEDED ITS OWN AIR-CONDITIONING SYSTEM!)
Logical Structure

John von Neumann
(1903 - 1957)

This is the concept of the Stored Program.

Gabriel Hugh Elkaim
Sort and Merge

Given two lists of names (for example):

ALABAMA, S.
ANTEATER, J.
ANTEATER, B.
AARDVARK, A.

TARDIGRADE, C.
BEAVER, M.
OWL, H.
ALLIGATOR, A.

Make one list in alphabetical order.

AARDVARK, A.
ALABAMA, S.
ALLIGATOR, A.
ANTEATER, B.
ANTEATER, J.
BEAVER, M.
OWL, H.
TARDIGRADE, C.
Getting Smaller

HOW CAN WE PUT ONE OF THESE IN EVERY HOME IN AMERICA?

CUT THE PRICE?

TIME TO RETIRE, FATSO!

1957
Still Need More Speed
Four Generations of Computers

1951 - 1958 VACUUM TUBE
- U-shaped bulb style
- Machine code on punch cards

1959 - 1969 TRANSISTOR
- Transistors are electronic switches across a resistor
- Assembly
- 1954 FORTRAN / COBOL
Four Generations of Computers

1965-1970 Integrated Circuit
- 8051 Intel
- Complete circuit is on a small silicon chip
- IBM 360 series
- Unbundle software from hardware

1971-Present MICROPROCESSOR (VLSI)
1 ns = 1 picosecond (ps)
The Next Generations of Computers

- S.O.C. - System on a chip
- CPU
- GPU
- Memory (RAM & ROM)
- I/O
- Ubiquitous Computing / I.O.T. (Internet of Things)
History Summary

- Know recently about the evolution of computers, it is helpful to understand why they are the way they are.
- Computing devices have been around a long time.
- Digital computers are relatively recent.
Control

Input -> HW -> Output

Storage