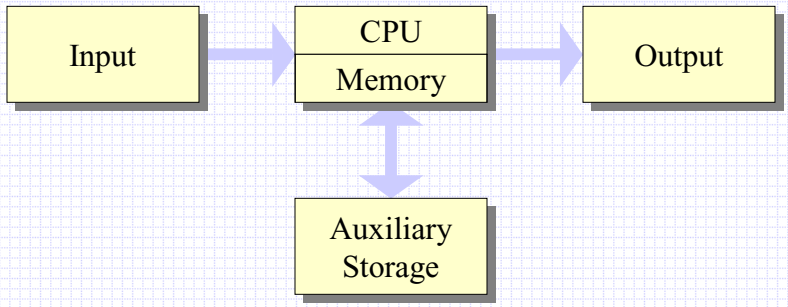
What Is A Computer?

- **com·put·er** (kem-py¡¹ter) *noun*
  1. A device that computes, especially a programmable electronic machine that performs high-speed mathematical or logical operations or that assembles, stores, correlates, or otherwise processes information.
  2. One who computes.

- The American Heritage® Dictionary of the English Language, Third Edition copyright © 1992 by Houghton Mifflin Company.

The Logical View of A Computer



Data and Information

- Data
  - Input from user or other sources
  - May be numbers, text, sound, images, etc.
  - May be unintelligible (i.e. unrecognizable)
  - May be commands or instructions
- Information
  - Output from the computer
  - Is formatted and understandable
  - Can be printed text, graphics, images
  - Can be sounds or video

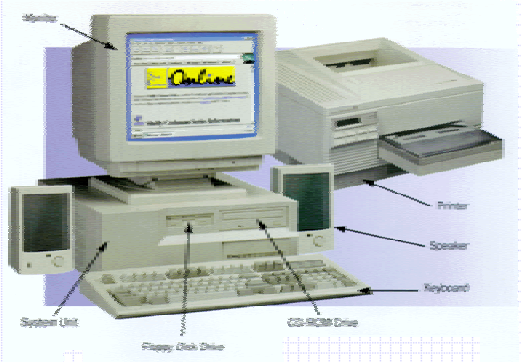
Converting Data to Information

- A collection of **instructions** in the form of a computer **program** is loaded into the main memory of the computer.
- When executed, a program can convert data into information.

Different Types of Computers

- Supercomputer
- Mainframe computer
- Minicomputer
- Workstations
- Personal computer
  - Desktop (e.g., PC's, I-Macs …)
  - Notebook and Laptop
  - Palmtop (e.g., Palm Pilots)
  - Personal Data Assistant (PDA)

An Old Personal Computer



Some Newer Computers




Computer Components

- Input devices
- Output devices
- Auxiliary storage devices
- Central processing unit (main computer)

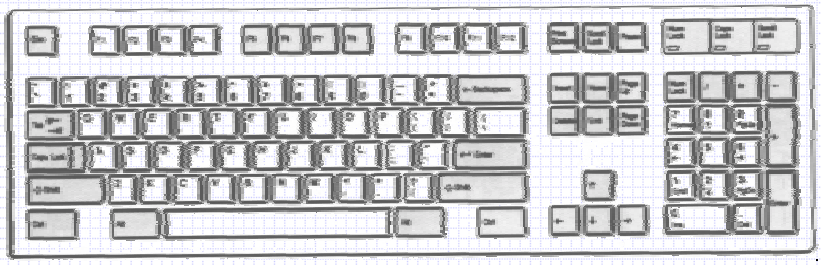
Input Devices

- Input devices are used to get data (or user commands) into the computer. There are many types of input devices and we'll discuss briefly a few of them in the following slides.

Keyboards

- The main form of input (allows numbers / alphabetic characters etc. to be entered directly).
  - Standard letters, numbers, punctuation etc…
  - Special keys:
    - Enter key: Used in typing for new line, used to indicate that the user has finished a selection and is ready to continue
    - Tab key: Allows text to be aligned vertically
    - Shift key: Used to get capital letters, used with mouse for special selection features
    - Ctrl key: Used with a letter key to indicate that a special function is to be performed
    - Function keys (F1 to F12): Depending on program they have specific functionality
    - Print Scrn: Captures the contents of the screen into a "clipboard" for copying purposes

A Standard Keyboard

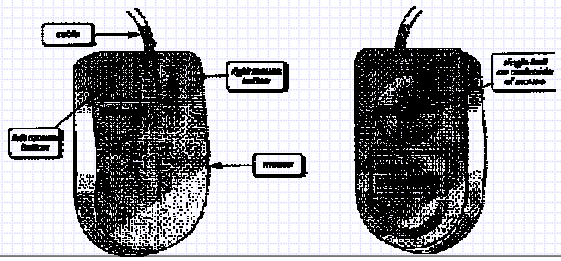


Other Keys

- Here is a list of some special characters on a computer keyboard and the names often associated with them.
  - ~ (tilde)
  - ! (bang, exclamation mark)
  - @ (at)
  - # (pound, hash, number sign)
  - % (percent)
  - ^ (caret)
  - & (ampersand, and)
  - * (asterisk, star, multiply)
  - / (slash)
  - \ (backslash)
  - | (bar)

Mice

- Allows pointing and clicking
- Used to select or choose something
- Used to position the "cursor" on the screen
- Nice for intuitive drawing operations



Mice With a Scroll Wheel

Optical Mice

- Some mice have no ball underneath, instead they have a light.
- Do not need to be cleaned as often, does not wear out
- Many work with special mouse pads
- More accurate than ball mouse … good for sensitive drawings

Optical Mice and Regular Mice

Cordless Mice

- Some mice are cordless … can you think of advantages and disadvantages of this ?

Trackball

- Kind of like an upside-down mouse
- Ball is controlled usually by thumb and one finger
- Used as a replacement for a mouse

Joysticks and Gamepads

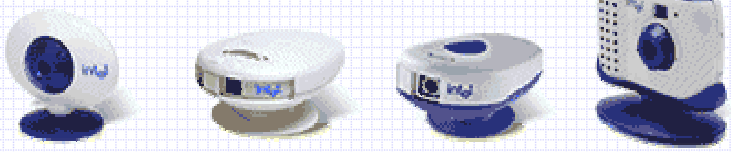
- Need them for fun games.
- Many, many types with different buttons, feedback etc …

Scanners

- Some are hand held, some are flatbed
- Kind of like colored photocopiers.
- Vary in price according to resolution (i.e., picture quality)

PC Cameras

- Many from different companies
- Different resolutions, features
- Different software
- Different connections (parallel, USB etc …)



Light Pen

- Same idea as mouse but pen works on screen

Bar Code Readers

- We've all seen these in grocery stores
- Used to read in product codes quickly and without error
- Also used for security cards

Other Input Devices

- There are others, for example:
  - Virtual reality suits and gloves
  - Tablets
  - Digital cameras
  - Microphones
  - …

Output Devices

- Output devices are used to show output to the user typically in the form of paper, sound or video.

Display Devices (Screens / Monitors)

- CRT - cathode ray tube - standard TV-like screens but vary with respect to quality, size, clarity, etc …

Display Devices

- LCD - liquid crystal display
  - Like on lap-top computers (passive or active matrix)
  - More expensive than CRT

Display Devices

- 3D Headsets - used in virtual reality

Display Devices

- Screen is made up of ***pixels*** - picture elements (i.e. dots). Pixels are the smallest electronic elements that compose digital pictures.
- All display devices have these common features:
  - size
    - length of diagonal of monitor
    - sometimes viewable length, sometimes tube length (tricky)
    - common values are 13", 14", 15", 17", 19", 20", 21"
  - dot pitch
    - size of a single dot on the screen
    - 0.23mm, 0.24mm, 0.26mm, 0.28mm are common
    - smaller is more crisp/less blurry

Display Devices

- All display devices have these common features:
  - refresh options
    - interlaced (every second row shown first) vs. non-interlaced
    - common refresh rate: 60Hz, 72Hz, 90Hz
  - maximum ***resolution***
    - number of columns and rows of pixels
    - common values are 640x480, 800x600, 1024x768, 1280x1024

Video Cards

- At least one required for every computer
- Many new ones have 3D acceleration features
- Some cards ONLY for 3D, still need a regular video card

Speakers

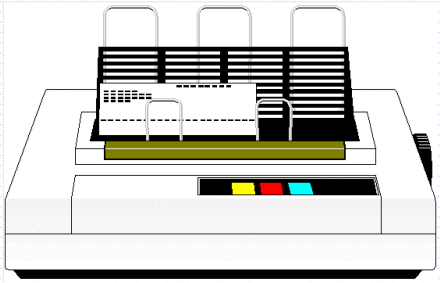
- Many varieties (differing quality, wattage etc…)
- Sometimes built-in to the monitor or computer case.

Sound Cards

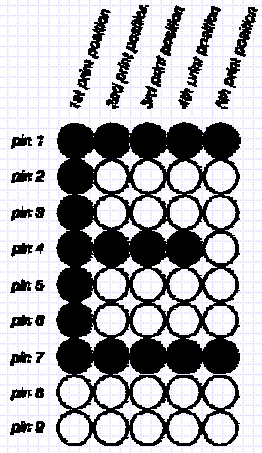
- Home PC's require a sound card

Printers

- Dot-matrix / impact printers
  - Older technology (not unlike typewriters) where array of dots make up characters
  - Noisy but really cheap to maintain



Formation of Letters



Printers

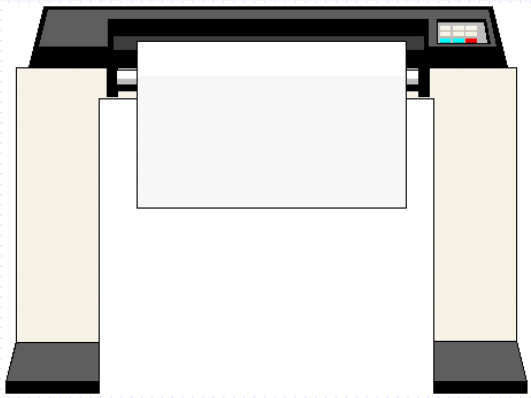
- Ink/bubble jet printers
  - Ink is sprayed onto paper (very accurate though)
  - Not bad quality
  - Cheap to maintain (ink is cheap)
  - Color is easily formed by combining (**C**yan, **M**agenta, **Y**ellow & blac**K**)

Printers

- Laser printers (black and white / color)
  - Best quality - similar to photocopying technology
  - Very quiet
  - Most expensive
  - High maintenance costs (toner)

Plotters

- Used for drawing blue prints, wiring diagrams etc …

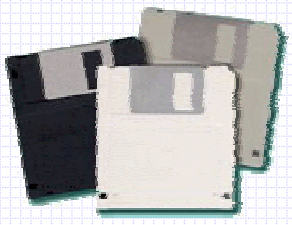


Auxiliary Storage Devices

- Auxiliary storage devices are used to store information more permanently.
- They can be used as input and output devices.
- There are many types of auxiliary storage devices.

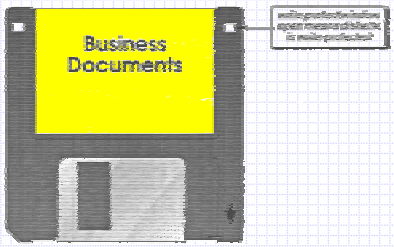
Floppy Diskettes

- Can transfer from machine to machine
- Requires a floppy disk drive
- Typical diskettes hold 1.44 million bytes (more later)
- Slower than main computer memory
- They can be bent or lost



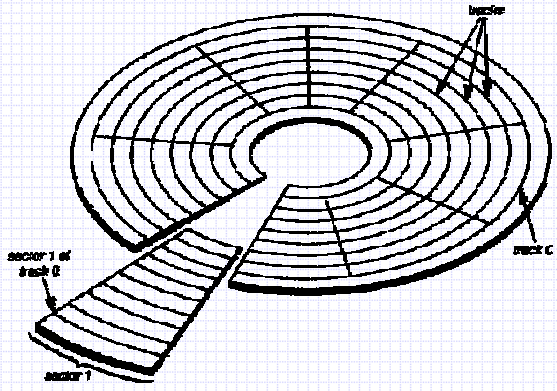
Floppy Diskettes

- Have write-protection capability (like VHS tapes and audio cassette tapes).
- When square is opened, the disk is write protected and cannot be written to.



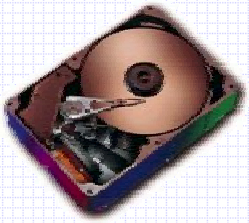
Floppy Diskettes

- Data is stored in tracks / sectors of a rotating disk.



Hard Disc Drives

- Faster than floppy
- Can hold thousands of more times more data than a floppy disk
- Often internal to the computer (not removed unless broken or upgraded)

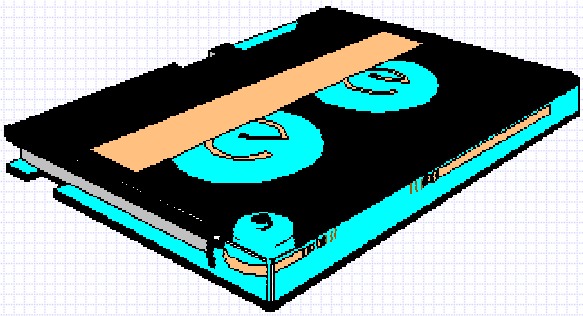


Zip/Jazz Drives

- Removable
- Store much more than single diskette (i.e. 100MB, 250MB or 1GB)
- Faster than diskettes (almost as fast as some hard disk drives)

Tape Drives

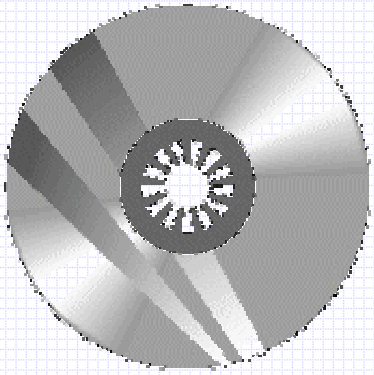
- Slower than disks (we must read/write the whole tape in one shot)
- Good for backups (cheap)

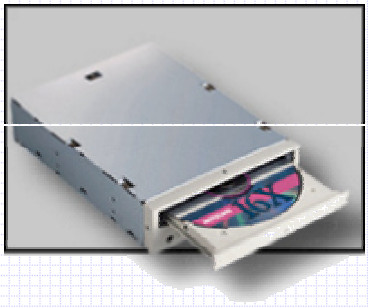


CD-ROM Drives

- Come in different speeds (2x, 4x, 8x, 24x, 52x, …)
- Some read only (CD), some write once (CD-R), some re-writable (CD-RW)
- Most new software comes on CD's and so new computers often come with a CD-ROM drive.
- Data is stored as a bunch of holes which are burned onto the CD. Once a regular CD has been written to, it cannot be unwritten, erased or overwritten. This is why they call it a ROM (Read only memory).
- Some CD's are re-writable
  - Must go through an "erasure" stage where a layer is burned off
  - Can only be re-written a fixed number of times

CD-ROM and CD-ROM Drives





DVD

- Digital Video Disks
  - Read-only
  - Contains high-quality movies
  - Often interactive with menus
  - Recordable DVD is becoming popular

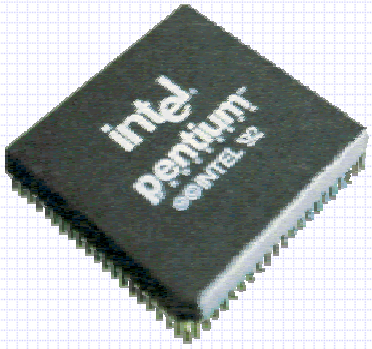
The System Unit

- The ***system unit*** is made up of many smaller components:
  - Main processor (or central processing unit: CPU)
  - Main memory (RAM - Random Access Memory)
  - Motherboard
  - Case
  - Power supply

Main Processor

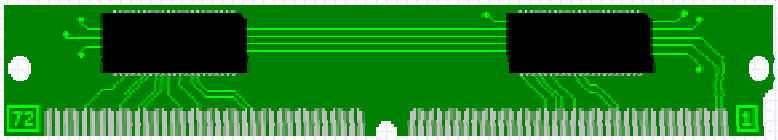
- The "main brain" that does all of the coordination and computation
- Different types from different companies:
  - Intel: Pentium, Pentium with MMX, Pentium II, Pentium III, Celeron, Coppermine,
  - Motorolla: 68000
  - AMD: Athlon, Duron, Thunderbird
  - Cyrix
- Different speeds:
  - 166MHz, 233MHz, 450MHz, 733MHz, 850MHz, 1000MHz = 1GHz …
  - Faster is better. but fastest is not worth it
  - Speeds increase every couple of months.

Main Processors



Main Memory

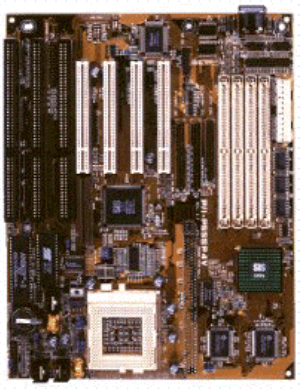
- Holds programs/data when computer is on
- The more memory, the more you programs you can run at once
- Often more means faster computer
- Different amounts (16MB, 32MB, 64MB, 128MB, 256MB)
- Different types/speeds (EDO, SDRAM, DDR, cache)



Motherboard

- Holds everything together (CPU, memory, video card, i/o cards).
- Different kinds that vary in speed, quality, number of expansion slots, maximum memory)

Motherboards and Peripheral Cards



Cases and Power Supplies

- All components in a system unit fit into a case with all disk drives and a power supply
- Different types - desktop, tower, mini tower etc …

Hardware and Software

- **Hardware** is the physical components that make up the machine
  - processor, motherboard, memory, drives, video/sound cards etc …
- **Firmware** is a program (set of instructions) that sit on a microchip in hardware
  - often used to start up (i.e. boot) the machine.
  - keeps settings such as "bios" (i.e., configuration) system settings
- **Software** is a program that runs on the computer
  - comes initially on a diskette, CD-ROM or downloaded from internet
  - usually needs to be installed on the hard disk of your computer
  - may be a game/drawing package etc …

System Software (Operating System)

- DOS
- Microsoft Windows
  - Windows 3.0
  - Windows 95 / 98 / ME
  - Windows NT / 2000 / XP
- OS/2
- Macs OS
  - System 7 / 8 / 9
  - OS X
- Unix
  - Solaris
  - Linux
- Responsible for
  - starting up (booting) the computer
  - interfacing with users
  - coordinating system devices
  - coordinating applications (i.e. running programs)

Application Software

- Business applications
  - Word processing and desktop publishing
  - Spreadsheets
  - Databases
  - Graphics and presentations
  - Communications (e-mail, internet, etc …)
- Utility applications (disk clean, virus scan etc …)
- Personal applications (diary, planners, tax returns, budgeting)
- Entertainment applications (games, movies)
- Learning (encyclopedias, kids learning, typing)

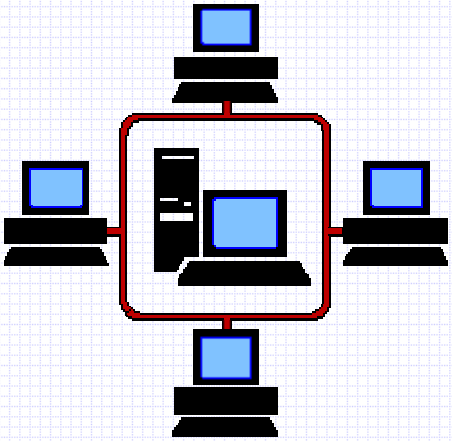
Computer Communications

- Communicating with other computers over networks.
- Modem
  - Used to connect to another computer over phone lines
  - Can download (get) information from remote (far away) computers.
  - Can upload (put) information onto remote computers.
  - Connect at different speeds (14,400, 28,800, 33,600 or 56k baud) indicating bits per second for transfer rates
  - There are many services such as Bulletin Board Systems (BBS) and Internet Service Providers (ISP)
  - You can send e-mail back and forth to friends provided that you have an account somewhere.

Communication Networks

- Local Area Network (LAN) - many computers connected physically (usually on a single floor or in a single building)
- Wide Area Network (WAN) - many computers connected logically but separated physically by phone lines (i.e. different countries).

Communication Networks



Ethical Issues

- Copyright
- Bugs
- Viruses and Worms
- Security
- Privacy
- Ergonomics

Copyright

- Software piracy - copying software and reselling is illegal
- Site licenses and network versions - usually indicate the number of users at one time
- Shareware - distributed freely, but creator usually expects honor system payment of small amount
- Freeware - free for everyone. Often crappy stuff that nobody would buy, but sometimes good stuff.

Bugs

- Programs you buy are not perfect, they may "crash" your computer in certain situations. This is a "bug" in the software.
- Some "bugs" do not cause a "crash" but just cause weird or undesirable effects.
- Some "bugs" are known and documented … they will (should) be fixed in future releases
- Some "bugs" are intermittent and not documented.
- Beta versions of software are versions that are currently being tested in the workplace.
- The "year 2000" (Y2K) problem was a well-known bug for many systems.

Viruses and Worms

- Some believe … more hype than its worth
- Malicious people create programs that deliberately do bad things
- Can erase your programs, delete some files, corrupt some files, … some are harmless but cause annoying effects
- Can lie dormant for periods of time and then emerge or "come to life" on certain days

Viruses and Worms

- Can be a program but cannot lie in data
- Can be transferred from disk to disk unknowingly
- Lots of software that can detect the common viruses by scanning all disks and software installed on your machine
- This slows down your work progress however
- Mainly, these viruses come with pirated software or shareware
- Email worms are very popular these days

Security and Privacy

- Security
  - Theft - top secret data must be encrypted with passwords to be protected
  - Intruders or hackers - they break into computers just because they can (often have no life)
  - Interception of transmissions - very important with military data and planning
- Privacy
  - If only Bill and Monica were aware of keeping their files private.

Ergonomics

- The study of making people comfortable when working on computers
- New keyboards come with warnings that sitting all day at the computer can cause severe problems
- Newer keyboards, mice, joysticks, chairs, desks, etc … are being developed

Representation of Data

- The basic information unit in the computer is a bit (short for binary digit).
- In memory the bit is stored in electronic or magnetic form and can take on two values.
- For simplicity these two values are designated 0 and 1.
- The Challenge: How do we represent all information in memory using only these two symbols?

Representing Data

- What kind of things need to be represented?
  - computer instructions which are stored in memory.
  - characters such as ‘A’, ‘B’ and ‘7’ which allows us to store text.
  - integer numbers such as 125 and 9878.
  - decimal numbers such as 3.14159 and 53.5×10^3.
  - graphic information which allows storage of photographic images.
  - sound information which allows us to store music.
- All of the above need to be represented and we have only two symbols, 0 and 1. In order to do this we get to group the bits together to form a bit pattern and the different patterns represent the different “things”. The way in which we choose these bit patterns is called “Data representation”

Example: Representing Text

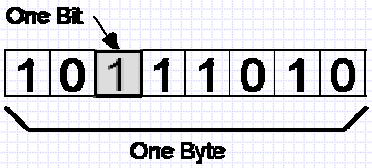
- If we wish to represent text we need a different bit pattern for each character. How many characters do we need?
- We have to represent
  - all the upper case letters (26)
  - all the lower case letters (26)
  - all the digits 0,1,2,3,4,5,6,7,8,9
  - all the punctuation such as . , ? ! etc
  - and other characters such as > < ( ) { } [ ] etc.
- In particular we also need to represent the character "blank" and a bunch of other special characters.

Example: Representing Text

- Question: How many bits do we need to do this?
  - If we use 1 bit there are 2 different bit patterns and they are: 0 and 1.
  - If we use 2 bits there are 4 different bit patterns and they are: 00, 01, 10, and 11
  - If we use 3 bits there are 8 different bit patterns and they are: 000, 001, 010, 011, 100, 101, 110, and 111
  - If we use 4 bits there are 16 different bit patterns. 0000, 0001, 0010, 0011, 0100, 0101, 0110 … etc.
  - If we use 5 bits there are 32 different bit patterns … not sufficient
  - If we use 6 bits there are 64 different bit patterns … not sufficient
  - If we use 7 bits there are 128 different bit patterns … this is sufficient

Bytes and Bits

- If we use 7 bits there are 128 different bit patterns … this is sufficient … but in computer science we don't like 7, so …
- we use 8 bits which gives 256 different bit patterns which is sufficient.
- Bytes:
  - The basic addressable memory cell is called a byte and is typically composed of 8 bits.
  - A byte is a memory cell which can store one character.



ASCII Codes

- Question: How do we decide which bit pattern corresponds to which character ?
- This is decided by a standards organization.
- There are a few standards and the most common one is called ASCII, which stands for "**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange".
- This standard gives each character a specific bit pattern.
- A more recent standard is the UNICODE standard which has much more bit patterns (16-bits) and allows support for different language characters.

Sample Bit Patterns (ASCII)

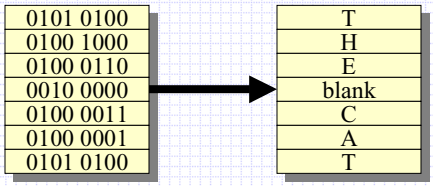
A	0100 0001	a	0110 0001
B	0100 0010	b	0110 0010
C	0100 0011	c	0110 0011
0	0011 0000	Blank	0010 0000
1	0011 0001	?	0011 1111
2	0011 0010		

Encoding a Phrase

- How would a a phrase look if written in ASCII?
  - THE CAT
  - 01010100 01001000 01000101 00100000 01000011 01000001 01010100
- This is not of much use to us but its just the right form for computer memory.

Storing Text in Memory

- Memory can be viewed as a succession of bytes and each byte containing a bit pattern.
- So we can conceptualize the text "THE CAT" as stored in memory (RAM or ROM) as follows:



Storing Other Information

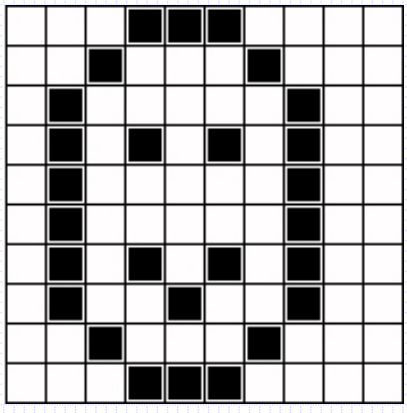
- What about integer numbers such as: 1234, 971, 22, or 1,456,345,567,789?
- It is somewhat outside the scope of the course to see what the bit patterns are but we might ask how many bits are required to store an integer number.
- Is one byte enough?
  - No! because one byte gives only 256 different patterns and that is not enough for integers.

Size of Integers

- How many patterns are there for bigger numbers of bytes?
  - 1 byte is 8 bits and that gives 256 different bit patterns
  - 2 bytes is 16 bits and that gives 65536 different bit patterns
  - 4 bytes is 32 bits and that gives 4,294,967,296 bit patterns
- SO for integers we would want each integer to be 4 bytes which gives us 4,294,967,296 different possibilities.

Storing Photos

- How do we store graphic information such as a photo ?
- We break up the photo into a grid pattern. Each element of the grid pattern is called a PIXEL or PIcture ELement.
- Here is an example of a picture broken down into a 10 by 10 grid of 100 pixels



Storing a pixel

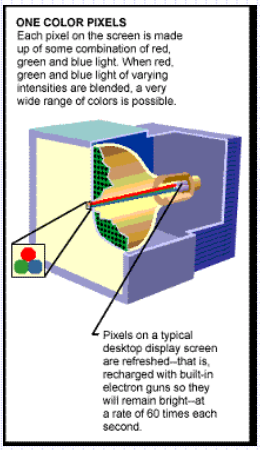
- How much information is required for each pixel?
- Answer: It depends on the kind of photo.

Black and white photo

- Gray scale photographs typically have 256 levels of gray from black to white. So each pixel requires 1 byte.
- Example: the photo schematically represented in the previous slide requires: 10 x 10 x (1 byte) = 100 bytes.
- More realistically the grid pattern may be more like 1280 by 1024. In this case the photograph may require 1280 x 1024 x 1 byte = 1,310,720 bytes.

Color Photo

- Images on the screen of your computer are made up of 3 primary colors for each pixel (red, green, blue):
- Suppose each color has 256 brightness levels. Then each pixel requires 3 bytes.
- So for an 1280 x 1024 grid we require 1280 x 1024 x 3bytes = 3,932,160 bytes.



Summary:

- Depending on the size of the grid, photographs require a great deal of memory!!!

Counting Number of Bytes

- Obviously we sometimes deal with information requiring a lot of storage and so we need notation for counting bytes.
- We usually use Capital "B" to represent Bytes, while lower case "b" is used to represent bits.
- In computer science
  - 1K = 1,024 (roughly 1,000)
  - 1M = 1,024K = 1,048,576 (roughly 1,000,000)
  - 1G = 1,024M = 1,048,576K = 1,073,741,824 (roughly 1,000,000,000).

How Big Are Files?

- A file containing text (a text file) has 1 byte for each character.
- So a file containing a large novel such as "War and Peace" has about a million characters and so would take around 1 MB.
- A text file containing a letter might have a thousand characters and so would take 1KB.
- Photographic files take anywhere for a few hundred KB to a few MB.

How Do Files Fit on Different Disks?

- Floppy disks store 1.44MB of data.
- Zip disks store about 100MB of data.
- How many bytes of data can be stored onto a hard disk ?
  - Used to be around 20MB (15 years ago). Now 40GB, 80GB, and 120GB are common.
- Assuming that we have a bunch of floppy diskettes that are full with data, how many diskettes can we copy to a 4.3GB hard drive?
  - Answer is roughly 4,300,000,000 ÷ 1,440,000 ≈ 2,986.
- What about a zip disk instead of a hard drive?
  - Answer is 100,000,000 ÷ 1,440,000 ≈ 70.

Files And Directories

- Most users don't really care how data is physically stored.
- From our point of view, we just store our data in terms of files.
- A file is a "package" of data that is stored on a disk. It is very similar to having a file stored in a filing cabinet.
- The files are organized in directories (also known as file folders).
- Directories can contain files or other directories.
- Every disk has a root directory.

Files And Directories

- There are many types of files and files can hold data for different things.
- Every file and directory MUST have a name which is called the filename.
- Often, a period and 3 characters finish the name and this is called the file extension.
- The file extension gives an indication as to the type of file (i.e. the filetype) it is and what can be done with it.
  - After all … if there is no limit as to what names to use … how do we know what any file does?

Examples of File Types

- Program or application (usually a .exe or .bat extension)
  - game
  - tax software
  - calendar
  - calculator
  - word processing package
  - paint program
  - internet browser

Examples of File Types

- Text file and documents (usually a .txt, .htm, .doc or .wpd extension but it depends on the type of document)
  - an essay typed into the computer
  - a recipe for some chicken noodle soup
  - a list of all your CDs or video tapes
  - a book you've written
- Image or picture files (usually a .gif, .jpg, .bmp or a .tif extension)
  - hand drawn images
  - scanned in pictures
  - photos
  - screen snapshots

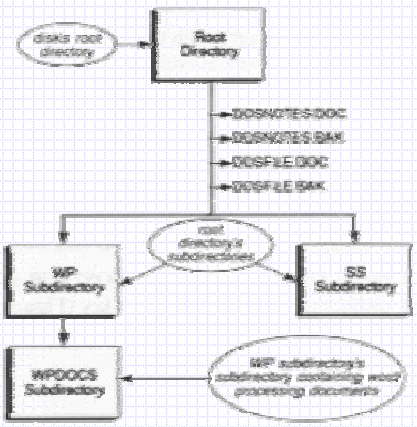
Examples of File Types

- sound (usually a .wav or .mp3 extension)
  - recorded sounds
  - music files (mp3,wav, realAudio)
- multimedia (usually a .avi or .mp2 extension)
  - video or movie clip
- zipped (usually a .zip or .cab extension)
  - any file that has been compressed to save space on the disk
  - must be unzipped before using it
- application specific files (any other extensions possible)
  - Lots of weird and unknown files come with software
  - nobody really knows what all the files mean except those people that create them

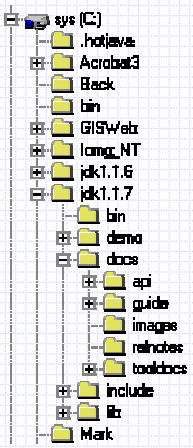
Directory Structure

- What is a directory structure?
  - It is a (family) tree of files and folders (directories) usually forming a hierarchy:
  - Folders just hold more files and folders
  - A pathname identifies a file and it's location in a directory structure.

Directory Tree



Directory Hierarchy



Example

- Here is an example of a directory structure with files and folders (i.e. directories). (The bolded words are directories):

```
A:\
    outline.doc
    outline.html
    notes\
        intro.html
        files.html
        assignments\
            assignment1\
                assignment1.txt
                sheet.txt
                marks.txt
```

Directory Structure

- Since a computer typically has many disk drives (floppy disk, hard disk, CR-ROM, zip drives …), every time we want to read or write a file, we need to specify the drive that we want to work on.
- Each drive is assigned a letter which can vary according to the machine that you'll work on.
- The A: in the example above indicates the drive letter.

Drive Letters

- Floppy drives usually have the drive letters of "A:" and "B:".
- The letters "C:" and "D:" often indicate hard disk drives while "E:" or "F:" often indicates a CD-ROM drive. However, this is NOT a hard rule.
- When specifying a file, we must specify the name of the file as well. In the example above outline.doc is one filename.

Paths

- Lastly, it may be that the file is inside a folder which itself may be inside another folder etc …
- So, we need to specify the full pathname which will indicate the series of folders that we must go through to get the file.
- These are often separated by backslash characters.
  - For example: A:\assignments\assignment1\assignment1.txt is the full pathname for the assignment1.txt file

Common File Operations

- View files and folders
- Select a drive
  - A: (floppy drive)
  - B: (floppy drive)
  - C: (typically the hard drive)
  - Z: (your personal drive in the SCS lab)
- Select or open a file or folder
  - opening a file usually causes some kind of application to start up.
  - in windows, programs are associated with file extensions
- Create, move, copy, delete or rename files and folders
- Format or copy a diskette (A: drive)