Introduction to Human Computer Interaction

Week 1, Unit 1

CC7 Human Computer Interaction

Lovely Jenn A. Reformado

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Introduction to Human Computer Interaction

What is HCI? | Examples of Technologies | Technologies: Good v. Bad | Why HCI?

What is Human Computer Interaction (HCI)?

- Multidisciplinary field of study on the design of computer technology and interaction between humans and computers
- Concerned with the physical, psychological, and theoretical aspects of the processes
- Has since expanded to cover almost all forms of information technology design

Examples of Technologies

Examples of Technologies

Examples of Technologies

Examples of Technologies

Technologies: Good v. Bad

- Is good or bad the right question?
- What makes a technology good or bad?
- How can we build good technologies?
- How can we verify or validate the goodness of our technologies?

Why HCI?

Errors / mistakes in computer technologies still exist today

- Focus on whether or not the technology works
- The concept is too cool / groundbreaking
- Functions are hard to utilize / process
- Specific people use things specifically
- Too much safety / security in the technology
- Too much focus on the design

Why HCI?

When creating technologies, it must be:

- Suitable for the task
- Easy to use
- Adaptable to the user's knowledge and experience
- Provides feedback on the performance
- Displays information in a format and pace understandable to the user
- Conforms to the principles of software ergonomics

Why HCI?

The idea of use is also necessary for HCI:

- **Useful –** accomplish what is required (play music, cook dinner, format a document)
- **Usable –** do it easily and naturally, without danger of error
- **Used –** make people want to use it, be attractive, engaging, fun

Four Components of HCI

Human | Computer | Interaction | Context

Four Components of HCI

- Human
- Computer
- Interaction
- Context

The Human

- Also known as the user / end-user
- Limited in their capacity to process information
- Has important implications for design
- Focuses on **who** the HCI is for

The Human

- Information is received and responses given via several input and output channels:
  - Visual
  - Auditory
  - Haptic channel
  - Movement

The Human

- Information is stored in memory
  - Sensory memory
  - Short-term (working) memory
  - Long-term memory

The Human

- Information is processed and applied:
  - Reasoning
  - Problem solving
  - Skill acquisition
  - Error

The Human

- Emotion influences human capabilities
- Users share common capabilities but are individuals with differences

The Computer

- Focuses on **where** the HCI is found
- Comprises various elements, each of which affects the user of the system
  - Input devices
  - Output display
  - Virtual reality systems
  - Various displays (physical controls, haptic dieback, sensors)
  - Paper output and input
  - Memory
  - Processing

The Interaction

- Interaction models help us to understand what is going on in the interaction between user and system
- Address the translations between what the user wants and what the system does
- Focuses on **what** the HCI is

The Interaction

- Ergonomics are physical characteristics of the interaction and how these influence its effectiveness
- Dialog between user and system is influenced by the style of the interface
- Interaction takes place within a social and organizational context that affects both user and system

The Context

- Also known as paradigms
- Examples of effective strategies for building interactive systems to design usable interactive systems
- Focuses on **how** the HCI will be formed
- Ranges from the introduction of timesharing computers, through the WIMP and web, to ubiquitous and context-aware computing

The Design of Everyday Things

Unit 2

CC7 Human Computer Interaction

Arnemie B. Gayyed

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- Fail Designing
- Donald A. Norman Principle
- Six concepts in designing

Fail Designing

Design is not just what it looks like and feels like.

Design is how it works

-Steve Jobs-

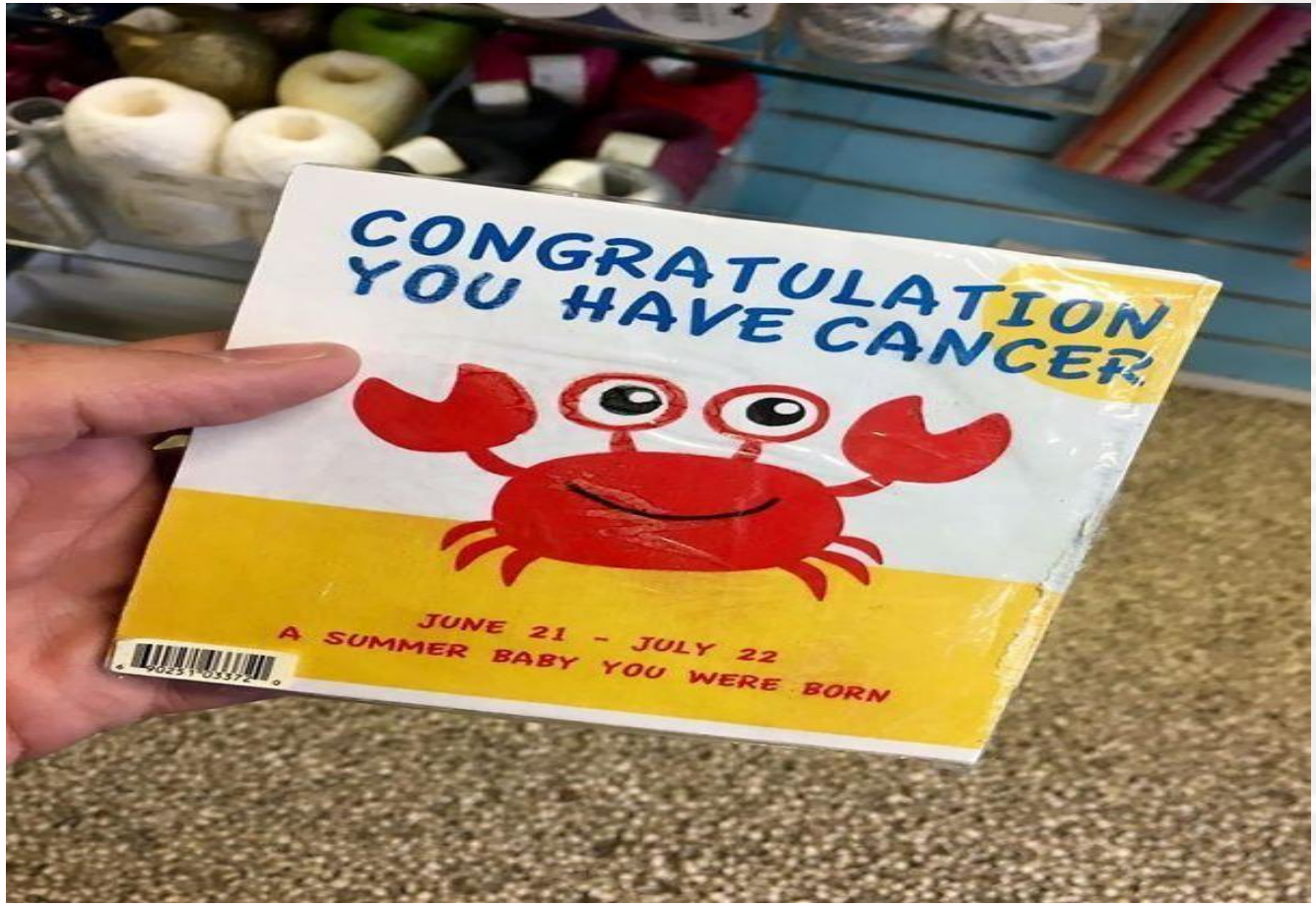
1. When you really need to examine the time in three dimension

2. Thou shall not pass

3. Social media... social toilet?

4. Its probably time to take the stairs

5. These people always see something positive



6. A door into the unknown

7. In case of fire, please find somewhere else to put it out

8. The serial killer playground

9. We’re on the escalator to nowhere, come on and bump.

10. Architectural masterpiece

11. All you need now is an all-terrain wheelchair

12. See no evil

13. Will it be fried eggs or a trip to hospital tonight?

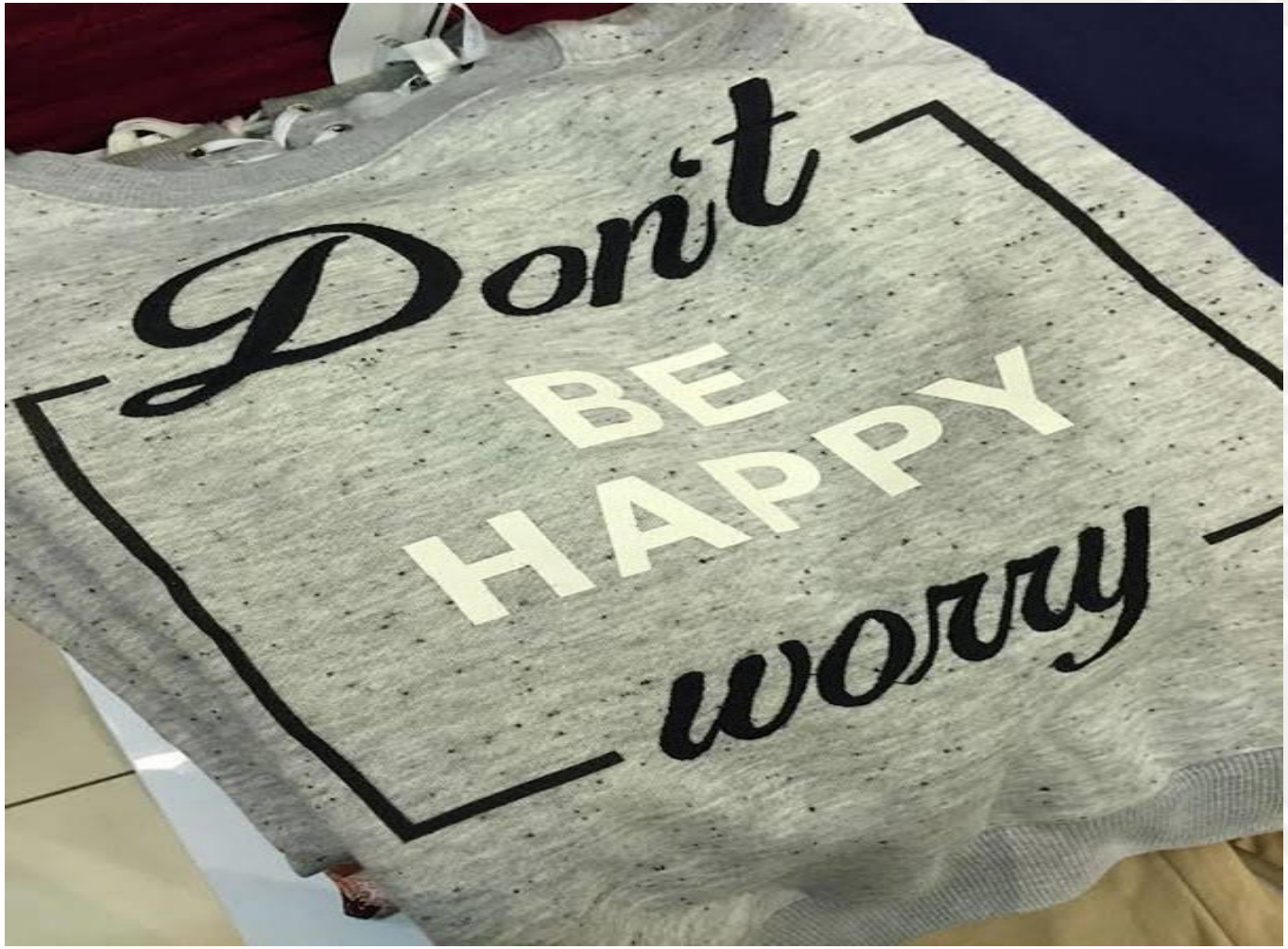
14. Big brother is watching you

15. All they say pride goes before a fall

16. Venn Diagram

17. Take a step into the unknown

18. We know few parents who might adopt this slogan



19. Kevin from Home Alone

20. The Family that should have bought better life insurance?

Donald A. Norman

- University professor, industry executive, company advisor, and board member;
- Electrical engineer, psychologist, computer scientist, cognitive scientist, designer;
- Speaker and author
- Founder and Director of the Design Lab at the University of California, San Diego

Design for real people

"We must design for people the way they are, not the way we wish them to be.

Also, don't be logical. Half the people in the world are below average"

-Donald A. Norman-

Donald A. Norman Principle

Gulf of Execution

- Is the difference between the intentions of the users and what the system allows them to do or how well the system supports those actions.
- In order to design the best interfaces, the gulf must be kept as small as possible

Example

Gulf of evaluation

- is the degree of ease with which a user can perceive and interpret whether or not the action they performed was successful.
- the gap in finding out what is the current state of the system.

Example

How do we avoid the twin gulf?

Six Principles of Design

- Visibility
- Feedback
- Affordance
- Mapping
- Constraints
- Consistency

1. Visibility

- Users should know, just by looking at an interface, what their options are and how to access them

2. Feedback

- Users should know, just by looking at an interface, what their options are and how to access them

3. Affordance

- is the link between how things look and how they're used. For example, a coffee mug has high affordance because you instantly know how to hold it just by looking at it

4. Mapping

- Mapping is the relationship between control and effect. The idea is that with good design, the controls to something will closely resemble what they affect.

5. Constraints

- restrict a particular form of user interaction with an interface

6. Consistency

- The same action has to cause the same reaction, every time.

Sources

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The Human

Unit 3

CC7 Human Computer Interaction

Arnemie Gayyed

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- The role of humans in HCI
- Human error
- Human emotions

Role of Humans in HCI

The Human | The Perceptual System | Human Memory | Human Thinking

The Human

- Human computer interaction starts with the human
- The central character is the human
- There is a need to understand:
  - Human capabilities
  - Human limitations
- There is a need to use a simplified model
- Select characteristics relevant to HCI:
  - Input-output channels (perceptual system)
  - Human memory
  - Human processing

The Perceptual System

- **Sight**
- **Hearing**
- **Touch**
- Taste
- Smell

The Perceptual System

Visual Processing

- Involves transformation and interpretation of a complete image
- Expectations affect the way an image is perceived
- Compensates for movement, color and brightness
- Helps resolve ambiguities

The Perceptual System

Visual Processing

- Perception of size
- Familiarity
- Depth perception
- Color perception
- Reading

The Perceptual System

Visual Processing - Reading

- Perception and processing of text is a special case
- Stages:
  - Visual pattern of the word is perceived
  - Decoded with an internal representation of the language
  - Syntactic and semantic analysis
- Example: Reading “IL”

The Perceptual System

Visual Processing - Reading

- Adults read 250 words per minute
- Words are recognized by shape
- Removing word shape clues by using all caps is detrimental to reading speed and accuracy

The Perceptual System

Hearing

- Human beings can hear sounds from 20 Hz to 15 kHz
- Can distinguish frequency changes of less than 1.5 Hz at low frequencies
- Less accurate at high frequencies
- Can be selective
- Can convey a lot of information
- Not maximized in interface design

The Perceptual System

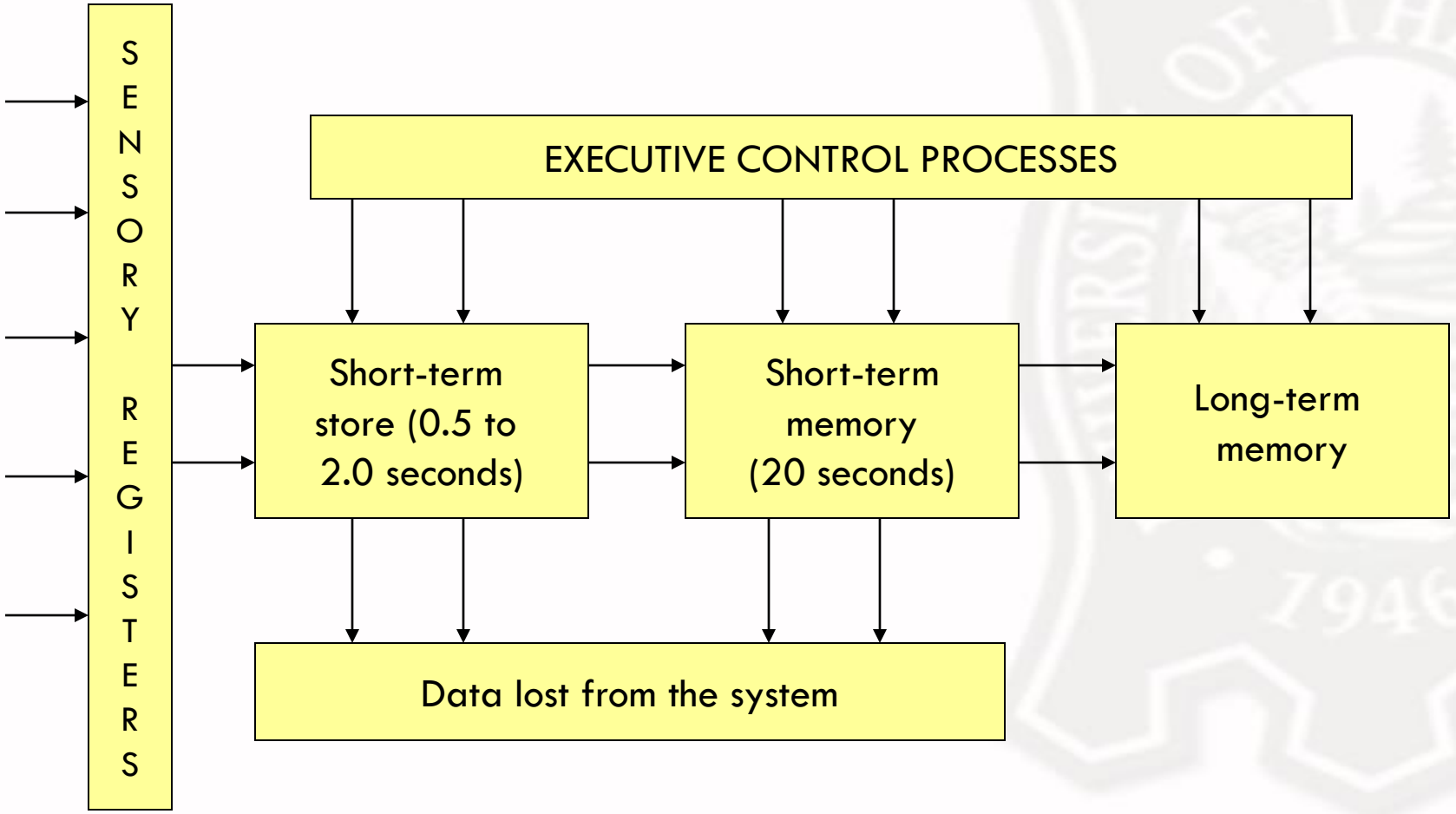
Touch

- Haptic perception - important means of feedback
- If and object is seen but not felt, speed and accuracy of a response is reduced
- Complaint of VR users

Human Memory

- Second part of the model of the human as an information processor
- Three types:
  - sensory buffers
  - short-term memory
  - long-term memory

Human Memory



Human Memory

Sensory Memory

- Iconic (visual) - persistence of the image after the stimulus has been removed
- Echoic (aural) - allows a brief "playback"
- Haptic - touch

Human Memory

Short-Term Memory

- Scratch-pad for temporary recall
- Used for information needed fleetingly
- Rapid access, limited capacity
- 7 +/- 2 chunks of information
- Patterns are useful memory aids

Human Memory

Long-Term Memory

- We store everything we "know" - factual information, experiential knowledge, procedural rules of behavior
- Huge, if not unlimited
- Relatively slow access time (1/10 second)
- Forgetting occurs more slowly

Human Memory

Long-Term Memory – Structure

- Episodic – memory of events stored sequentially; can reconstruct actual events
- Semantic – structure derived from facts, concepts, or skills; derived from episodic memory
- Can be organized to:
  - Semantic networks
  - Frames
  - Scripts
  - Production rules

Human Memory

Long-Term Memory – Structure (Organization)

- Semantic networks
  - Interconnections or associations among memories
  - Does not allow to model the complex objects or events composed of several activities
  - Example: what are the words currently associated with "dog"?

Human Memory

Long-Term Memory – Structure (Organization)

- Frames
  - Objects that contain slots or attributes
  - Attributes represent default, fixed or variable information
  - Example: dog
  - Fixed - Legs: 4
  - Default - Diet: Carnivorous, Sound: Bark
  - Variable – Size, Color

Human Memory

Long-Term Memory – Structure (Organization)

- Scripts
  - Represents default stereotypical information
  - Contains: entry conditions, results, props, roles, scenes, and tracks
  - Example:
  - Goal: To fill my mug with coffee
  - Entry conditions: My mug must first be empty
  - Results: My mug is full of coffee
  - Props: Mug, coffee machine, coffee
  - Roles:
    - Secretary makes the coffee
    - I fill my cup

Human Memory

Long-Term Memory – Structure (Organization)

- Production rules
  - Series of condition-action (if-then) statements
  - Examples:
  - IF it is raining THEN bring an umbrella
  - IF the high school is being dismissed THEN traffic will be horrible

Human Memory

Long-Term Memory – Processes

- Storing
  - Total time hypothesis - amount learned is proportional to amount of time spent
  - Distribution of practice effect - learning time is most effective if distributed over time
  - Information must be meaningful for it to be stored

Human Memory

Long-Term Memory – Processes

- Forgetting
  - Decay
  - Interference - old replaced by new or vice versa
  - Retroactive interference – new information replaces the old
  - Proactive inhibition – the old memory interferes with the new information

Human Memory

Long-Term Memory – Processes

- Remembering
  - Recall - reproduced from memory
  - Recognition - the info has been seen before

Human Thinking

Reasoning

- Process of deriving new information from what is known
- Types:
  - Deductive reasoning – two or more assertions that lead to a conclusion; mathematical certainty
  - Inductive reasoning - arriving at generalizations from observations we have seen about cases we have not seen
  - Abductive reasoning - formulation of hypotheses to explain a phenomena

Human Thinking

Problem Solving

- Process of finding a solution to an unfamiliar situation
- Three examples:
  - Gestalt
  - Problem space theory
  - Analogy in problem solving

Gestalt

- People draw on previous experiences
- Have insights
- People as sense-makers
- Restructure the problem
- Theory lacked structure and support
- Does not explain insight and restructuring

- The whole is greater than the some of its parts
- People perform based on their understanding general principles of a situation
- If we perform on memorized facts, we make stupid mistakes

Problem space theory

- Problem is represented in terms of problem states
- Heuristics are employed to go from initial to goal state
- General problem solver works for well-structured domains
- Real-world problems are more complex

Skill acquisition

- Ability to remember larger and larger chunks, e.g. chess players
- Novices - group problems according to superficial characterisitics
- Experts - group according to conceptual similarities

Human Error

Human v. Computer | Concept of Error | Types of Slips | Mistakes | Failure to Detect Errors

Human v. Computer

Human

- Result of millions of years of evolution
- Guiding principle was survival, not precision
- Robustness in the face of unexpected circumstances
- Ability to deceive

Computer

- Less than 100 years old
- Reliable
- Consistent
- Based on mathematics

Human v. Computer

Human (Computation)

- Slow, complex
- Highly parallel
- Rapid change
- Error tolerant
- Forgiving

Computer (Computation)

- Fast
- Not fault tolerant
- High speed
- Precise

The Concept of Error

- The computer was given information it could not process
- Blame shifted on the human being
- Achieving a goal should be a cooperative endeavor
- Task is not to assess blame but to complete the task
- Types of Errors:
  - Slip – results from automatic behavior
  - Mistake – stems from conscious deliberation

Types of Slips

- Capture errors
- Description errors
- Data driven errors
- Association activation errors
- Loss of activation errors
- Mode errors

Types of Slips

Capture Error

- A frequently done activity captures the one intended
- Example: mistakenly dialing telephone numbers with the same prefix
  - 426-6001 - Ateneo trunk line
  - 426-6071 - DISCS direct line

Types of Slips

Description Error

- An action is performed on the wrong artifact
- Example:
  - Bottles of shampoo and conditioner, especially if they have the same bottle design

Types of Slips

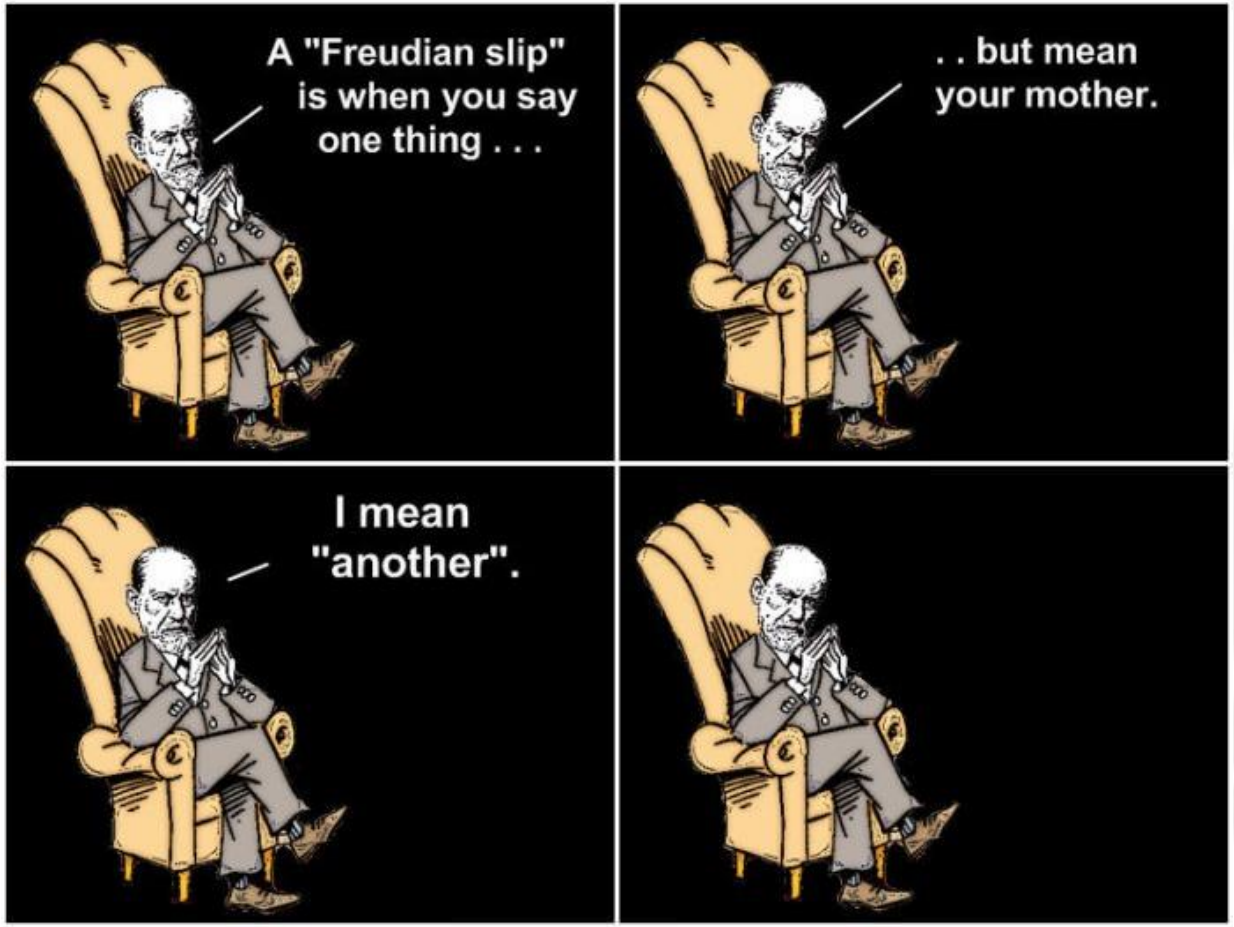
Data-Driven Error

- Triggered by the arrival of sensory data
- Examples:
  - Typing what you are thinking / hearing / seeing and not what is intended
  - Calling someone by the wrong name

Types of Slips

Freudian Slips

- Verbal / memory mistake that usually reveals the subconscious
- Example:
  - A child calling their teacher “Mom” or “Dad”



Types of Slips

Loss of Activation Errors

- Act of forgetting to do something
- Example:
  - Walking somewhere to get something but forgetting the moment you step into the destination

Types of Slips

Mode Error

- Action sequence performed in the wrong mode
- Examples:
  - Typing in the password with CAPS LOCK on
  - Using different tools as if it were another

The Concept of Error

Mistake

- Choice of inappropriate goals
- Poor decision, misclassifies a situation, or fails to take all factors into account
- Mental thought is not neat and orderly
- The disorder leads to creativity, discovery, and great robustness of behavior

Failure to Detect Problems

- User's ability to detect errors is unreliable
- Relevance bias - people seek confirmatory evidence when evaluating a hypothesis
- Partial explanation - crude agreement between what the user expects and what he sees
- Overlap of model and world - mental model is partially consistent with the world

Designing for Emotions

Why Emotions | Levels of Emotion-Based Processing

Why Emotions?

- Emotions makes the human smart
- Much of human behavior is subconscious
- Affective system helps make judgments
- People without emotions cannot choose between alternatives

Effects of Using Emotions for Design

- Broadening of thorough processes
- Greater creativity
- Greater imagination
- More tolerant of minor difficulties

Levels of Emotion-Based Processing

- Visceral
- Behavioral
- Reflective

Levels of Emotion-Based Processing

Visceral

- Pre-conscious, pre-thought
- Appearance matters
- First impressions are formed
- Initial impact of the product (touch, feel, appearance)

Levels of Emotion-Based Processing

Behavioral

- Focuses on the use
- Experience with the product:
  - Function
  - Performance
  - Usability

Levels of Emotion-Based Processing

Behavioral

Levels of Emotion-Based Processing

Reflective

- Affected by culture, experience, education, and individual differences
- Can override the visceral and behavioral
- Sophistication vs. popularity
- Long-term relationships
- Consideration of the future

Levels of Emotion-Based Processing

Levels of Emotion-Based Processing

Working with the three levels:

- Visceral - appearance
- Behavioral - pleasure and effectiveness of use
- Reflective - self-image, personal satisfaction, memories

The Computer

Unit 4

CC7 Human Computer Interaction

Arnemie B. Gayyed

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The Role of Computers in HCI

Interactions with computers | Computer peripherals and parts | Why know the computer devices?

Interaction with Computers

- What are our goals when interacting with people?
- How does our interactions with people relate to our interactions with computers?
- Interaction is a process of information transfer.

Computer Peripherals and Parts

- Input / output devices
- Virtual Reality systems
- Bio sensors
- Computer memory
- Computer processors

Why Know the Computer Devices?

- Match the devices that complements the capabilities and limitations of the human
  - Perceptual system
  - Human memory and processing
  - Human error
  - Human emotions
- Not every user would have all the required computer devices

Input Devices

Keyboard | Mouse | Microphone | Trackball | Touchpad |Touchscreen Devices | Controllers | Scanner | Drawing Tablet | Eye Tracking Devices | Hand Tracking Devices

List of Input Devices

- Keyboard
- Mouse
- Microphone
- Trackball
- Touchpad
- Touchscreen devices
- Controllers
- Scanner
- Drawing Tablet
- Eye Tracking Devices
- Hand Tracking Devices

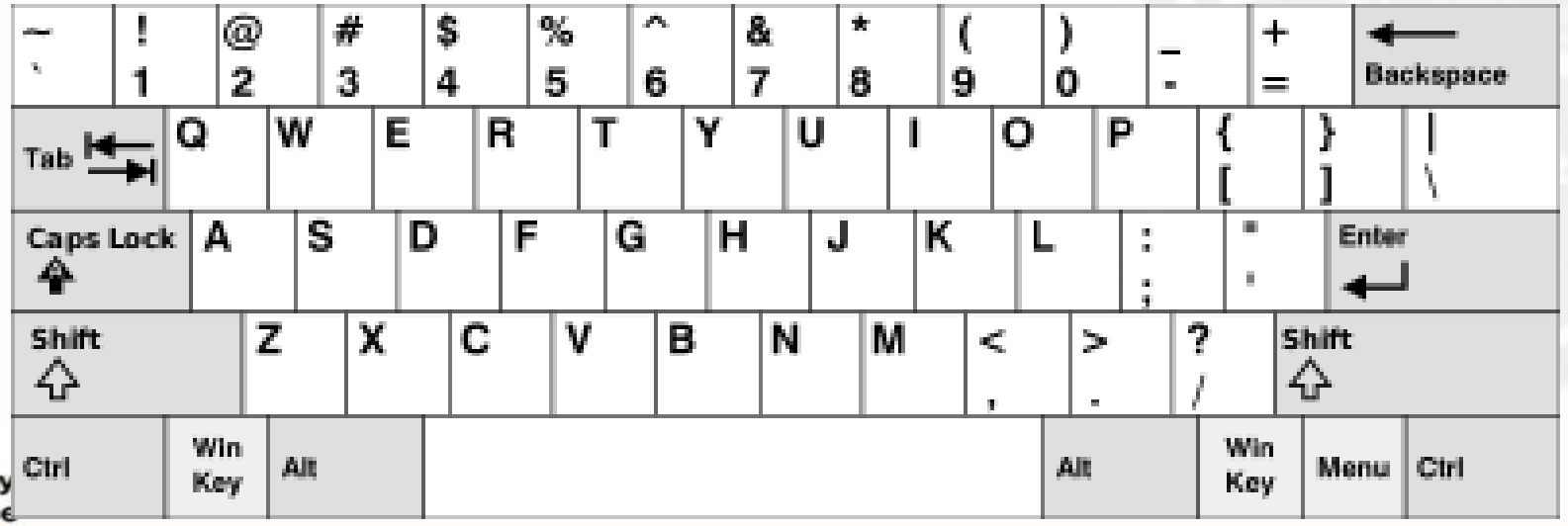
Input Device – Keyboard

- Like a typewriter, it is composed of buttons used to create letters, numbers, and symbols, and perform additional functions
- Buttons or keys act as mechanical levers or electronic switches
- Arrangement of buttons depend on the format:
  - QWERTY
  - QWERTZ
  - AZERTY
  - DVORAK

Input Device – Keyboard

QWERTY / Sholes Keyboard

- Named after the first 6 alphabetic keys on the top left
- May be created:
  - Due to mechanical failings in early typewriters
  - To make it easier to decode morse code



Input Device – Keyboard

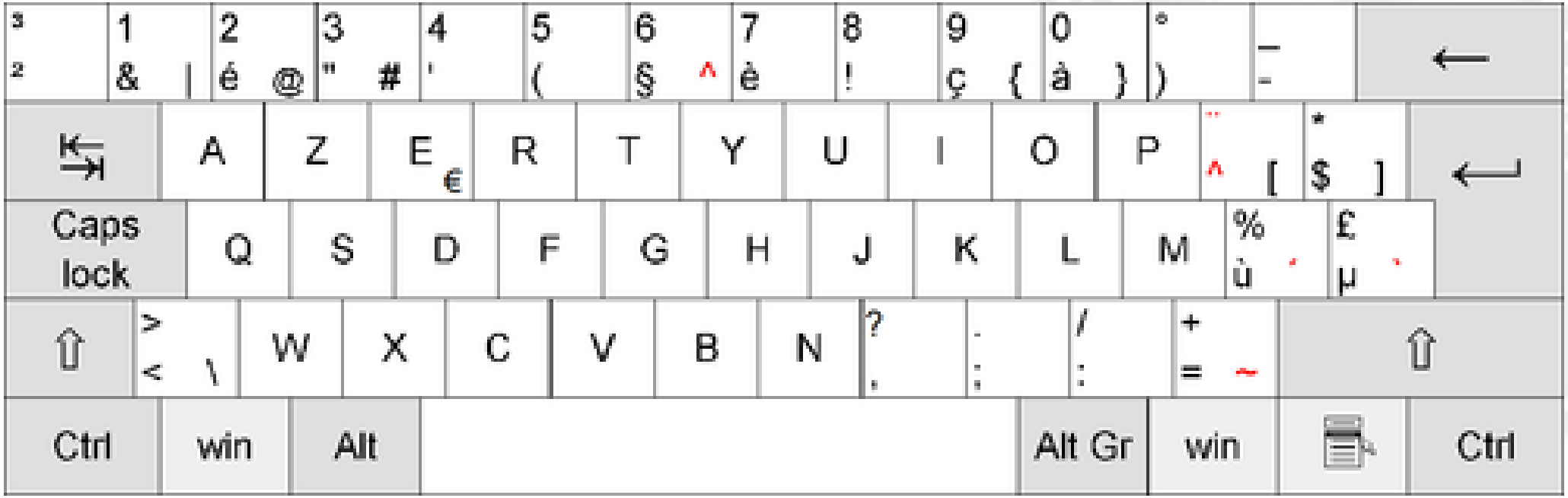
QWERTZ / Swiss Keyboard

- Used in German-speaking countries

Input Device – Keyboard

AZERTY Keyboard

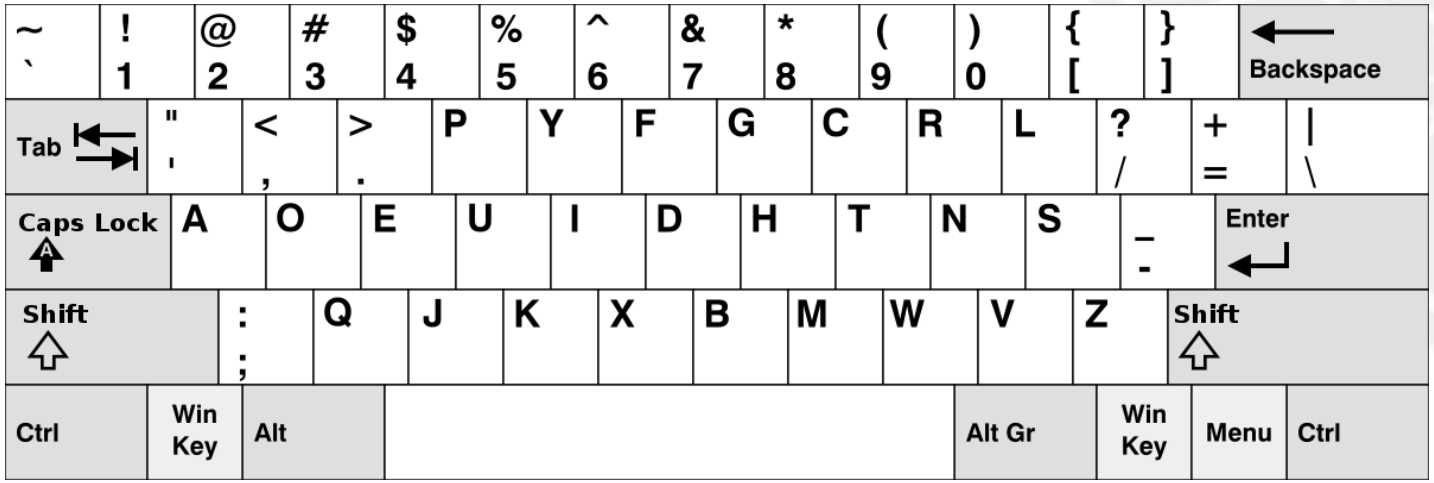
- Commonly used in France and Belgium



Input Device – Keyboard

DVORAK Keyboard

- Ergonomic alternative to the QWERTY layout
- All vowels and punctuation marks are on the left side
- All consonants on the right side
- Most used letters in the middle row so it's easier to reach



Input Device – Mouse

- Handheld hardware input device that controls a cursor in a GUI (graphical user interface)
- Move and select text, icons, files, and folders on computer
- Commonly makes use of a pointer on a display
- Types:
  - Ambidextrous
  - Left-handed
  - Vertical

Input Device – Mouse

Ambidextrous Mouse

- Designed to fit either left-handed or right-handed people
- Most common type of mouse

Input Device – Mouse

Left-Handed Mouse

- Specifically designed for users whose dominant hand is their left hand

Input Device – Mouse

Vertical Mouse

- Taller than it is wide
- Designed to reduce strain
- Mouse is held vertically, much like you would during a handshake
- Buttons are located right beneath the grasp

Input Device – Microphone

- Translates sound vibrations in the air into electronic signals or scribes them to a recording medium

Input Device – Trackball

- Small ball set in a holder
- Can be rotated by hand to move a cursor on a computer

Input Device – Touchpad

- For controlling the pointer on a display screen
- Done by sliding the finger along a touch-sensitive surface

Input Device – Touchscreen Devices

- Technically both an input and output device
- User places input through multi-touch gestures by touching the screen or through a stylus
- Output may be shown in another screen or in the same screen

Input Device – Game Controller

- Also known as a gaming controller or controller
- Used to provide input to a video game
- Can be haptic
- Gamepad
  - Common game controller
  - Came from console games
  - Used for better mobility of a character

Input Device – Game Controller

- Other game controllers
  - Paddle
  - Steering wheel set
  - Touchscreen
  - Motion sensor
  - Light gun
  - Rhythm game controllers

Input Device – Scanner

- Uses a light beam to scan codes, text, or graphic images directly into a computer or computer system

Input Device – Drawing Tablet

- Converts movements from a stylus pressed on a designated area on the tablet's screen
- Commonly used for digital arts

Input Device – Eye Tracking Device

- Sensor technology that makes it possible to know where a person is looking in real-time
- Uses a specialized camera
- Detects the presence, attention, and focus of the user

Input Device – Hand Tracking Device

- Makes use of various sensors
- Captures data on the position, orientation, and velocity of hands
- Can be a device that is attached to the hand or a device away from the hand

Output Devices

Monitor | Speaker | Headphone | Printer

List of Output Devices

- Monitor
- Speakers
- Headphones
- Printers

Output Device – Monitor

- Displays information in pictorial or text form
- Modern monitors use liquid crystal display (LCD)
- Three popular LCD monitor types:
  - Twisted nematic (TN)
  - IPS (In-Plane Switching)
  - VA (Vertical Alignment)

Output Device – Monitor

Twisted Nematic (TN) Panels

- Oldest type of LCD panel
- Most budget-friendly; has low cost production
- Limited viewing angles, particularly on vertical axis
- High refresh rates; low input lag
- Colors of the TN panels:
  - Reproduction is not strong
  - Can invert completely when viewed from an extreme angle

Output Device – Monitor

In-Plane Switching (IPS) Panels

- Developed to improve limitations of TN panels
- Vastly superior viewing angles
- Best color reproduction:
  - Good black color reproduction
  - Best used for graphic design

Output Device – Monitor

Vertical Alignment (VA) Panels

- Compromise between TN and IPS
- Has best contrast ratios
- Used extensively for TV manufacturing
- Viewing angles are in the middle of IPS and TN
- Have slower response times than TNs
- Ideal for general use

Output Device – Speakers

- Connects to a computer to generate sound
- Signal is created by the computer's sound card

Output Device – Headphones

- Small speakers that can be worn in or around the ears
- Traditional headphones:
  - Have two ear cups
  - Attached by a band
  - Placed over the head
- Earbuds or earphones:
  - Placed inside the outer part of the ear canal

Output Device – Printer

- Accepts text and graphic output from a computer
- Traditional printers transfer the information to paper

Output Device – Printer

3D Printer

- Computer-aided manufacturing (CAM) device
- Creates three-dimensional objects
- Builds a three-dimensional model out of a custom material


Mashable
explains

Virtual Reality Systems

What is virtual reality? | VR headset | Motion controllers | Optical tracking

What is Virtual Reality?

- Simulated experience that can create an artificial world
- Can look and move around the artificial world, and interact with objects around
- Utilizes limited visual and auditory processing and high haptic feedback for a more immersive experience

Virtual Reality Devices

- Virtual reality headset
- Motion controllers
- Optical tracking

VR Device - Headset

- Also called VR goggles
- Head-worn apparatus that completely covers the eyes for an immersive 3D experience
- Can be attached to a computer (Valve Index)
- Can be self-contained (Oculus Quest 2)

VR Devices – Motion Controllers

- Collection of devices that detect the user's motion in different levels
- Tracked with cameras, sensors in the controllers, or both
- Examples:
  - Hand controllers
  - Wired glove
  - Omnidirectional treadmill

VR Devices – Optical Tracking

- Process of monitoring the user's position through visual information
- Mostly done through sets of cameras and other sensors in or out of the headset
- Can track smaller body parts (fingers) to the entire body

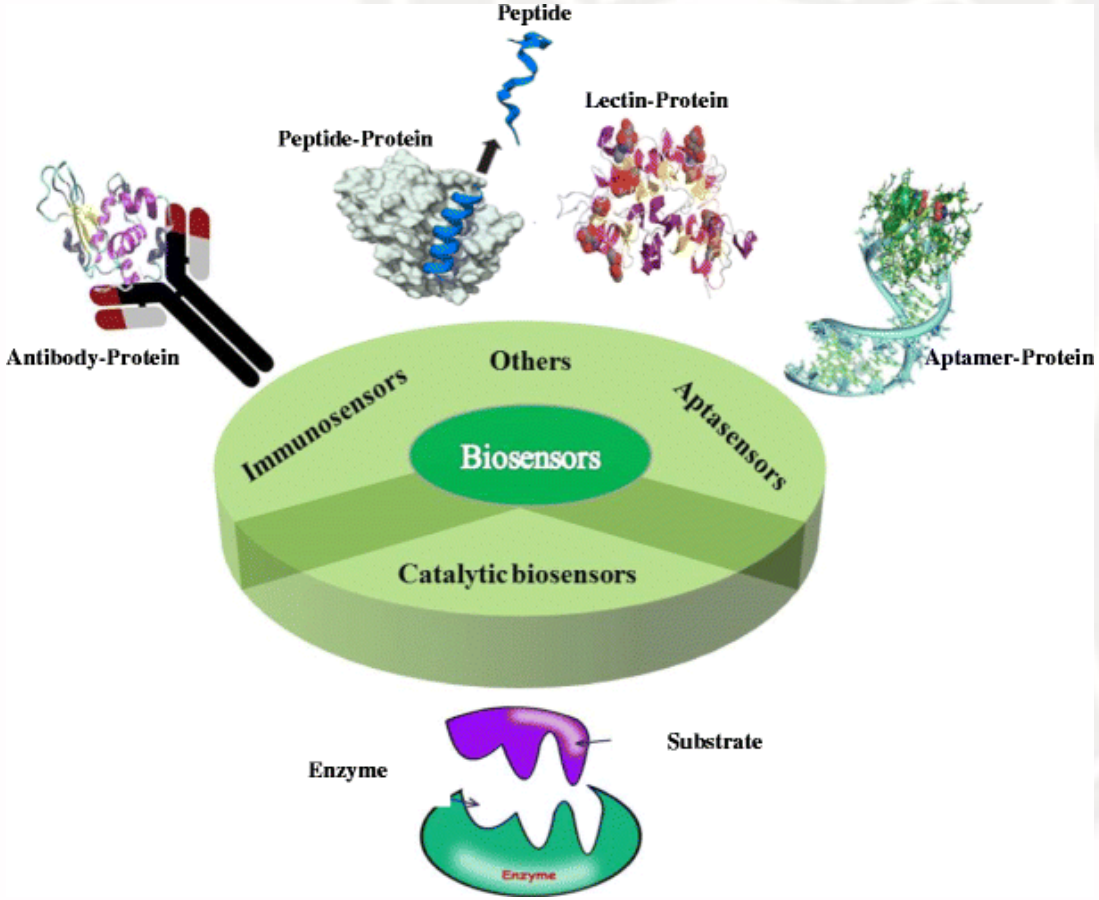
VR - Mojo Contact Lens

Bio Sensors

What is biosensing? | Biosensors | Brain sensors

What is Biosensing?

- Detection of target molecules based on the principles used by a living system
- Can be used for a more precise means of determining user input with little movement



Biosensor

- Self-contained integrated device
- Capable of providing specific quantitative analytical information using a biological recognition element
  - Enzymes
  - Antibodies
  - Natural receptors
  - Cells

Brain Sensors

- Can allow to control software, apps, and machines
- Done by developing new virtual reality, augmented reality, and brain-controlled technology with brain-computer Interface (BCI) software

Computer Memory

Non-volatile memory | Volatile memory

Computer Memory Devices

- Non-volatile memory
  - Hard disk drive
  - Solid state drive
  - Flash memory
  - Nonvolatile memory express
- Volatile memory
  - Random access memory

Non-Volatile Memory

- Type of computer memory that can retain stored information even after power is removed
- Common examples:
  - HDD (Hard Disk Drive)
  - Flash memory
  - SSD (Solid State Drive)
  - NVMe (Nonvolatile Memory Express)

Non-Volatile Memory

Hard Disk Drive (HDD)

- Magnetic storage medium for a computer
- Hard disks are flat circular plates made of aluminum or glass and coated with a magnetic material
- Used for general storage, but quite slower

Non-Volatile Memory

Flash Memory

- General term for electronic non-volatile memory
- Can be electrically erased and reprogrammed
- Used for a lot of modern memory devices:
  - USB flash drives
  - Memory cards
  - SSDs and NVMes

Non-Volatile Memory

Solid State Drive (SDD)

- New generation of storage device used in computers
- Uses flash-based memory
  - Much faster than a traditional mechanical hard disk
- Used for more modern systems that require fast access of storage

Non-Volatile Memory

Nonvolatile Memory Express (NVMe)

- New storage access and transport protocol for flash and next-generation solid-state drives
- Delivers the highest throughput and fastest response times yet for all types of enterprise workloads

Volatile Memory

- Computer memory that only maintains its data while the device is powered
- Used for primary storage in personal computers
- Much faster to read from and write to than the other kinds of storage in a computer
- Data stored in volatile memory are temporary data used in computer systems or ones needed by the processor

Volatile Memory

Random Access Memory (RAM)

- Short-term memory where data is stored as the processor needs it
  - Play a game from computer's hard drive
  - Stream a movie from the Internet
- Processor can get to the data quickly

Computer Processors

Computer processing and processors | Limitations that decrease processor performance

Computer Processing

Processing can be too slow or too fast

Too slow

- Unable to catch input when it happens
- Input is buffered; feedback is too slow

Too fast

- Output comes out too quickly; user is unable to read it

Computer Processor

Central Processing Unit

- Circuit board inside a computer that executes instructions on behalf of programs
- Modern computer processors can process millions of instructions in a second
- Processors are considered the main chip on a computer

Computer Processor

Limitations that Decrease Processor Performance

- Computation limitations
- Storage channel limitations
- Graphics limitations
- Network limitations