

# Kazakh British Technical University

## Informatics




“The More You Sweat in Practice,  
the Less You Bleed in Battle.”

Made  
by:

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Almaty 2016



# 1. History of Computers

# What is a computer?

It is as a little machine that follows very specific instructions over and over.

A computer cannot learn, unless told to do so, and won't respond to anything.

A **computer** is an electronic machine that accepts information (Data), processes it according to specific instructions, and provides the results as new information.

# What have computers done for us?

Consider the following:

1. Made the world incredibly smaller by facilitating communications.
2. Advanced science and medical discovery more in 10 years than in centuries of history.
3. Designed cars, roads, cities, clothing, etc.
4. Tested transportation long before the prototypes ever left their studios.
5. Exploded our imaginations with color and virtual reality.
6. Controlled our market-place and caused the “Black Monday” crash.
7. Opened freedom of speech to areas all over the world via the Internet.

# What is a computing system?

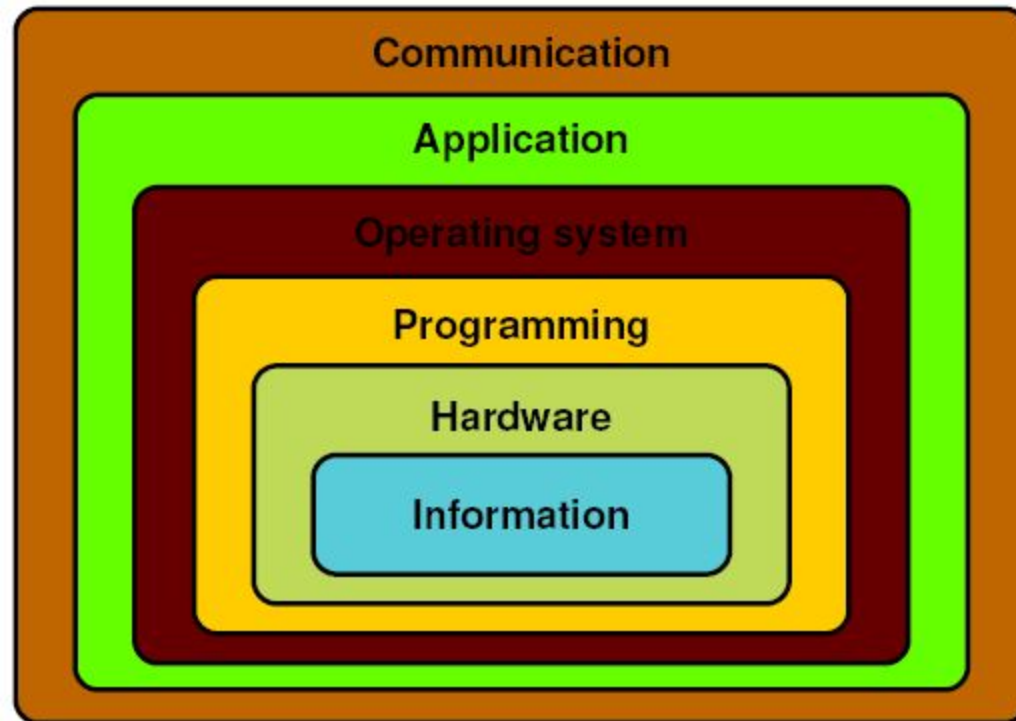
- A computing system is a dynamic entity, used to solve problems and interact with its environment.
- A computing system is composed of hardware, software, and the data that they manage.
- Computer hardware is the collection of physical elements that make up the machine and its related pieces: boxes, circuit boards, chips, wires, disk drives, keyboards, monitors, printers, and so on.

# What is a computing system?

- Computer software is the collection of programs that provide the instructions that a computer carries out.
- And at the very heart of a computer system is the information that it manages.
- Without data, the hardware and software are essentially useless.

# Layers of a Computing System

- A computing system is like an onion, made up of many layers. Each layer plays a specific role in the overall design of the system.



# Abstraction

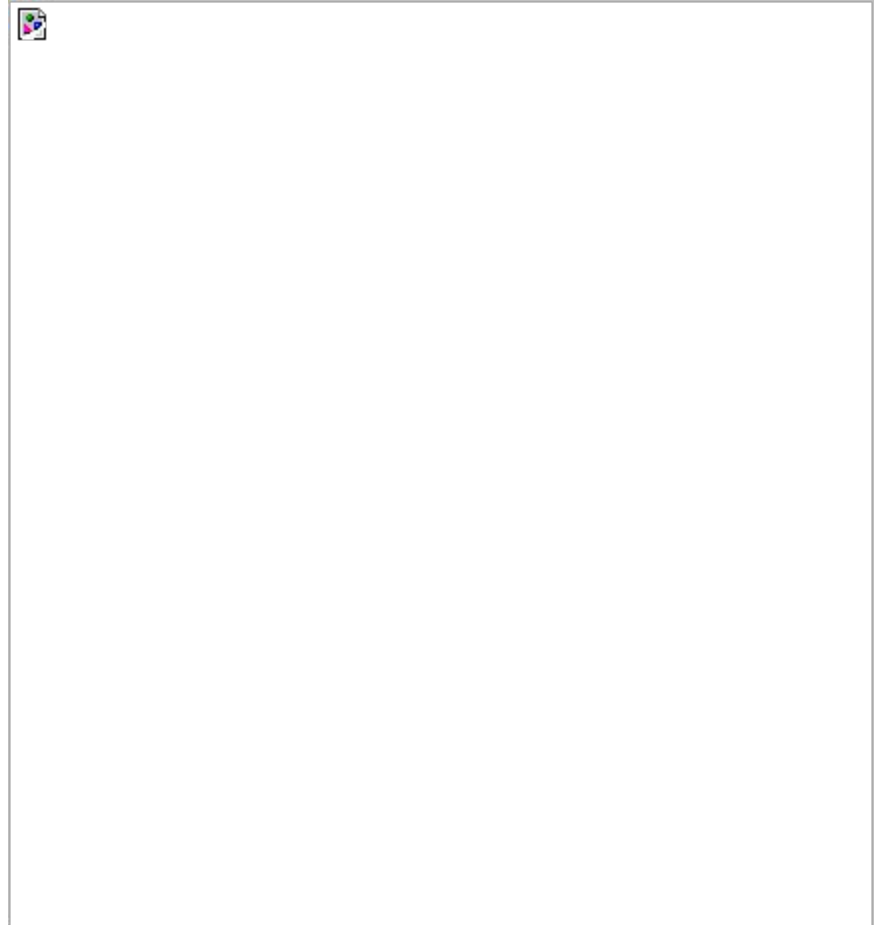
- The levels of a computing system that we just examined are examples of abstraction.
- An abstraction is a mental model, a way to think about something, which removes or hides complex details.
- An abstraction leaves only the information necessary to accomplish our goal.



# Abstraction

# Abstraction

- Abstract art, as the name implies, is another example of abstraction.
- An abstract painting represents something, but doesn't get bogged down in the details of reality.
- In the picture you can see only the basic hint of the woman or the staircase, because the artist is not interested in the details of exactly how the woman or the staircase look.
- Abstraction is the key to computing. The layers of a computing
- system embody the idea of abstraction.



# Starting up...

- Before you we can start the computer must be booted up which happens when we turn on the power
- We usually have to use the power switch on the monitor and the main “box” of the computer which goes by many names:
  - CPU, Tower, case, or simply “the computer”
  - Best described as the “System Unit”

# What devices have be plugged into power outlet?

- System Unit
- Monitor
- Printer
- Speakers
- Scanner
- External HD/Optical Drive
- Camera (outlet or battery)
- DSL/Cable/Network devices

# All components need a DATA connection to the computer

- A Data connection lets signals carrying data to go to and from the main box
- Some devices get power from the computer over the data connection:
  - Mouse, keyboard, microphone, and USB drives
- Other devices have their own power cord
  - Printer, monitor, scanner, external Hard Drive

# Types of Devices

- All components have a particular role to play in the computer system. On the next slides we can find a list of computer components.
- This is based on how the device relates to the data you want to work with
- The types are:
  - Input, Output, Processing, Storage

# Types of Devices

- **Input** – from real world to computer
- **Output** – from computer to real world
- **Processing** – manipulates data that has been entered into the computer
- **Storage** – hold information that has been entered into or created by the computer

# Input

- Accepts data from real world and gets it into the computer
- Mouse
- Keyboard
- Scanner
- Microphone



# Output

- Takes data that is in computer and gets it out to use in the real world
- Monitor/LCD projector
- Printer
- Speakers

# Processing

- Manipulates data stored in the computer to create something new
  - Graphic effects in movies or checkbook balance
- This happens in the System Unit where the CPU (Central Processing Unit) chip and motherboard are located

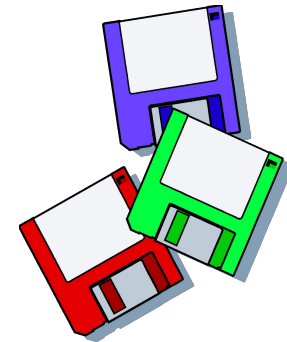
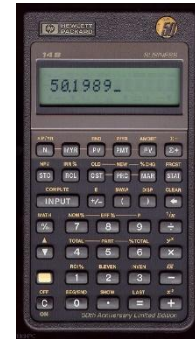
# Storage

- Holds information that has been entered into the computer or created by doing processing on what was entered
- Information is held in FILES on disk drives
  - Floppy
  - USB drive (not a disk but acts like one)
  - Hard
  - CD/DVD (optical)
  - SSD

# History of Computers

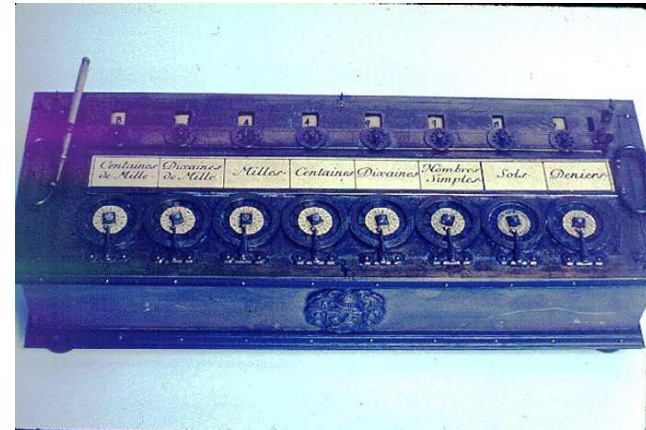
Modern computers result from 2 streams of evolution

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



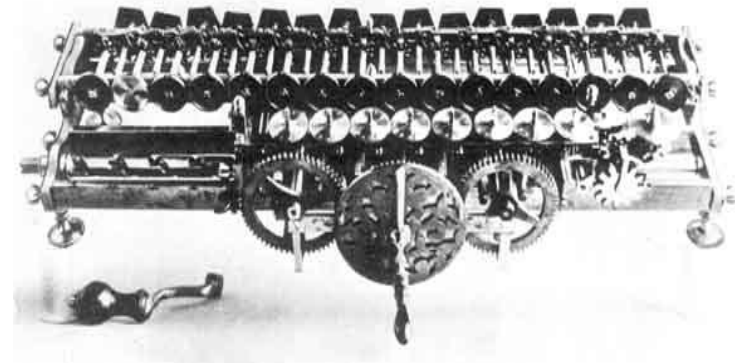
# Mechanization 1

- The abacus
  - 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 Leibniz (1646-1716)
- 1670's - Leibniz 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 (1752-1834)
- 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 or IBM





# Charles Babbage (1792-1871)

- 1822-33 - Difference Engine
  - compute polynomials for math tables
  - abandoned, wasn't precise

1830-71 - Analytical Engine  
designed but never completed,  
ahead of its time

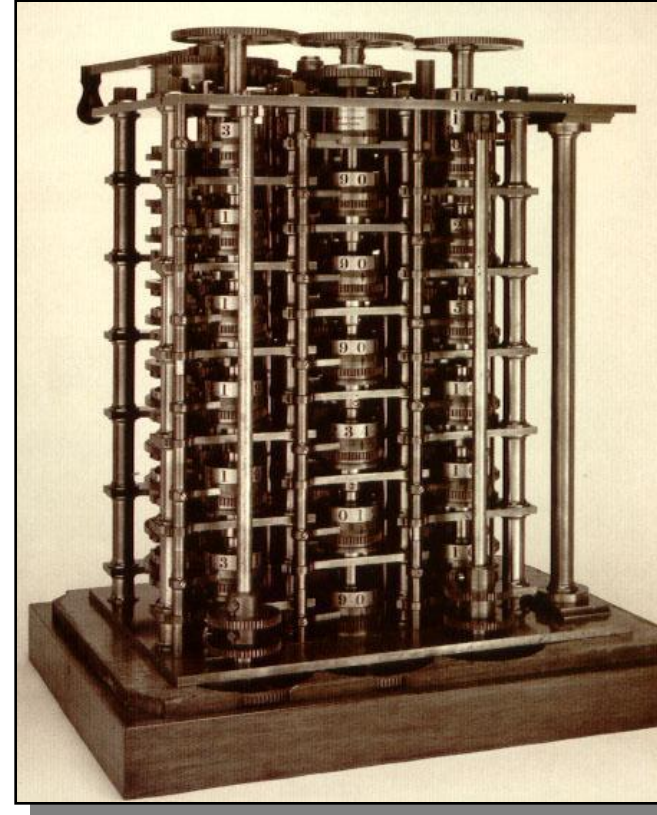
Mill - arithmetic computations

Store - store data and results

Operation cards - program instructions

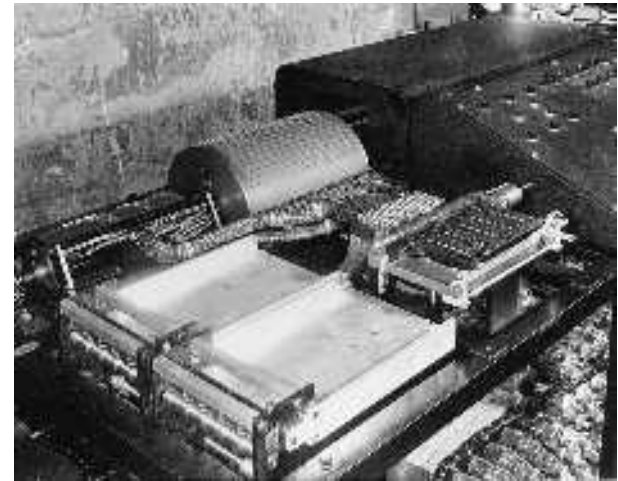
Variable cards - select memory location for ops

Output - printer or punch cards

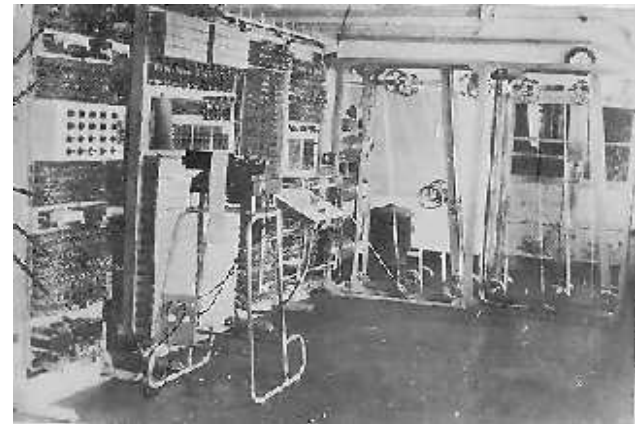


# First Computers

- 1939-42 - ABC
  - John Atanasoff and Clifford Berry (Iowa State)
  - small scale - 300 vacuum tubes



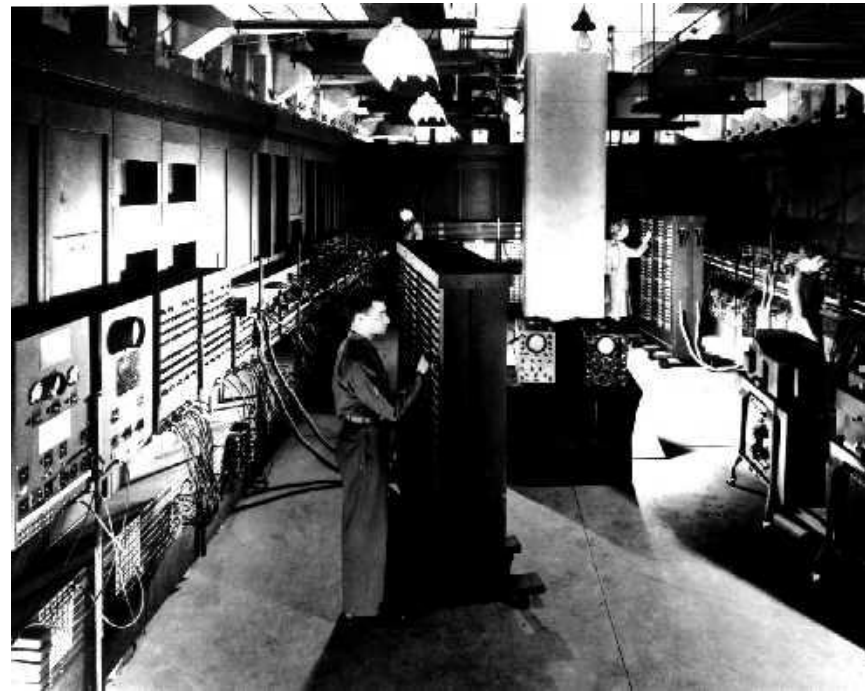
- 1944 - Mark I  
electromechanical computer  
Howard Aiken (Harvard U.)  
first real analytical engine  
based on relays



# ENIAC - 1946

## Electronic Numerical Integrator and Calculator

- Best known as first fully electronic computer
- It drew a lot of power that dimmed the lights of Philadelphia when it was switched on due to the use of 18000 Vacuum Tubes.
- 1,500 relays
- 20 x 40 foot room
- 5,000 Additions / sec.
- Grace Hopper
  - debugging it



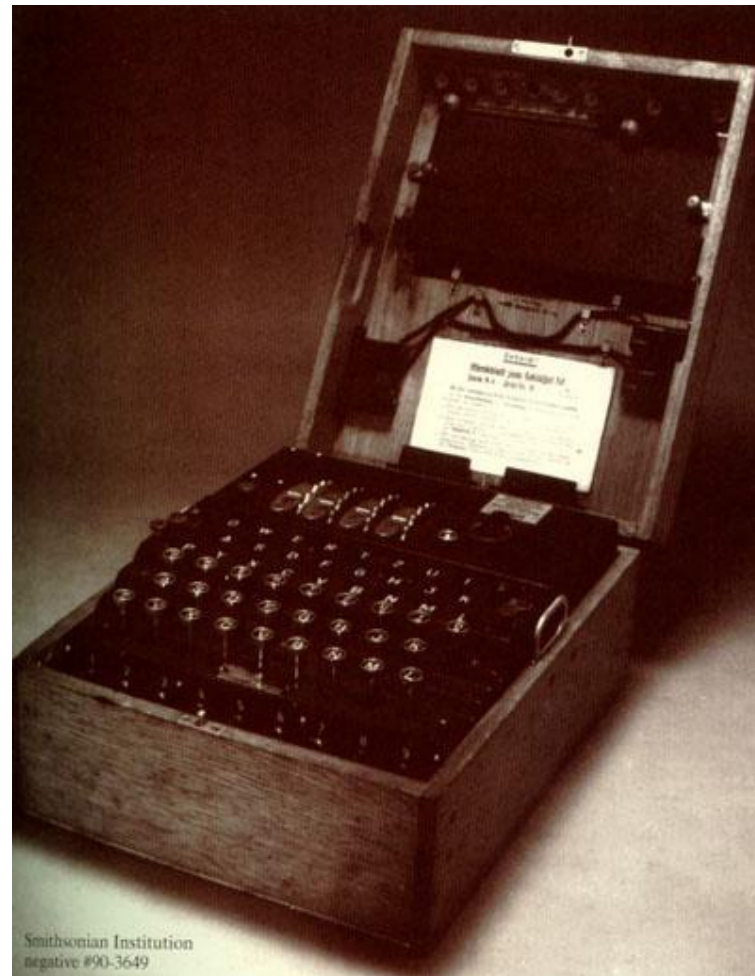
# von Neumann Architecture

- 1946 - John von Neumann (Princeton)
- Developed stored program concept
  - both programs and data stored in same memory
- Modern computers said to use von Neumann architecture

# The Effect of World War II

Back in time to the days of war...

- \* During WWII, the German Navy developed a cipher machine named **Enigma**. The Enigma machine could automatically encode a message in such a way that only another Enigma machine could read decode it.



1938

# The Effect of World War II

- \* In 1938 the Polish Secret Service managed to steal an Enigma machine that was smuggled to England.

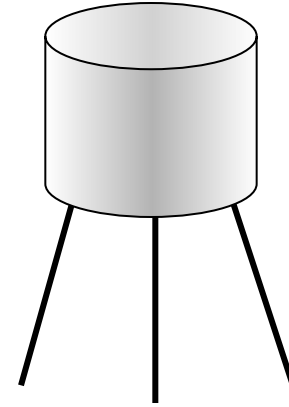
1938

- \* Secretly the British developed a computer named **Colossus** that could decipher as many as 2,000 messages per day. That computer used Vacuum tubes and was the world's first entirely digital computer. Surprisingly, though Colossus presented a similar technology to that of ENIAC, it had only 2,400 compared to 18,000 in ENIAC!!!

# Two Inventions that changed the way computers are built!!

## 1- The **Transistor**

**The most significant single invention of the modern era. It was invented by 3 scientists at At&T's Bell Labs.**

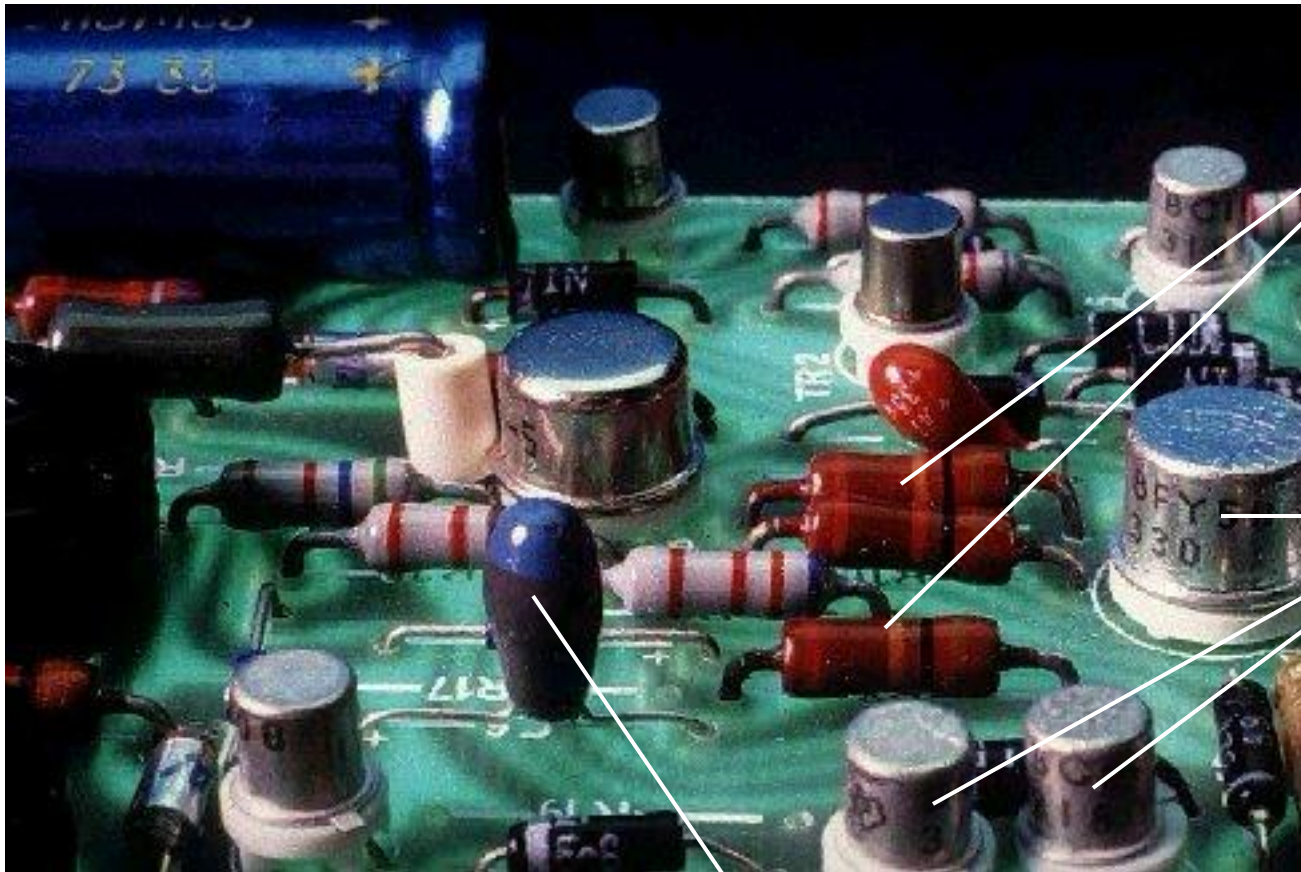


1946

**One of the first overseas companies was a Japanese company called Tokyo Telecommunications Laboratory. The company had troubles paying the license fee (\$25,000) that company became in 1956 what's called now Sony! it replaced the Vacuum tube.**

- \* Transistors are smaller (*sometimes microscopic*)
- \* Fast and don't need to warm up

# Transistors on a circuit board



Resistors

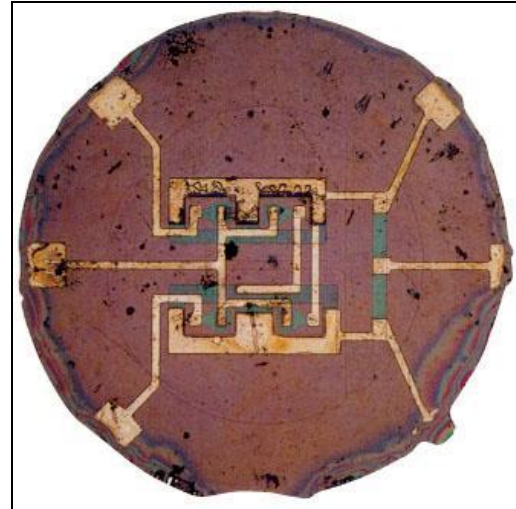
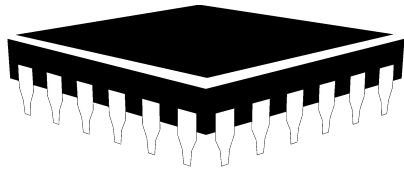
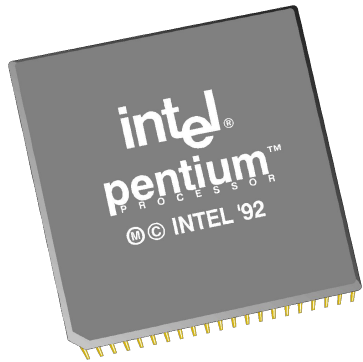
Transistors

Capacitor



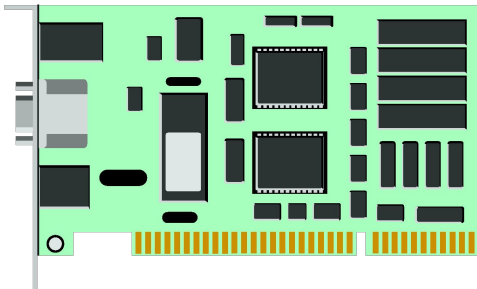
# Two Inventions that changed the way computers are built!!

## 2- The (IC) Integrated Circuit



1961

The IC revolutionized the entire electronic technology.  
Ex: The Pentium Processor contains 3.1 Million Transistors in 1.5 inch square!



# Work

Steps in using Computer:

- Boot up
- Login
- Work (can be work or play to us)
- Shutdown (can hit power switch if all data files already closed)

# Computer Generations

- 1st Generation - before 1960
  - vacuum tubes and relays          ENIAC
- 2nd Generation - 1958 - 65
  - transistors (individual circuits)    IBM 7090
- 3rd Generation - 1964 - 80
  - integrated circuits or chips
  - operating systems                  IBM 360
- 4th Generation - after 1980
  - large-scale integration - microprocessors

# What “Work” do we do with Computer?

- Documents
- Numbers (checkbook, spreadsheets)
- Lists (address book, calendar)
- Music
- Pictures
- Video
- Games
- Email/IM/Chat
- Search/Shop on World Wide Web

# What is “Information”?

- **information**, *n.* Knowledge communicated or received *concerning a particular fact or circumstance.*
- Information resolves uncertainty. Information is simply that which cannot be predicted.
- *The less predictable a message is, the more information it conveys!*

# Communications Resources and Information

Why do *unexpected* messages get allocated the biggest headlines?

...because they carry the *most information.*

# Information

- The word **informatics** comes from France word *informatique*, which comes from *information* and *automatique*.
- So, it means *automated information*.

# Information

- All the computer work we do is tied to Information
- The computer can store three types:
  - **Auditory** – music, speech, sounds
  - **Visual** – pictures, graphs, video
  - **Text: Language/Numbers** – documents, emails, chat, web pages, etc.



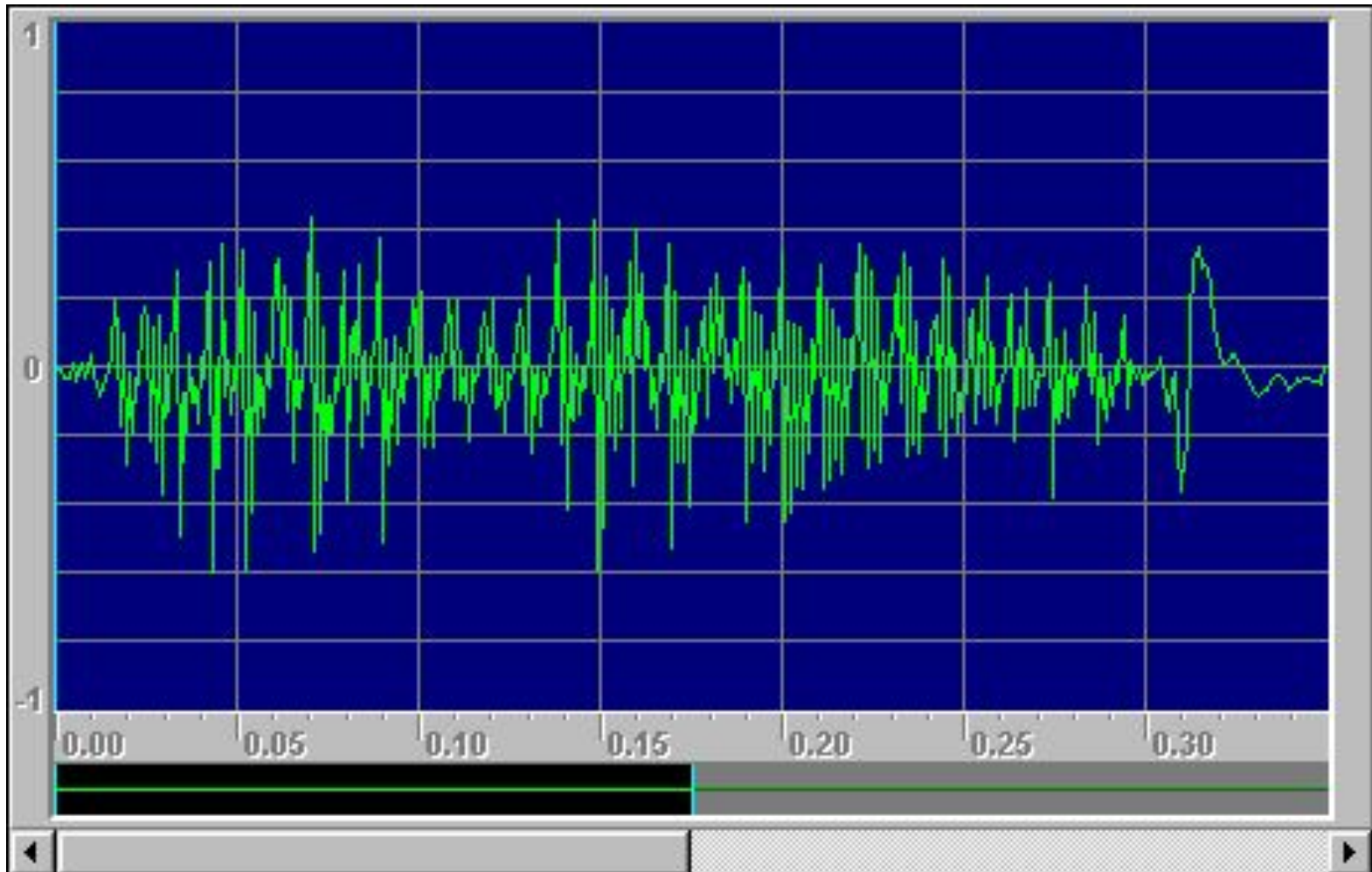
# How do computers store Information?

- We have Digital Computers (and phones, cable, satellite, audio recorders, etc.)
- This means everything is translated into numbers and that is what is stored, transmitted and processed.
- “Digit” means finger/number because we have 10 fingers and our numbers are based on that
- Computers don’t have fingers so they use a different number system (more later)

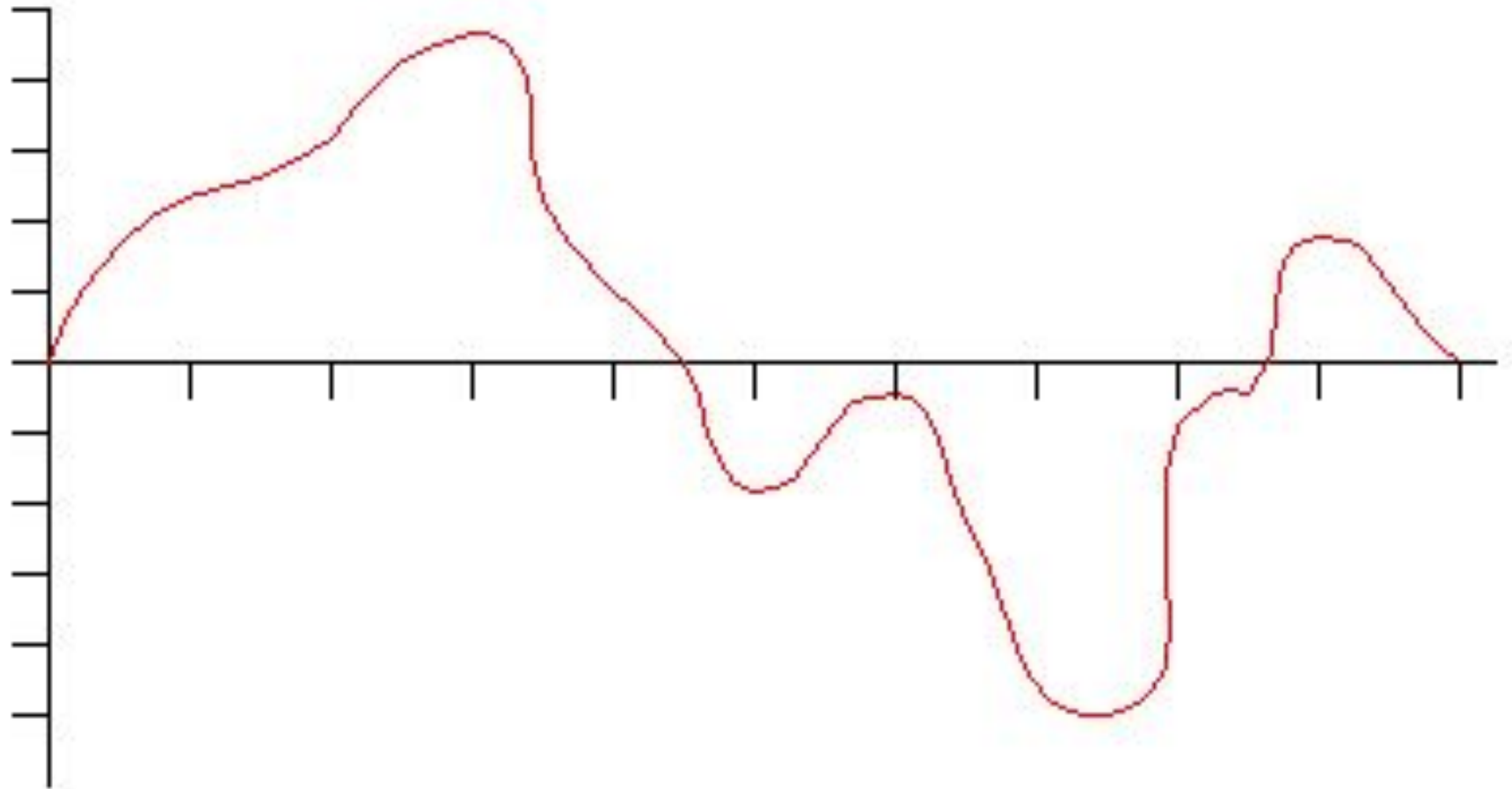
# How do we go from Information to Numbers?

- We have to measure the information and assign a number to the measurement
- This can be the level of a sound wave at a point in time or the color/brightness of a spot in a picture
- Language/Numbers are easy – just assign a number to each character

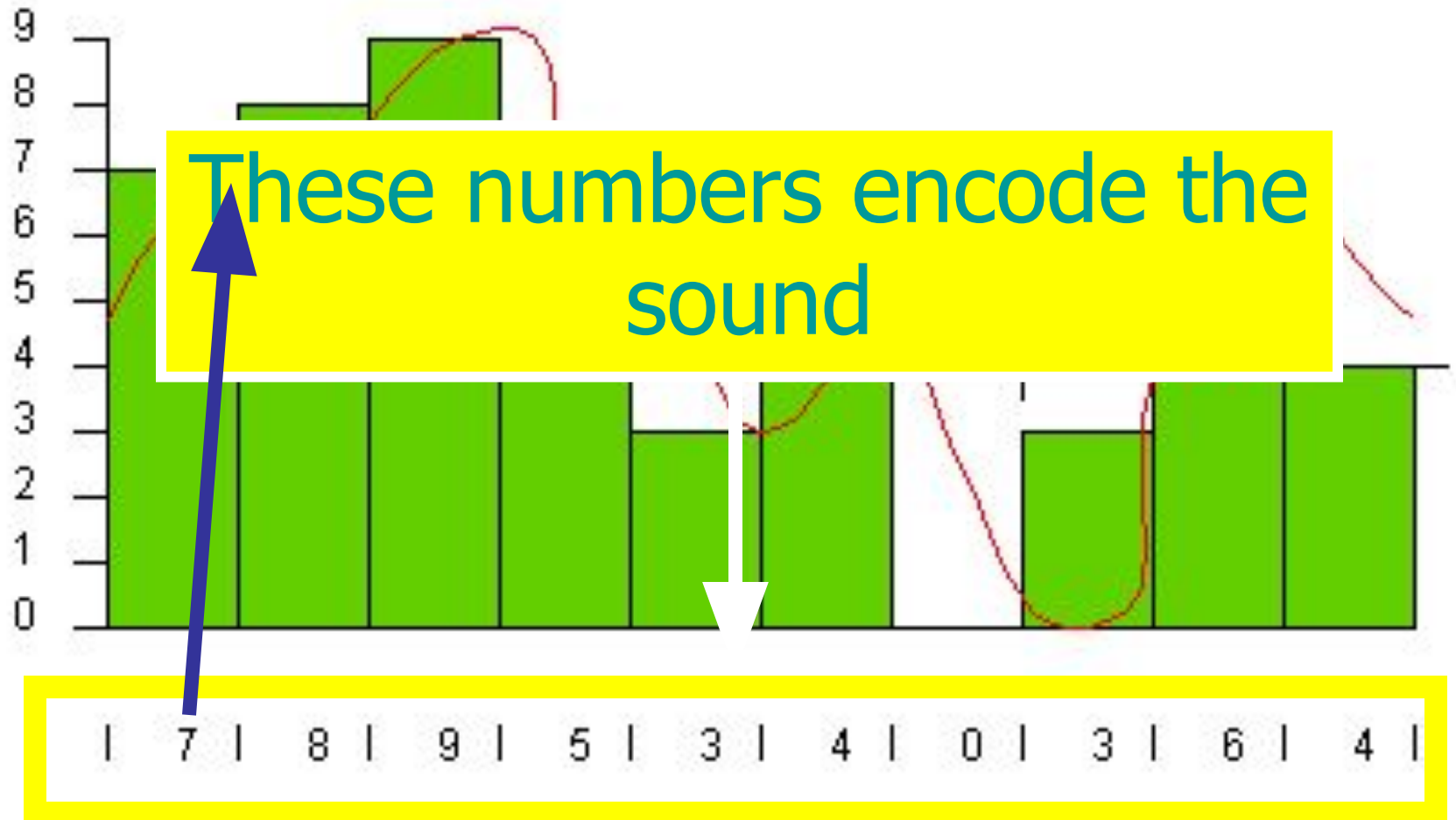
# Encoding a Sound Wave



# Simple Wave

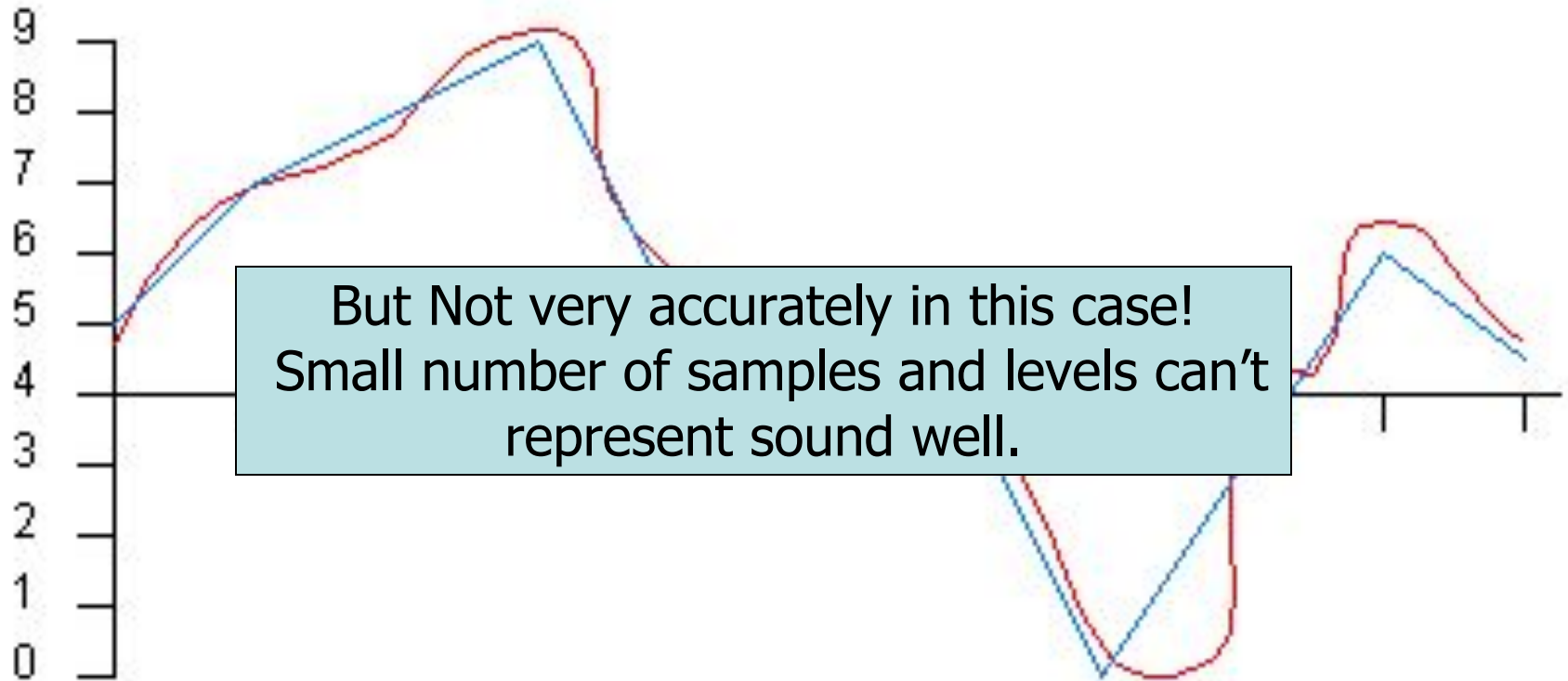


# Sampling = Convert to Numbers

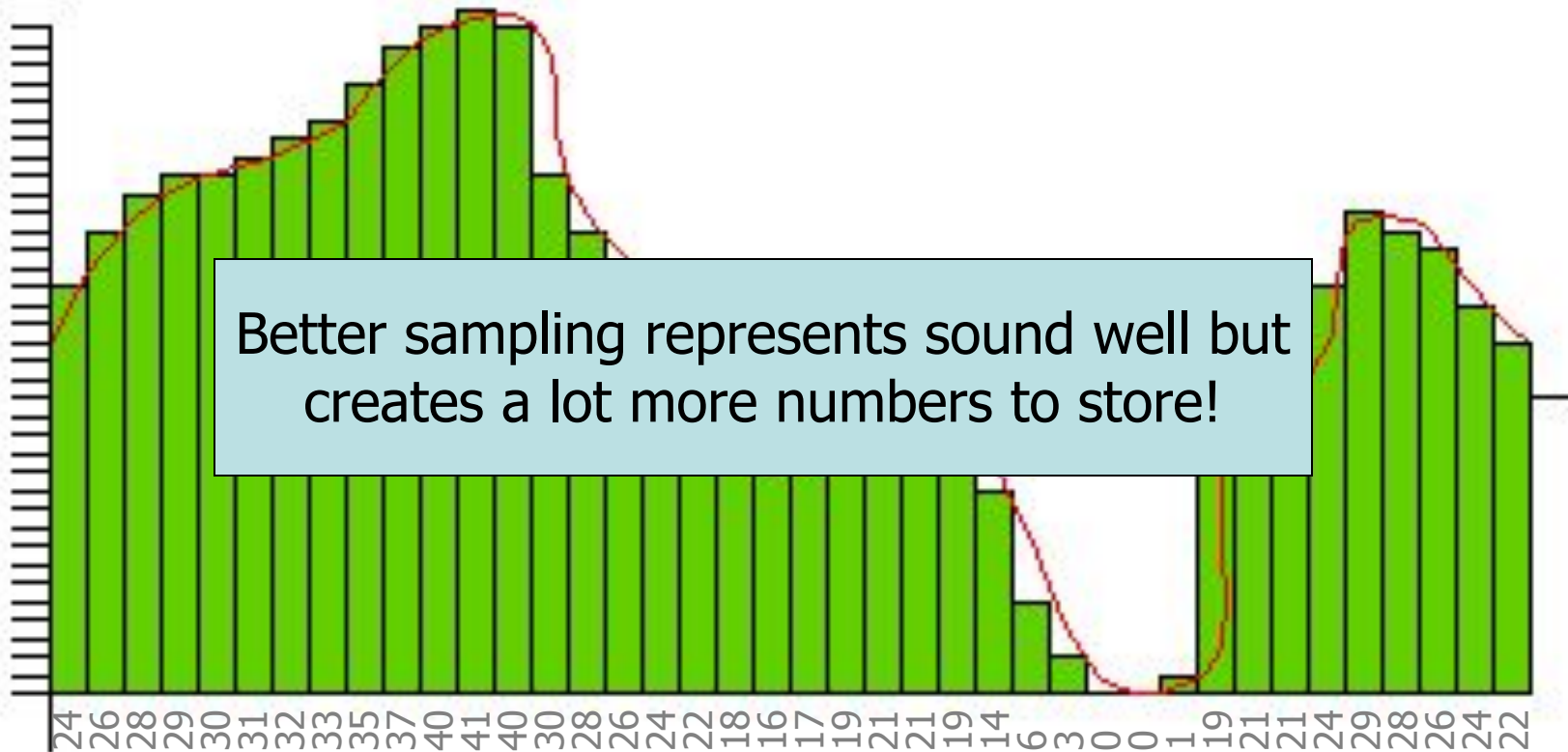


# Numbers = Digital

- The numbers 7-8-9-5-3-4-0-3-6-4 represent the sound
- We have "Digitized" the sound wave
- By putting them on the graph and connecting the dots we can recreate the wave



# More samples and More Numbers (levels) = Better sound



# Pictures

- Similar to sounds but numbers are assigned to different colors (rather than the height of the wave)
- Picture is broken down into many small pieces with a color assigned to each piece
- Pieces are called **Pixels**



# Digitized Pictures



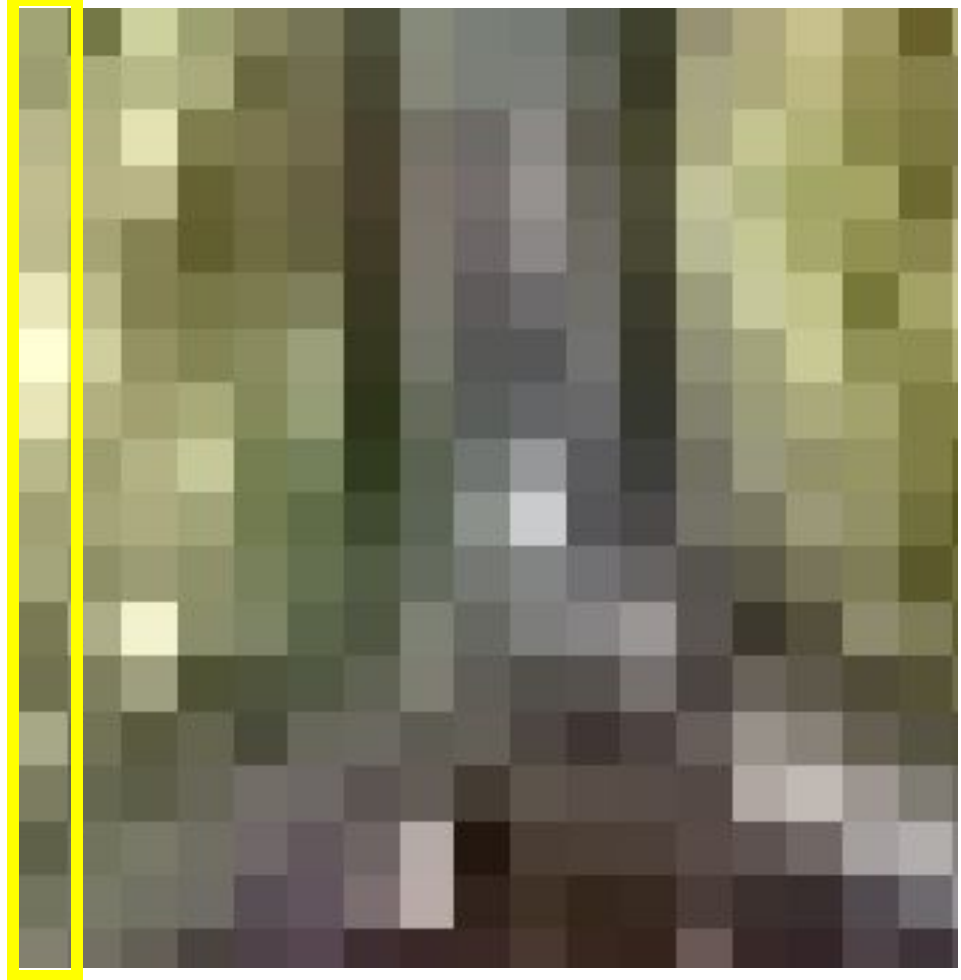
# Numbers to Color

- These numbers encode the first column of pixels.

40  
39  
41  
42  
42  
49  
50  
49  
42  
39  
39  
35  
34  
20  
33  
34  
35  
34

- Every other pixel in the picture is also represented by a number

- This means LOTS of numbers!



# Characters are Bytes

- In “computerese” the letters of the alphabet, the ten digits and all the different symbols like ]-\*%#\$. . . (in short all the **characters** we use) are called Bytes
- Each byte is paired to a number in the computer
- The word “computer” would take 8 bytes (numbers) to store

# Binary Systems

- A *bit* or binary digit is the building blocks of memory
  - 0 or 1 (off or on)

# Memory Capacity

Unit	Abbrv	Equivalent to	Comparison to Power of 10
Byte	B	8 bits	
Kilobyte	KB	$2^{10}$ bytes = 1,024 bytes	$>10^3$
Megabyte	MB	$2^{20}$ bytes = 1,048,576 bytes	$>10^6$
Gigabyte	GB	$2^{30}$ bytes = 1,073,741,824 bytes	$>10^9$
Terabyte	TB	$2^{40}$ bytes = 1,099,511,627,776 bytes	$>10^{12}$

# Symbolic Representation

- Computers communicate in binary
  - so you often see numbers like 2, 4, 8, 16, 32, 64, 128, 256, ...
  - which are powers of 2
  - $2^1, 2^2, 2^3, 2^4, 2^5, 2^6, 2^7, 2^8, \dots$
- For numbers
  - 0, 1, 2, 3, 4, 5, 6, 7, 8 in binary is
  - 0, 1, 10, 11, 100, 101, 110, 111, 1000

# Characters

- Characters are represented by a standard system
- ASCII (American Standard Code for Information Exchange)
  - keyboard characters plus a few special symbols
  - ‘A’ = 0100 0001
  - ‘B’ = 0100 0010