Topic 1: Introduction

What is a Computer?

What is Computer Science?

How do we Solve Problems with a Computer?

Textbook

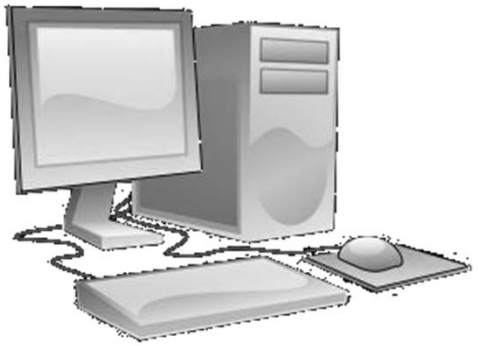
- Recommended Exercises
  - Starting Out with Python (2nd, 3rd, or 4th Edition)
    - Short Answer: 2 and 6
    - True or False: 1, 3, 4, 5, 6, and 8
    - Multiple Choice: 19

- Recommended Reading
  - Starting Out with Python (2nd, 3rd, or 4th Edition)
    - Sections 1.1, 1.2, 1.4

What is a Computer?

What is a Computer?

- Definitions vary:
  - Boring definition:
    - A boxy device with a typewriter-like interface that stores and processes information



What is a Computer?

– Criminal Code of Canada (s. 342.1):

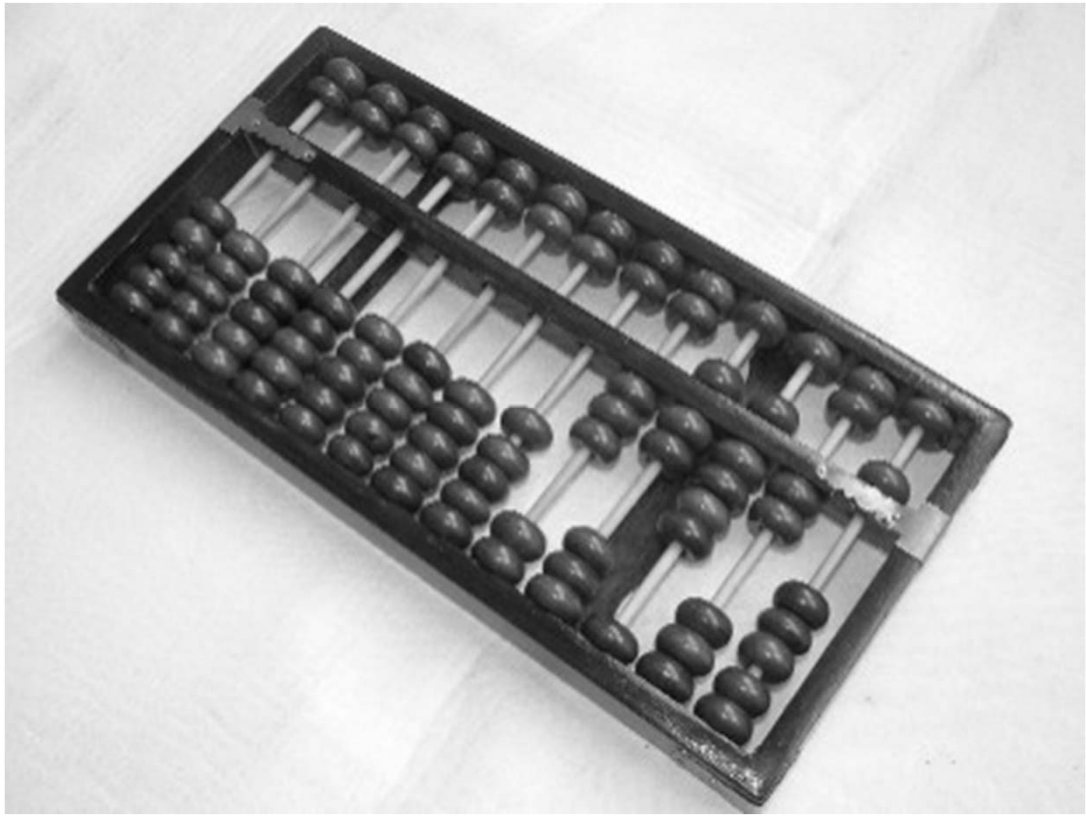
- “computer system” means a device that, or a group of interconnected or related devices one or more of which,
  a) contains computer programs or other data, and
  b) pursuant to computer programs,
     i. performs logic and control, and
     ii. may perform any other function;
- “computer program” means data representing instructions or statements that, when executed in a computer system, causes the computer system to perform a function;

What is a Computer?

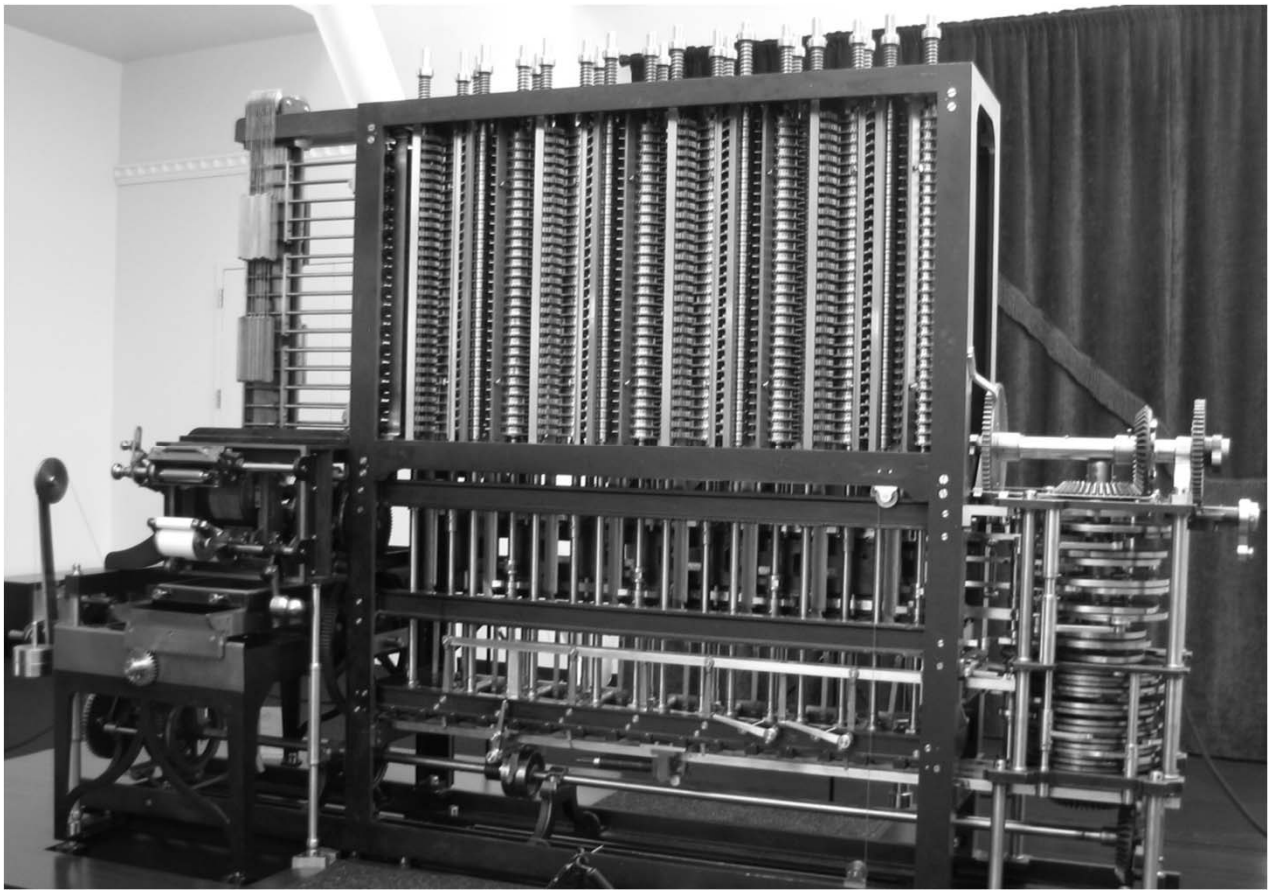
– Legal definition under the Uniform Computer Information Transactions Act (UCITA), USA:
  - An electronic device that accepts information in digital or similar form and manipulates it for a result based on a sequence of instructions

– Another possibility:
  1. One who computes
  2. A tool that receives, processes and presents data

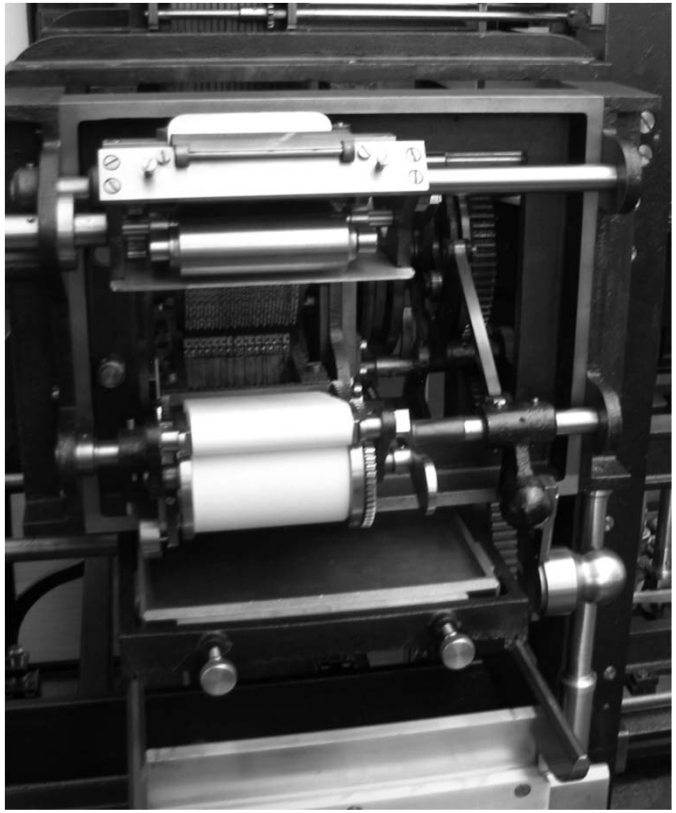
Computers - Abacus

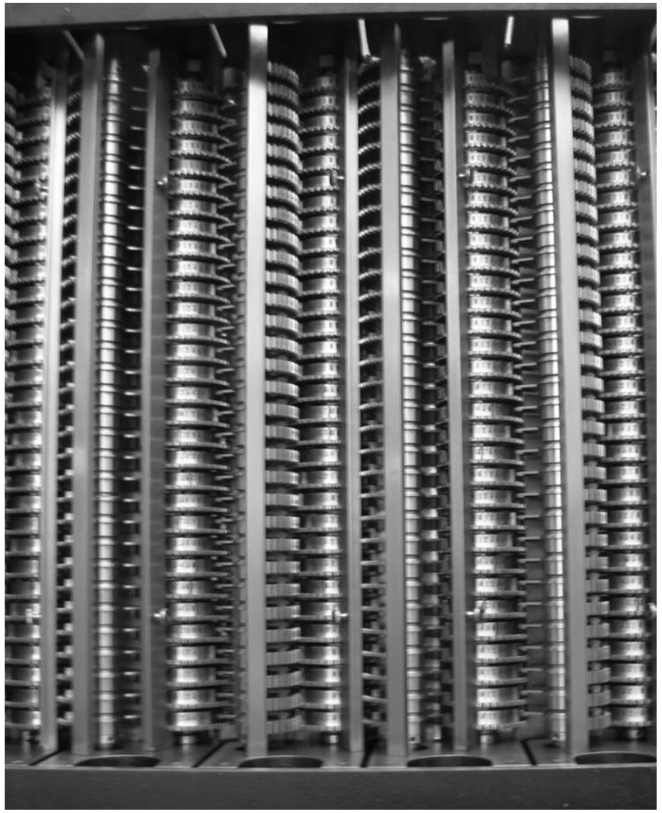


Computers – Difference Engine

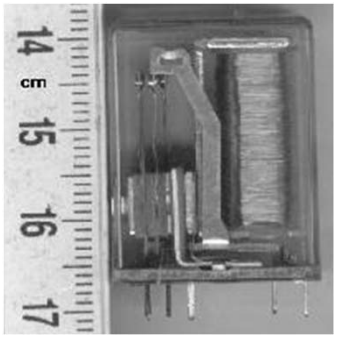


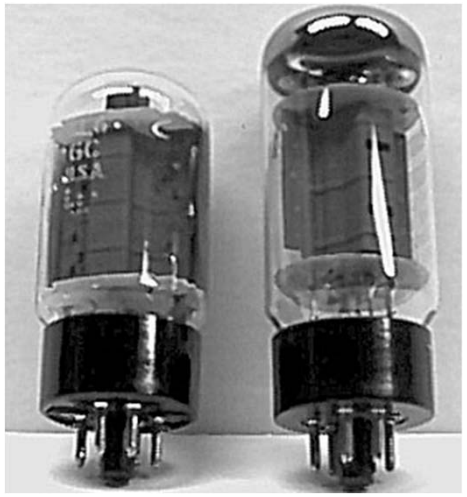
Computers – Difference Engine

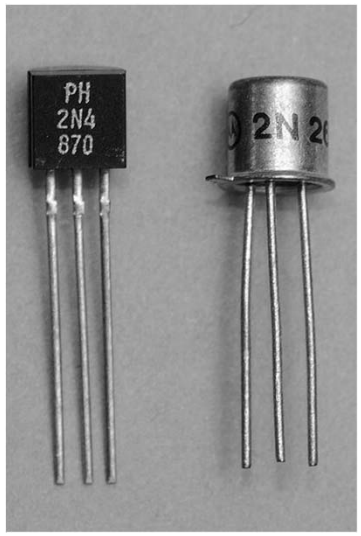




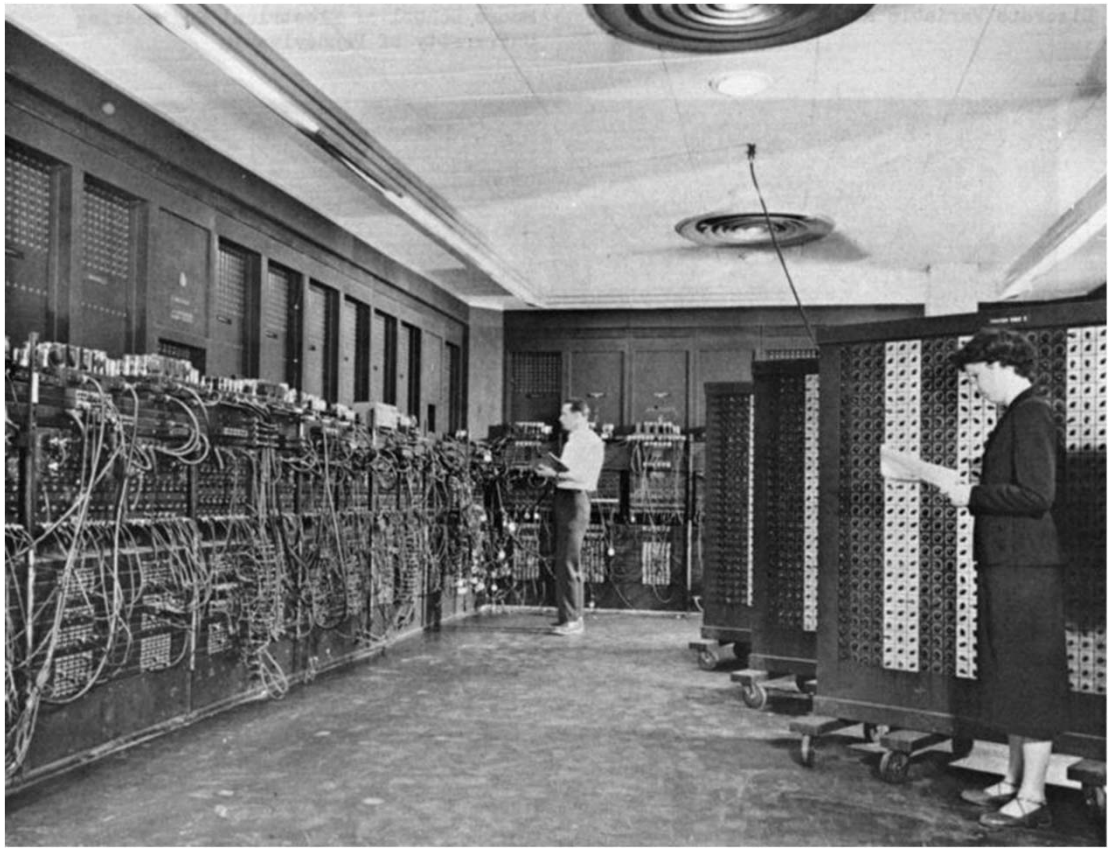
Electric Switches







Computers - ENIAC



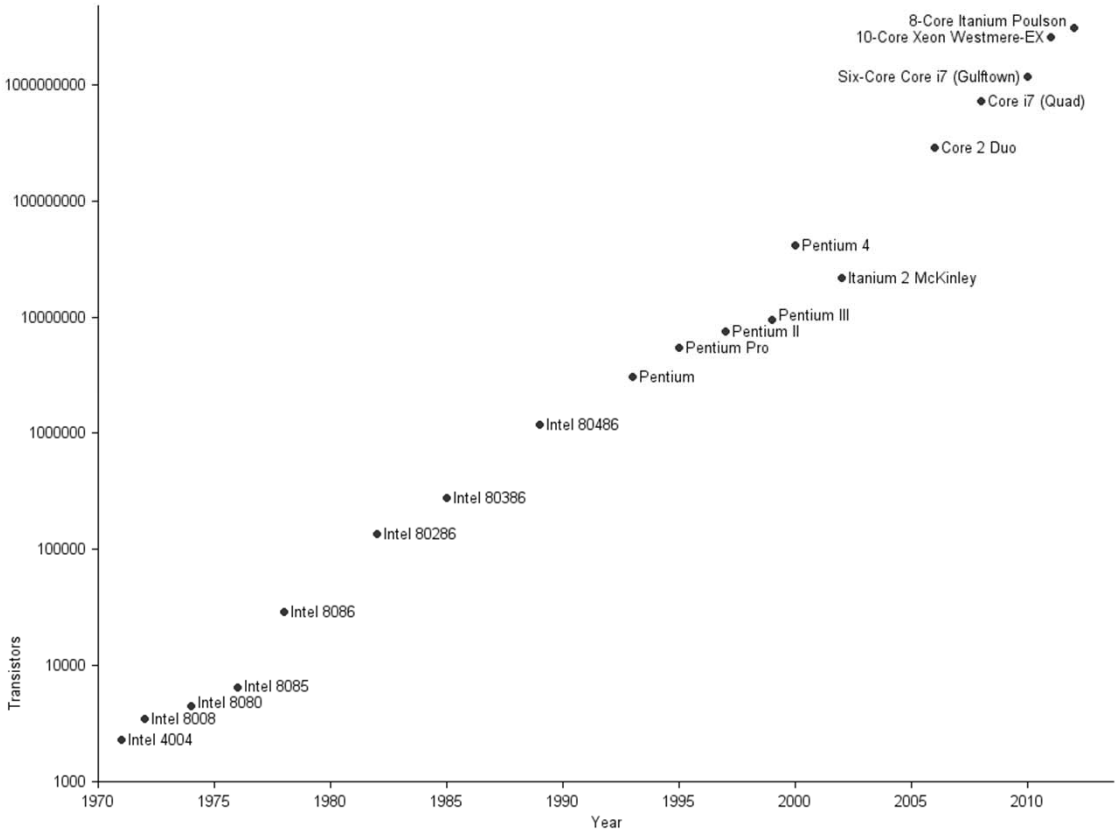
Computers - ENIAC

Computers

Moore's Law

- "The complexity for minimum component costs has increased at a rate of roughly a factor of two per year ... Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years."

Moore's Law


8-Core Itanium Poulson
10-Core Xeon Westmere-EX
Six-Core Core i7 (Gulftown)
Core i7 (Quad)
Core 2 Duo
Pentium 4
Itanium 2 McKinley
Pentium III
Pentium II
Pentium Pro
Pentium
Intel 80486
Intel 80386
Intel 80286
Intel 8086
Intel 8085
Intel 8080
Intel 8008
Intel 4004
Transistors
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Year

What is Computer Science?

- “Science” is:

Computer Science

- Definition:
  - The scientific study of computation and computer technology, hardware and software
  - The study of the theoretical foundations of information and computation, and their implementation and application in computer systems

Disciplines

- Human-Computer Interaction / Information Visualization
- Computer Graphics / Computer Vision
- Databases
- Information Security and Privacy
- Theory of Computation
- Networking and Distributed Systems
- Artificial Intelligence
- Software Engineering
- Game Development
- …

Human Computer Interaction

- How do we make a computer easy to use?
  - User Interface Design
  - How do we measure if an interface is “good”?
  - Includes aspects of biology and behavioral sciences




Computer Graphics

- Image generation
  - How do we do it faster?
  - How do we make it look more “real”?
  - How do we store image data compactly?

- Computer vision
  - How can we make a computer “see”?

Databases

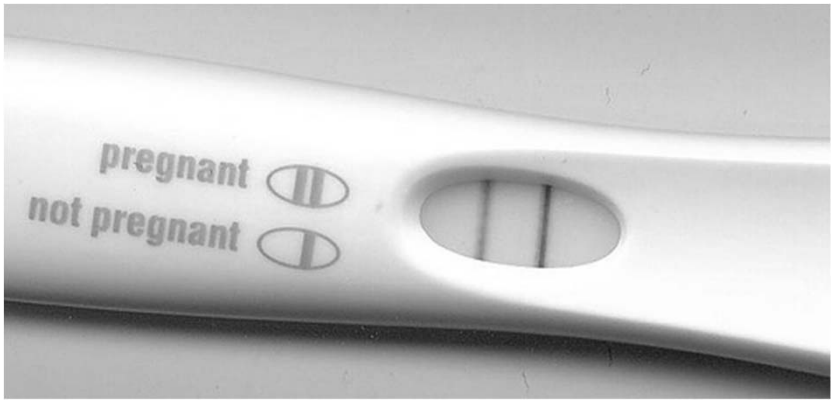
- How do we store large amounts of information?
  - How do we find it quickly once we have stored it?

Databases

Headlines from February 2012:

"How Target Figured Out A Teen Girl Was Pregnant Before Her Father Did"

"How Target knows when its shoppers are pregnant - and figured out a teen was before her father did"



"How Companies Learn Your Secrets"

"Should Target Tell Your Loved Ones You Are Pregnant, Or Should You?"

"How Target Knew a High School Girl Was Pregnant Before Her Parents Did"

"Target Figures Out Teen Girl Is Pregnant Before Her Father Does, Sends Helpful Coupons"

Information Security and Privacy

- Information Security
  - Ensure stored/transmitted information is confidential (prevent eavesdropping), authentic (comes from who it's supposed to), in its original form, etc…
- Privacy
  - Ensure only authorized entities can access data/information
  - Prevent accidental/malicious disclosure

Theory of Computation

- Two primary subfields
  - Complexity Theory
    - How efficiently can the problem be solved
      - Time
      - Memory Space
    - How is the efficiency impacted by the (size of) input that is supplied?
  - Computability Theory
    - Can the problem be solved with a computer?
    - Some things are not computable (eg. Halting Problem)!

Networks

- Deals with networks surrounding one computer to networks that span the planet
  - How do we transfer data quickly?
    - Do we need a consistent level of service?
  - How do we transfer data reliably? Wirelessly?
  - How do we get the data where it needs to go?
  - Should network providers be allowed to inspect, filter or manipulate data?

Distributed Systems

- How can we get multiple computers to work together to solve a problem?
  - Representing the problem in a way that allows it to be solved in parallel
  - Coordinating actions
    - Dealing with race conditions / deadlock
    - Avoiding duplicate work

Artificial Intelligence

- Studies and develops intelligent machines and pieces of software
- But what was intelligence?
  - Is a computer that can perform arithmetic intelligent?
  - Is a computer that can play chess intelligent?
  - Is a self-driving car intelligent?
  - Is Watson intelligent?

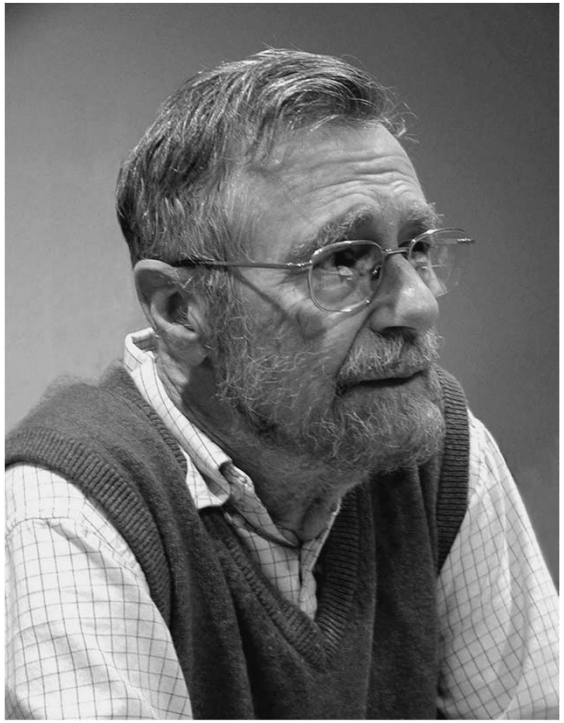
Software Engineering

- How do we develop large software projects?
  - How do we model the problem so that many people can work on it at once?
  - How do we ensure that the software does what it is supposed to?
  - How do we find and fix bugs in a large application?
  - What design decisions can we make to ease future expansion?

Game Development

- Brings many areas together
  - Graphics, HCI,
  - Networks, Distributed Systems,
  - Artificial Intelligence, Software Engineering,
  - …
  - Frequently pushes the limits of these areas
- What makes a game fun?
  - How do we define fun?
  - How do we measure fun?

Computer Science



"Computer science is no more about computers than astronomy is about telescopes."

– Edsger Dijkstra

How Do We Solve Problems with a Computer?

- First question: How do we learn?
  - What does it mean to understand something?

Bloom's Taxonomy

- Benjamin Bloom
  - An educator who studied how people think
- Identified six levels of competence
  - Knowledge
  - Comprehension
  - Application
  - Analysis
  - Synthesis
  - Evaluation

Solving Problems

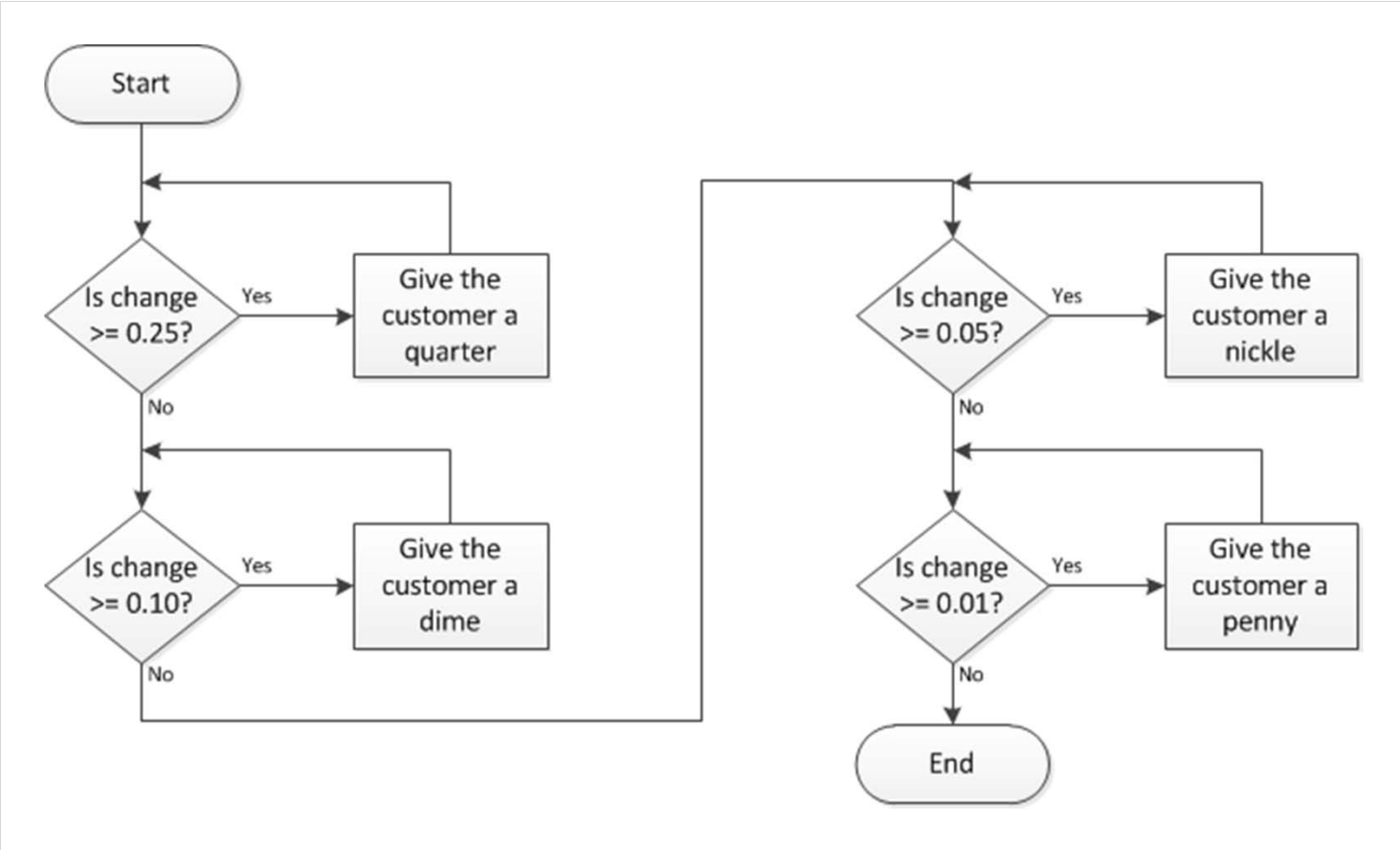
- How do we solve problems?

Top Down Design

- Start with the entire problem
- Break the problem into approximately 3 to 5 smaller steps
- Repeat the process for each step that is still too complex

What is an Algorithm?

What is an Algorithm?



What is Programming?

Where Are We Going?

- Computers are tools that we use to solve problems
  - Need to understand the problem that we want to solve
  - Need to understand how a computer works to model the problem on a computer
  - Need to learn how to program the computer to solve the problem

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