CONCLUSION

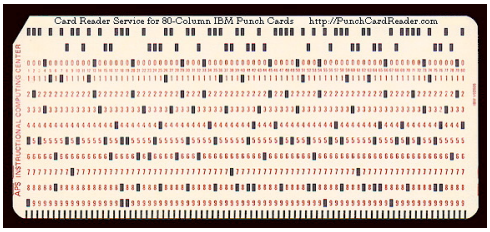
CS2110
Spring 2018

History

2

Programming and computers:

Momentous changes since the 1940s –or since even the use of punch cards and attempt at automation …



3

Punch cards

Jacquard loom

Loom still used in China

Mechanical loom invented by Joseph Marie Jacquard in 1801.

Used the holes punched in pasteboard punch cards to control the weaving of patterns in fabric.

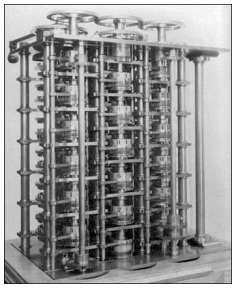
Punch card corresponds to one row of the design.

Based on earlier invention by French mechanic Falcon in 1728.

Charles Babbage designed a "difference engine" in 1822

4

Compute mathematical tables for log, sin, cos, other trigonometric functions.



No electricity

The mathematicians doing the calculations were called computers

Oxford English Dictionary, 1971

5

Computer: one who computes; a calculator, rekoner. spec. a person employed to make calculations in an observatory, in surveying. etc.

1664: Sir T. Browne. The calendars of these computers.

1704. T. Swift. A very skillful computer.

1744. Walpole. Told by some nice computers of national glory.

1855. Brewster Newton. To pay the expenses of a computer for reducing his observations.

The mathematicians doing the calculations were called computers

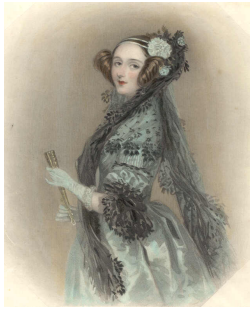
Charles Babbage planned to use cards to store programs in his Analytical engine. (First designs of real computers, middle 1800s until his death in 1871.)

6

First programmer was Ada Lovelace, daughter of poet Lord Byron.

Privately schooled in math. One tutor was Augustus De Morgan.

The Right Honourable Augusta Ada, Countess of Lovelace.



7

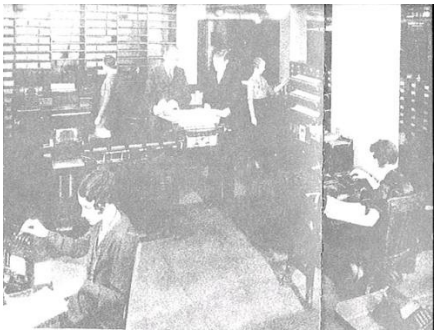
Herman Hollerith.
His tabulating machines used in compiling the 1890 Census.
Hollerith's patents were acquired by the Computing-Tabulating-Recording Co.
Later became **IBM**.

The operator places each card in the reader, pulls down a lever, and removes the card after each punched hole is counted.

Hollerith 1890 Census Tabulator

8

Computers, calculating the US census



9

History of computers

1935-38. Konrad Zuse - **Z1 Computer**

1935-39. John Atanasoff and Berry (grad student). Iowa State

1944. Howard Aiken & Grace Hopper **Harvard Mark I Computer**

1946. John Presper Eckert & John W. Mauchly **ENIAC 1 Computer** 20,000 vacuum tubes later ...

1947-48 The Transistor, at Bell-labs.

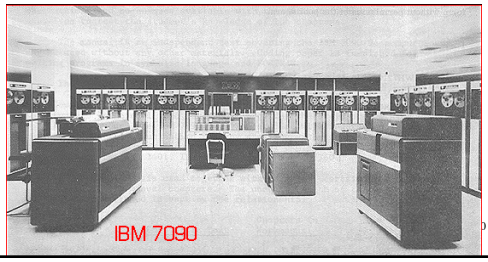
1953. IBM. the IBM 701.

10

How did Gries get into Computer Science?

1959. Took his only computer course. Senior, Queens College.

1960. Mathematician-programmer at the US Naval Weapons Lab in Dahlgren, Virginia.



11

1960. Mathematician-programmer at the US Naval Weapons Lab in Dahlgren, Virginia.

Programmed in Fortran and IBM 7090 assembly language

```
if (SEX == 'M') MALES= MALES + 1;
else FEMALES= FEMALES + 1;

        CLI   SEX,'M'      Male?
        BNO   IS_FEM       If not, branch around
        L     7,MALES      Load MALES into register 7;
        LA    7,1(,7)      add 1;
        ST    7,MALES      and store the result
        B     GO_ON        Finished with this portion
IS_FEM  L     7,FEMALES    If not male, load FEMALES into register 7;
        LA    7,1(,7)      add 1;
        ST    7,FEMALES    and store
GO_ON   EQU   *
```

11

12

1960: Big Year for Programming Languages

LISP (List Processor): McCarthy, MIT (moved to Stanford). First functional programming language. No assignment statement. Write everything as recursive functions. (take 3110)

COBOL (Common Business-Oriented Language). Became most widely used language for business, data processing.

ALGOL (Algorithmic Language). Developed by an international team over a 3-year period. McCarthy was on it, John Backus was on it (developed Fortran in mid 1950's). Gries's soon-to-be PhD supervisor, Fritz Bauer of Munich, led the team.

12

1959. Took his only computer course. Senior, Queens College.

1960. Mathematician-programmer at the US Naval Weapons Lab in Dahlgren, Virginia.

1962. Back to grad school, in Math, at University of Illinois

Graduate Assistantship: Help two Germans write the ALCOR-Illinois 7090 Compiler.

John Backus, FORTRAN, mid 1950's: 30 people years

This compiler: 6 ~people-years

Today, CS compiler writing course: 2 students, one semester

1963-66 Dr. rer. nat. in Math in Munich Institute of Technology

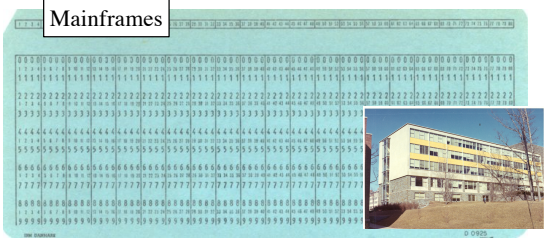
1966-69 Asst. Professor, Stanford CS

1969- Cornell!

Late 1960s

IBM 360 Mainframes

Write programs on IBM "punch cards. Deck of cards making up a program trucked to Langmuir labs by the airport 2-3 times a day; get them back, with output, 3-4 hours later



About 1973. BIG STEP FORWARD

1. Write program on punch cards.
2. Wait in line (20 min) to put cards in card reader in Upson basement
3. Output comes back in 5 minutes

About 1973. BIG STEP FORWARD

Switched to using the programming language Pascal, developed by Niklaus Wirth at Stanford.

About 1979. Teraks

Prof. Tim Teitelbaum sees opportunity. He and grad student Tom Reps develop "Cornell Program Synthesizer". Year later, Cornell uses Teraks in its prog course.

November 1981, Terak with 56K RAM, one floppy drive: $8,935.

Want 10MB hard drive? $8,000 more

1983-84

Switched to Macintosh in labs

Late 1980s

Put fifth floor addition on Upson. We made the case that our labs were in our office and therefore we need bigger offices.

1980s

CS began getting computers on their desks.

Nowadays

Everybody has a computer in their office.

2014

Moved into Gates Hall!

Programming languages. Dates approximate

Year	Major languages	Teach at Cornell
1956's	Fortran	
1960	Algol, LISP, COBOL	
1965	PL/I	PL/C (1969)
1970	C	
1972	Pascal	
1980's	Smalltalk (object-oriented)	Pascal (1980's)
1980's	(late) C++	
1996	Java	C and C++
2008	Java / Matlab	
2011	Python / Matlab / Java	

Java is not the Only OO Language

Java is not the Only OO Language

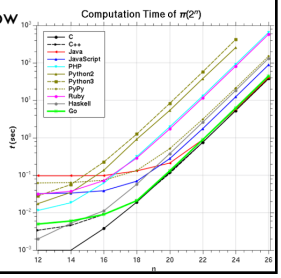
19

- Usability
- Performance
- Security

Performance

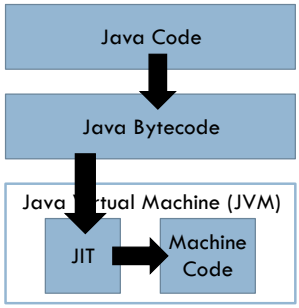
20

- Java has a reputation for being slow
- Early versions were slow
- Java programs start up slow



Compiling in Java

21



- Compiler converts source code (*.java) into platform-neutral bytecode (*.class)
- JVM runs bytecode using just-in-time compilation
- JIT performs dynamic code optimization

Garbage Collection

22

- What happens to objects after you are done with them?
- Why don't you run out of memory?
- JVM implements **garbage collection**. It detects and frees objects that are no longer needed

Reachable Objects

23

- An object is reachable if it is referenced anywhere in the call stack
  - local variables
  - method parameters
  - global variables
- An object is reachable if it is referenced by a reachable object
  - fields
  - array elements

Mark-and-Sweep

24

- Each object has an extra 1-bit field that is reserved for garbage collecting use
- Garbage Collector (GC) operates in two phases:
  - mark: GC does a tree traversal of reachable objects from the stack and sets the GC field
  - sweep: GC scans all memory from start to finish and frees all objects that do not have the GC field set

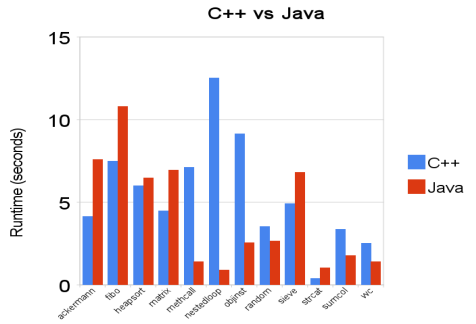
Optimized Garbage Collection

25

- Concurrent mark-and-sweep
- Generational management
- Garbage-First garbage collector

Performance

26



Shortcomings of Java

27

- Java has no separation between specification and implementation
- Writing correct concurrent programs in Java is hard and/or inefficient
- People continue to develop new languages (e.g., Rust) that address some of these shortcomings
  - steeper learning curve
  - longer compile times

tl;dr;

28

- Modern compiled, OO languages have similar performance
- Different companies use different languages for historical, philosophical, or legal reasons
- The concepts you learned in this class apply to any language
  - abstraction
  - isolation
  - inheritance
  - incremental development & testing

Object-Oriented Design

29

- Problem: how to design a large program
- Design considerations:
  - How easy to make changes? (Flexible)
  - How easy to reuse? (Reusable)
  - How easy to maintain? (Maintain)

Object-Oriented Design

30

1. What classes do you need?
2. What is the relationship between those classes?
3. What classes should do what?
4. How should objects interact?

Example: Dice Game

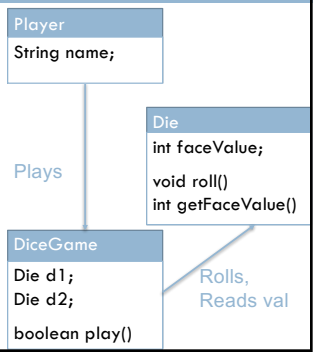
31

Application domain: Play a dice game. Players requests to roll the dice. System presents results: If the dice face values sum to seven, player wins; otherwise player loses.

Example: Dice Game

32

1. What classes do you need?
2. What is the relationship between those classes?
3. How should objects interact?
4. What classes should do what?



Design Patterns

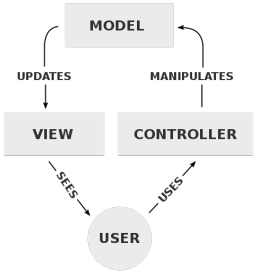
33

- Design patterns are general, re-usable solutions to commonly recurring problems
- OO design patterns typically show relationships and interactions between classes or objects
- Not a magic solution; blindly applying design patterns can overcomplicate your code

Example: MVC

34

- Model-View-Controller is a common pattern for developing applications with GUIs



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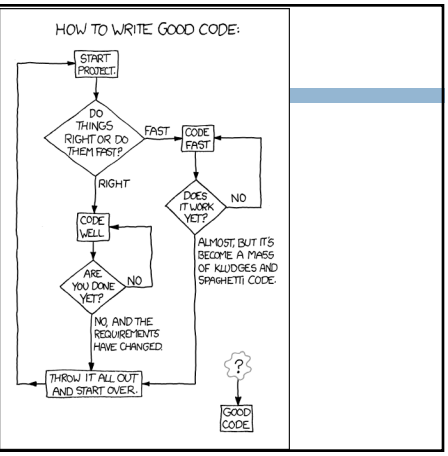
36

- Object-oriented programming, reasoning about complex problems
- Testing; Reasoning about correctness
- Algorithmic complexity, analyzing algorithms,
- Data structures: linked lists, trees, hash tables, graphs, etc.
- Programming paradigms: recursion, parallel execution


HOW TO WRITE GOOD CODE:
START PROJECT.
DO THINGS RIGHT OR DO THEM FAST?
FAST
CODE FAST
DOES IT WORK YET?
NO
ALMOST, BUT IT'S BECOME A MASS OF KLUDGES AND SPAGHETTI CODE.
RIGHT
CODE WELL.
ARE YOU DONE YET?
NO
NO, AND THE REQUIREMENTS HAVE CHANGED.
THROW IT ALL OUT AND START OVER.
?
GOOD CODE.