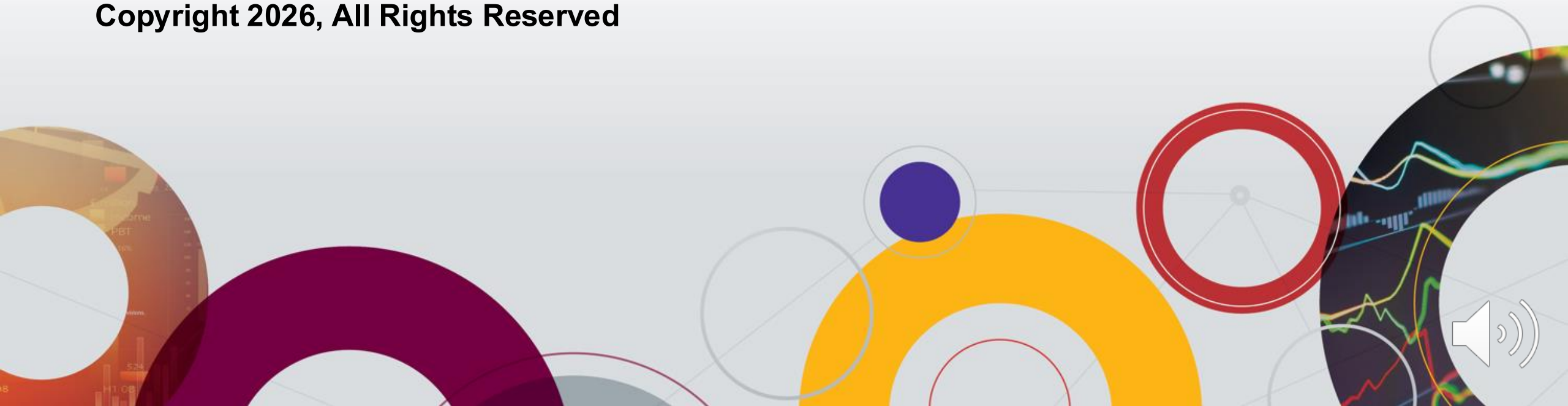


2.5b Software Engineering

10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
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Human-computer interaction (HCI)

Field devoted to human interaction with computers

- Often focused on “usability” of software
- Not a new concern: Miller (1968) noted criticality of response time

A leader is Shneiderman (2016)

- “Computers must take human diversity into account, from physical abilities and physical workplaces to cognitive and perceptual abilities”

Overview textbook of HCI in healthcare (Kushniruk, 2024)

Some challenges for usability in healthcare

- Medical information systems must be both usable and useful, due to complex nature of tasks and information (Pantazi, 2006)
- Users should be involved in design of systems, although most medical software is commercial

Process for evaluating HCI called usability testing (Yen, 2012)

Usability – what not to do

Nielsen

- [Introduction to Usability](#)
- [Top Web Design Mistakes](#)

[World's Worst Web](#) – bad things to do on Web pages

Shneiderman (2016) golden rules for human-computer interaction

Strive for consistency – in terminology, prompts, menus, help screens, color, layout, capitalization, and fonts

Cater to universal usability – add features for novices, such as explanations, and for frequent users, such as abbreviations, special keys, hidden commands, and macro facilities

Offer informative feedback

Design dialogs to yield closure – organize sequences of actions into groups with a beginning, middle, and end

Prevent errors – design for error prevention and offer simple error handling when they do occur

Permit easy reversal of actions

Support internal locus of control – users should sense they are in control of the interface

Reduce short-term memory load

Usability is growing concern, including for biomedical computing applications

US government recommendations and sites

- NIST EHR Usability Protocol for testing and validation of EHRs (Lowry, 2012)
- [Digital.gov](#) – includes resources on usability
- [US Digital Services Playbook](#)

Review of usability testing methods (Yen, 2012)

Framework for EHR usability

- Better EHR book (Zhang, 2014)
- [Toolkit](#)

Expressions of concern from leadership of medicine

- Need a “manageable cockpit” (Sinsky, 2018)
- Challenges going forward (Ratwani, 2019)
 - [Everybody has responsibilities](#)
- Usability practices improving among vendors (Hettinger, 2021)

Attention must be paid to human factors, especially in era of artificial intelligence (AI) (Chignell, 2023)

Use cases

Malan, 2001: “A goal-oriented set of interactions between external actors [users] and system under consideration.”

Oft-cited reference is Cockburn (2001)

Sometimes makes use of Unified Modeling Language (UML) (Gomaa, 2011)

Use cases are of two types (Washington, 2008)

- System use case – describes interaction between user and system
- Business use case – describes how high-level business process achieves its goals

Can be short statements or long detailed descriptions

Simplified use case template

Use Case	Descriptive Name
Description	Goal to be achieved
Actors	Actors involved (primary, secondary)
Assumptions	Conditions required for case to terminate
Steps	Interactions between actors and system to achieve goal
Variations	Variations in steps of case
Non-functional	Non-functional requirements

Other use case terminology:

- <<include>> - a base case already defined, analogous to a subroutine
- <<extends>> - changes to steps from an existing use case



Use case example: Authenticating to an electronic health record (EHR)

Description

- The goal is for a clinician to authenticate to an electronic health record (EHR)

Actors

- Primary: Clinician
- Secondary: Health System

Assumptions

- Clinician: wants to authenticate to system
- Health system: wants to insure only authorized users access system and log all attempts

Use Case: Authenticating to EHR (cont.)

Steps

- Clinician: Navigate to log-in screen.
- Clinician: Enter user name.
- System: Log entry and date/time stamp, validate this is a legitimate user name.
- Clinician: Enter password.
- System: Log attempt and date/time stamp, validate password is correct for this user name.
- System: If user name and password valid, allow entry into system.

Use Case: Authenticating to EHR (cont.)

Variations

- 4a. System may require additional authentication, such as a thumbprint verification.
 - 4a1. User places thumb on to thumbprint reader.
 - 5a1. Validate that thumbprint matches user.
- 6a. Log is processed to report all unsuccessful attempts to enter system for security analysis.

Non-functional

- Performance: Response time should be under 1 second for each system step.

Simple use case statements for biomedical applications

Clinician retrieving a specific piece of clinical data

Researcher aggregating data from an EHR

Patient looking up information about a newly diagnosed disease in an on-line database

Clinician receiving an alert about a drug prescribing error

Researcher evaluating data from a gene microarray experiment



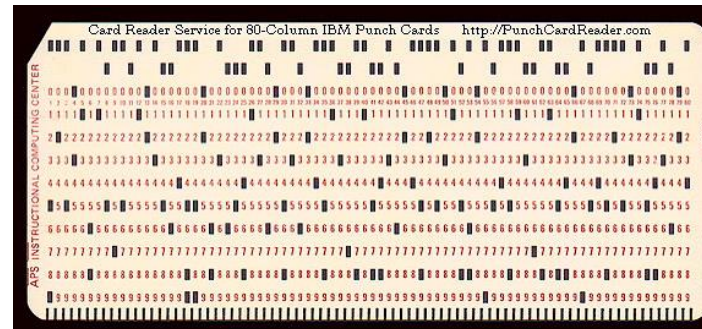
A personal history of computing

Started in high school – 1973

- HP 9830A with one-line LED display, thermal printer, and cassette “mass storage”; programmed in BASIC

Off to college as a computer science major
– 1976

- Early bit-mapped graphics on PLATO was exciting
- But punch cards were among things leading me to change my major in 1978



Personal history (cont.)

While in medical school, restarted with a Commodore 64 – 1983

- 64K RAM, 5¼" floppy drive, and 300 baud modem
- A “special computer” (Owen, 2022)

Joined the PC world – 1984

- IBM PCJr souped up to 640K RAM, 20 MB hard disk, and 2400 baud modem
- Much early programming in Turbo Pascal
- Learned about “informatics” and started seeking information by phone and letters (no Google!)



Personal history (cont.)

Became a Mac person when headed off to informatics fellowship – 1987

- Also first use of Internet – main apps were email, FTP, and telnet

Back to a PC – 1990s

- From “Web will never work” (1990) to game changer (1992)

Move to laptops in 1990s; last desktop around 2005

Connectivity

- First @Home broadband around 1998 – first connections for my children
- Last modem around 2003; wireless ubiquitous around planet now
- Now it's smartphones, tablets, etc.



Bringing it all together

Some things still amaze me

- Multi-terabyte hard disks under \$100
- Wireless broadband (5G), especially in places like automobiles, and everywhere in the world
- Wifi on airplanes
- Email and Web interaction on a phone
- Automatic syncing to projectors

What have I learned?

- Technology does matter, but its use of information is still more critical

What does the future hold?