CISC 101

Welcome!

Elements of Computing Science I

http://sites.cs.queensu.ca/courses/cisc101

- Most of the lecture notes and other material will be (and is) posted

Slides courtesy of Dr. Alan McLeod

CISC 101 Introduction

- Me: Sarah-Jane Whittaker
  - PhD Candidate, Queen's School of Computing
  - sarah@cs.queensu.ca
  - 550 Goodwin Hall
- TAs (thus far)
  - Muhammad Aboelfotoh
  - Mallory Ketcheson

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Queen's School of Computing

SCHOOL OF COMPUTING

- www.cs.queensu.ca
  - Linked on main page of course web site
- Lots of information
  - Undergrad and graduate programs and courses
  - What's happening in the School
  - … and more!

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Labs and Tutorials

- No scheduled labs or tutorials this week
  - They begin next week
- Tutorials
  - The period before your lab
  - In Jeffrey Hall – see the course web site
  - Gives you a chance to talk to your TA or for the TA to present material to you before the lab
  - You will write tests in your tutorial

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Labs and Tutorials – Cont.

- Labs
  - Two hours in JEF155 or JEF157
  - Work, work, work! TAs are there to help
- You can attend more than one section
  - Good way to get extra help
  - If there are too many attendees, priority will be given to students in that section

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Lectures

- Lectures will not go for three hours straight
  - There will be a break at the mid-point
  - May end early if I have covered all the material
- I will be programming examples in lectures
  - Feel free to bring your laptops and code as well
- Lecture slides will be posted on the website

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Grading

- Marking scheme
  - 24% - three tests
    - Weeks 4, 7 and 10
  - 15% - three assignments
    - Due on Sundays before midnight in weeks 3, 6 and 9
  - 61% - <u>one</u> final exam
- Tests are written in your tutorial
  - 40 minutes in length, on paper, no aids
- Assignments are submitted in Moodle
  - One assignment submission per person!

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Grading - Cont.

- Note that for the final exam:

If you obtain less than 50% on the final exam then that will be your final grade. In this case, your test and assignment marks will not count.

- *This is not meant to stress you out!*
- The best strategy is to learn the material as we go
  - Best accomplished by attending tutorials and labs

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Assignment Rules

- Each assignment will have its own marking scheme
  - Marks and comments will be entered into Moodle by your TA
- See the *Assignment → Submission* page for instructions on uploading to Moodle
- No late submissions!
  - If you do not submit by the deadline, you will receive a grade of zero
  - Don't leave your assignment to the night before!!!

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Assignment Rules - Cont.

- "Group Efforts"
  - I encourage you to discuss your difficulties with your peers, myself and your TAs
  - You may look at other people's code
  - **You cannot copy other people's code!**
  - Submissions will be electronically and physically checked for code duplication
  - If you are caught with duplicated code then it is considered a violation of academic integrity
    - More on that later …
  - You will not learn anything if you copy someone else's code!

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Moodle

- News and updates
- Assignment and test marks
- Question: would you like forums?
  - One for each assignment?
  - *Study group* forum already available
- Don't change your time zone
  - Always use the default: "Server's local time"
  - Assignment deadlines use this time

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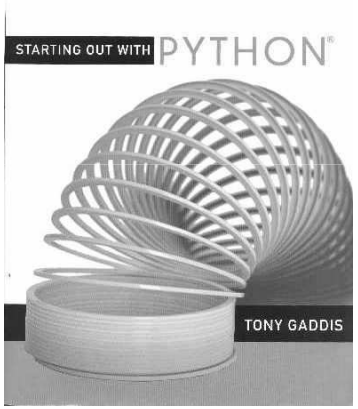
Resources

- Recommended textbook:



- Used last two years
- Refers to an older version of Python
- See *Resources → Textbook* on the course website

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Resources - Cont.

- Older CISC 101 textbooks will not refer to the Python language
- Many other learning resources are available
  - See the *Resources* page on the course website
- "*Should I buy the textbook?*" (You ask!)

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Some Policies

- Email
  - Complex questions can not be answered well via email
    - *e.g.*, code debugging
  - Both I and the TAs may ask that you see us in person
- Code of Conduct
  - Students are required to abide by the Queen's Code of Conduct and all established policies
    - *e.g.,* Computer User Code of Ethics
  - Behaviour that violates the code will not be tolerated
    - *e.g.,* harassment or discrimination
  - Sanctions will be pursued

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Some Policies – Cont.

- Academic Integrity
  - "a commitment to the fundamental values of honesty, trust, fairness, respect and responsibility"
  - Offenses include plagiarism
  - Penalties are ...
    - First offense: a grade of zero on the assignment or test
    - Second offense: a grade of zero for the course
  - Please review the University's official policy
    - Link on the course website (*Policies → Academic Integrity*)

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Some Policies – Cont.

- Academic Accommodations
  - Not a problem, but please contact both the instructor and Disability Services as soon as possible
    - May need advanced notice to accommodate you
- Late Submissions
  - Late submissions are not permitted
  - A missed assignment or test will be marked as zero
  - Extensions will be provided where warranted
    - *e.g.,* illness, personal crisis
  - Contact the instructor as soon as you can
    - Failure to do so will still result in a grade of zero

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A Few More Things …

1. I am unlikely to be reached by calling my office
2. When e-mailing try to avoid using your `hotmail` or `gmail` or non-`queensu` address
3. Check to make sure you can access the CISC 101 Moodle space … in a few days
   - E-mail me if you can't
4. Update your Moodle profile (if necessary)
5. Please communicate with me!
   - I can't fix problems with the course if you don't tell me about them

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Is This a Python Course?

- So, what is this course about, anyways?
- From the calendar description:

> *CISC101 is an "Introduction to algorithms: their definition, design, coding, and execution on computers. Intended for students who have no programming experience. All or most assignment work will be completed during lab time."*

Doesn't say anything about

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CISC 101 or CISC 121?

- Do you already have some programming experience?
  - You may wish to take CISC 121 instead
- See the *About → 101 or 121* page on the website
- Contact me or the CISC 121 instructor
  - Margaret Lamb
  - `malamb@cs.queensu.ca`

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Purpose of the Course

- The best way to learn about programming is to do it – *of course*!
- Programming is a creative process…

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Purpose of the Course - Cont.

- I will teach you about …
  - The basic structure and operation of the hardware we are using to express ourselves
  - Some time-tested techniques used with the language to efficiently express algorithms
  - Some common algorithms
  - Good programming style and best practices
- But, can I teach you how to program?
  - I certainly could not teach you how to paint!!!

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Purpose of the Course - Cont.

- You will …
  - Figure out how to write a program that does what you want
  - Have a chance to see if you like programming
  - Be exposed to other aspects of Computer Science
  - Have fun!!!

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Playtime!

- Play with Pygame

- Do some GUI stuff with Tkinter and maybe PyQT
- Use other modules for math and physics, or sound and images
- And more …

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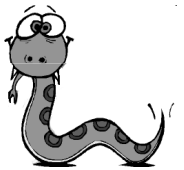
Why Python?

- Why not?
- Python is a solid language like many others
  - C++, C#, VB, Java, Delphi, *etc.*
- It is:
  - Easy to learn
  - Powerful
  - Object-oriented
  - Available for many platforms
  - Structured the same as other modern languages
  - Not named after a snake!!!



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Python

- Development tools for novice Python programmers can be downloaded from `www.python.org`
- See the course website's *Resources → Python Software* page for more information

Slides courtesy of Dr. Alan McLeod

What You Need to Do

- Decide to get the textbook or not
- Look over course web site
  - There is a great deal of information to review!
  - Install Python on your own computer?
- Let me know if you need to change your lab section from what is listed in your timetable
- Contact me if you have any problems or questions!

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Getting Started

- Take some of the "MAGIC" out computers
  - An overview of computer architecture
  - How did the technology get to where it is today?
    - von Neumann Architecture
    - ENIAC
    - The transistor
    - Integrated circuits

`http://www.howstuffworks.com/microprocessor.htm`

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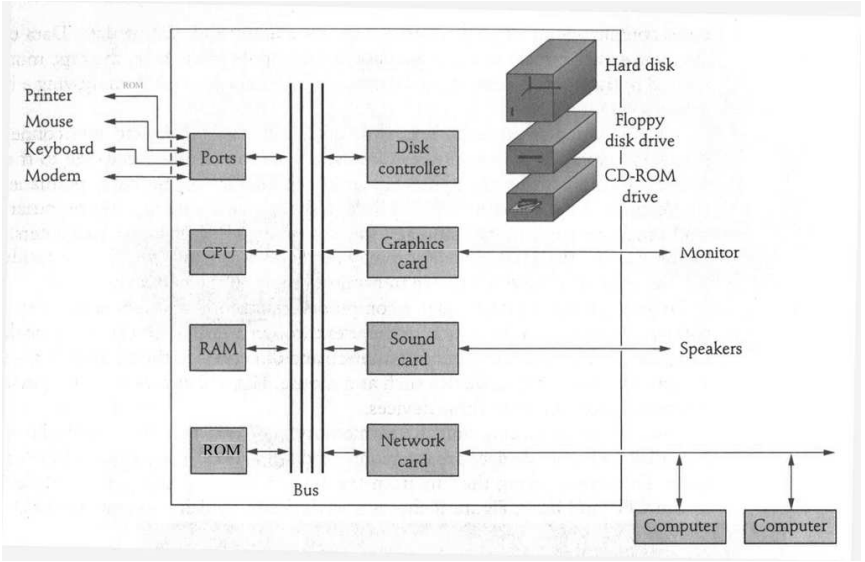
Computer Architecture (PC)



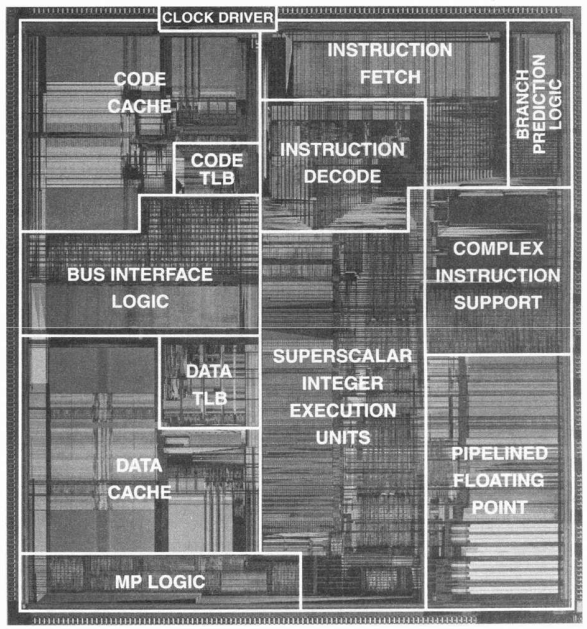
Slides courtesy of Dr. Alan McLeod

CPU

- Central Processing Unit
  - The heart of the computer
  - Consists of millions of transistors on a single chip

  - Next slide shows the physical layout of a Pentium chip

Slides courtesy of Dr. Alan McLeod



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CPU - Cont.

- The latest is Twelve Core
  - Twelve processors on one chip!
- Characterized by their clock speed
  - Controls the number of operations per second that they can carry out
- The first PC contained an 8080 chip
  - Introduced in 1979
  - Had a clock speed of 2 MHz
    - That's 2,000,000 cycles per second
- Now Pentium IV's operate at at least 2 GHz!

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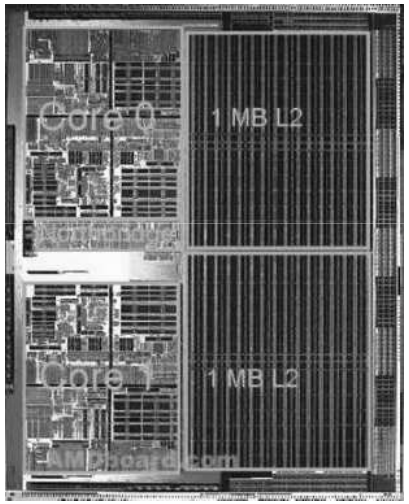
Dual Core Processor



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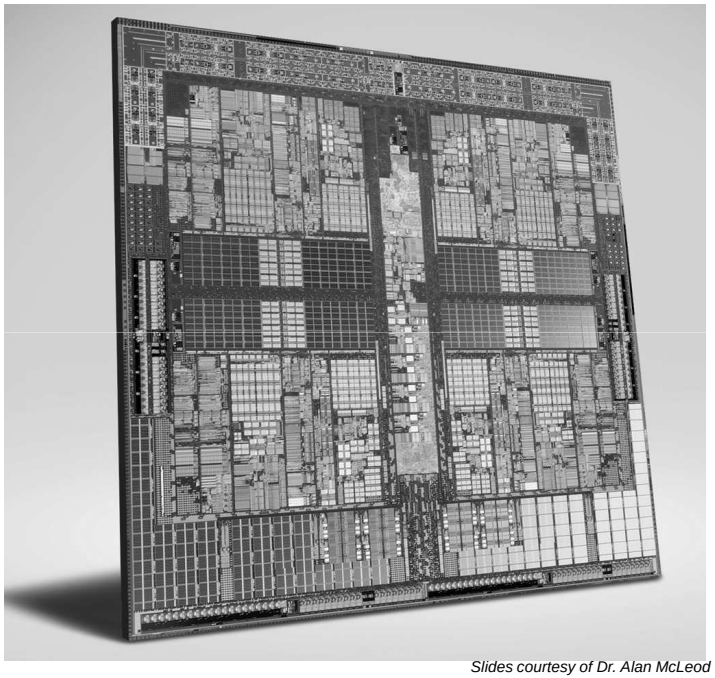
Quad Core



Winter 2011

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CPU - Cont.

- Responsible for …
  - Locating and carrying out program instructions from RAM
  - Carrying out arithmetic operations on data stored temporarily in a few “registers”
  - Moving data between RAM and other storage devices
    - … except for those devices that can use Direct Memory Access (DMA)

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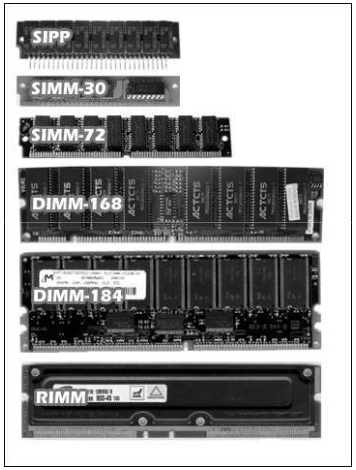
RAM and ROM

- Random Access Memory
  - Volatile memory
    - When the power goes off, the data disappears
  - RAM holds data and program instructions



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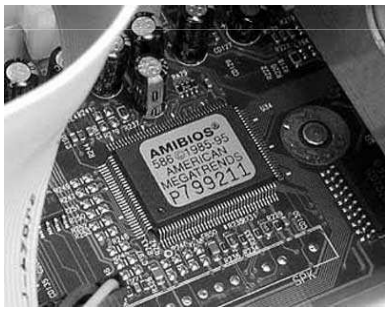
RAM and ROM

- Read Only Memory
  - Not volatile
  - Contains code and BIOS data used to start (“boot”) the computer



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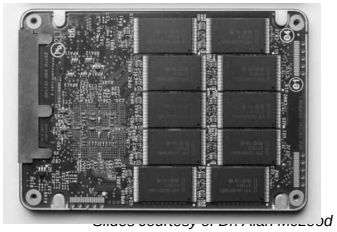
Other Components

- Disk storage
  - Data stored on magnetic or optical media
  - Not volatile! (Hopefully!)
  - Disk read/write operations are much slower than operations carried out in RAM by the CPU
  - Program code is first loaded from the disk to RAM and then executed
  - Modern (but still rather pricey!) solid state drives just have banks of non-volatile RAM



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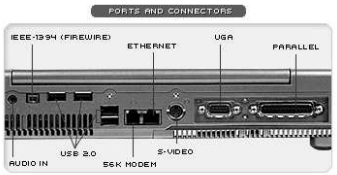
Other Components

- Data ports
  - Serial (RS232), Parallel, USB, PS2, *etc.*
  - Provide input/output for the user
    - Via the keyboard, mouse, monitor, sound card, microphone, printer, scanner, joystick, webcam, *etc.* (you get the idea!)
- Modems, network cards and/or wireless adapters
  - Provide a means of connecting to other computers



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Booting Your Computer

- Initial BIOS is loaded from ROM into RAM
  - Basic Input-Output System (BIOS)
  - Computer detects any attached hard/optical/flash drives
- Computer then looks at the MBR on the hard drive
  - Master Boot Record (MBR)
  - Small portion at the beginning of the disk
  - Describes the layout of the drive
  - Loads a boot loader
    - Knows how to tell the operating system (OS) to load

Content courtesy of Benjamin Hall

Slides courtesy of Dr. Alan McLeod

Booting Your Computer – Cont.

- Computer then loads the OS
  - Loads drivers necessary to control the hardware
- Last task is to load the Graphical User Interface
  - Provides you with your operating environment
- You can now log in and write your programs!

Content courtesy of Benjamin Hall

Slides courtesy of Dr. Alan McLeod

Processes and Process Switching

- When a program executes, the operating system does so in a *process*
  - Each program has its own process
  - Many complex programs launch additional processes
- A CPU can only manage one process at a time!
- The OS must *switch* between processes
  - Allow users to run several programs simultaneously
  - Done with the *scheduler*
    - Takes care of what process gets to use the CPU at given time
    - May also need to manage several CPUs

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Processes and Process Switching – Cont.

Less than a quarter of the processes running on a relatively idle Mac laptop:

```
UID PID PPID C STIME TTY TIME CMD
0 1 0 0 0:01.92 ?? 0:01.99 /sbin/launchd
0 10 1 0 0:02.70 ?? 0:18.84 /usr/libexec/kextd
0 11 1 0 0:00.67 ?? 0:01.50 /usr/sbin/DirectoryService
0 12 1 0 0:00.16 ?? 0:00.23 /usr/sbin/notifyd
0 13 1 0 0:00.09 ?? 0:00.19 /usr/sbin/syslogd
0 14 1 0 0:00.06 ?? 0:00.10 /usr/sbin/diskarbitrationd
0 15 1 0 0:01.06 ?? 0:01.80 /usr/libexec/configd
0 16 1 0 0:00.28 ?? 0:00.40 /usr/sbin/blued
1 17 1 0 0:00.10 ?? 0:00.25 /usr/sbin/distnoted
65 19 1 0 0:00.18 ?? 0:00.27 /usr/sbin/mDNSResponder -launchd
0 22 1 0 0:00.16 ?? 0:00.28 /usr/sbin/securityd -i
0 25 1 0 0:00.16 ?? 0:00.20 /usr/sbin/ntpd -c /private/etc/ntp-restrict.conf -
   n -g -p /var/run/ntpd.pid -f /var/db/ntp.drift
0 26 1 0 0:00.21 ?? 0:00.58 /usr/sbin/httpd -D FOREGROUND
0 27 1 0 0:00.05 ?? 0:00.07 /usr/sbin/krb5kdc -
```


Content courtesy of Benjamin Hall *Slides courtesy of Dr. Alan McLeod*

Binary Numeric System

- Computers store and use data with the *binary numeric system*
  - A single *bit* is a 0 or a 1
    - Magnetic orientation (*e.g.*, hard-disk drives)
    - Presence or absence of electrical charge (*e.g.*, RAM)
    - And more …
  - A *binary number* is composed of multiple bits

1 0 1 1 0 0 0 1 1 0 1 0

Slides courtesy of Dr. Alan McLeod

Binary Numeric System – Cont.

- Binary numbers can be easily converted to decimal values
  - Assign an index *i* to each bit from right to left
    - Start with 0 and increase each index by 1
  - Sum all values 2^i where the bit at index *i* contains a 1

$2^{11} + 2^9 + 2^8 + 2^4 + 2^3 + 2^1 = 2842$

11	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
1	0	1	1	0	0	0	1	1	0	1	0

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Numerical Bases

- Decimal numbers have a *base* of 10
  - *e.g.*, $942 = (9 \times 10^2) + (4 \times 10^1) + (2 \times 10^0)$
- Binary numbers have a base of 2
  - *e.g.*, $1100 = (1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (0 \times 2^0)$
- Octal numbers have a base of 8
  - *e.g.*, $721 = (7 \times 8^2) + (2 \times 8^1) + (1 \times 8^0)$
- Hexadecimal values have a base of 16
  - Digits 0-9 and letters A-F for values 10-15
  - *e.g.*, A0C = $(10 \times 16^2) + (0 \times 16^1) + (12 \times 16^0)$

Boolean Values and Logical Operators

- The *Boolean domain* is {0, 1}
  - A *Boolean value* is either 0 or 1
    - 0 is often interpreted as false
    - 1 is often interpreted as true
- *Boolean logical operators*
  - Use Boolean values for input and output
  - Will compare or examine values and return a result
- Three primary operators
  - `AND`
  - `OR`
  - `NOT`

Boolean Values and Logical Operators

- Consider Boolean variables *a* and *b*
  - *a* and *b* can contain any Boolean value
  - There are four possible combinations of values for *a* and *b*
  - These combinations are shown to the right in a *truth table*

a	*b*
0	0
0	1
1	0
1	1

- AND ($a \wedge b$)
  - True only if both *a* and *b* are true
  - False otherwise

a	*b*	($a \wedge b$)
0	0	0
0	1	0
1	0	0
1	1	1

Boolean Values and Logical Operators

- OR ($a \vee b$)
  - True if at least one of *a* or *b* is true
  - False, otherwise

a	*b*	($a \vee b$)
0	0	0
0	1	1
1	0	1
1	1	1

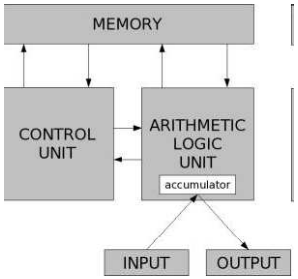
- NOT (! *a*)
  - True if *a* is false
  - False if *a* is true

a	(! *a*)
0	1
1	0

- Why is Boolean logic important?
  - You will be using these operators to test conditions in your algorithms!

von Neumann Architecture

- Created in 1944/5
- The structure we have been referring to thus far
  - Separate units for input and output
  - Data is stored in a separate memory location
  - The ALU carries out instructions on data items moved into the ALU
  - The Control Unit acts as a stage manager



Slides courtesy of Dr. Alan McLeod

von Neumann Cycle

- **Fetch**
  - The address of the next instruction is read from the instruction counter. The next instruction is read from this memory address to instruction register.
- **Decode**
  - The instruction is translated to a format that is usable for the execution unit by the decoder.
- **Fetch operands**
  - Depending to the actual instruction operands from a memory location have to be fetched to be accessible for the execution unit.
- **Execute**
  - The arithmetical logical unit performs the operations and writes the results to registers or memory according to the instruction.
- **Update instruction counter**
  - The instruction counter is incremented for the next cycle. Now the first step can start again.

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von Neumann Architecture - Cont.

- Named after John von Neumann
  - Idea most likely developed by J. Presper Eckert and John Mauchly
  - All working on the ENIAC computer at the Moore School at the University of Pennsylvania at the same time

von Neumann

Mauchly (L) and Eckert (R)

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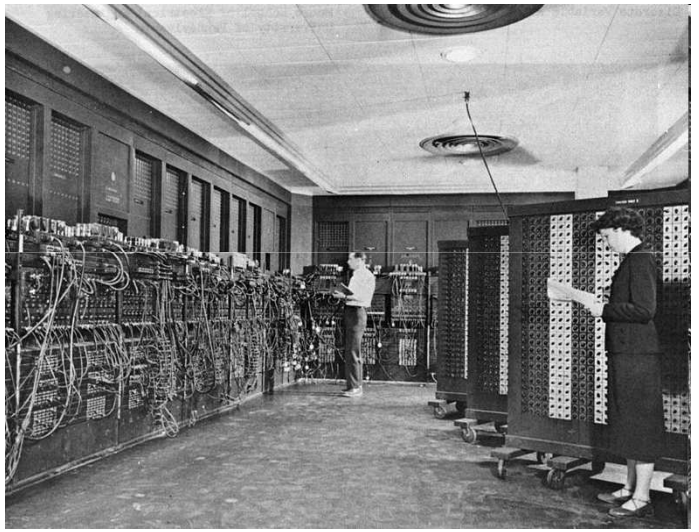
ENIAC



Slides courtesy of Dr. Alan McLeod

ENIAC - Cont.

http://news.cnet.com/1606-2_3-29770.html

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ENIAC - Cont.

From Wikipedia

- "Electronic Numerical Integrator And Computer"
- First electronic computer, built in the late 1940's to calculate artillery firing tables
- ENIAC contained 17,468 vacuum tubes, 7,200 crystal diodes, 1,500 relays, 70,000 resistors, 10,000 capacitors and around 5 million hand-soldered joints
- It weighed 30 tons, took up 680 square feet (63 m^2), and consumed 150 kW of power

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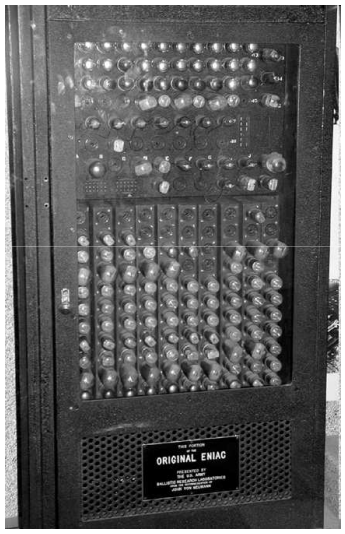
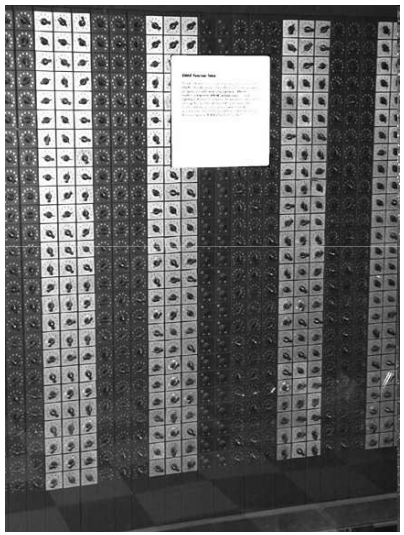
ENIAC - Cont.





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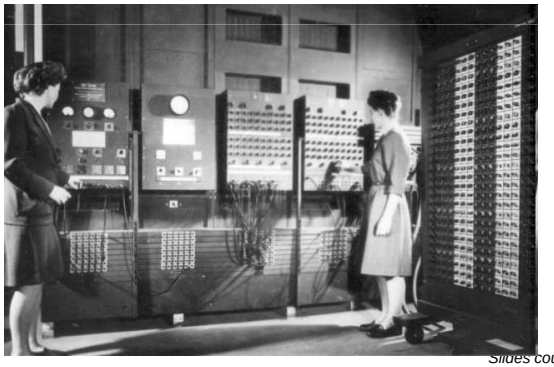
ENIAC - Cont.

- Six women (inducted into the Women in Technology International Hall of Fame) took several weeks to manually enter a single program into the machine

Kay McNulty, Betty Jennings, Betty Snyder, Marlyn Wescoff, Fran Bilas and Ruth Lichterman



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Operating the “Differential Analyzer” (an analog mechanical calculator) in the basement of the Moore School (1942-45)

Slides courtesy of Dr. Alan McLeod

ENIAC - Cont.

- In 1942, their annual salary was $1,620
- The job title of all of the women was “computer”!

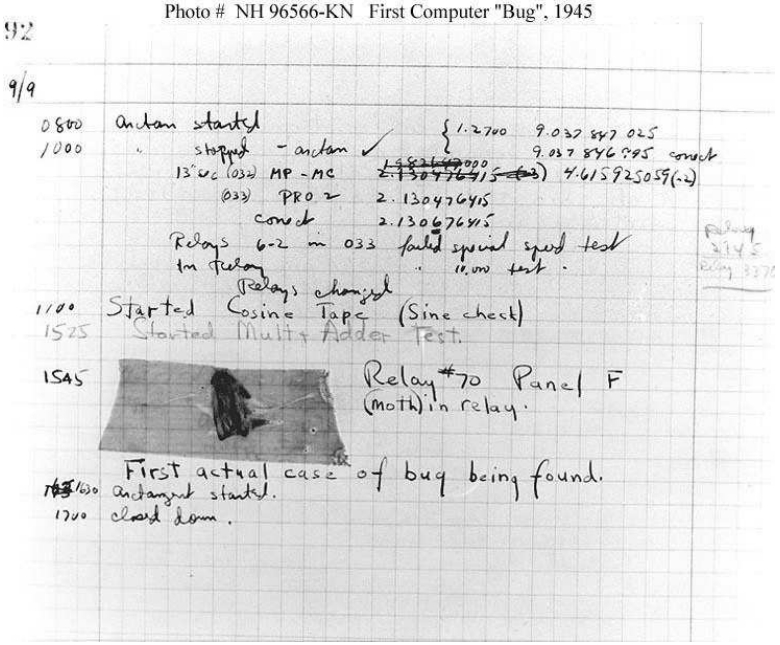
Slides courtesy of Dr. Alan McLeod

Aside – The First Computer Bug

- In 1947 Grace Murray Hopper was a technologist on a Mark II Aiken Relay Calculator at Harvard University
- She logged the following:

Slides courtesy of Dr. Alan McLeod

Photo # NH 96566-KN First Computer "Bug", 1945



Slides courtesy of Dr. Alan McLeod

The First Computer Bug - Cont.

- The word went out that she had "debugged" the machine
- Grace Murray Hopper became known as the "Mother of Cobol" and is one of the most important people in the history of computers

http://www.jamesshuggins.com/h/tek1/grace_hopper.htm

Slides courtesy of Dr. Alan McLeod

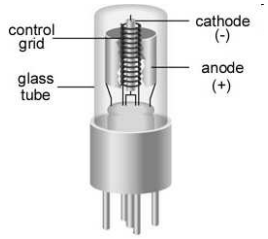
After the ENIAC

- Only this one ENIAC was ever built
- It was followed by the EDVAC in 1950
- The first commercial computer was the UNIVAC I
  - Delivered to the Bureau of the Census in the U.S. in 1951

Walter Cronkite at right…

Slides courtesy of Dr. Alan McLeod

Before Transistors…

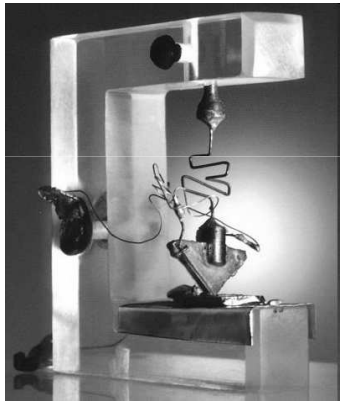


Vacuum tubes – large, lots of heat, lots of energy required …

Slides courtesy of Dr. Alan McLeod

Transistors

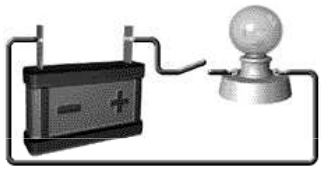
- First demonstrated in 1947, at Bell Labs by William Shockley



Slides courtesy of Dr. Alan McLeod

Transistors - Cont.

- Transistors work just like the following circuit:

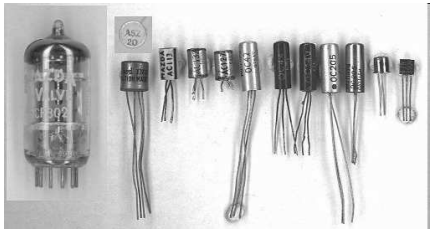


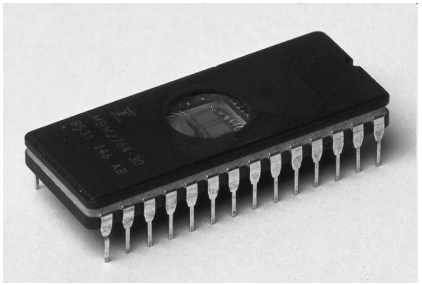
- Each wire in a computer has a signal that is either on or off for the duration of a single clock tick
  - A clock tick is a very short time!
  - Results in a 1 or 0 in binary

Slides courtesy of Dr. Alan McLeod

Transistors - Cont.

- Individual



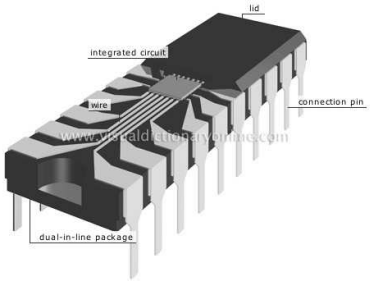


- Integrated Circuits
  - Started in1958

Slides courtesy of Dr. Alan McLeod

Integrated Circuits

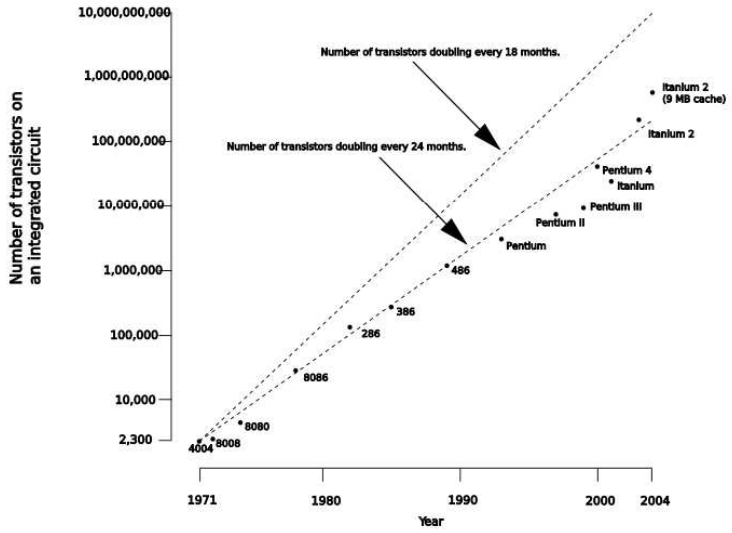
- An IC combines thousands, if not millions of transistors onto a single chip
  - Chips are flat crystals made of silicon
    - Silicon is a semiconductor material



Slides courtesy of Dr. Alan McLeod

Moore's "Law"

"The number of transistors in a processor will double every 24 months."



Slides courtesy of Dr. Alan McLeod

Moore's "Law" - Cont.

- First documented by Intel co-founder Gordon E. Moore in 1965
- But has the quality of software improved exponentially over the same time period?

Slides courtesy of Dr. Alan McLeod

Integrated Circuit Fabrication

See Intel Videos at:

`http://intelpr.feedroom.com/?fr_story=33c969acc3f25d0f702e56eb10b55c5692bd0f81&rf=bm`

`http://intelpr.feedroom.com/?fr_story=FEEDROOM195302&rf=bm`

Slides courtesy of Dr. Alan McLeod