

63.135 Information Technology and Society

IT Background

- Hardware
- Operating systems
- Networks
- Application software

(These are the main concepts of IT fluency, as presented in 63.120, Introduction to Information Technology)

IT hardware

- Computers
- Output devices (printers, monitors)
- Input devices (mouse, keyboard, scanner)
- Network gear (modem, router, server)
- Internet (ISP, backbone)
- Telephones
- Cable boxes
- Copper wire, coaxial cable, fiber optic cable

Data

- *Bit*: a single truth value or on/off switch
- *Byte*: 8 bits, capable of storing a small number or a character
- *Word*: 32 or 64 bits, the size value a processor can manipulate in one operation
- Access is *sequential* or *random*

Digitizing information

- *Definition*: using symbols to represent information
- *Discrete*: requires detecting presence/absence (true/false)
- *Bit patterns* are arbitrary abstractions that stand for other things
- *Example*: numeric digits for phone dialing

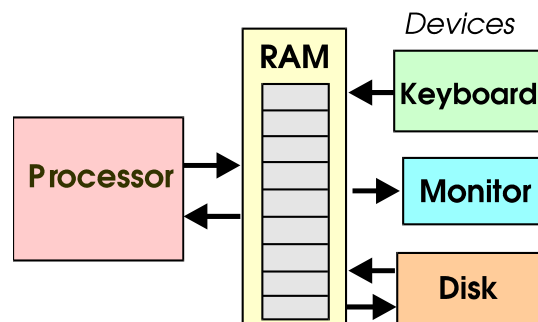
Any information is digitally encodable

- *Bias-Free Universal Medium Principle*: “Bits can represent all discrete information; bits have no inherent meaning” (Snyder, Ch. 11)
- *Analog* information, e.g., in wave or sensor-supplied form, can be *digitized* by sampling or other methods such as OCR
- *Meaning* of bits depends on interpretation set by an application



- *Example*: TCP/IP packet stores *any* data available over Internet

Architecture of a computer



- Data flows as shown by arrows
- Data is communicated and stored as *bits* (on/off pulses or switches)

The fetch-execute cycle

PC \leftarrow 0

Repeat

Copy instruction from MEM(PC) to IR

Increment PC

Execute operation in IR

until operation is STOP

- *PC = Program Counter register*
- *IR = Instruction Register*
- $\leftarrow = \textit{gets}$

System software

- Operating systems (Windows, Linux, Mac OSX)
- Network and Web server software
- Java virtual machine
- Software-development software (Java compiler)
- Software used by ISPs and by Internet backbone (e.g., Cisco Systems)

Operating systems

- *Examples:* Windows, UNIX, Mac OS
- Run all the time, providing services to users and apps
- Manage primary storage (RAM)
- Provide graphical user interface (GUI)
- Support secondary storage through file system
- Support multitasking (execution of multiple programs concurrently)
- Support networking (interactions among computers)

Application software

- Word processors, text editors
- Presentation graphics apps
- Spreadsheets
- Internet browsers
- Email apps
- HTML generators
- Database management systems
- Search engines (Google, Yahoo)

Word processing

- Text editing and formatting
- Screen views: normal, print-preview
- Output to printer
- Storage, retrieval, export, import
- Export (*.txt*, *.html*)
- Tables, outline, speller, drawing tools, headers, footers, pictures

Document and paragraph formatting

- *Styles*: named packages of format choices
- Document layout (margins)
- Multi-column
- Paragraph
 - Indent
 - Vertical spacing before or after
 - Keep together, keep with next
 - Bullet
 - Enumeration
 - Left, center, right, justified

Creating and using slides with a presentation graphics app

- *Example:* PowerPoint
- Support for in-person presentation
- Bite-sized idea chunks
- Outline format
- Special features, e.g., animation
- Footers
- Notes pages

Spreadsheets

- *Model:* paper spreadsheet grid, where some cells are calculated
- Visicalc, Lotus 1-2-3, Quattro: “Killer apps” of 80s-90s
- *Excel:* Part of MS Office suite
- Principle of spreadsheet: automatic calculation of formulas in cells (e.g., sum of column)
- All data dependencies should be formulas

Using spreadsheet data

- Derive summary results (sum, average, variance)
- Display, print
- Create charts (pie, bar, line)
- Export to word-processor or text file
- Use as database table; e.g., can sort, query

Why database management?

- Much information is easiest to manage in *tables* (relations)
- Use of general-purpose *database management systems* (DBMSs) is growing
- End users often query and even design these tables

Database management

- Supports retrievable arrangement of data
- *Examples:* library catalog, student records, business records
- Want to separate the database management software from the data design, enabling data design on site
- Likewise *query design* is possible on site
- Simple DB management can be done with MS Word tables, Excel spreadsheets

Tables

- Store information for lookup
- Database tables include *metadata* (headers)
- Records have *attributes* (fields), which have names, types, values
- *Example:* student table (*name, ID, email, major*)
- Row representing instance of entity is a *tuple* (record)
- *Sets* of tuples (relations) are unordered, by definition
- *Primary key* is unique identifier of a tuple

Queries

- *Query*: specification of a view
- *Examples*:
 - Select all student records where major is Business Administration
 - Select all employees where salary > 25000 and salary < 50000
 - Select name, salary from employees
- Query languages
 - Query by example
 - Structured Query Language (SQL)

Other database tools

- *Web pages* may access and even update database files for customer service
- *Forms* enable easy entry of data into a relation
- *Reports* format DB information for distribution
- *Graphical design tools* enable study of linked relationships among tables
- Integrity rules assure that a database remains internally consistent; e.g., no fact should appear more than once in a database

Networked computing

Motivation:

- Much of the benefit of computing is in being connected with other users and with resources
- In changing networked environment users need to have some knowledge of underlying concepts

Implementation:

- Standard rules of communication enable compatibility for communication

The Internet

- *World Wide Web*: Browsers, servers, web pages
- *URL*: Uniform Resource Locator; components: protocol, server, pathname
- *HTML* (Hypertext Markup Language) enables nonlinear, formatted documents
- *Internet Protocol*: Defines “IP address” format
- *TCP/IP*: Transfer Control Protocol/IP; provides standard *packet* format

Online data and search

- Libraries are still the best source of pre-1985 information; catalogs are online
- Data hierarchies narrow search, step by step: root, branch, leaf
- Search engines: Crawler (indexer); query processing
- Evaluate sources for legitimacy, authoritativeness
- Primary vs. secondary/tertiary sources
- Search techniques: Use of quotes, AND, NOT, refined search

Client/server computing

- User is “client,” making request; website responds as “server”
- *Example:* visiting a site, downloading HTML file
- No continuous connection, just requests/responses
- Some web pages are generated specifically for one transaction, e.g., flight reservations
- *Middleware:* software, e.g., DBMS, that handles layers (other than client and servers in C/S relationship), $C \rightarrow S \rightarrow M \rightarrow S \rightarrow C$
- Server becomes client of middleware server

E-commerce

- *Definition*: “Conducting business using electronic data communication”
(Snyder, Ch. 16)
- *Variations*: web shopping, electronic funds transfer, point-of-sale transactions, business to business commerce, networked meetings
- *Features*: diverse audience, client/server environment, transaction based, need for interoperability standards, unreliability of systems

Transaction processing

- A transaction is an *atomic* (indivisible) series of steps constituting one meaningful interaction
- Simultaneous requests require database *lock* to preserve atomicity
- Another term for this is *serialized behavior*
- *Example*: edits of a document by multiple authors should be serialized so that conflicting versions never coexist

Interoperability requires standards

- HTTP (Hypertext Transfer Protocol)
- HTML enables web-based data to be self-formatting (appearance)
- CGI (Common Gateway Interface), an extension of HTML
- Java virtual machine supports same *applets* downloaded from Internet to different platforms
- XML (Extensible Markup Language) enables data to be self describing (meaning)
- W3C (World Wide Web Consortium) sets standards

Concepts

analog	Internet
application software	interoperability
architecture	network
bit	online data
client/server	operating system
data	presentation graphics
database	processor
digital	query
disk storage	RAM
E commerce	record
export	spreadsheet
fetch-execute cycle	table
formula	text formatting
hardware	transaction processing
HTML	universal medium
HTTP	URL
information technology	World Wide Web

References

J. Parsons and D. Oja. *Computer Concepts*,
10th ed. Thomson, 2008.

L. Snyder. *Fluency with Information
Technology: Skills, Concepts, and
Capabilities*. Addison Wesley, 2006.