

CSCI 135 Information Technology and Society

Topic 1: Technical background

1. History of computing
2. Hardware and operating systems
3. Networked computing and the Internet
4. Text formatting, spreadsheets, and database management

Inquiry

- What are the major *technical changes* in computing that affect us as members of society?
- What are the effects of
 - universal connectedness,
 - ubiquity of computing,
 - speed and low cost of processing, storage, copying, and communication of information?

Objectives

- 1a. Explain basic principles of computer hardware and operating systems
- 1b. Explain concepts of major office applications
- 1c. Use software that supports collaboration
- 1d. Explain concepts of networked and Internet computing

1. History of computing

IT includes:

- Data processing, mechanical or electronic
- Silicon-based micro-electronics
- Electronic computing with stored programs
- Telecommunications and broadcasting
- Opto-electronics, devices that work with light
- Genetic engineering based on the molecular symbols in DNA

Kinds of technology

- *Extending human power*: spear, lever, telescope, radio
- *Autonomous and modeled on natural processes*: e.g., clock, creating a new reality for users, replacing direct experience (e.g., hunger) with abstract signals
- *Information processing*: a new kind of autonomous technology that operates on and transmits *information* instead of *power*

Pre-history

- Leibnitz and Newton developed the *calculus* to reason about scientific data
- G. Boole developed a mathematics of truth values, *logic*
- Charles Babbage invented a computing *machine* based on mechanics, e.g., cogwheels; never built
- Countess Ada Lovelace *programmed* for Babbage's invention; first programmer
- *Looms* were automated, 18th century
- 1890 U.S. census was tabulated with help of *punched cards*

Electronic technology and the IT revolution

- *Telephone*: 1876; *radio*: 1898
- *Vacuum tube*: 1906; *transistor*: 1947
- *Semiconductor technology* uses the principle that voltage above a certain threshold will be conducted (switch that switches a switch)
- *Silicon transistor*: 1954; *integrated circuit*: 1957
- 1959-1962: price of semiconductors fell 85%
- 1962-1971: price of semiconductors fell 98%
- *Microprocessor*: 1971

Development of cybertechnology

Phases:

1. (1950s-1960s) Stand-alone mainframes. *Issues:* Can machines think? Is Big Brother watching you?
2. (1970s-1980s) Convergence of computers and communications as networks
3. (1990s-2000s) Internet; convergence of text, video, sound on the Web. *Issues:* free speech, anonymity, jurisdiction, trust
4. (2000s) Ubiquity of computing, computers as part of who we are

Computers

- ENIAC, 1946 (Mauchly-Eckert), 30 tons, drew enough power to dim the lights of Phila.
- UNIVAC, 1951, first commercial computer
- Altair, 1975, first microcomputer
- Apple, 1977; IBM PC, 1981; Macintosh, 1984
- Networked and Internet computing on mass scale, 1990s
- **Cost of data processing**
 - 1960, per million operations: \$75
 - 1990: less than \$0.0001

Cybernetics

- *Definition:* the study of feedback-driven systems (Norbert Wiener, 1948)
- Word origin: *kyber*, person at helm of boat
- Cybernetics relates to *interaction*; much of computing is interaction
- *Cybertechnology* is computer technology

Changes driving the IT revolution

- *Software*: advances have included desktop applications with graphical interfaces; interactive browser-based apps and services; Web 2.0
- *Hardware*: high-speed processors and Internet service; massive memory and storage; general-purpose computing on cell phones; communications standards
- Universal interchangeability of information, made possible by standards of storage and communication

Technologies of life

- DNA hosts a *language* of sequences of symbols; reproduction of life is a kind of computation
- DNA discovered, 1953; cloning procedures, 1973; human gene cloned, 1977
- Human genome project launched, 1990, with government funding
- *Bioinformatics* is the use of computational methods in biology; an interdisciplinary field with computer-science participation

2. Hardware and operating systems

Kinds of hardware:

- Computers (including mobile phones)
- Output devices (printers, monitors)
- Input devices (mouse, keyboard, scanner)
- Storage devices (disks, flash drives)
- Network and Internet gear (modems, routers, transmission media)

Data

- *Digital data:* information that is represented using symbols, e.g., {0, 1}
- *Bit:* a single truth value or on/off switch
- *Byte:* 8 bits, e.g., a character
- *Word:* 32 or 64 bits, the size value a processor can manipulate in one operation
- Access to storage is *sequential* or *random*
- *Bit patterns* are arbitrary abstractions that stand for other things. *Example:* numeric digits for phone dialing

Any information is digitally encodable

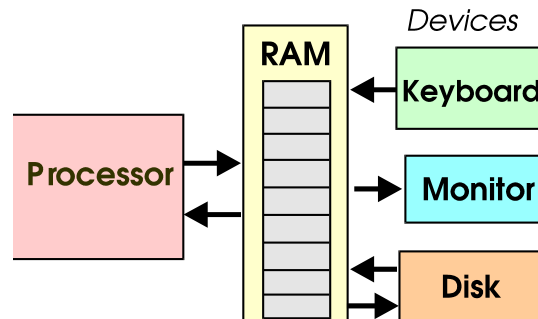
- *Analog* information is on a *continuum*, e.g., in wave or sensor-supplied form
- Analog data may be *digitized* by sampling or other methods such as OCR
- Digital data may be converted to analog form



Universal interchangeability of information

- *Bias-Free Universal Medium Principle*: Bits may represent any information and lack inherent meaning
- *Digital technology* enables use of this principle for human benefit
- *Example*: TCP/IP packets store *any* data available over the Internet; text, numeric, picture, sound, video
- *Meaning* of bits depends on interpretation set by an application

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

- Data and programs are located in memory
- All activities are under control of the *processor*
- The processor repeatedly
 - retrieves an instruction from memory
 - plus a data location
 - executes the instruction
 - until the instruction is to halt.

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)

File management

- The *storage metaphor* for most OSs is a *file system* consisting of *files* and *folders* (*subdirectories*)
- Folders may contain folders or files in a *hierarchy*
- Each file may be short, long, or empty; may be changed in size and content if on hard disk
- File is stored physically in a linked sequence of disk sectors
- A folder may be displayed sorted on any attribute
- Operations on files: *copy, move, delete, rename*

3. Networked computing and the Internet

- *Distributed computing* uses physically separated processors; networks implement distributed computing
- Much of the benefit of computing is in being connected with other users and with shared resources
- The speed and connectivity enabled by networking have major social implications
- *Hypothesis: The networked character of computing today accelerates the rate of change in computing and in society*

Networked computing

- A *network* is a set of computers *configured* to share data and other resources
- Special system software and communication hardware enable networking
- *Standards* are required for computers to communicate and work together
- A *server* is a computer on a network that responds to user (*client*) requests for data, in *client/server computing*
- The *Internet* is a worldwide network of networks

Client/server computing

- Client initiates all actions, server responds
- *Examples:* browser is client, web-site host is server serving HTML files; email uses server
- 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 added layers (other than client and server) in n -tiered C/S relationship
- Server becomes client of middleware server:
(C → S → M → S → C)

The Internet

- A network of networks, originated by DARPA, 1960-1964, as a military communication system invulnerable to nuclear attack
- Based on packet transmission and decentralized control; online 1969
- Internet Protocol (IP) and host-to-host (TCP) defined, 1978
- Modem invented for PCs, 1978
- IT revolution was started in 1970s, in form of the personal computer and the Internet

Internet standards

- *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

The Internet

- The Internet is a worldwide network of networks that links almost all computing devices worldwide
- *Agreed standards* enable exchange of data
- The Internet has a physical infrastructure and has governing bodies to make decisions
- Users connect to Internet via Internet Service Providers (ISPs)

Internet history

- Developed by Defense Advanced Research Projects Agency, DARPA, as a decentralized solution to danger of a disruption of military communication in case of nuclear war
- Mosaic (later, Netscape) browser, mid-1990s, enabled millions to use the Internet easily
- Web 2.0, 21st century, expressed the ability to use the Web interactively

The World Wide Web

- *World Wide Web*: An abstract information space within the Internet in which servers host web pages, clients access Web servers via browsers
- *HTTP*: Hypertext Transfer Protocol, governs retrieval of web sites by users
- *URL* (Uniform Resource Locator)
 - the address of a web page
 - components: **protocol**, **server**, **pathname**
(<http://www.framingham.edu/~dkeil>)
- *HTML* (Hypertext Markup Language) enables nonlinear, formatted documents

The World Wide Web

- Developed in Europe, 1990, at CERN, Geneva
- Based on hacker culture and *hypertext* concept, HTML, HTTP, URL
- Early browsers: Mosaic, Netscape (Later: Internet Explorer, Firefox)
- Networks became information processing systems via Java (1995) and Jini (1999)
- A universal global infrastructure based on fiber optics and digital transmission is in formation

Cell-phone technology

- Cell phones are IT, have processor, run apps, but are not general-purpose computers
- A *cell* is a geographic area with a tower and with transmit/receive hardware
- Voice sound (analog data) is converted to digital form by a chip
- Digital signal processor compresses bits to be transmitted in packets via radio waves, decompresses at receiving end for conversion to sound

Internet phones

- *IPhone* (for Apple software) and *Droid* (open-source software) are mobile devices, or specs for them, that communicate and run downloaded programs (apps)
- Internet access is becoming generally available now via cell-phone technology
- Packets travel via radio waves from cell towers in this technology; computers use cables and wireless routers

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

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

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

Web 2.0 (interactive Web)

- *Social networks* (Facebook, MySpace): Web sites that enable users to post “profile” info about themselves and to connect to “friends”
- *Instant Messaging*: Real-time text conversations
- *Podcasts*: Subscribers receive text, audio, or video files from providers as they are produced
- *Blogs*: public personal journals with support for user response
- *Wikis*: Web documents editable by multiple users as a collaboration tool

Web 2.0: The Interactive Web

- Publishing: Blogs and wikis
- Syndicating: Podcasts and feeds
- Organizing data: Tagging, bookmarking
- Connecting people: Social networking (Facebook)
- Linking data
- YouTube, Twitter

Overview of Web 2.0

- Background: world wide web began as static linked pages
- Web 2.0 features interactive apps that rely on the user to make the sites more attractive to new users
- *Examples:* Facebook (social network), Flickr (photo sharing), YouTube (video sharing), Wikipedia (collaborative encyclopedia), Gmail (browser-based email with IM)

User-generated content

- *Social media sites:* enable sharing information, opinion, entertainment
- *Democratic journalism:* news stories voted on by participants; e.g., *Digg*, *Newsline*
- *Blogs:* usually immediate, unedited reactions by non journalists
- *Wikipedia:* 1.7 million articles ('07), 600 million words (vs. *Encyclopedia Britannica*, 40 million words), anonymous writers, any article editable by anyone

Features of Web 2.0

- Factors in development of Web 2.0:
 - Universal broadband connectivity
 - Mobile phones with Internet access
 - Web-based apps that run within browser
 - Readiness of users to contribute content; e.g., digital photos and video
- “A culture of participation”
- Mobile-phone apps and standard interfaces (Droid, Iphone)

Web 2.0: features not seen before

- Increasing richness of interaction
- *Interactive blogs* (vs. one-way communication)
- *Video sharing* (vs. broadcasting)
- *Wikis* (vs. centrally edited publication)
- *Social networks* (Facebook, MySpace, LinkedIn)
- *Web 1.0*: Downloading information, hyperlinking, E business

Examples

- *Social networks* (Facebook, MySpace): Web sites that enable users to post “profile” info about themselves and to connect to “friends”
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Twitter

- A Twitter user may send a broadcast (tweet) to all the user’s followers
- Followers choose who they follow
- Followers are known to senders
- Tweets may be forwarded
- Is follower relationship public information?

The Internet's acceleration of change

- The Internet, around 1995
 - enabled all members of society to be directly connected
 - hence was the factor that allowed computing to become universal in society
- *Hypothesis*: knowledge acting on knowledge enables very rapid rate of social change

Social implications of network communication

Features with effects on society:

- *Scope* (vastness of reach; interactivity)
- *Speed* (giving immediacy and access)
- *Anonymity* (implying diminished trust)
- *Reproducibility* (enables harassment and violation of privacy)
- *Many-to-many communication* (for first time in history)

Collaborative tools

- Wikipedia, Wiktionary, wikis
- Blogs
- Open Directory Project
- Free Software Foundation
- Webcams monitored by volunteers
- Crime reporting to other community residents to enlist volunteers
- Track Changes (MS Word)

Cloud computing

- *Definition:* use of remote applications, services, and storage hosted by specialized data centers
- *Basis:* availability of mass storage in data centers, accessed via high-speed Internet
- *Advantages:* businesses are freed of the need to manage their own data centers
- *Data center:* a location for mass storage on servers
- Annual projected 2014 usage of cloud: \$55B

Cookies

- A *cookie* is a file that a browser allows a web site to leave on the computer of a visitor to the web site
- Browsers also allow web sites to request and receive cookies previously left on visitor's computers
- *Example:* an E business site may leave a cookie at a user's site that enables the site to give better informed service to the user on a later visit

Malware

- *Virus* replicates self from file to file
- *Trojan horse* disguises self as a useful application
- *Worm* replicates from computer to computer
- *Botnets* are sets of computers (zombies) controlled remotely in background
- Email address spoofing: Email return addresses are not necessarily genuine, can deceive users into infecting their computers

Firewalls

- Most users wish to be clients (obtaining data from Internet servers) but not servers (providing information on request)
- Purpose of firewalls is to block outside access to computers via the Internet
- Firewall *packet filtering* may block outside access to logical Port 21 (FTP port), for example
- *Network address translation* (NAT) by firewalls assigns workstations IP addresses known only within the network

Security and encryption

- *Secure web sites* are password-protected
- *Secure connections* are those that encrypt the data communicated; protocol is *https*
- *Encryption* transforms a message into a difficult-to-read text; decryption transforms encrypted text to readable form
- Encryption/decryption use algorithms and a private key; some algorithms also permit a public key
- *Strong encryption* is hard to “break”
- Public keys enable client browsers to encrypt messages for sending securely to recipients

Free Internet-based services

- *Social networking*: Unexpected uses have been political campaigns, product marketing
- *Web-based email*: Advantages includes access to email and archive from any Internet client machine
- *Search engines*: Priority of a site in the provider's index decides site's visibility
- *Payment for free services*: Advertising; donations or payment by a few big users

Ubiquitous computing

- Following mainframe, network, and Internet phases of cybertechnology
- A.k.a. *pervasive computing*
- Objects in our work or recreational environments will exhibit "ambient intelligence" via wirelessly connected "smart objects" and intelligent web agents
- RFID is an example
- Accelerated rate of change and convergence of IT and biotech

4. Text formatting, spreadsheets, and database management

Text and image editing

- Text editing, formatting, printing
- Storage, retrieval, export (*.txt*, *.pdf*, *.html*, *.gif*), import
- Tables, outline, speller, drawing tools, headers, footers, pictures
- Supports malleability of information

Headers and headings

- *Page headers* appear automatically at the top of each page
- An option is to include automatic page numbering
- Alternative: page footers at bottom of page
- *Section headings* appear above paragraphs or bullets
- Headings have predefined styles: *Heading 1*, *Heading 2*, etc.

Global control of formatting

- Named styles are instances of the key concept of *global control of formatting*
- This means that the user can change major formatting elements of a whole document in one operation
- Other instances of GCF in MS Word:
 - Page headers and footers
 - Document-wide Page Layout, e.g., for margins

Named styles

- *Named style*: A standard paragraph format that is reusable because it may be invoked by name
- *Examples*: titles, headings, paragraphs, bulleted text, numbered text
- *Advantage*: Changing the definition of a style causes new definition to be applied to each instance where style is used
- A style may be associated with a function key for easy application
- If “Heading 1” style is used, user may generate an automatic table of contents in MS Word

Tracking changes

- For *collaborative* creation and editing of documents, *Track Changes* in MS Word enables viewing all *proposed changes*
- Deletions and insertions are colored in red with strikethroughs
- To use Track Changes, choose *Review/Track Changes*
- *Option:* include editing comments

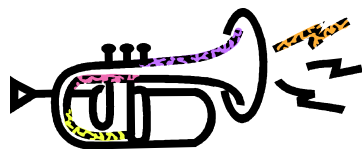
Spreadsheets

- *Model:* paper spreadsheet grid, where some cells are calculated
- Spreadsheet software created market for PCs in business in 1980s
- *Excel:* Part of MS Office suite
- *Principle of spreadsheet:* use automatic calculation of formulas in cells (e.g., sum of column) to represent *any* data dependencies

Cell contents

- Three kinds:
 - Label (non-numeric)
 - Numeric literal (2, 3.52)
 - Formula, normally referring to contents of other numeric cells
- Columns are denoted by letters
- Rows are numbered
- Formulas begin “=”, e.g.:
=A1 + A2 **=sum(A1,A2)**

Information integrity: Rule #1



Use formulas to generate any values that depend on other cell values

Why?

To cause consequences of changes in data values to be applied automatically

Example: batting averages

BATTING				
	AB	R	H	Avg
Mauer, Min	457	73	159	0.348 =D3/B3
Jeter, NY	546	97	188	0.344 =D4/B4
Tejada, Bal	564	91	187	0.332 =D5/B5
Guerrero, La	546	82	180	0.330 =D6/B6
Dye, Chi	479	93	157	0.328 =D7/B7
Morneau, Min	506	81	161	0.318 =D8/B8
Ramirez, Bos	446	78	142	0.318 =D9/B9
Johnson, Tor	410	78	130	0.317 =D10/B10
DeRosa, Tex	453	71	143	0.316 =D11/B11
Suzuki, Sea	604	88	190	0.315 =D12/B12

- Note *formula* in “Avg” column
- When formula is copied down, row number adjusts automatically

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

- *Examples*:
 - Select all student records where *major* is Business Administration
 - Select all *employees* where *salary* > 25000 and *salary* < 50000
 - Select *name, salary* from *employees*
- Excel queries are expressed as *filters*

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

Concepts

analog	fetch-execute cycle	processor
application software	firewall	program
architecture	formula	protocol
bit	hardware	query
client/server	HTML	record
cloud computing	HTTP	semiconductor
cookie	information technology	social network
cybertechnology	Internet	spreadsheet
data	interoperability	table
database	malware	text formatting
digital	network	Twitter
disk storage	online data	URL
E commerce	operating system	Web 2.0
encryption	presentation graphics	wiki
export		World Wide Web

Questions

- What most stayed in your mind in discussing this topic?
- For you, what was the *least* clear concept that you encountered in this topic?

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.