

Informatics

01

Defining Information Technology

Claudio Sartori
Department of Computer Science and Engineering
claudio.sartori@unibo.it
<https://www.unibo.it/sitoweb/claudio.sartori/>

**Computer science is no more
about computers than astronomy
is about telescopes**

Learning Objectives

- The “big idea” of computing inventions
- Explain why it’s important to know the right word
- Define basic hardware and software terms
- Define and give examples of “idea” terms

Computation's Big Ideas

- Digitizing information
- Stored-program computers
- Transistors
- Integrated circuits
- “Personal” computers
- The Internet
- World Wide Web
- Layered Software

Computation's Greatest Hits

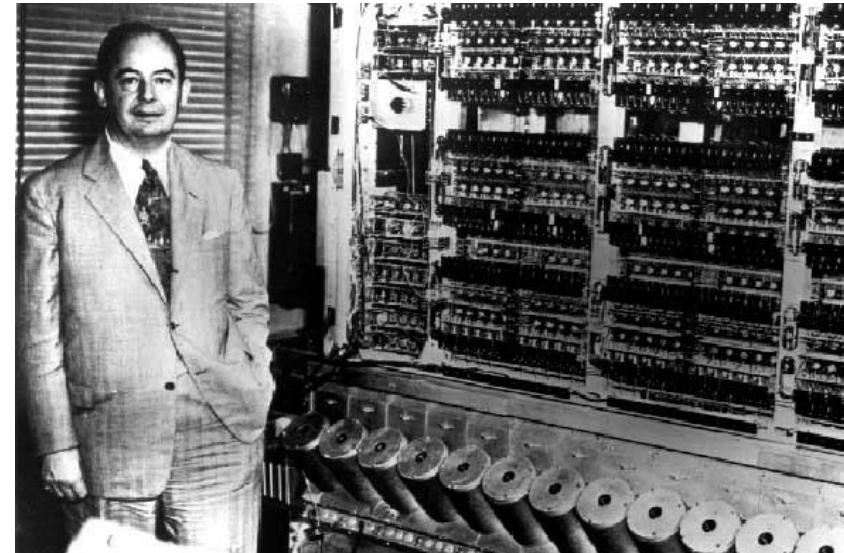
- Digitizing information
 - data represented as numbers
 - the breakthrough! machines reading digital info
 - census data digitized (1890)
 - 1880 it took 8 years to process the data by hand
 - punch cards digitized the process (not a computer, a card reader)

Computation's Greatest Hits

- Stored-Program Computers
 - central processing unit: instructions stored in memory (software)
 - programs can be changed quickly, more complex, and autonomous
 - large and complex: fills a room
 - vacuum tubes
 - use a lot of power
 - burn out

The pioneers

- Alan Turing (1912-1954)
- John von Neumann
(1903-1957)

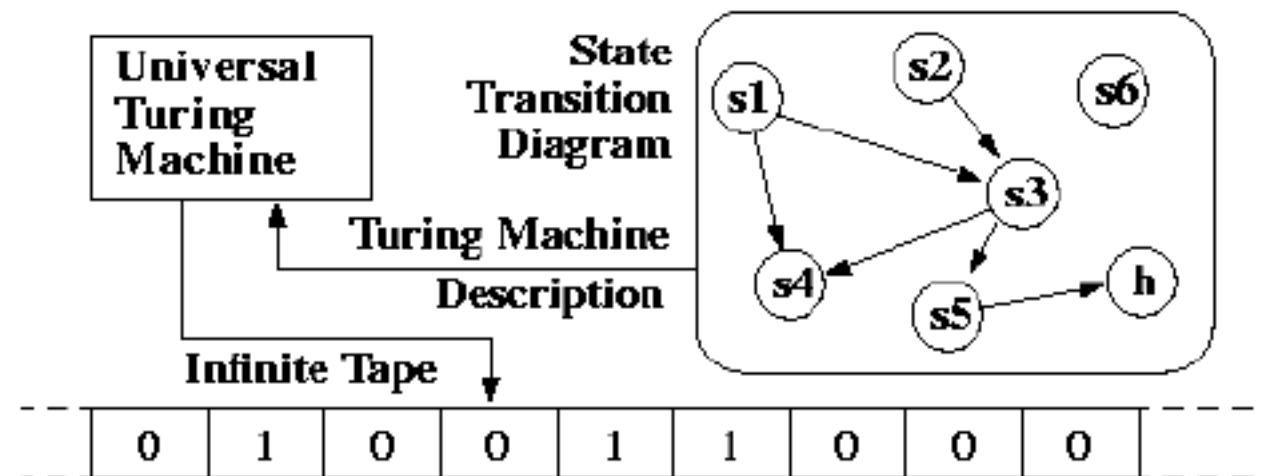


A little history...

- Up to the sixties the word *computer* indicated a clerk with computing tasks
- The first researchers of the *computer science* were mathematicians who were interested in the *theory of computability*
- Their works in the '20s, '30s and '40s of the XXth century provided a formal definition for
 - Automatic computing
 - Computability
 - Programming languages

The Turing machine

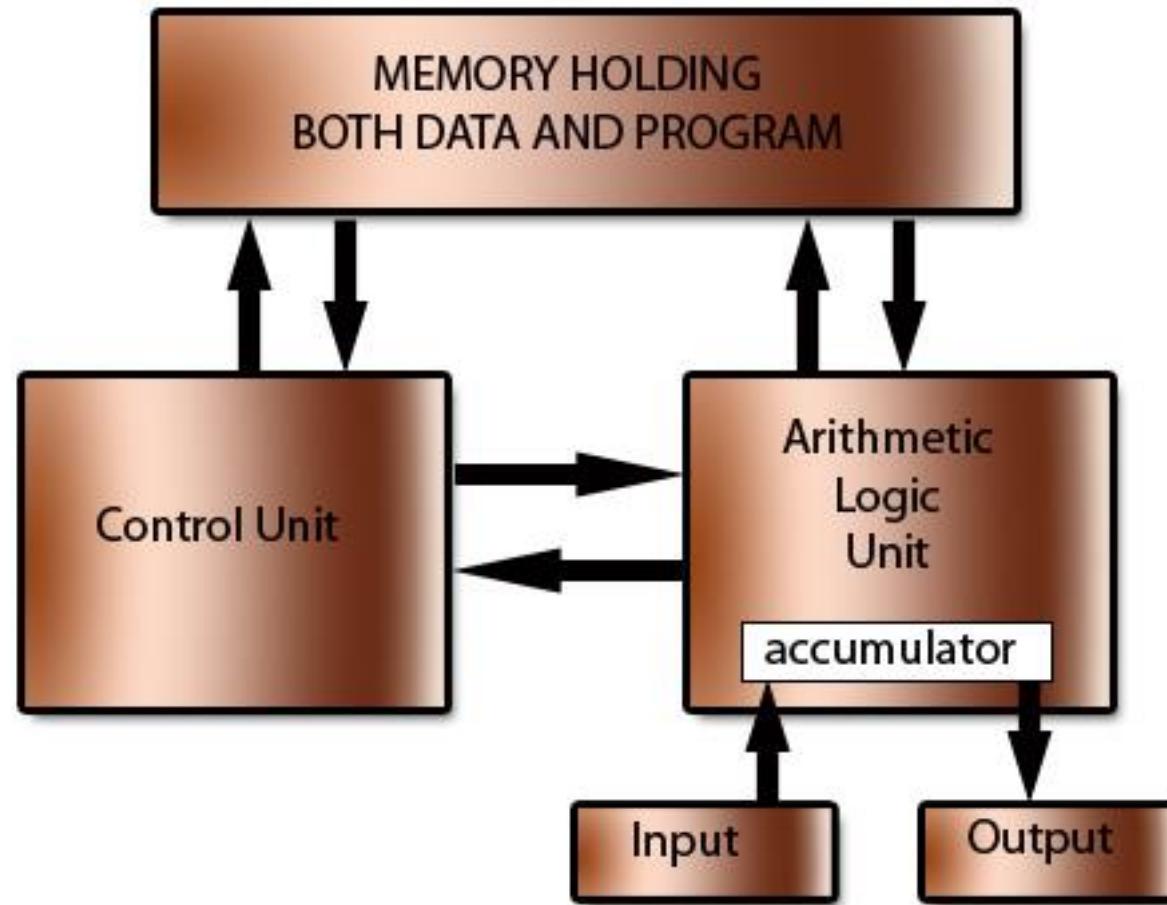
- A mathematical model
- A theoretical mechanism that is able to compute *any computable function*
- "On computable numbers", 1936



The Von Neumann's model

- 1944 – Von Neumann writes “First Draft of a Report on the EDVAC” (completed in 1949)
- Introduces the modern architecture for the “stored program”
- Introduces the clear separation between *hardware* and its natural complement, the *software*
- Electronic Discrete Variable Automatic Computer
 - Based on binary numbers
 - Used for ballistics
 - In use till 1961

The Von Neumann or Stored Program architecture



The Von Neumann's architecture

- Processor
 - Control Unit
 - Arithmetic/Logic Unit
- Memory
- Input
- Output

Milestones - 1945

- Vannevar Bush writes “As we may think” describing its idea for a new device, the Memex:
“A device in which an individual stores all his books, records and communications, and that is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory”



ENIAC, 1946

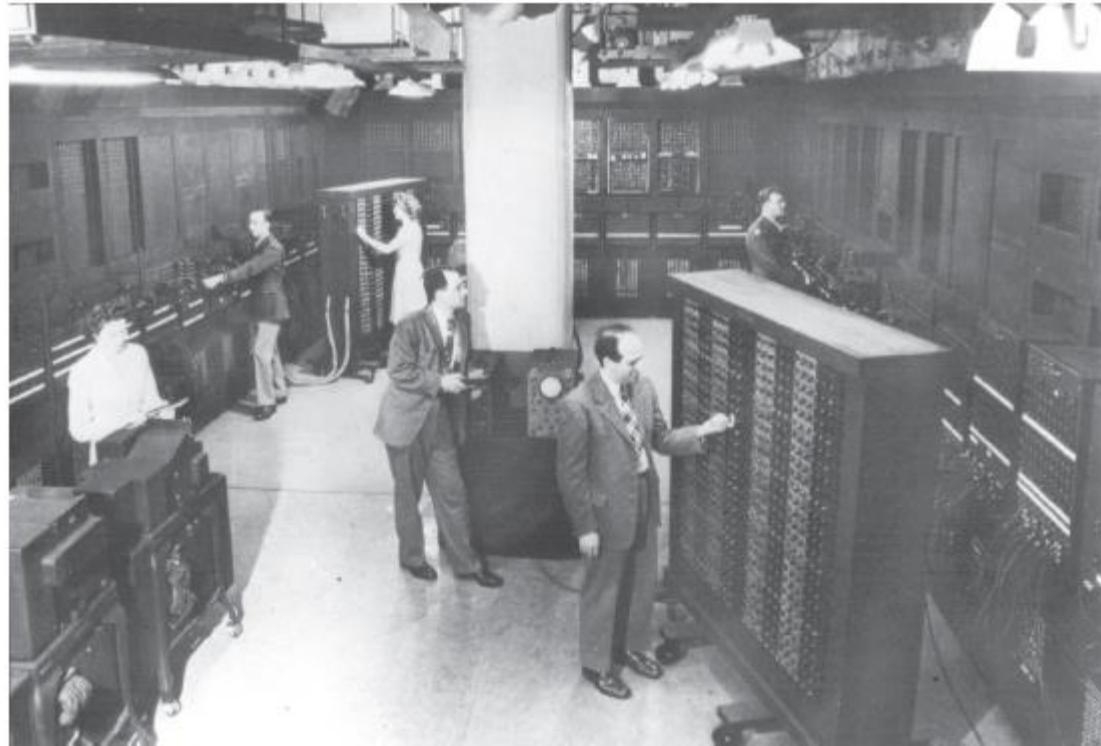


Figure 1.4 ENIAC. The Electronic Numerical Integrator and Calculator, started in 1943 and finished in 1946, shown in its formal portrait.

ENIAC

- 1943-1946 - John W. Mauchly and J. Presper Eckert University of Pennsylvania
- It is a huge computing machine designed mainly for producing artillery tables
- It can compute, but it isn't a computer yet
 - A change in the computation requires a change in the electrical circuits!

... milestones ...

Photo # 1019636-EN: "First Computer 'Bug'", 1945



- 1947 – the first “computer bug”, a moth sneaked inside the computer Mark II was burned by the hot tubes and made the computer stop
 - Since then the word “bug” indicates a computer malfunction, mainly software, even if, in that case, the problem was at the hardware level

Computation's Greatest Hits

- Transistors
 - alternative to vacuum tubes
 - low power, less heat
 - extremely reliable
 - small in size and weight
 - the problem: lots of assembly required

... milestones ...

- 1947 – W. Shockley, J. Bardeen, W. Brattain, dei Bell Labs, invent the transistor
- 1950 – Engineering Research Associates of Minneapolis sells ERA 1101, the first mass produced computer
- 1952 – Grace Hopper (1906-1992) writes “A-0”, the first *compiler for a programming language*

The Alternatives



(a)



(b)

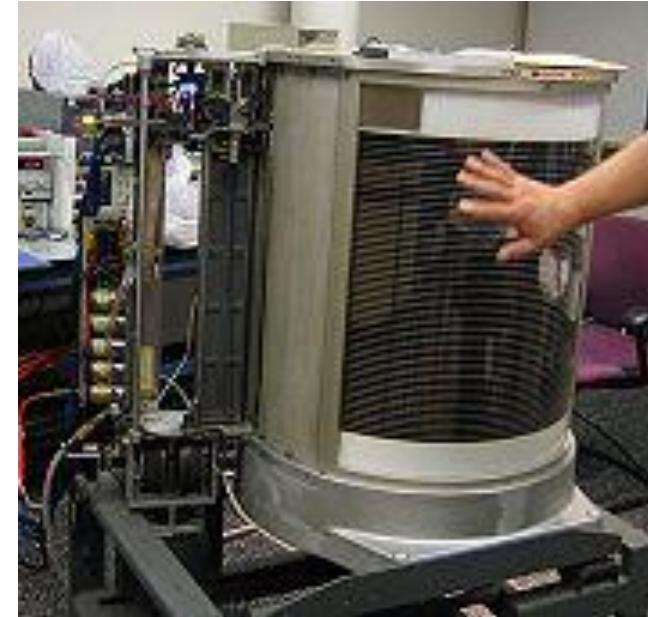


(c)

Figure 1.6 Transistors: (a) the first transistor made by Bardeen, Brattain, and Shockley; (b) a size comparison of a packaged transistor compared to a vacuum tube; and (c) a circuit board with electronic components mounted.

RAMAC

- 1955 – IBM releases RAMAC, the first computer with a hard disk
 - 5MB
 - \$ 180.000
 - 1000 pieces sold



Computation's Greatest Hits

- Integrated Circuits
 - transistors and connective parts (e.g., wires) are fabricated together in a multistep process
 - photolithography makes it all possible by “printing” the wires onto the circuits

... milestones ...

- 1956 – release of the first *operating system* “GM-NAA I/O System”, for IBM 704
- 1958 – Jack St.Clair Kilby builds, for Texas Instruments, the first *integrated circuit*, a.k.a. *chip*



Computation's Greatest Hits

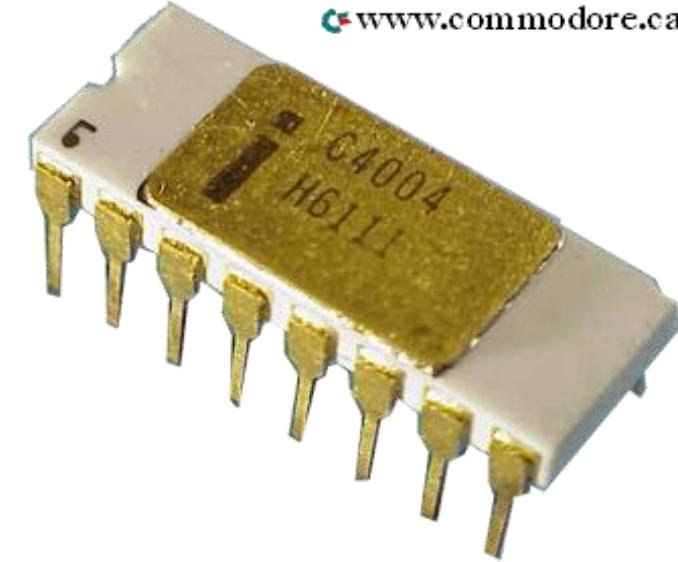
- Personal Computers
 - 1973: first personal machine, Xerox's Alto
 - “There is no reason for any individual to have a computer in their home.”
 - how many computers do you have with you today?

... milestones ...

- 1960 – AT&T sells Dataphone, the first *modem* for transmitting data over a phone line
- 1962 – LINC (Laboratory Instrumentation Computer) sells the first system for data processing in a scientific lab
- 1965 – Ted Nelson writes “Computers Creativity and the Nature of the Written Word”, where he introduces the word “hypertext” with the current meaning

... milestones...

- 1970 – Arpanet links the first 4 computers
- 1971 – Ray Tomlinson, for BBN, sends the first e-mail with Arpanet
- 1971 – Intel releases the first *microprocessor*, a complete computer on a single chip
- 1974 – Xerox releases “Alto”, the first workstation with mouse and graphic interface
- 1975 – Altair 8800 “Micro Instrumentation and Telemetry Systems” sells the first PC for \$397



... milestones ...

- 1979 – Daniel Bricklin e Robert Frankston develop VisiCalc, the first *spreadsheet*, the ancestor of Microsoft Excel
- 1982 – THERAC 25: a software malfunction in the controller of a linear accelerator of the french company GCR caused 6 deaths
- 1984 – Apple, founded in 1975 by Steve Jobs and Steve Wozniak, sells Macintosh, the first consumer PC with mouse and graphic interface
- 1989 – Tim Berners-Lee, CERN in the report “Information Management: A Proposal” sketches the architecture of the web as a collection of hypertexts

Computation's Greatest Hits

- The Internet
 - a network of networks
 - ARPANet sent its first message in 1969
 - used for email and file transfer
- HTTP and the World Wide Web
 - brings the Internet to the general public
 - HTTP can transfer any file to any computer
 - Mosaic: first widely used Web browser

Computation's Greatest Hits

- Layered Software Development
 - until 1980 programs had little structure, making them difficult to write and maintain
 - programs at one level apply code for lower levels, and provide more advanced facilities for higher levels

Software Stack

- The Software Stack
 - Concept used to structure and organize the software in contemporary computer systems
 - Series of layers of programs that implement user applications.
 - Each software layer implements operations used to build the layers above

Software Stack

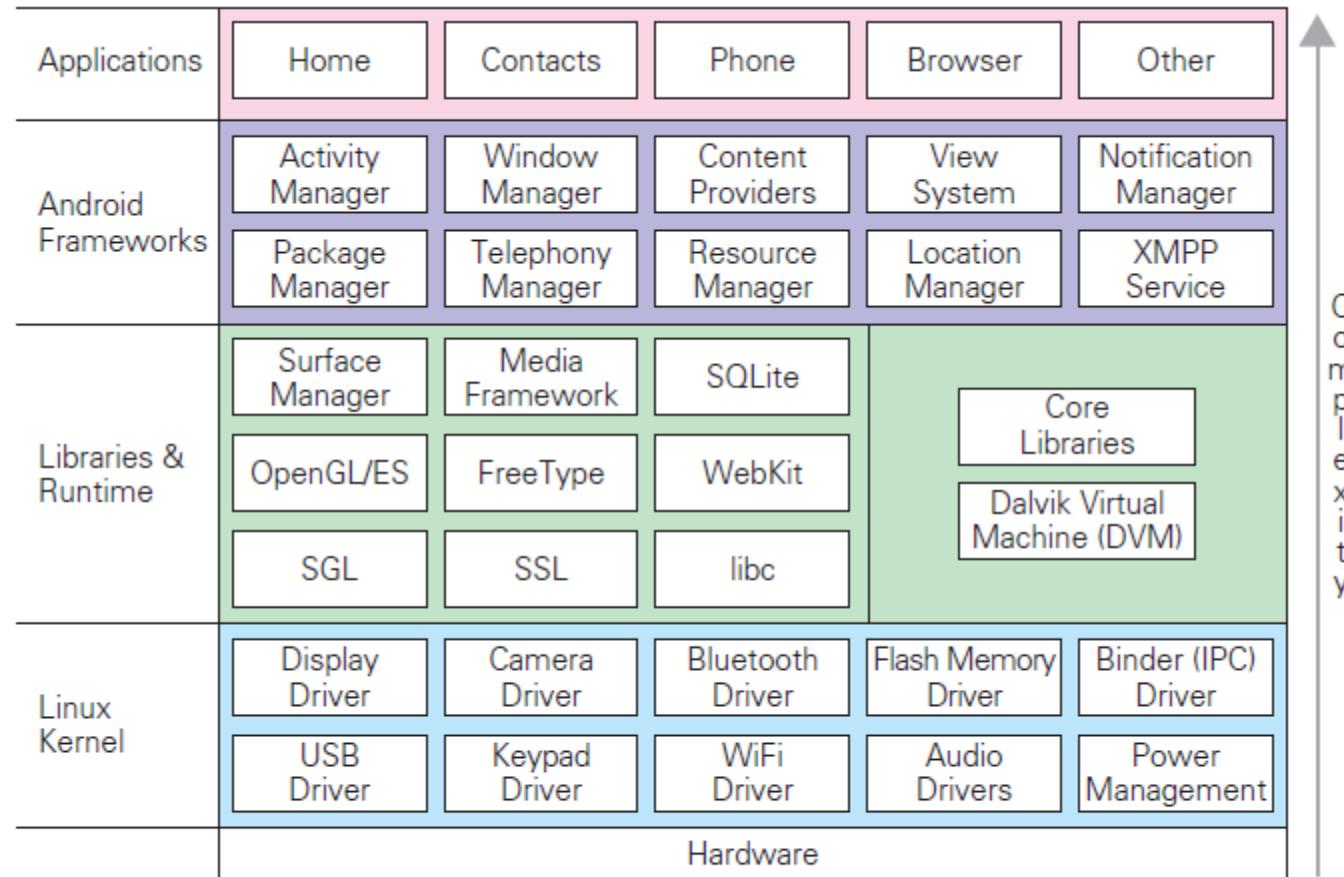


Figure 1.8 The software stack for the Android smartphone; the hardware is on the bottom, the apps are on top.

Software Stack

- Referring to the figure on the previous slide:
 - To check out a video on YouTube using a smart phone, you would:
 - use the **browser** application to get to YouTube
 - the **browser** app uses the **window manager**, and several other frameworks
 - the **window manager** uses **media manager**, and several other libraries
 - the **media manager** uses the **display drivers**, and several other kernel operations

Terms

- Not only should you learn the right computing terms, but you should also understand how to use them to benefit from the technology.
- There are two practical reasons for this:
 1. Tech Support: everyone needs and uses it
 2. To learn a new subject, we must learn its terminology

Tech Support

- Usually, you must look up the answer yourself using the *Help* feature, or you must contact tech support
 - The technician might not know what you talking about
 - Without the right word, the search algorithm of the *Help* facility won't work for you

Find The Computer

- Processor
 - the computer itself, usually hidden inside the box
 - connects to various input and output devices
 - the variations between computers depend on
 - the devices connected to the processor
 - the software run by the system

Here's The Computer

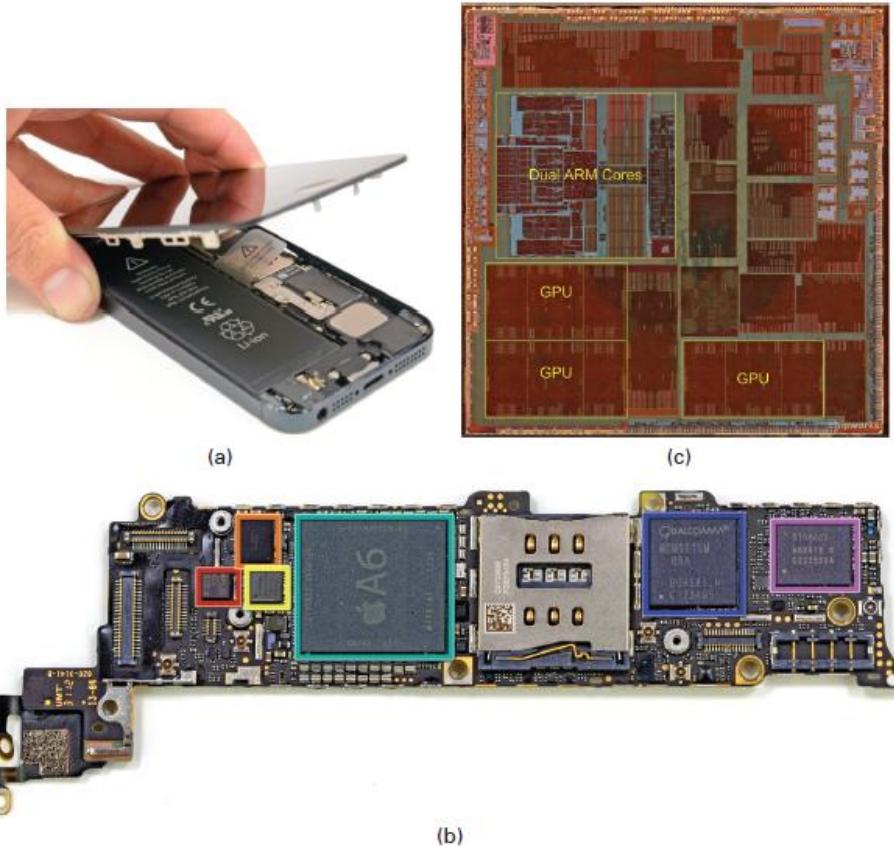


Figure 1.9 “Teardown” of the iPhone 5: (a) the open case showing that more than half of the volume seems to be a lithium-ion battery, (b) the circuit board, which contains all the electronics including the A6 main processor chip (green), and is opposite the battery, and (c) detail of the A6 chip showing two ARM processors plus three graphics processing units—all are computers.

Software

Software is the collective name for programs.

- Programs contain the instructions that form applications
- The processor follows the program and carries out the application

Algorithms

An algorithm is a precise and systematic method for producing a specified result.

- Programs express algorithms
- Example: long division

The Words for Ideas

- “Abstract”
 - The word has several meanings:
 - In natural language: *to remove* can mean *to steal*
 - In computing: *to abstract* also means to remove, but this time, it’s an idea or a process, and it is extracted from some form of information
- Abstractions
 - Parables and fables require us to abstract the essential point of the story so that we can learn from it

Abstractions

- Notice two key points:
 1. Many, but not all the details, of the story are irrelevant to the concept
 2. The abstraction has meaning beyond the story
- In computing, separating the relevant from the irrelevant, and applying the abstraction to other cases are essential

The Words for Ideas

- “Generalize”
 - Process to recognize the common idea in two or more situations
 - To **generalize** is to express an idea, concept, or process that applies to many situations
 - The statement that sums up that idea is called a **generalization**
 - If it is true most of the time, we can generalize an idea

Summary

We learned how to do the following:

- Know the importance of major computing inventions in the last hundred years
- Know and use the right word
- Give informed definitions for common computer terms
- Consider a brief list of “idea” words, such as abstract and generalize.