CSC106 Lecture 2

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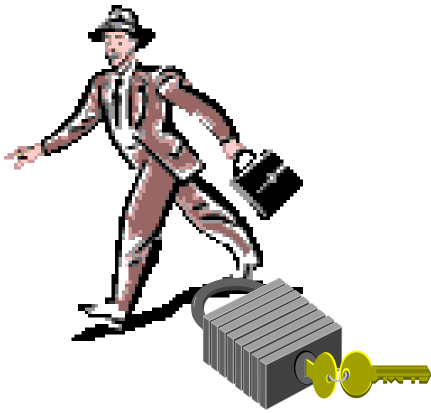
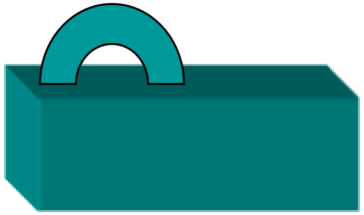
Problem Solving

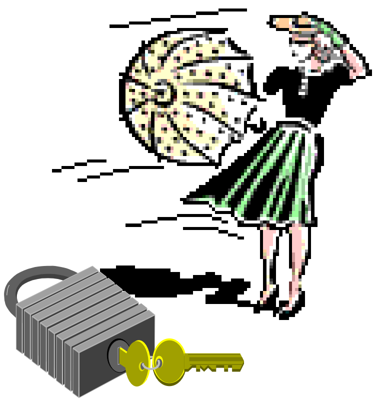
- **Two people, Bob and Alice, are in love. They want to communicate with one another, but they live in a country with an immoral telephone and postal service (no email/IM/texting yet).**

- **They decide to communicate through the mail using a small strong box that can be locked using one or more combination locks. They each have a combination lock.**

- **How can they use this strong box, their combination locks, and the post to securely communicate their love notes to one another?**







Problem solving reflection?
Did you use any of these…..

- Lateral thinking: approaching solutions indirectly and creatively
- Trial-and-error: testing possible solutions until the right one is found
- Proof: try to prove that the problem cannot be solved.
- Abstraction: solving the problem in a model of the system before applying it to the real system
- Analogy: using a solution that solved an analogous problem
- Divide and conquer: breaking down a large, complex problem into smaller, solvable problems
- Brainstorming: (especially among groups of people)
- Hypothesis testing: prove, or disprove hypothesis
- Reduction: transforming the problem into another problem for which solutions exist
- Method of focal objects: synthesizing seemingly non-matching characteristics into something new
- Means-ends analysis: choosing an action at each step to move closer to the goal
- See what others have done: Look online, ask someone with expertise
- Morphological analysis: assessing the output and interactions
- Root cause analysis: eliminating the cause of the problem
- Research

Goals – at the end of this session you will be able to …

- Translate between base 2, 10, and 16
- Recognize, define, and give examples of the concepts of universality, duality, and self-referencing as they apply to computer science
- Create a working definition of an algorithm

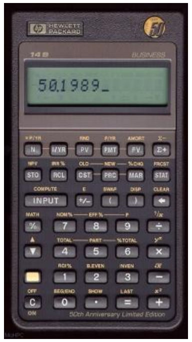
“Quiz” 1

- Working with an index card
- On one side answer the following:
  - ***What is computer science?*** (**Your** definition. One that you might use to explain to a person outside of the discipline)
- On the other side complete the following sentence:
  - ***A computer scientist is a person who ….***

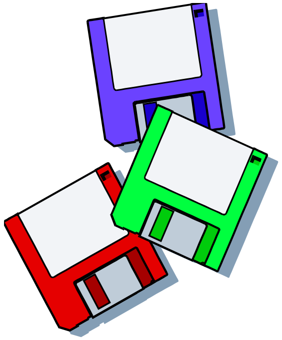
Please put your name and student # on the card

Pre-History of Computers

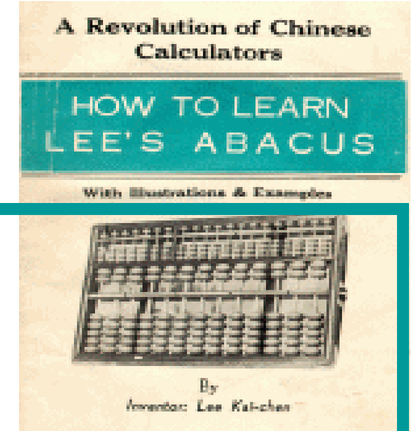
Modern computers result from 2 streams of evolution



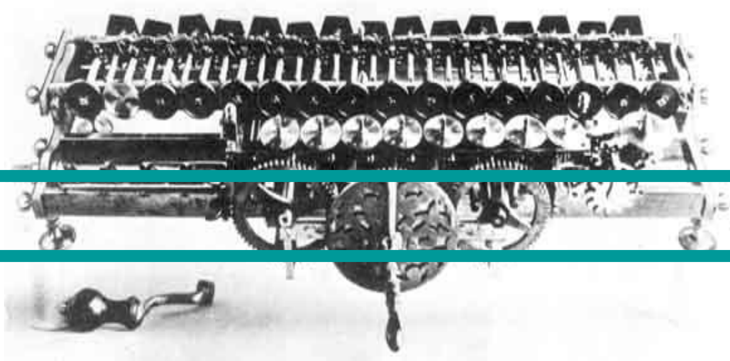
- Mechanization of arithmetic
  - calculating machines (hardware)
- Concept of stored programs
  - process control (software)

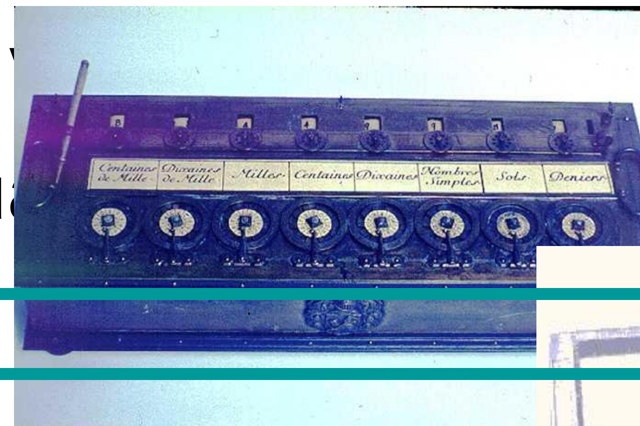


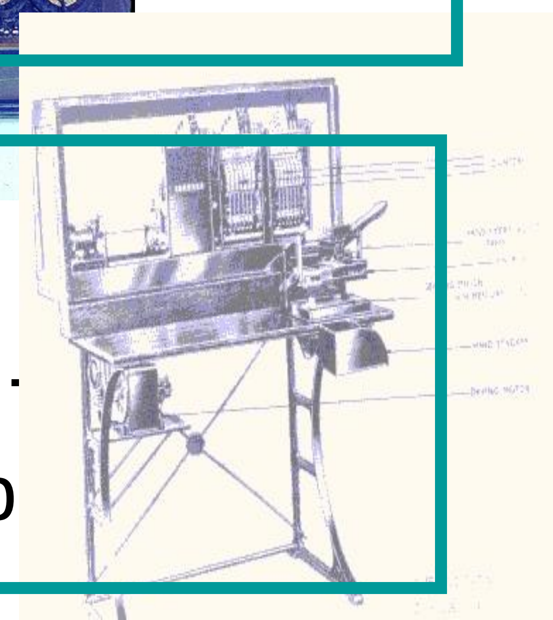
An Evolving Idea



- The abacus
- Blaise Pascal 1642 - Pascal's Adder
- Gottfried Wilhelm v 6-1716)
- qua rd's Loom



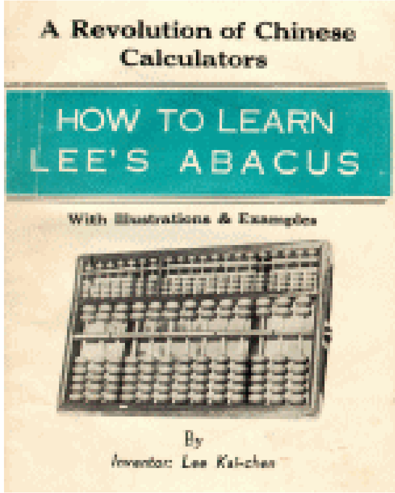




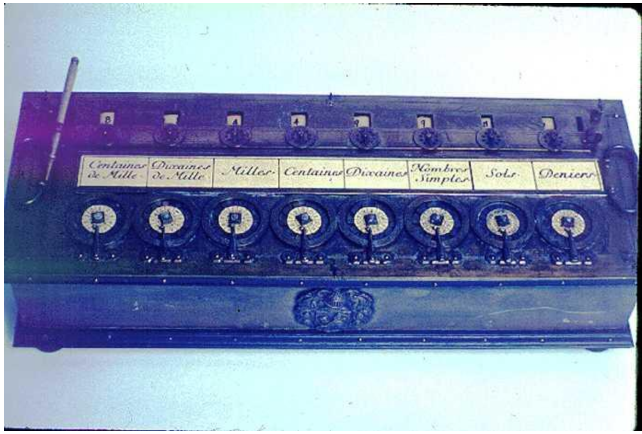
- Herman Hollerith (1860-1929)
- 1822-33 - Difference Engine --
- 1830-71 - Analytical Engine -- Babb

Mechanization 1

- The abacus
  - origin unknown
  - used by the Chinese 3 to 4 thousand years ago

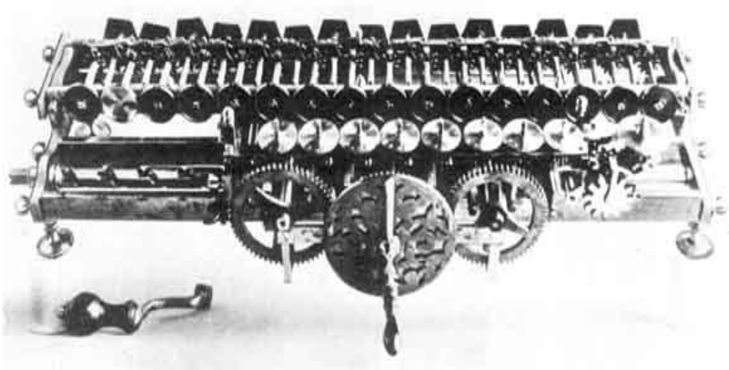


- Blaise Pascal (1623-1662)
- 1642 - Pascal's Adder
  - 1st mechanized adding machine
  - gears and wheels
  - add and subtract, calculate taxes
  - inaccurate

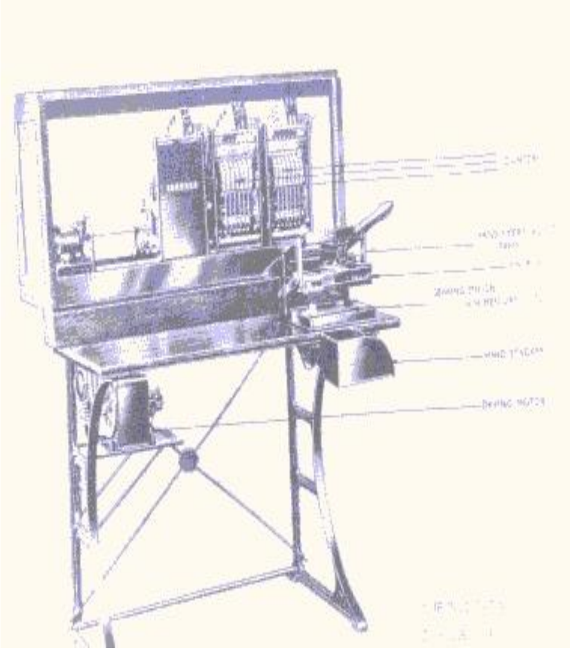


Mechanization 2

- Gottfried Wilhelm von Liebniz (1646-1716)
- 1670’s - Liebniz calculator
  - similar to Pascal’s design
  - add, subtract, multiply, divide
  - more reliable and accurate
  - still inaccurate
  - he also invented calculus



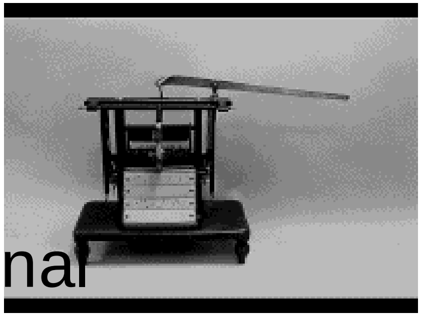
Stored Program 1



- Joseph Marie Jacquard
- 1800 - Jacquard’s Loom
  - weaving loom
  - metal punch cards to position threads for the weaving process
  - within the decade, 11,000 used in France
  - may have been 1st case of unemployment caused by automation

Stored Program 2

- Herman Hollerith (1860-1929)
  - designed a machine that used electric charges to read info off of punch cards
  - for use in 1890 US census
  - store and process census data on punched cards
  - started his own company in 1896
  - in 1924 that company became International Business Machines Corporation



Charles Babbage

- 1822-33 - Difference Engine
  - abandoned, wasn’t precise
- 1830-71 - Analytical Engine
  - designed but never completed, ahead of its time
  - Mill - arithmetic computations
  - Store - store data and results
  - Operation cards - program instructions
  - Variable cards - select memory location for ops
  - Output - printer or punch cards

An Evolving Idea

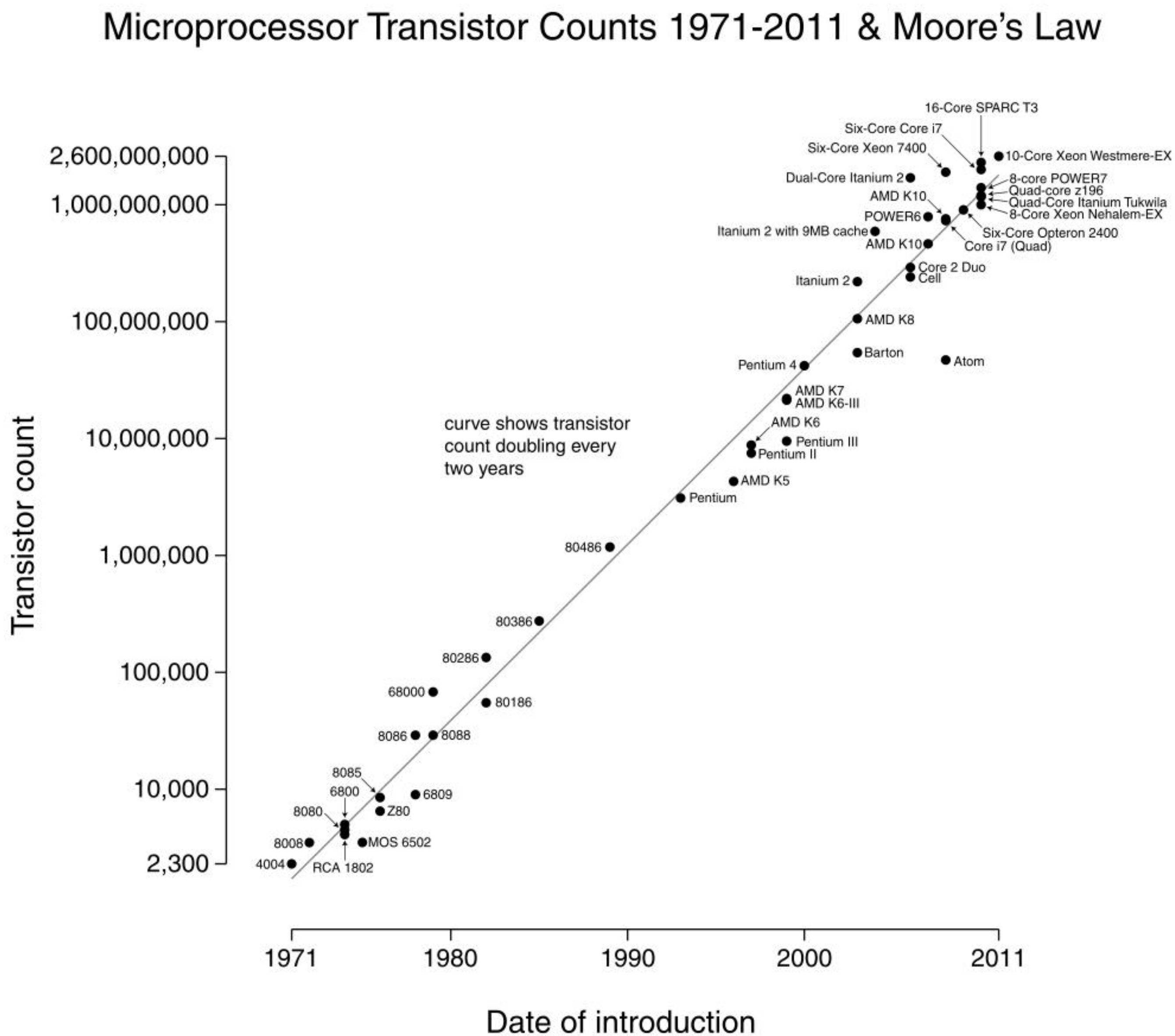
- Computers get real
  - 1939 - German Konrad Zuse and the first digital computer
  - 1943 - Alan Turing and Bletchly Park
  - 1939 - John Atanasoft and ABC
  - 1944 - Howard Aiken and Mark I
  - 1946 - Mauchly and Eckert design ENIAC
  - 1951 - Mauchly and Eckert launch UNIVAC
  - 1946 - John von Neumann

Generations

- First Generation - early 1950s:
  - Vacuum tubes
- Second Generation - 1956:
  - Transistors
- Third Generation - mid 1960s:
  - 100s of transistors into an **integrated circuit on a silicon chip**
- Fourth Generation - 1971:
  - main components of a computer on a silicon chip = the microprocessor

Integrated Circuit Benefits

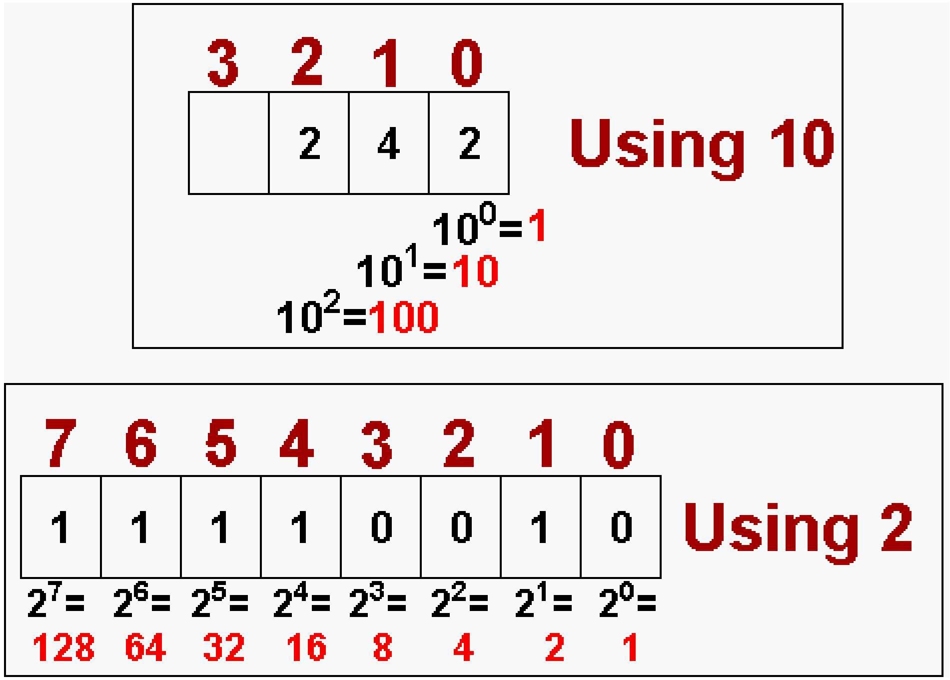
- Reliability
- Size
- Speed
- Efficiency
- Cost



- **Moore's Law:** In 1965 Gordon Moore predicted that the power of a silicon chip of the same price would double about every 2 years for the next 10 years.

Stay Cool -- Its Only Ones and Zeros

- 2 -- the magic number in computing



Clicker Question

With the chart below as a hint, what are the binary representations of the following base 10 numbers?

28

172

254

128	64	32	16	8	4	2	1

A). 00011000, 10101100, 11111100

B). 00011100, 10101100, 11111110

C). 00011100, 10101000, 11111110

D). 00111100, 10101000, 11111110

Bits as Codes

ASCII - American Standard Code for Information Interchange - most widely used code, represents each character as a unique 8-bit code.

Character	ASCII binary code
A	0 1 0 0 0 0 0 1
B	0 1 0 0 0 0 1 0
C	0 1 0 0 0 0 1 1
D	0 1 0 0 0 1 0 0
E	0 1 0 0 0 1 0 1
F	0 1 0 0 0 1 1 0
G	0 1 0 0 0 1 1 1
H	0 1 0 0 1 0 0 0
I	0 1 0 0 1 0 0 1
J	0 1 0 0 1 0 1 0
K	0 1 0 0 1 0 1 1
L	0 1 0 0 1 1 0 0
M	0 1 0 0 1 1 0 1
N	0 1 0 0 1 1 1 0
O	0 1 0 0 1 1 1 1
P	0 1 0 1 0 0 0 0
Q	0 1 0 1 0 0 0 1
R	0 1 0 1 0 0 1 0
S	0 1 0 1 0 0 1 1
T	0 1 0 1 0 1 0 0
U	0 1 0 1 0 1 0 1
V	0 1 0 1 0 1 1 0
W	0 1 0 1 0 1 1 1
X	0 1 0 1 1 0 0 0
Y	0 1 0 1 1 0 0 1
Z	0 1 0 1 1 0 1 0
0	0 0 1 1 0 0 0 0
1	0 0 1 1 0 0 0 1
2	0 0 1 1 0 0 1 0
3	0 0 1 1 0 0 1 1
4	0 0 1 1 0 1 0 0
5	0 0 1 1 0 1 0 1
6	0 0 1 1 0 1 1 0
7	0 0 1 1 0 1 1 1
8	0 0 1 1 1 0 0 0
9	0 0 1 1 1 0 0 1

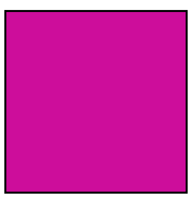
Using Base 16 (hexadecimal) notation

256	16	1

F, E, D, C, B, A, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0

Values that can go into the cells

Powers of 16



205 of Red

C	D
16	1

13 of Green

O	D
16	1

153 of Blue

9	9
16	1

Computers and Algorithms

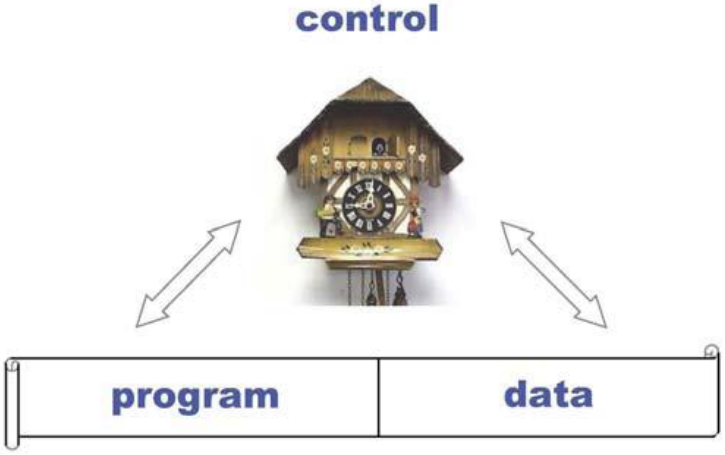
- A computer is a storyteller and algorithms are its tales.
- Let’s look at the storyteller …

The Storyteller

- Three key concepts
  - Universality
  - Duality
  - Self-reference

The storyteller (computer): Universality

- **Computer = control + program + data**
  - **Control** operates on [**program** | **data**]
  - e.g.[**100010** | **11101**]
  - What does representing information digitally allow us to do with the information?



The storyteller (computer): Duality

- **[print this | print this]**

Program (Signified)

Data (Signifiers)

Abbott and Costello's “Who's on First?” -- confusion between a baseball player's nickname (the signifier) and the pronoun “who” (the signified). http://youtu.be/sShMA85pv8M

The storyteller (computer): Self-referencing

- [print this twice | print this twice]

Program

Data

Self reproduction requires careful coordination between:
(i) A Program explaining how to copy the Data;
(ii) A Data string describing the same program.

The tales the storyteller tells – the **algorithms**

- The storyteller can read a series of 0's and 1's, but what is behind those symbols? It is an **algorithm** ….

Recipes and algorithms

LIME JELLO SALAD

Ingredients

1 box	Lime Jello mix
1 can	pears, drained
3 oz. pkg	cream cheese, softened
1 pint	whipped cream

Directions

1) Prepare jello according to package directions and cool until slightly thickened.
2) Mash pears with cream cheese and whipped cream.
3) Mix together with jello and pour into a mold.
4) Chill until firm.

~ *courtesy of the Jolly Jabber*

Challenges with recipes?

- Precision of terms (need a well defined language)
- Expressiveness of terms (need abstractions)
- An art or a science?

An informal definition

- It is a solution to a problem expressed as a well defined sequence of steps

- Requirements:
  - Finishes its work for any input and produces a result
  - And that it produces a correct result.

Refining our informal definition …

- Every algorithm has an ***input*** (or ***problem instance***) and an ***output***.

- If an algorithm A finishes its work on an input x in a finite time, then we say that the algorithm A ***halts*** on x.

Definition:

A is an algorithm solving a given problem/task if

- For any input, A halts
- For any input, A produces the correct result

Take away question

- Will Moore’s Law still be “accurate” in the future?