Who am I?

Humera Tariq

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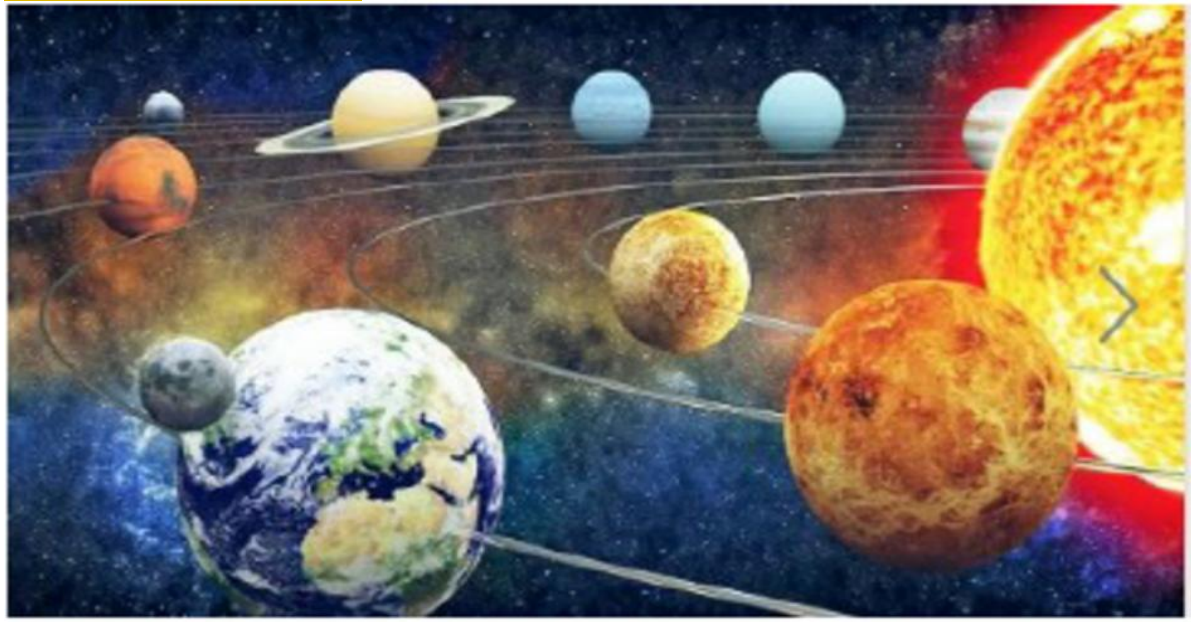
Starting in the name of Allah,

the most beneficial,
the most merciful.



أَمْ لِلْإِنسَانِ مَا تَمَنَّىٰ ﴿٢٤﴾

کیا انسان کو ہر وہ چیز حاصل ہے جس کی اس نے تمنا کی؟

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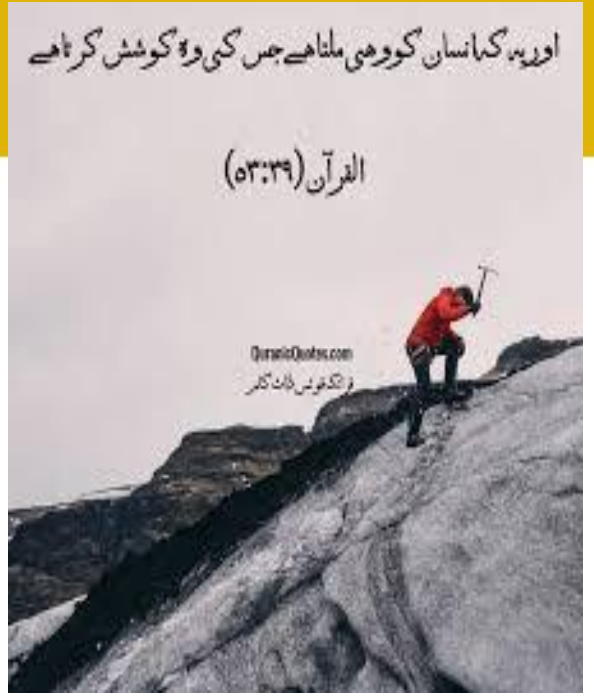
Surah An-Najm Chapter 53 Verse 39

And there is not for man except that [good] for which he strives.



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Week 01

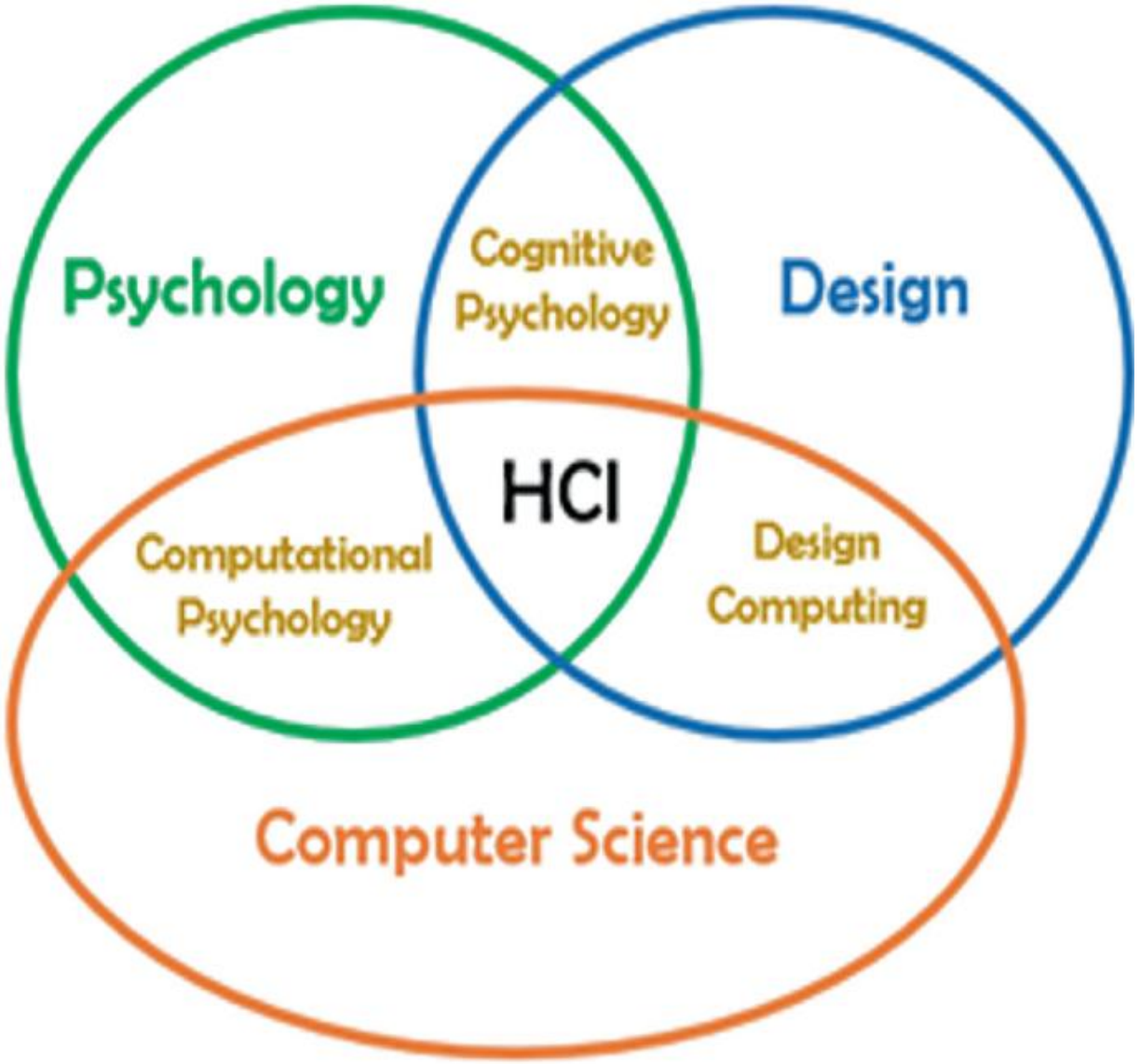
Human Computer Interaction & Computer Graphics

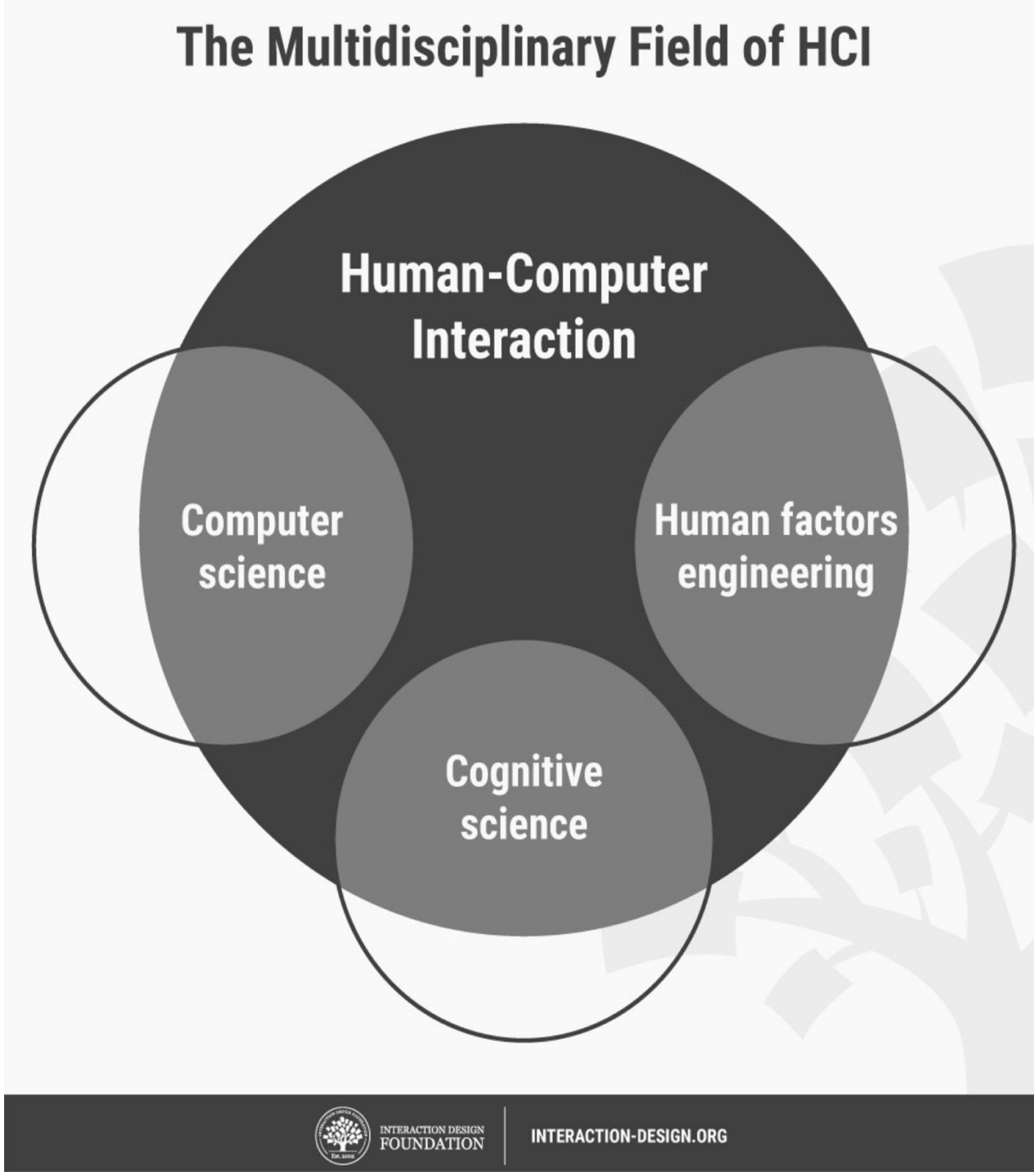
Department of Computer Science (DCS/UBIT)
University of Karachi
January 2026

Week-1 Discussion

Agenda	Lecture Activities (Bloom's Aligned)	Domain
Analyze UI vs UX Failure	**Smart board Navigation to understand (UI/UX) from a human perspective**	C
Observe human memory limits	**Estimate, record, and reflect on memory retention recognizing humans' variability and attention limits**	C, A
Explain humans as agents	**Humans as agents: sense → decide → act → feedback**	C
Evaluate interfaces using Miller's Law **(Lab1)**	**Evaluate interface usability using 7±2 memory limits**	C
Perform memory experiments	**Conduct recall and rehearsal experiments to reveal STM limits**	P , C
Analyze semantic networks **(Assignment 1)**	**Understand human knowledge structure; semantic network**	C
Reflect on affect in design	**Reflect on User Centered Design through Legends and Example UIs.**	A

HCI is also sometimes referred to as man-machine interaction (MMI) or computer-human interaction (CHI).





John M. Carroll

Distinguished Professor of Information Sciences and Technology, Pennsylvania State University
Verified email at ist.psu.edu - Homepage

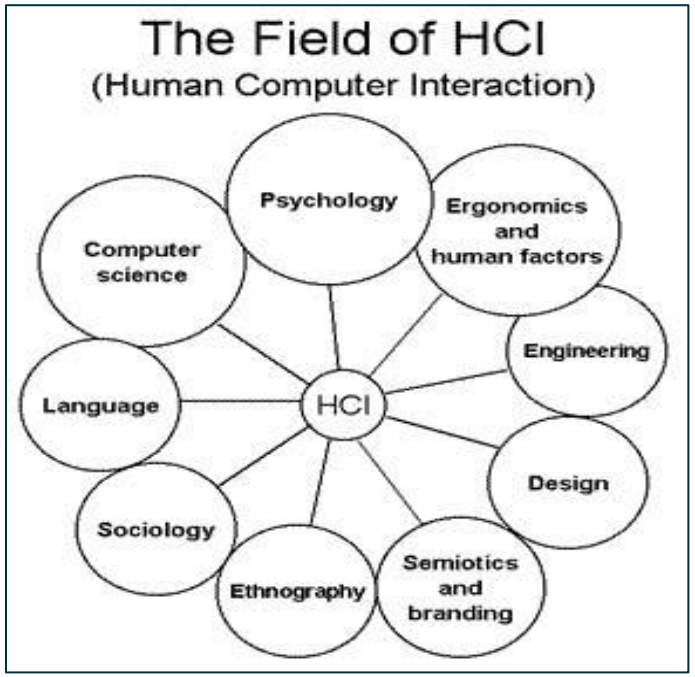
Human-Computer Interaction Computer-Supported Colla… Community Informatics
Design Research Learning Science

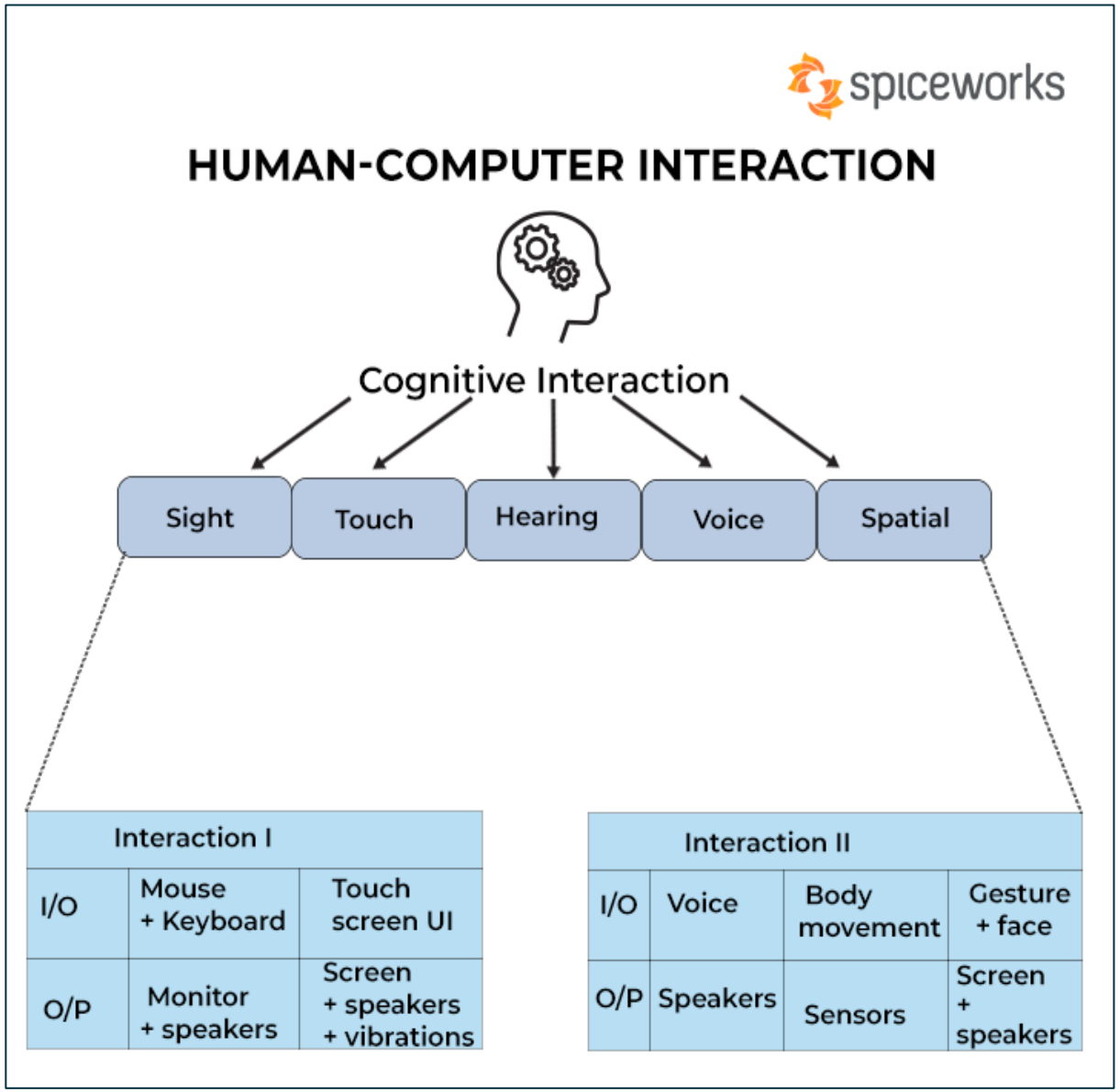
John M. Carroll says that it no longer makes sense to regard HCI as a specialty of computer science because it has become much more diverse than computer science itself. (The encyclopedia of human-computer interaction 2nd ed.). Now HCI is related to psychology, communication studies, cognitive science, information science and design, in particular with UX/UI design.

Ergonomics is the branch of engineering science in which biological science is used to study the relation between workers and their environments.

Ethnography is a branch of anthropology and the systematic study of individual cultures. It explores cultural phenomena from the point of view of the subject of the study.

Anthropology is the holistic study of humankind, exploring our biological evolution, cultural diversity, societies, languages, and history from the earliest origins to the present

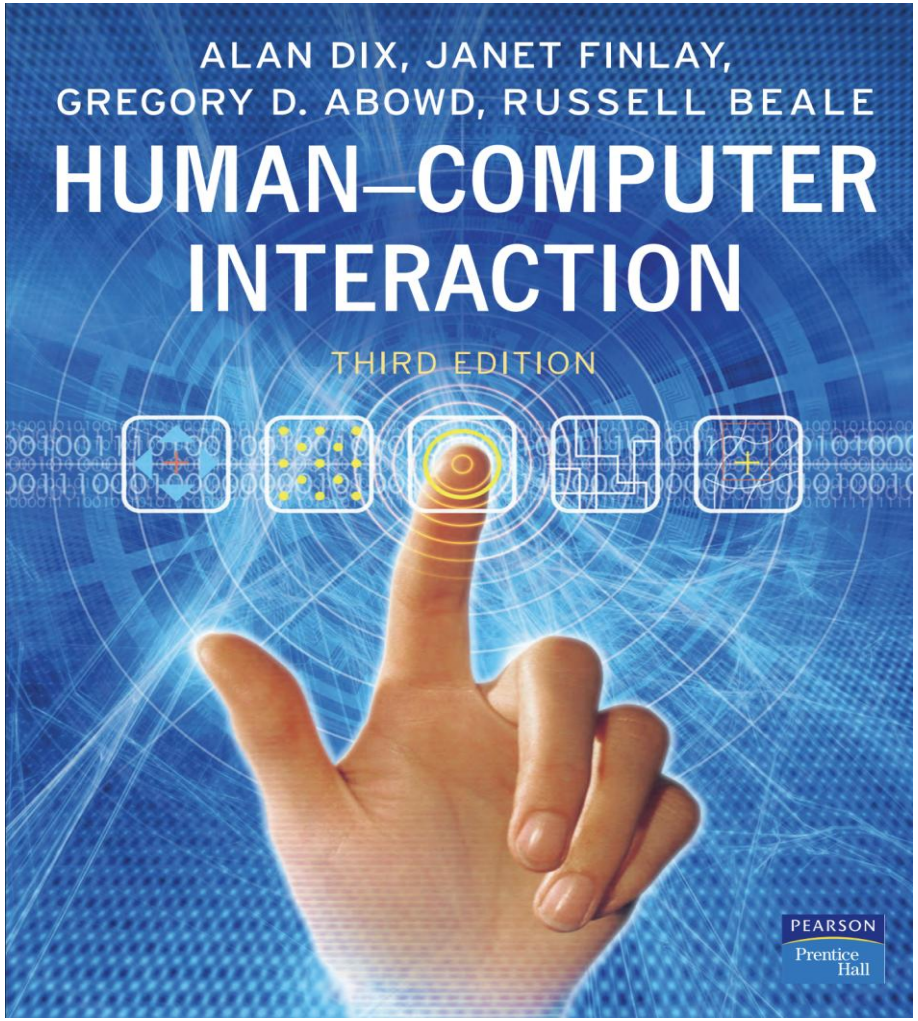


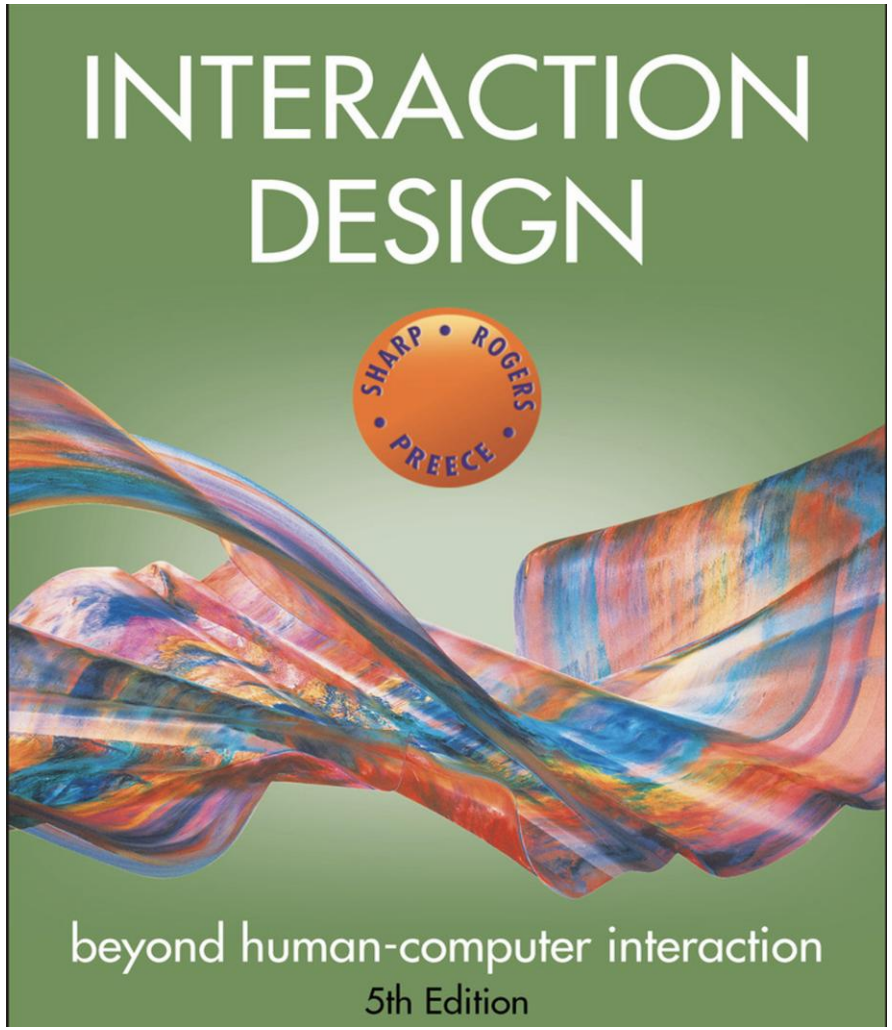


BOOKS - Lecture Resources

Alan Dix, Janet Finlay, Gregory Abowd and Russell Beale. (2003) Human Computer, Interaction (third edition), Prentice Hall, ISBN 0130461091

https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2014.00643/full





Helen Sharp, Open University

Yvonne Rogers, London

Jennifer Preece, MaryLand, USA

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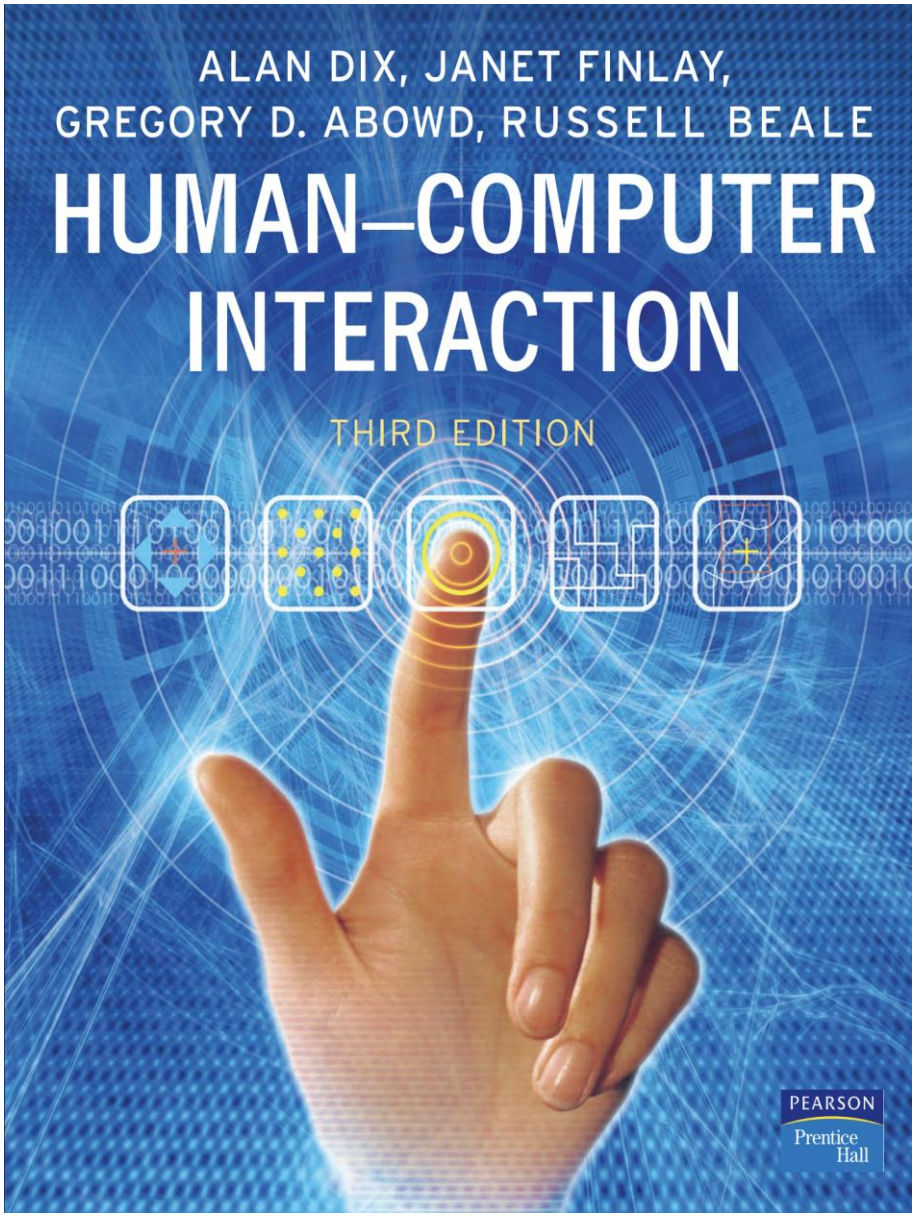
Dix – HCI (4 Parts - 21 Chapters)



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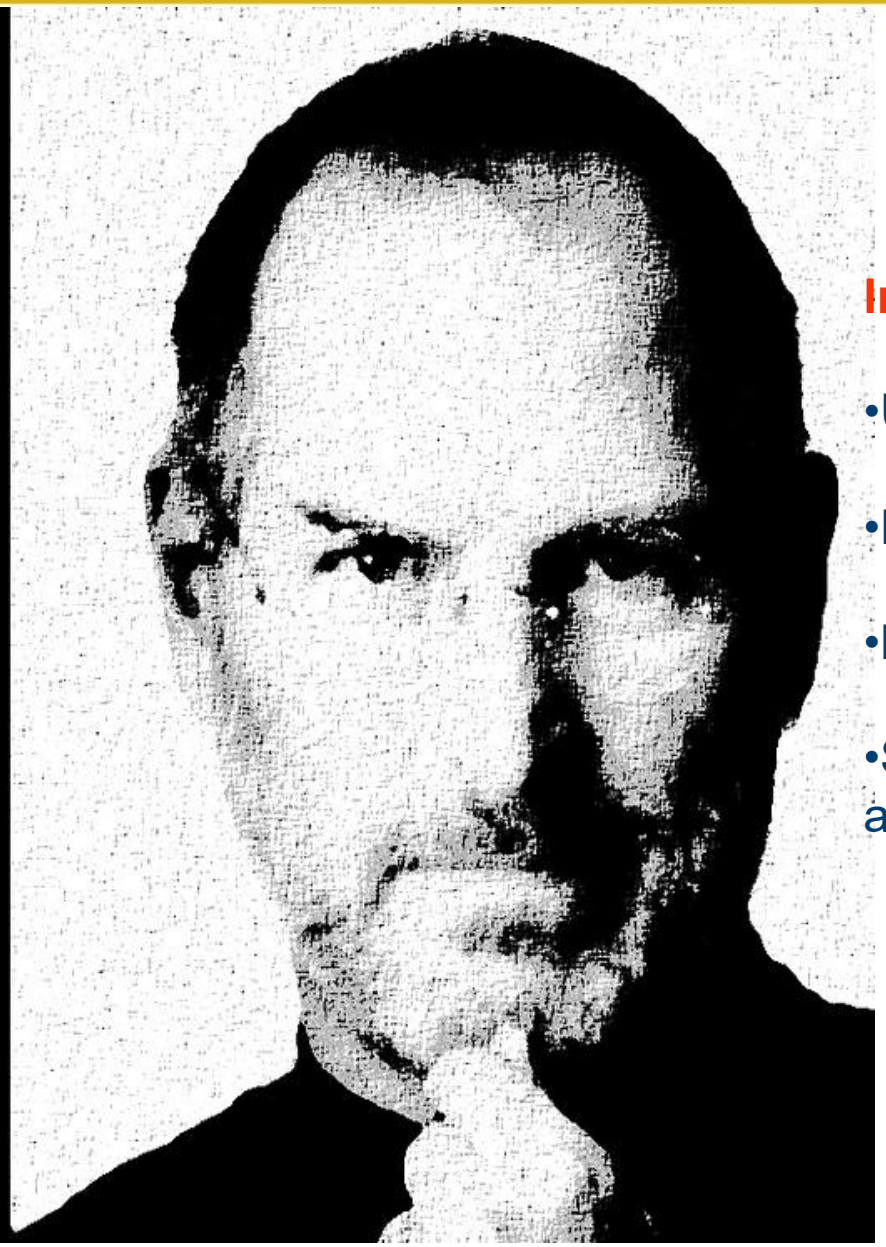
“I have no special talent. I am only passionately curious.” (Albert Einstein)

Your time is limited, so don't waste it living someone else's life. Don't let the noise of others' opinions drown out your own inner voice. And most important, have the courage to follow your heart and intuition. They somehow already know what you truly want to become. Everything else is secondary.

Stay Hungry. Stay Foolish.



In HCI terms,_____championed:

- User-centered design
- Emotional design
- Learnability and simplicity
- Seamless interaction between human and machine

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Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain context of HCI and different measures for evaluation.	C	2
2. Apply the principles of good design for people from the perspective of age and disabilities.	C	3
3. Analyze techniques for user centered design for a medium sized software.	C	4
4. Evaluate the usability of a medium size software user interface.		5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
Contexts for HCI, Psychology of usable things, Processes for User-Centered Design, Metrics and Measures for Evaluation, Usability heuristics and principles of Usability testing, Physical capabilities, Cognitive and social models for interaction design, Principles of good interaction design, Accessibility, Principles of GUI, Visual design elements, Data gathering, Task analysis, Prototyping, Help and user documentation, Internationalization, Usability inspection methods, Usability testing methods, New Interaction Technologies, Usability in practice, Visual Design and Typography, Icon Design, Ubiquitous, Augmented and Virtual Reality.
Teaching Methodology:
Lecturing, Written Assignments, Project, Report Writing
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, 6th Ed, Pearson Inc, 2016. 2. Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design, Benyon, D. 3rd Ed., Pearson. 2013 3. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 4th Ed, Wiley, 2014

HEC

BS COMPUTER SCIENCE

ASSOCIATE DEGREE COMPUTING

(2025)

HCI & Computer Graphics

By the end of this course the student will be able to:

- Explain key principles, models, and theories of human-computer interaction.
- Analyze and identify usability issues in user interfaces through heuristic evaluation, cognitive walkthroughs, and user studies.
- Design interactive user interfaces applying usability, accessibility, and visual design principles.
- Describe fundamental graphics concepts such as rendering pipelines, transformation, clipping, and projection.
- Implement 2D and 3D rendering algorithms including shading, lighting, rasterization, and texturing.

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Grading Scheme

✓ Attendance + Activeness	~15%
✓ Experiential Learning/ Labs/Experiments	~20% + Bonus
✓ Critical Thinking : In class Presentation	~10% + Bonus
✓ In-class/Lab Exercises/problem solving:	~15%
✓ Midterm /Quizzes/Assignment/ worksheets	~15%
✓ Final Exam	~25%

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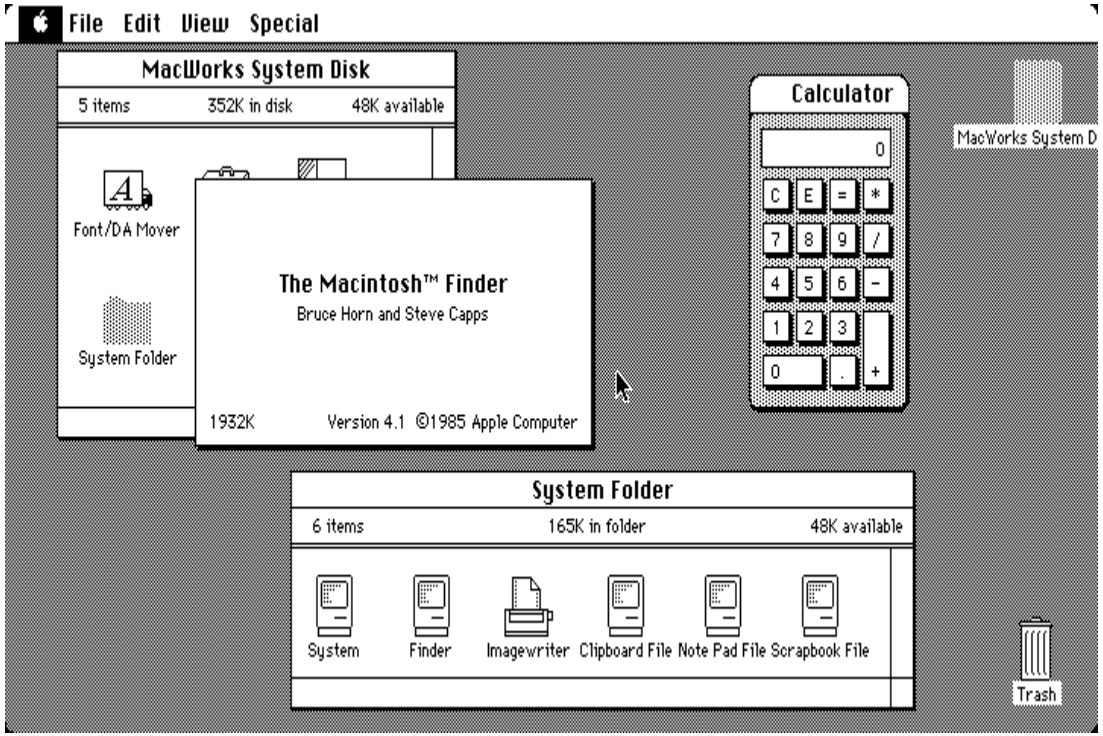
Evolution HCI-CG

Resolution, Color, typography, buttons, icons
Scroll, touch

(all the ways- the user interact)

hardware: bit-mapped display, mouse–chord-keyboard (like 5 piano keys) , single person setup, seated



http://www.catb.org/esr/writings/taouu/html/ch02s05.html

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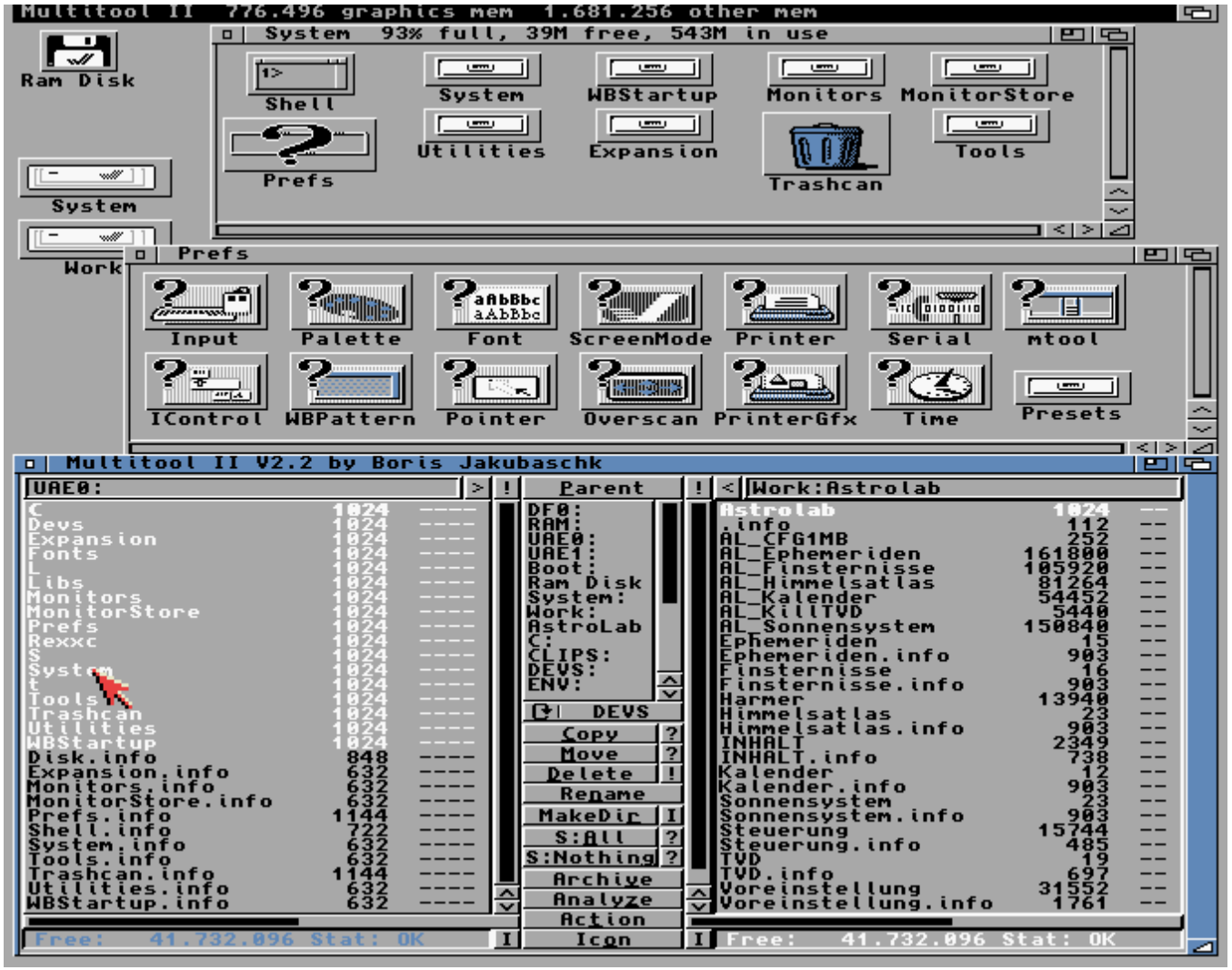
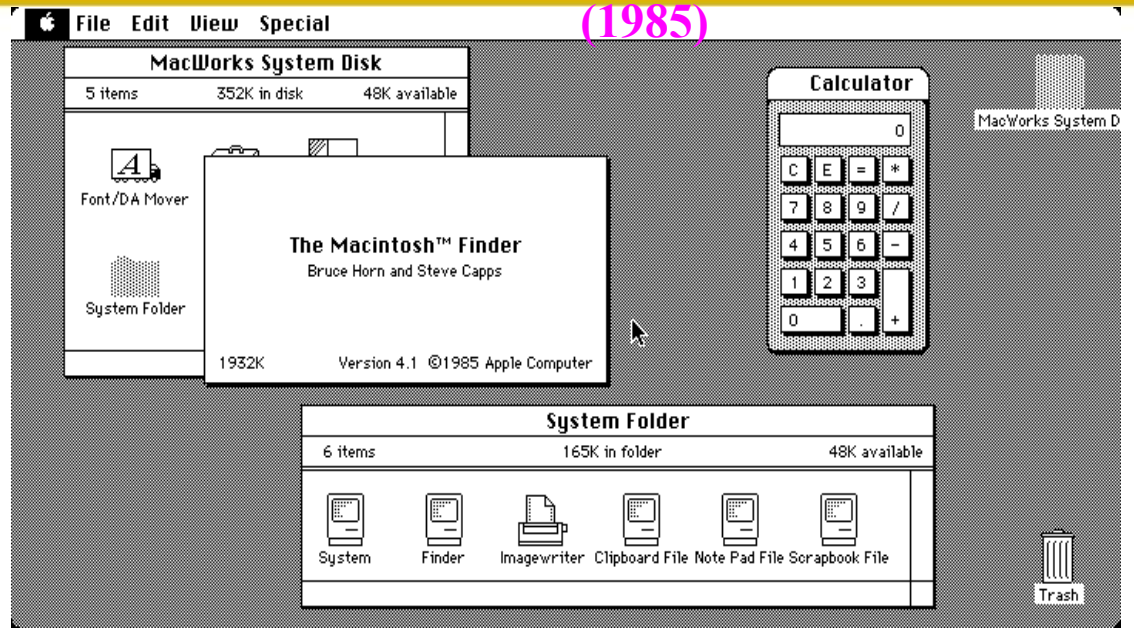
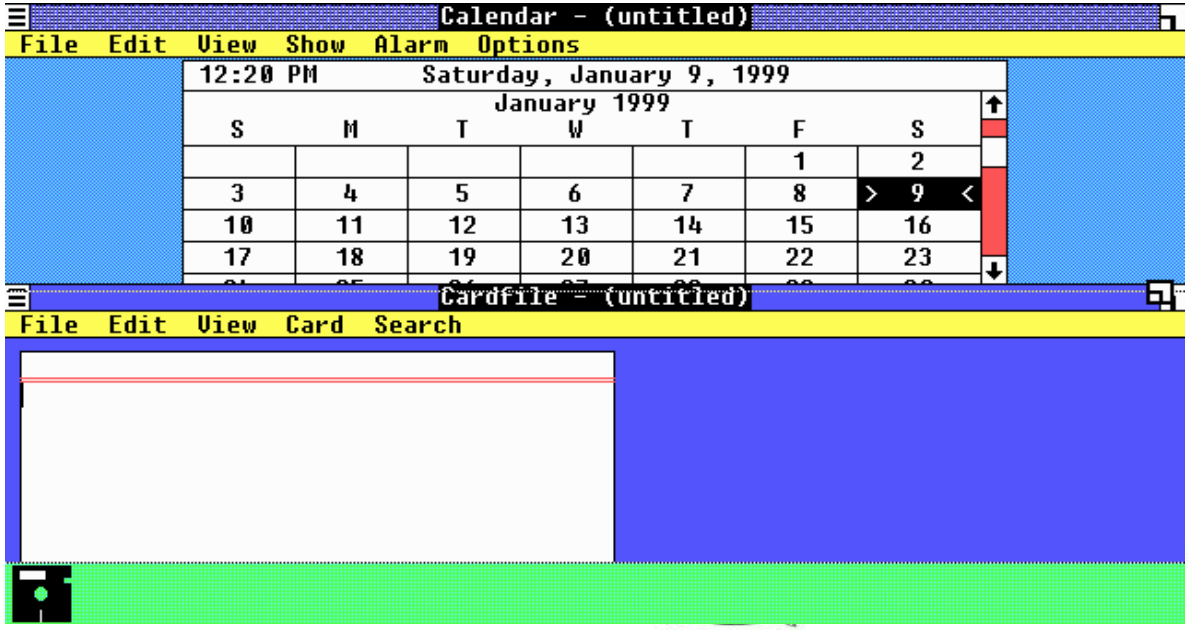
Today's GUIs was born at the Xerox Palo Alto Research Center (PARC)

German-made Amiga



(1985)



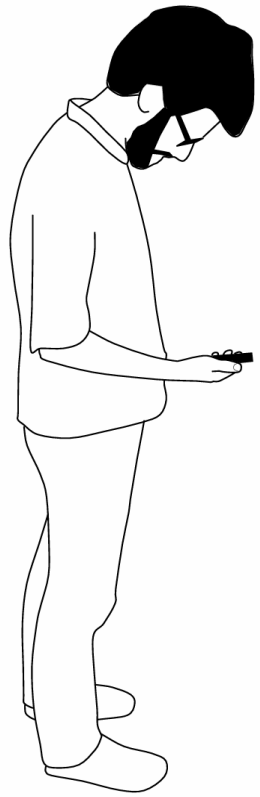


Windows 1.0 (1985).

Human-computer interaction (HCI) is a multidisciplinary field of study focusing on the design of computer technology, and particularly the interaction between humans (the users) and computers.

Desktop Environments

Mobile Technologies



Interactive Environments

Digital Devices

ICONS

E-reader

Digital assistant

GPS navigation device

Gaming console

Desktop computer

Smart thermostat

Smartwatch

Digital audio player

Vr headset

Smart home hub

MicroSD card

Smart TV

Bluetooth headphones

Smartphone

3D printer

USB flash drive

Drone

Digital camera

Smart speaker

Digital photo frame

Wireless router

Tablet

Smart light bulb

Laptop

External

3 UI formats

User interfaces are the access points where **users interact** with designs.

1.Graphical user interfaces (GUIs): Users interact with visual representations on digital control panels. A computer's desktop is a GUI.

2.Voice-controlled interfaces (VUIs): Users interact with these through their voices. Most smart assistants, E.g., Siri on iPhone and Alexa on Amazon devices—are VUIs.

3.Gesture-based interfaces: Users engage with 3D design spaces through bodily motions—e.g., in virtual reality (VR) games.

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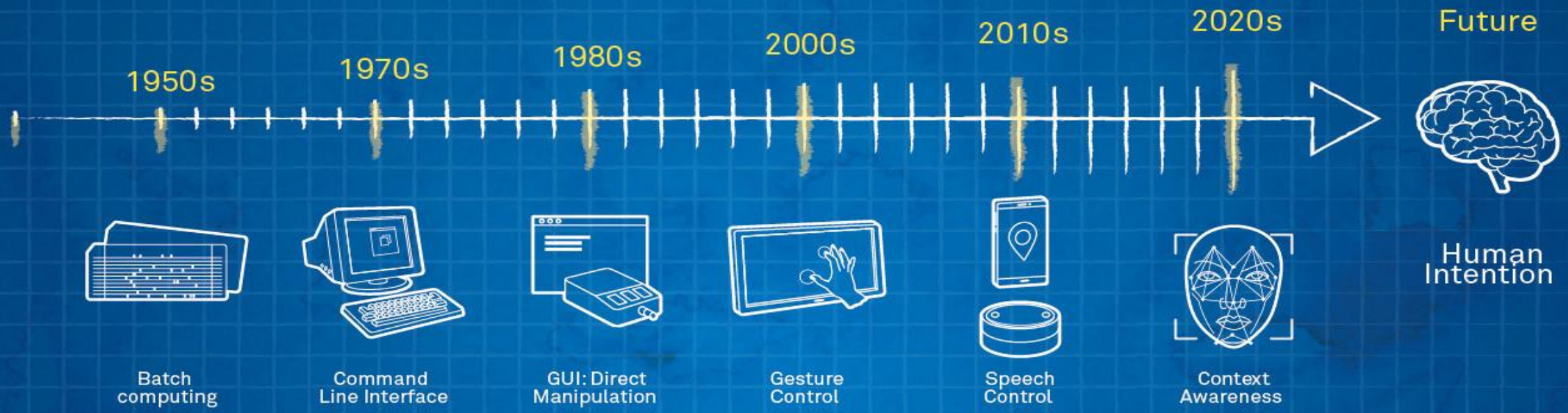
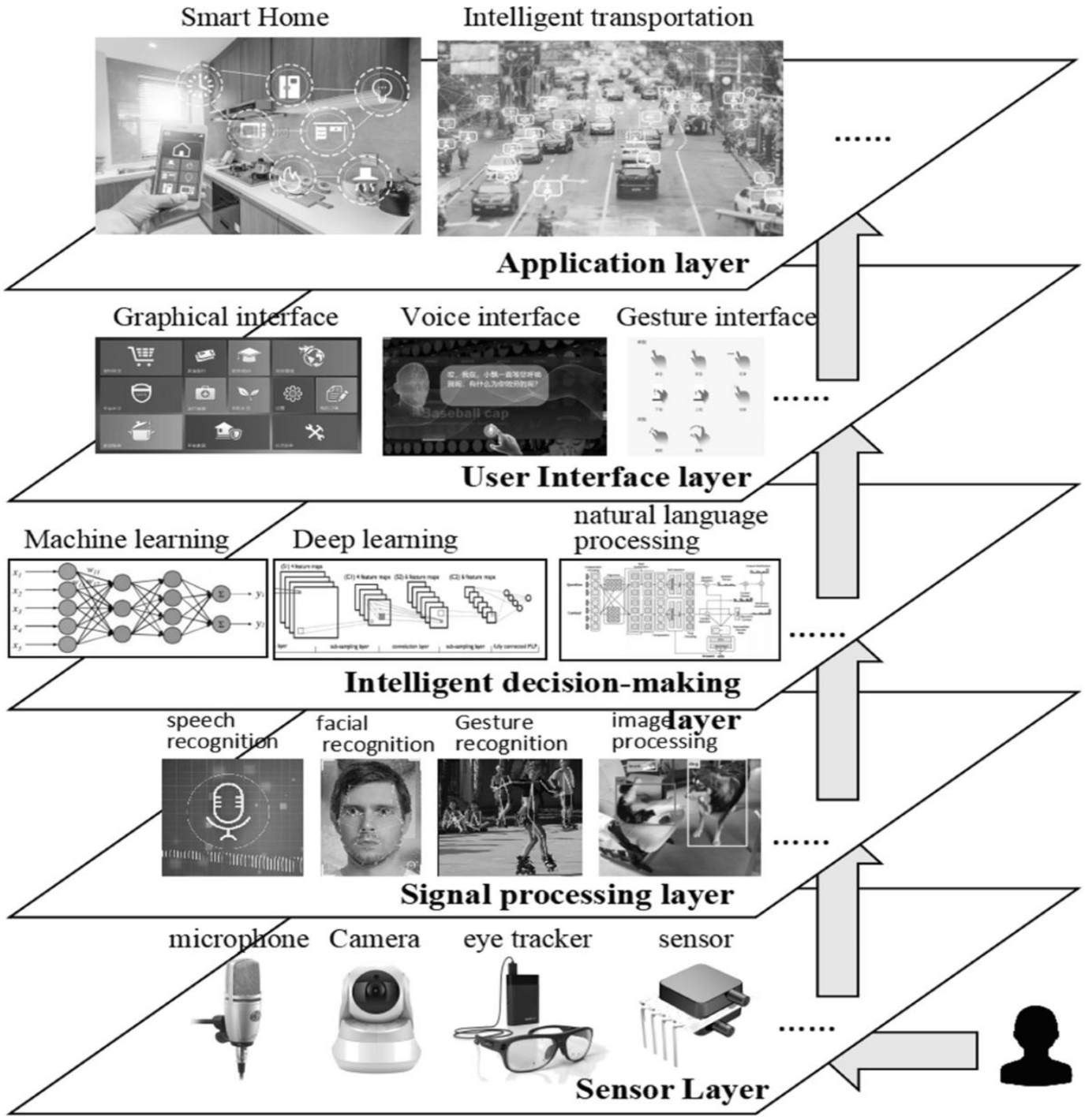
Evolution of human-to-computer interaction



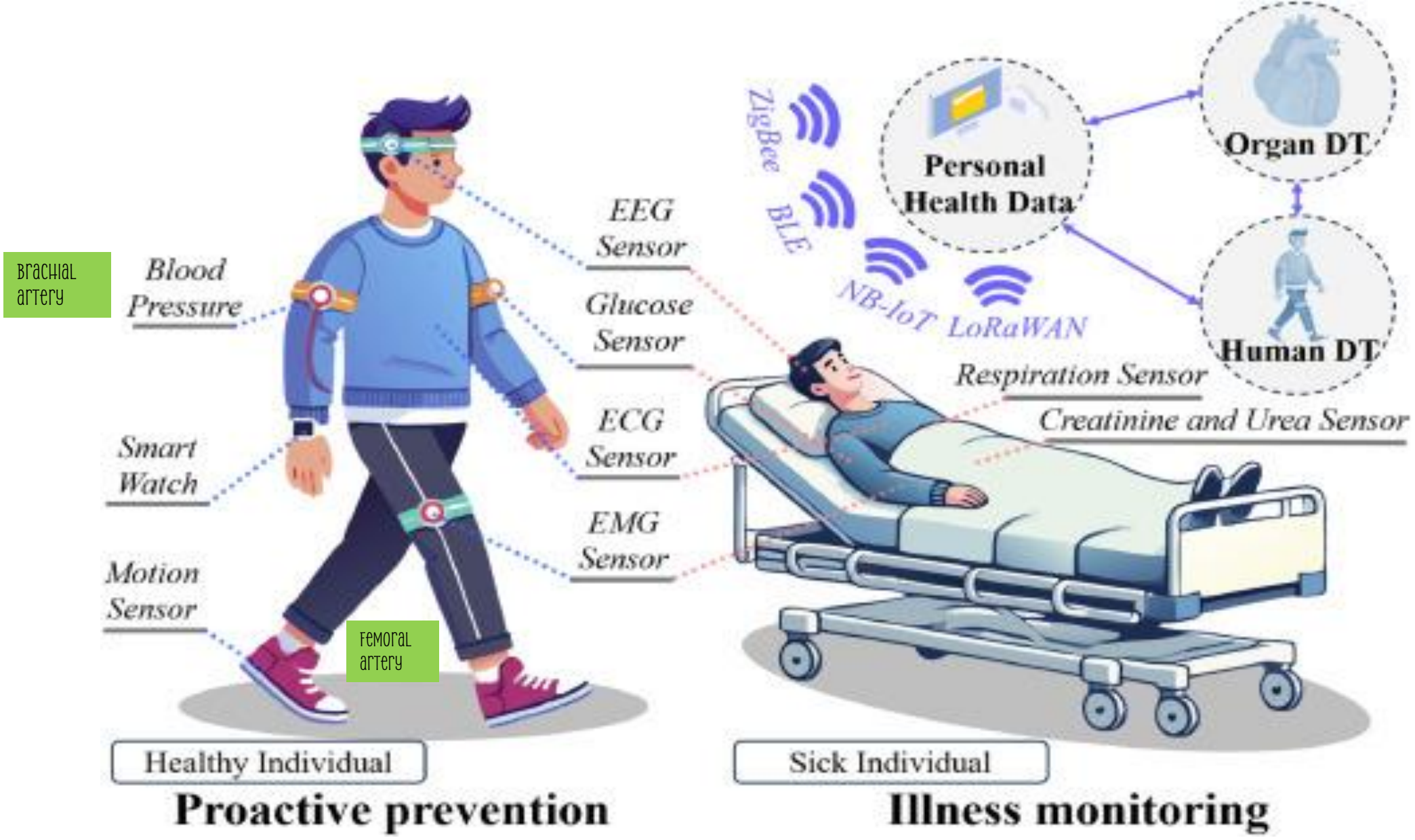
INTENTION	"Do a computation"	"Do what I instruct"	"Do what I touch"	"Do what I show"	"Do what I say"	"Do what I usually do"	**"Do what I mean"**
INPUT	Punch cards, paper tape	Keyboards, Terminals	Mouse, trackpad, touchscreen, stroke recording	Depth cameras, gesture recording	ASR, NLP, Service Coordination	GPS, accelerometer, camera, sensors	Eye tracking, emotion detection, activity recognition, pulse, skin flush, vocal tone, laughter, etc
DEVICE	Mainframes, batch processing	Workstations, Personal Computers, keyword search	Personal Computers, Smartphones	Smartphones, Tablets, Smart TVs	Smartphones, Smart homes, Personal Digital Assistants	Smartphones, Smart objects	Virtual and Augmented Reality, Robots, Smart Vehicles, Internet of Actions, Responsive Media

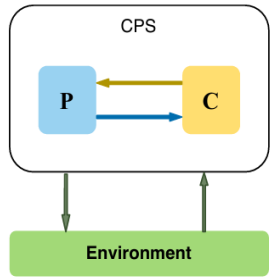
https://www.linkedin.com/pulse/my-phone-isnt-smart-until-can-read-mind-bo-begole/



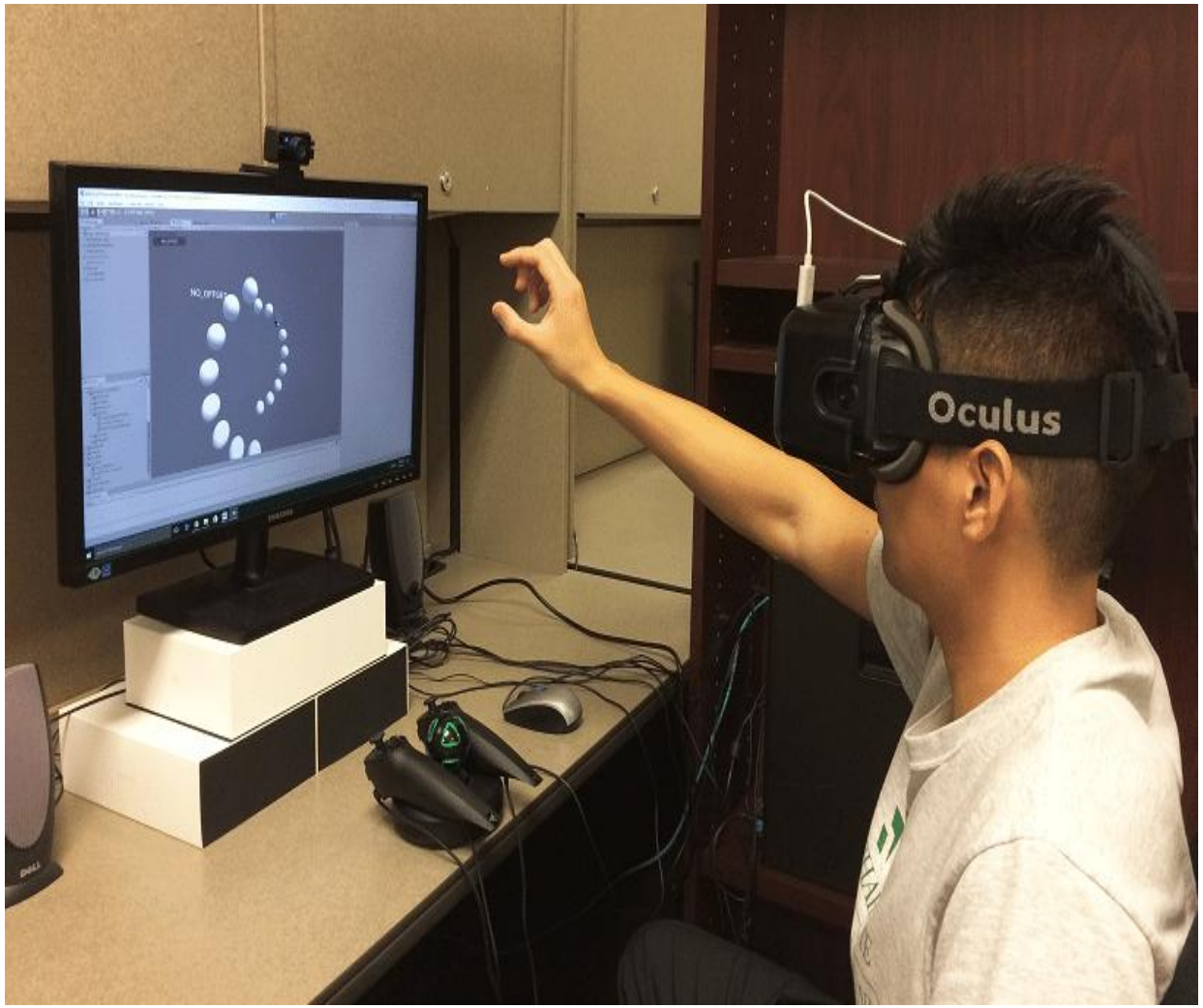
https://hcik4.wordpress.com/2008/11/01/the-most-important-factor-in-hci/

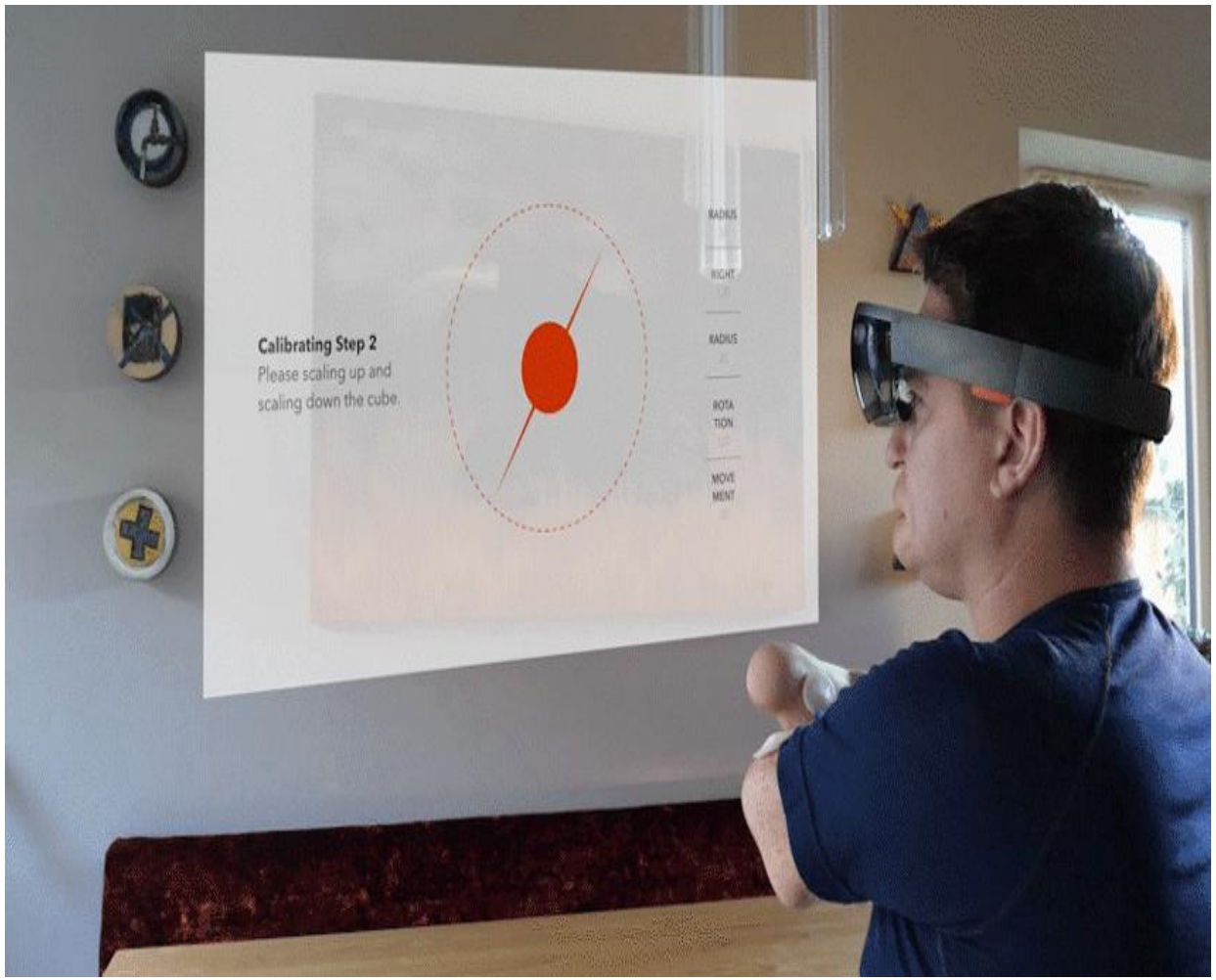
HCI expanded from early graphical user interfaces to include myriad interaction techniques and devices, multi-modal interactions, tool support for model-based user interface specification, and a host of emerging ubiquitous, handheld and context-aware interactions."

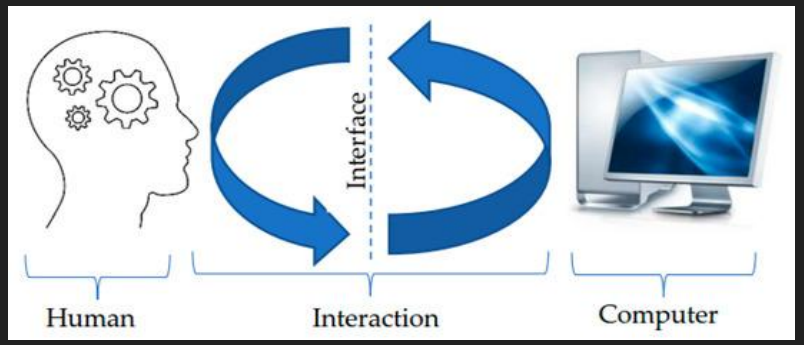




[Leveraging digital twin for healthcare emergency management system: Recent advances, critical challenges, and future directions - ScienceDirect]


Oculus


Calibrating Step 2
Please scaling up and
scaling down the cube.
RADIUS
RADIUS
ROTA
TION
MOVE
MENT



Foundation of HCI

- *Study, Observe, learn how people use computers and other things*
- *Design UI, technology and the entire user experience (UX)*
- *Analyze, evaluate and assess human computer interaction*

Alan_Dix Book Chapter 1 (pdf pgs 37- 57=> 20)

OVERVIEW

- Humans are limited in their capacity to process information. This has important implications for design.
- Information is received and responses given via a number of input and output channels:
  - visual channel
  - auditory channel
  - haptic channel
  - movement.
- Information is stored in memory:
  - sensory memory
  - short-term (working) memory
  - long-term memory.
- Information is processed and applied:
  - reasoning
  - problem solving
  - skill acquisition
  - error.
- Emotion influences human capabilities.
- Users share common capabilities but are individuals with differences, which should not be ignored.

1.8 SUMMARY

In this chapter we have considered the human as an information processor, receiving inputs from the world, storing, manipulating and using information, and reacting to the information received. Information is received through the senses, particularly, in the case of computer use, through sight, hearing and touch. It is stored in memory, either temporarily in sensory or working memory, or permanently in long-term memory. It can then be used in reasoning and problem solving. Recurrent familiar situations allow people to acquire skills in a particular domain, as their information structures become better defined. However, this can also lead to error, if the context changes.

Human perception and cognition are complex and sophisticated but they are not without their limitations. We have considered some of these limitations in this chapter. An understanding of the capabilities and limitations of the human as information processor can help us to design interactive systems which support the former and compensate for the latter. The principles, guidelines and models which can be derived from cognitive psychology and the techniques which it provides are invaluable tools for the designer of interactive systems.

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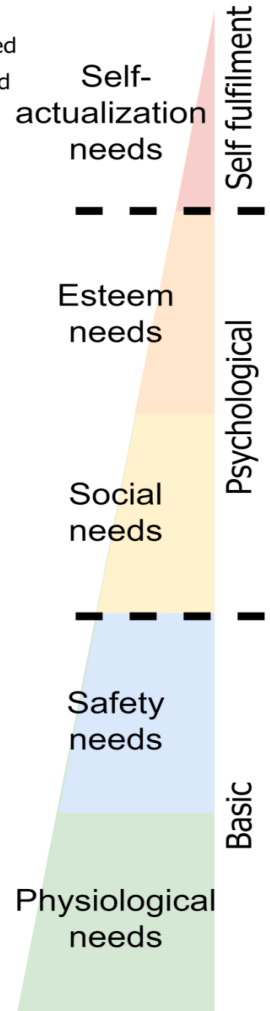
Maslow's Hierarchy Of Needs

Maslow's hierarchy of needs links basic human needs and desires - survival needs must be met before higher ones. The sequence is flexible, with esteem occasionally surpassing love, and individuals can self-actualize despite poverty. Human behaviors are complex, often motivated by a combination of needs. Going up the hierarchy, the physiological and short-term requirements shift to more psychological and long-term aspirations. Maslow's pyramid helps to identify target needs, humanize personas, and align quantitative data with qualitative needs that are applicable in workplace motivation, education, counseling, and nursing.



Physiological needs

Biological requirements essential for human survival, e.g. air, food, drink, shelter, clothing, warmth, sex, and sleep.

Safety needs

Fulfillment is found in life's order, predictability, and control, provided by family and society, contributing to emotional and financial security.

Social needs

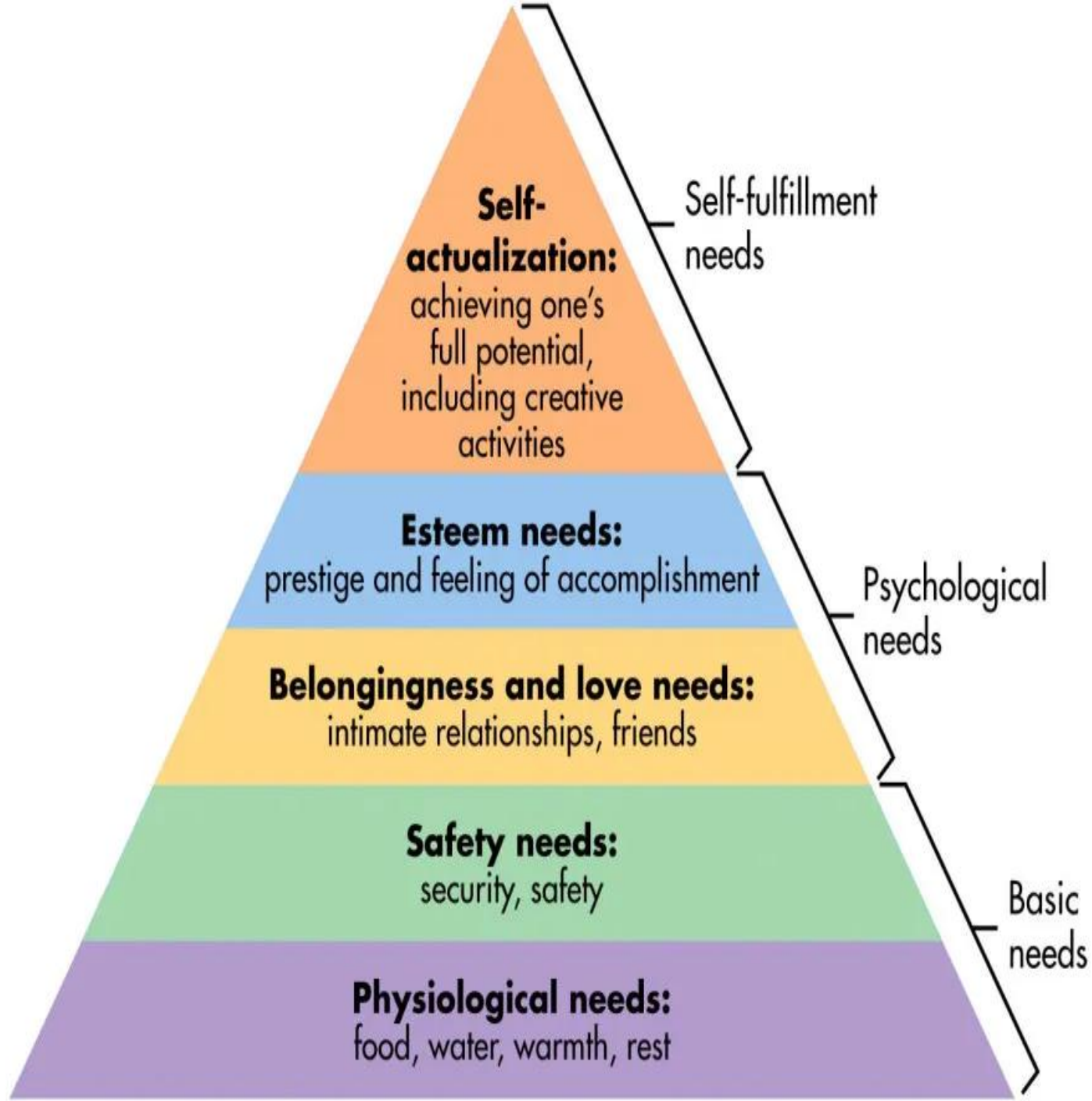
Emotional needs include interpersonal relationships, like friendship, intimacy, trust, acceptance, and the exchange of affection through affiliating, connectedness, and group belonging.

Esteem needs

Represent a desire to be accepted and valued and are split into: 1. esteem for oneself (dignity, achievement, mastery, independence), 2. the desire for reputation or respect from others (status, prestige).

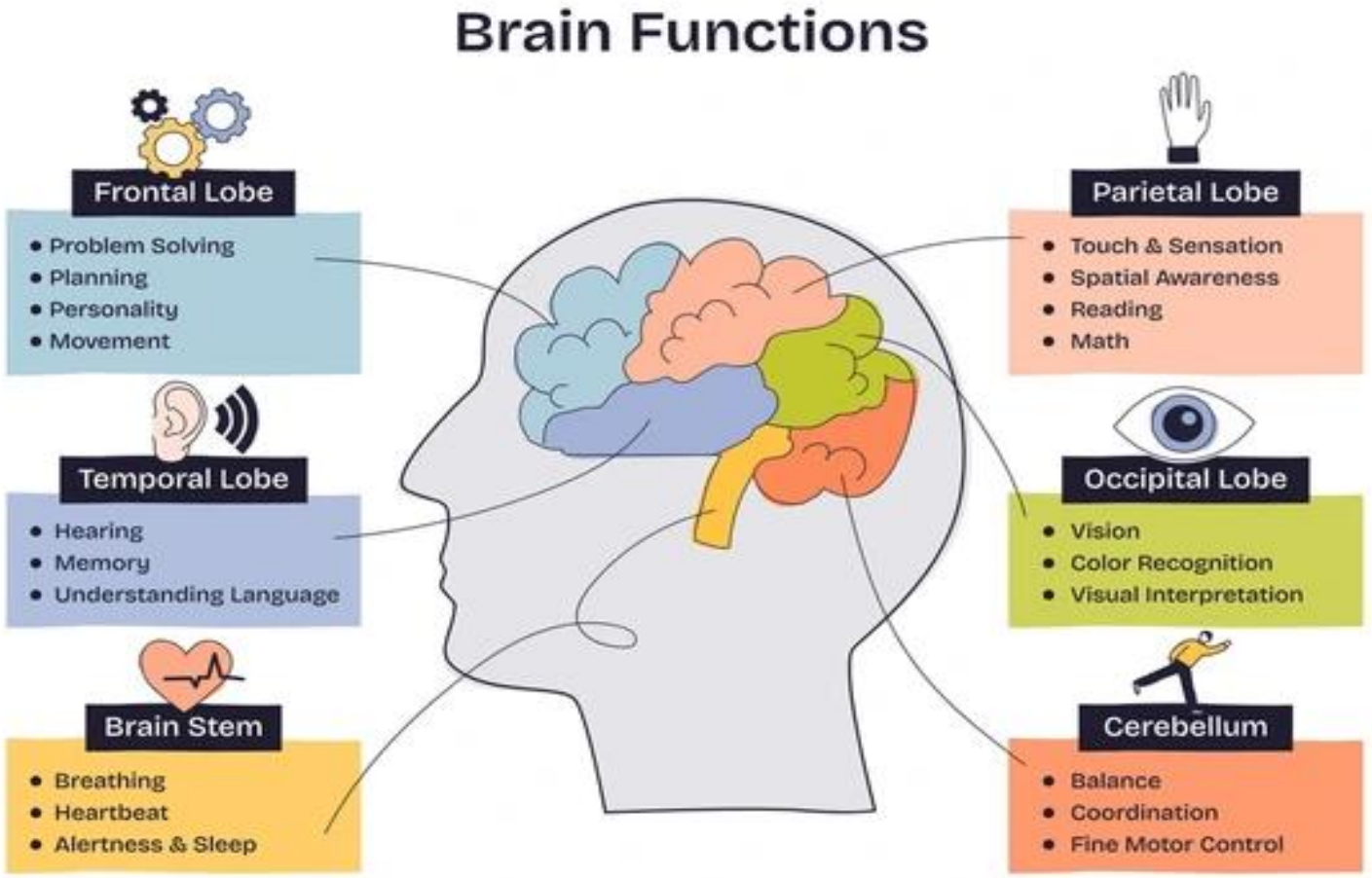
Self-actualization

People are striving to reach the limits of an individual realizing a person's potential, self-fulfillment, seeking personal growth, and peak experiences, which is difficult to achieve consistently.



HCI First Building Block Cognitive psychology

How humans perceive the world around them, how they store and process information and solve problems, and how they physically manipulate objects?



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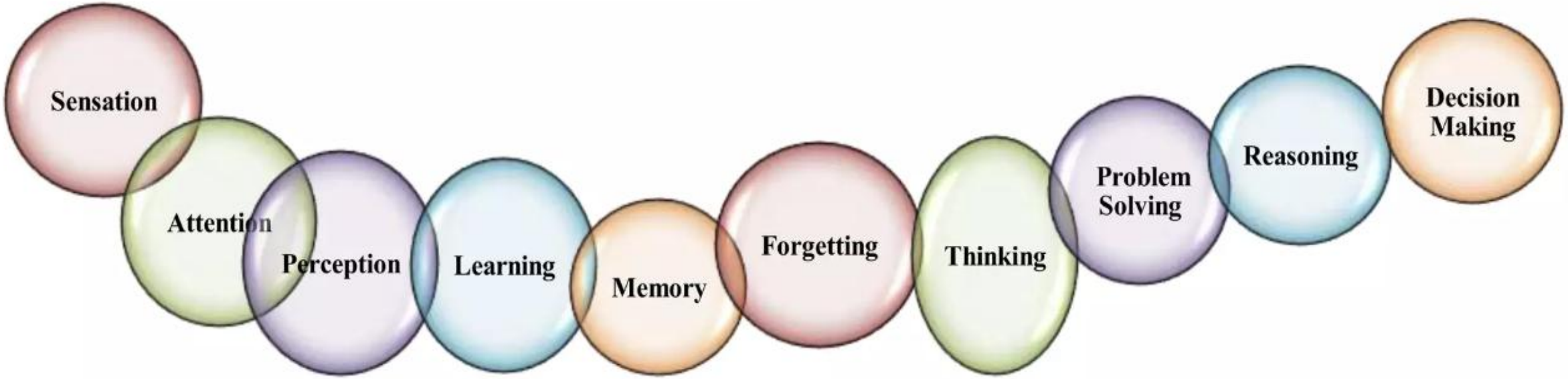
Cognitive Processes (Higher mental state)

- ✓ Attention is the mental process of brining few stimuli into the center of awareness out of many stimuli present.
- ✓ The process of assigning meaning to the information received about the environment based on past experiences.



- ✓ Cognitive processes include all processes underlying mental activities like attention, perception, learning, memory thinking, problem solving, reasoning.

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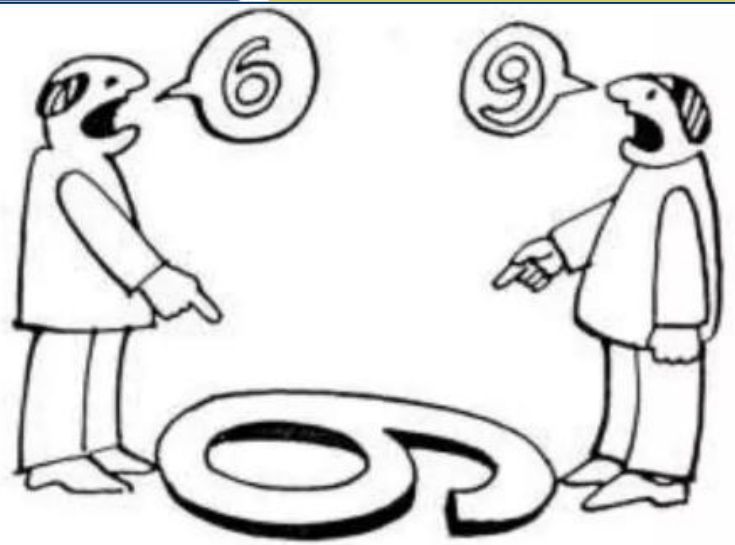
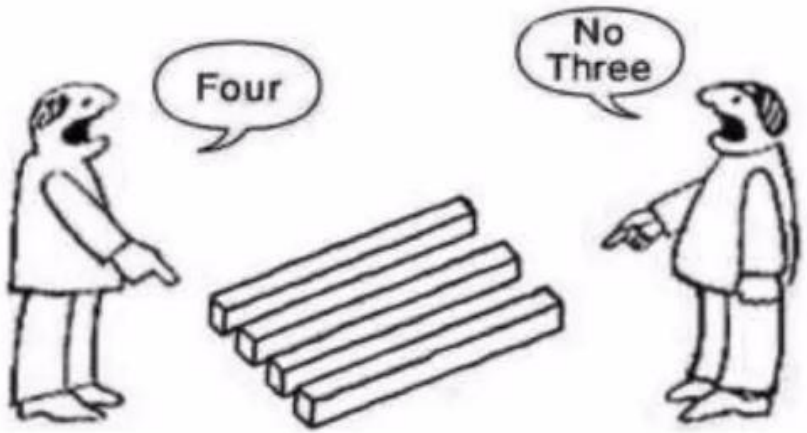
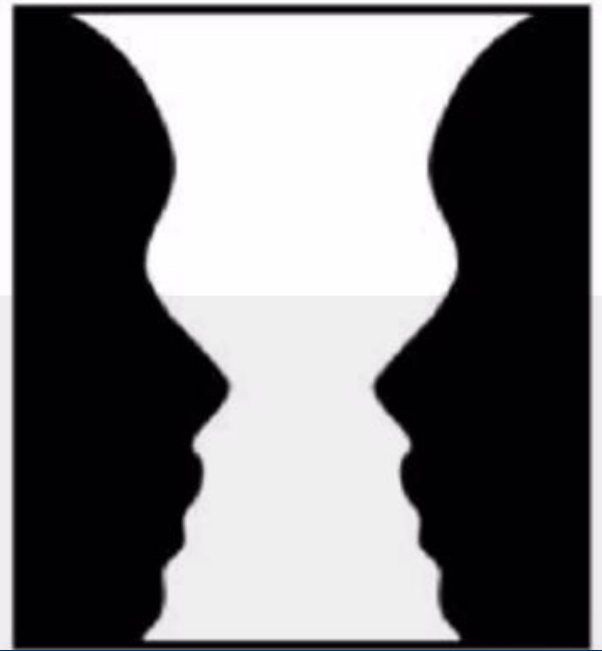
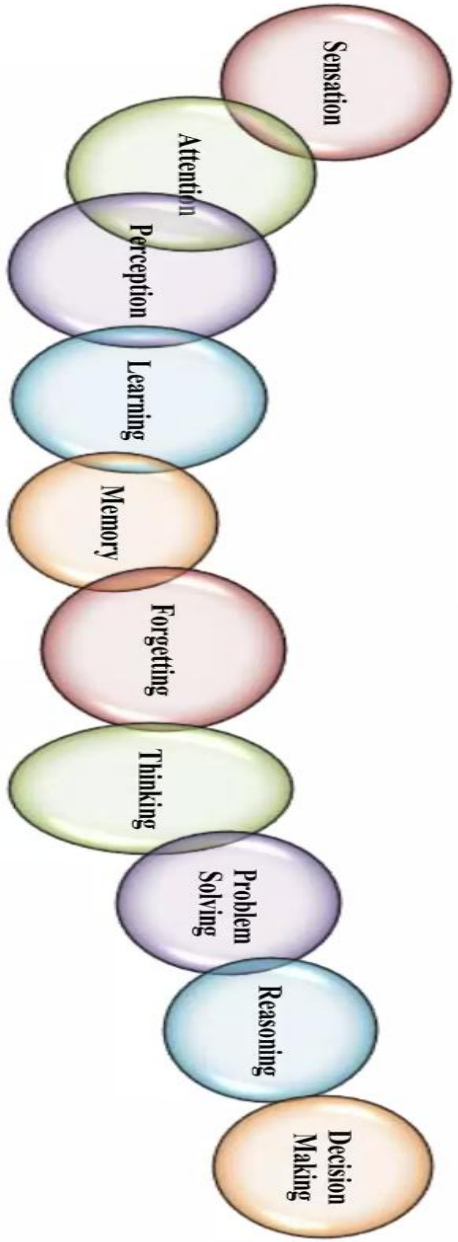
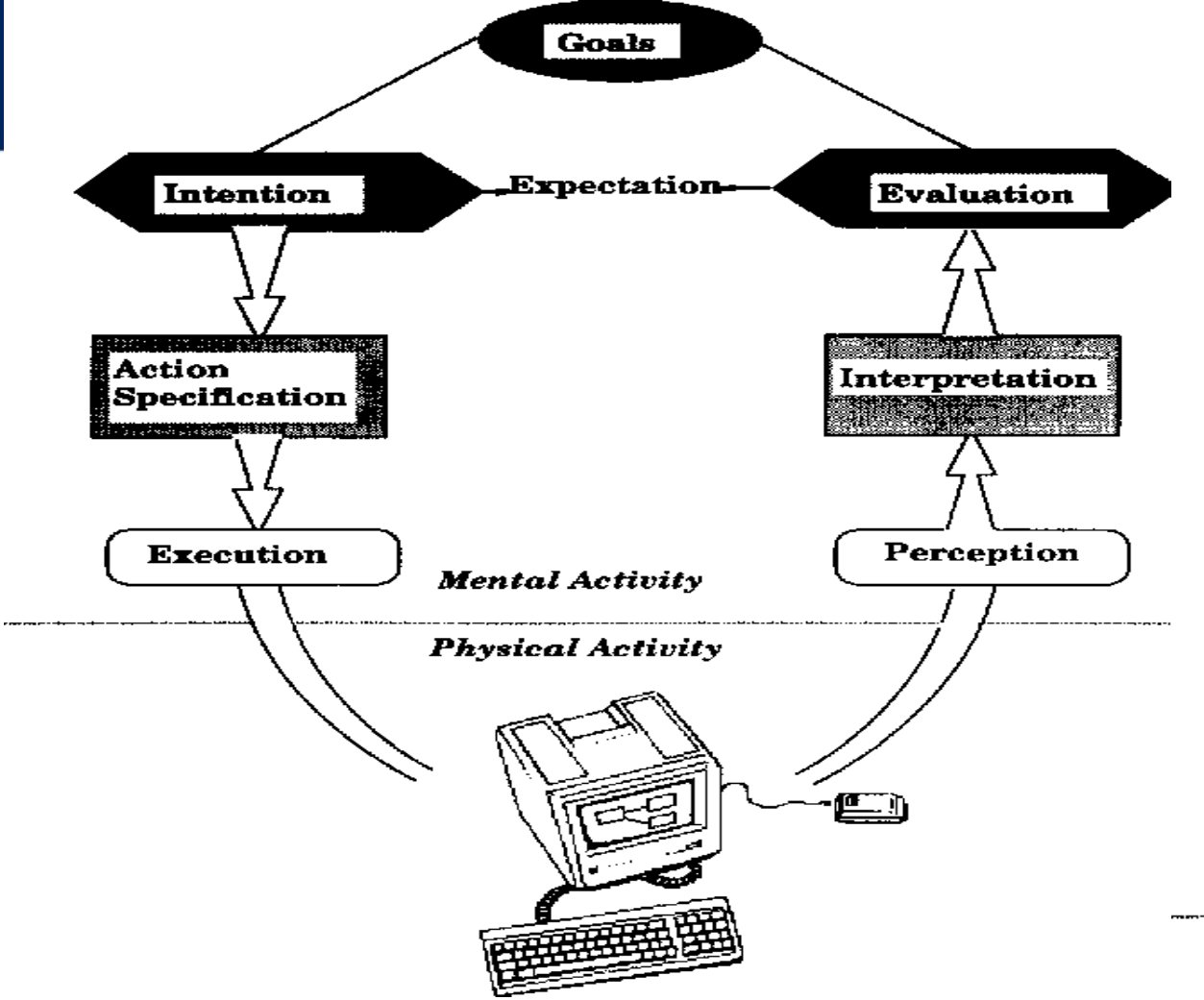
Map picture onto cognitive process

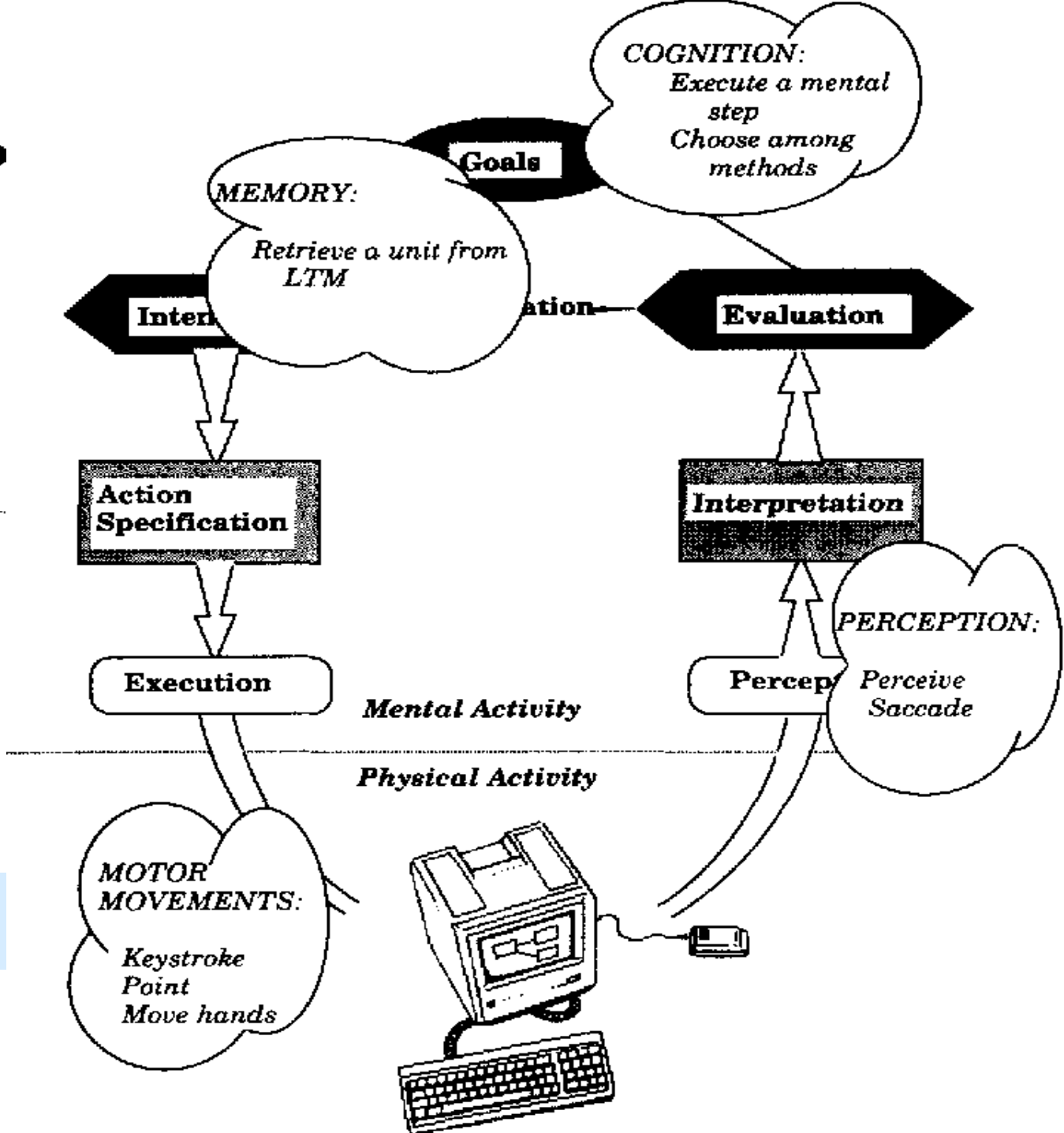










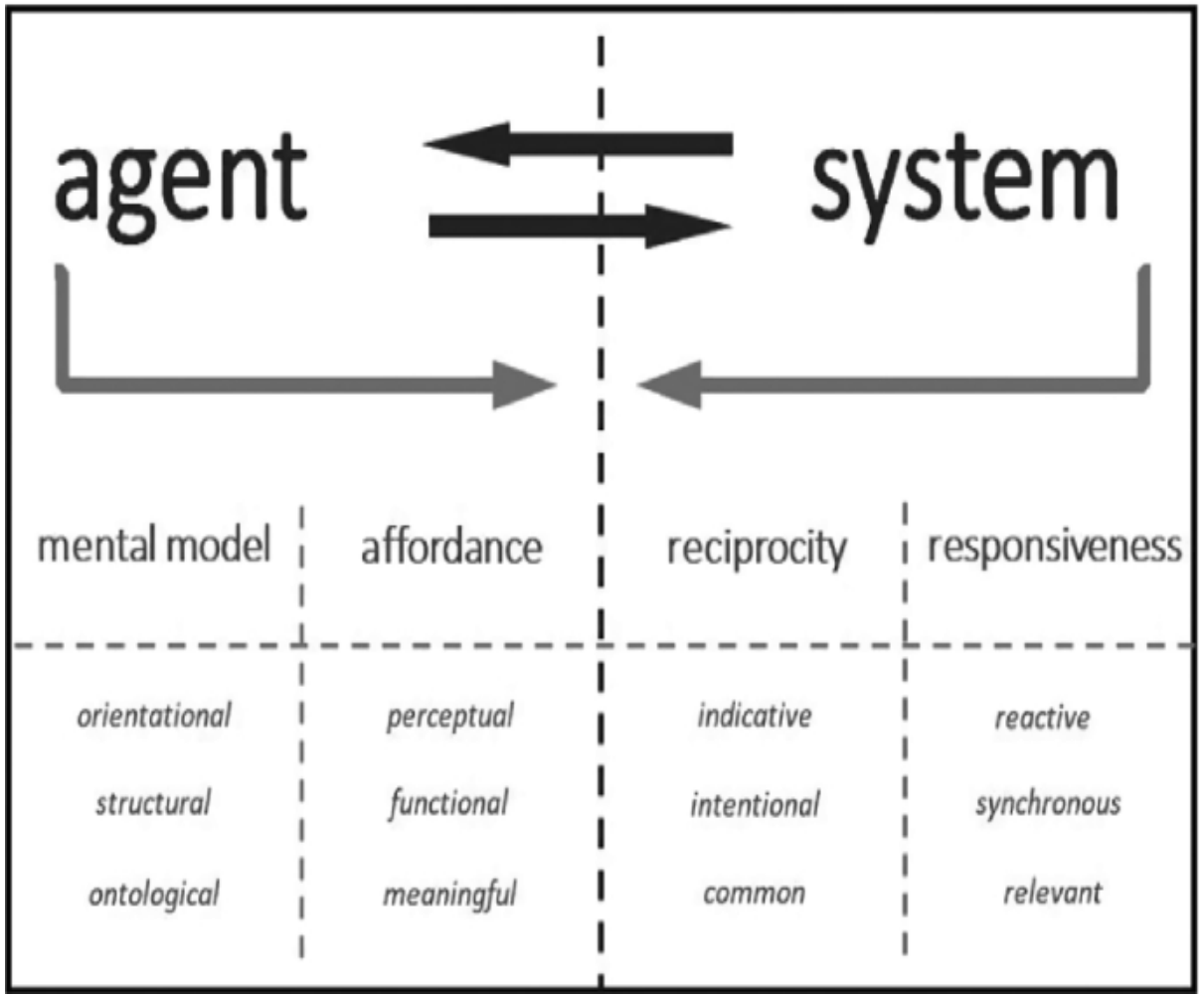


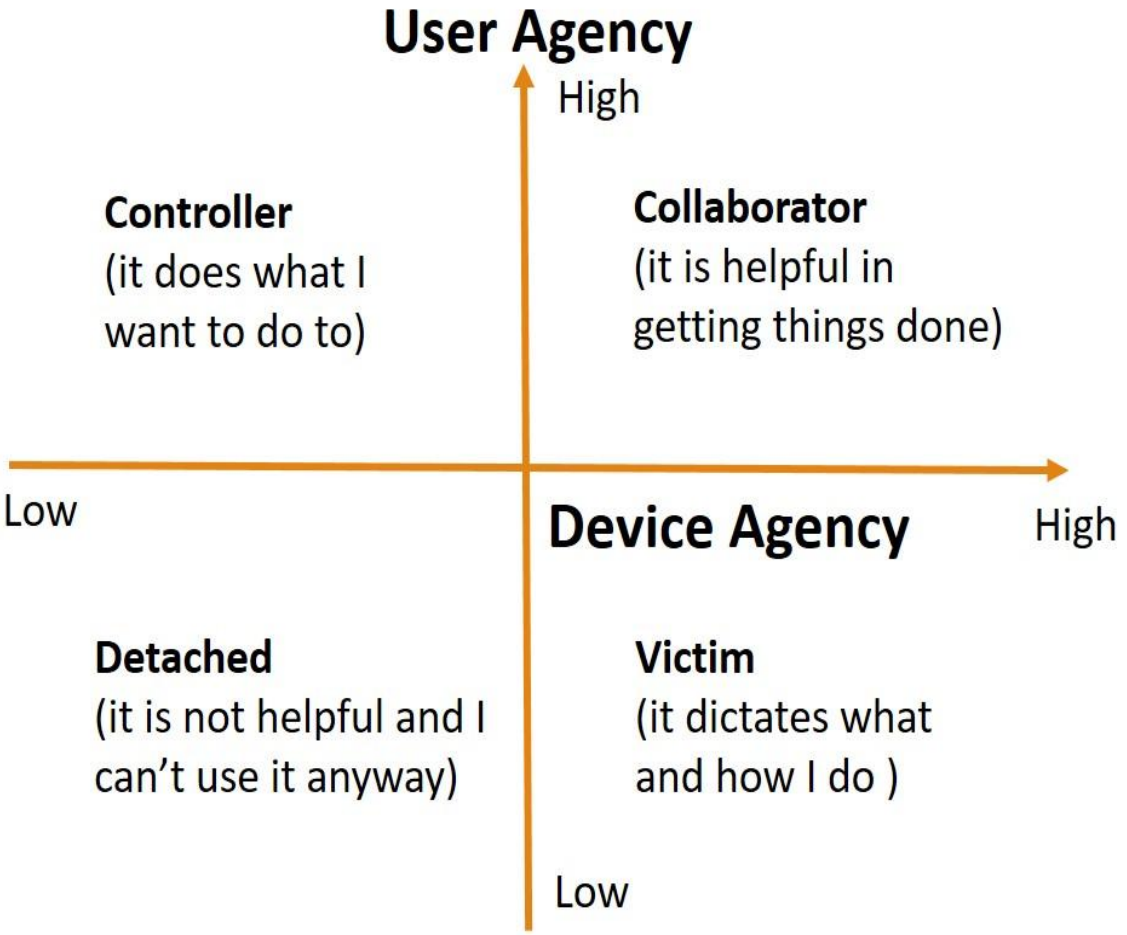
The seven steps of user activities involved in the performance of a computer-based task (based on Norman, 1986).

Published in Hum. Comput. Interact. 1990

The Growth of Cognitive Modeling in Human-Computer Interaction Since GOMS

Human Agency/Sense of Agency





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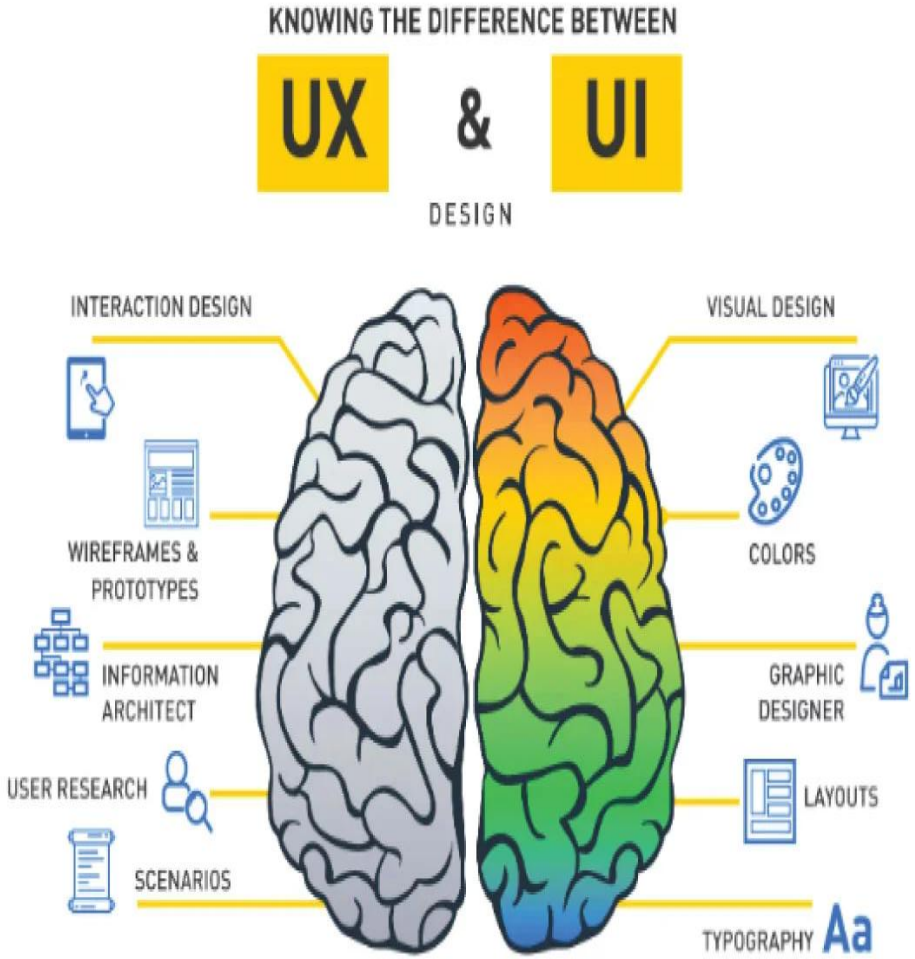
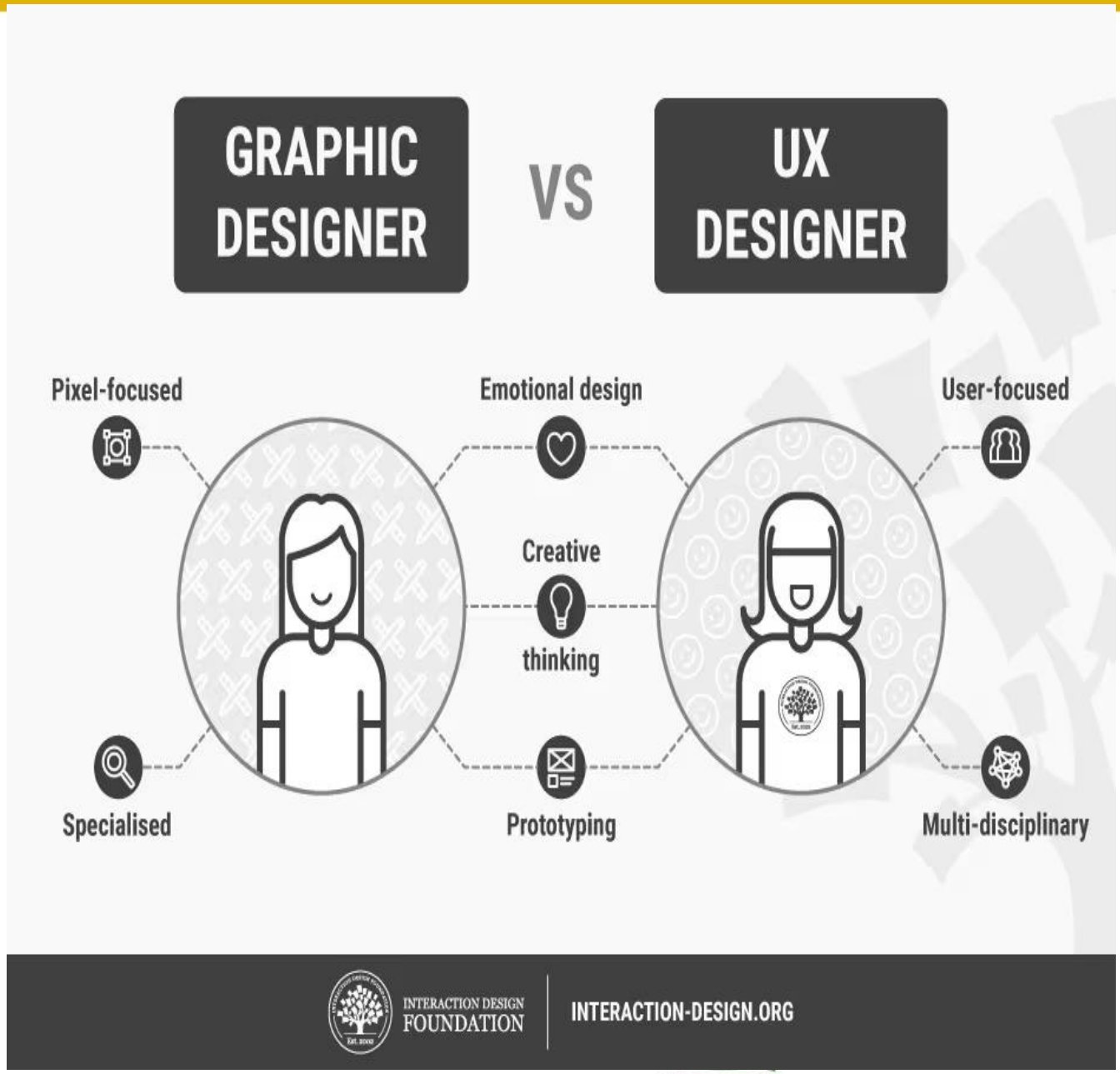
So will we model UI/UX in HCI?





Cursors, avatars, virtual hands or tools, and other rendered graphical objects, enable users to _____ with computers such as PCs, game consoles or virtual reality systems.

These representations are _____ objects that artificially extend the users' physical bodies, enabling them to manipulate the virtual environment by performing _____actions that are continuously mapped to their_____ .

HCI-CG = Modeling UI/UX & Interactios

Category	Principle / Law	Purpose	Tools / Models	Practical Use / Coding
Interaction Modeling	GOMS, KLM	Predict user task performance	Analytical / cognitive models	Task breakdown, estimate time for tasks
Pointing & Selection	Fitts' Law	Optimize speed & accuracy of selecting targets	Formulas, UX calculators	Button sizes, menu placement, mouse/VR interaction
Decision Making	Hick-Hyman Law	Predict time to choose among options	Analytical evaluation	Menu complexity, navigation design
Learning & Practice	Power Law of Practice	Model how users improve with repetition	Observational / logging	Training interfaces, repeated tasks
Usability Evaluation	Nielsen's Heuristics	Ensure interface is usable & intuitive	Checklists, cognitive walkthrough	UX testing, evaluation of prototypes
User-Centered Design	Norman's Principles	Align design with user mental models	Personas, Scenarios	Prototype evaluation, interface layout
Prototyping & UI Flow	—	Early visualization of interactions	Figma, Adobe XD, Balsamiq, Axure	Interactive wireframes, click-throughs
Interaction Coding	—	Implement user actions & feedback	HTML/CSS/JS, React, Python GUI	Event-driven behaviors, small usability experiments

Computer Graphics (CG) in UI/UX

Category	Principle / Law	Purpose	Tools / Frameworks	Practical Use / Coding
Visual Modeling	Gestalt Principles	Organize visual elements for clarity	Blender, Maya	Layout design, grouping & hierarchy
Rendering & Feedback	Weber-Fechner Law	Optimize perception of contrast, color	OpenGL, WebGL, Three.js	Visual clarity, readability
Animation & Motion	—	Provide feedback & improve UX	Unity, Unreal Engine	Button hover, transitions, animation curves
Interactive Graphics	Fitts' Law (applied)	Ensure targets are reachable & clickable	Unity, WebGL, VR SDKs	VR/AR buttons, menus, object manipulation
Immersive Interaction	Human factors / ergonomics	Improve comfort & efficiency	Unity XR, WebXR	AR/VR UI, gesture-based interfaces
Shader & Effects	—	Enhance realism & visual guidance	GLSL, HLSL	Highlighting, feedback on interaction

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How I track your course CS-555 performance ?

Week	Date	Reasonable & Meaningful Questions	Exercises / Problems Solved	Verbal Presentation / Discussion	Whiteboard / Live Problem Solving	Live Demo / Implementation	Remarks
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

Rubric Notes (Bloom's Taxonomy: C->Cognitive, P->Psychomotor , A->Affective)

- **Reasonable & Meaningful Questions** → student asks insightful questions that deepen understanding
- **Exercises / Problems Solved** → weekly lab assignments, homework, or exercises
- **Verbal Presentation / Discussion** → participates in class discussions, explains ideas verbally
- **Whiteboard / Live Problem Solving** → solves problems on whiteboard in class or tutorials
- **Live Demo / Implementation/github/discord** → shows working program or prototype
- **Remarks** → optional qualitative notes from instructor or student self-reflection

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Wake up- Your turn to speak & participate is coming

- select-class-25
- select-class-26
- unverified
- global-internships

Resources

- issues-questions
- links-tools
- resources-iad
- resources-hci-cg
- resources-ai-351-pf-26
- write-publish

Announcements

- announcements-iad-a-bscs
- anmnts-cs-555-hci-cg-a-26
- announcements-iad-b-bscs
- anmnts-cs-555-hci-cg-b-26
- announcements-bsai
- anmnts-ai-351-pf-26

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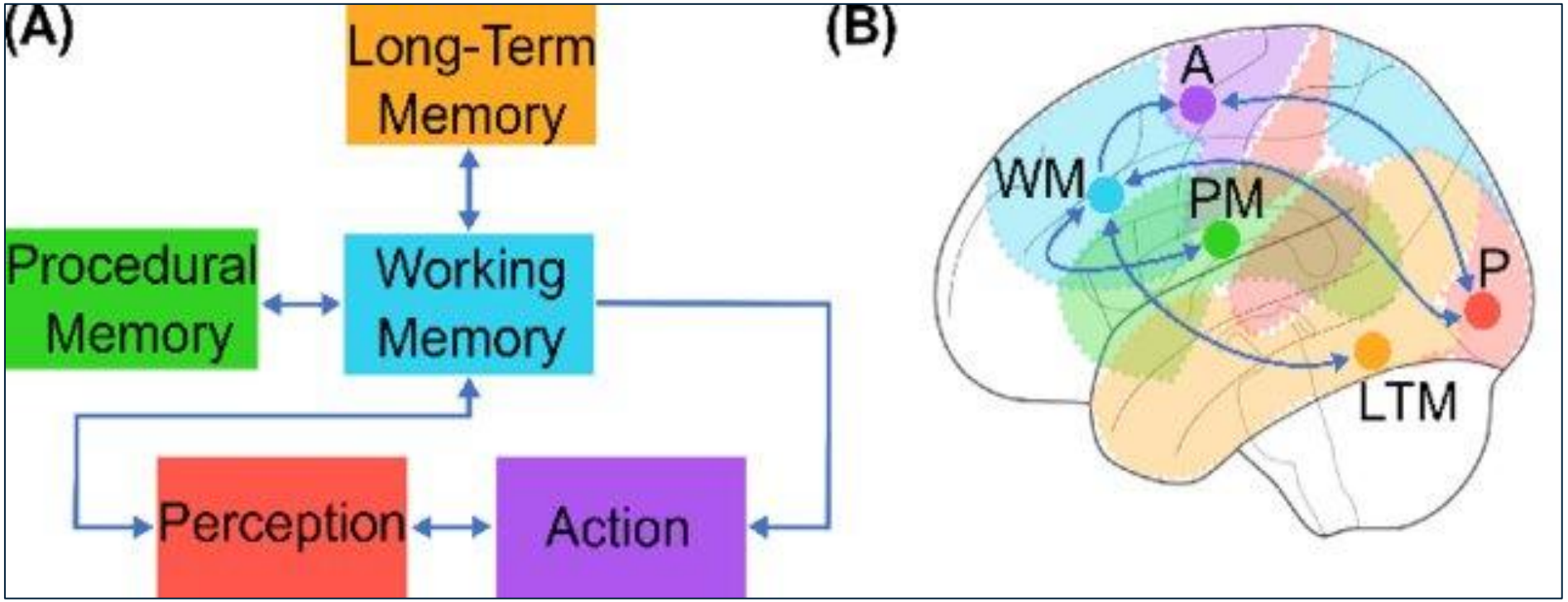
Interaction Modeling (Cognitive/Analytical Models)

Applying psychologic principals to UI/UX interaction

(CMC; Laird, Lebiere, &Rosenbloom, 2017)

(A) The Common Model of Cognition (CMC); (B) Proposed associations between components and anatomical brain regions.



The Role of The Basal Ganglia in the Human Cognitive Architecture: A Dynamic Causal Modeling Comparison Across Tasks and Individuals

May 2021

Conference: 43nd Annual Meeting of the Cognitive Science Society · At: Vienna, Austria

Lab: Paul Rosenbloom's Lab

Catherine Sibert · Holly Hake · John E. Laird · Show all 6 authors · Andrea Stocco

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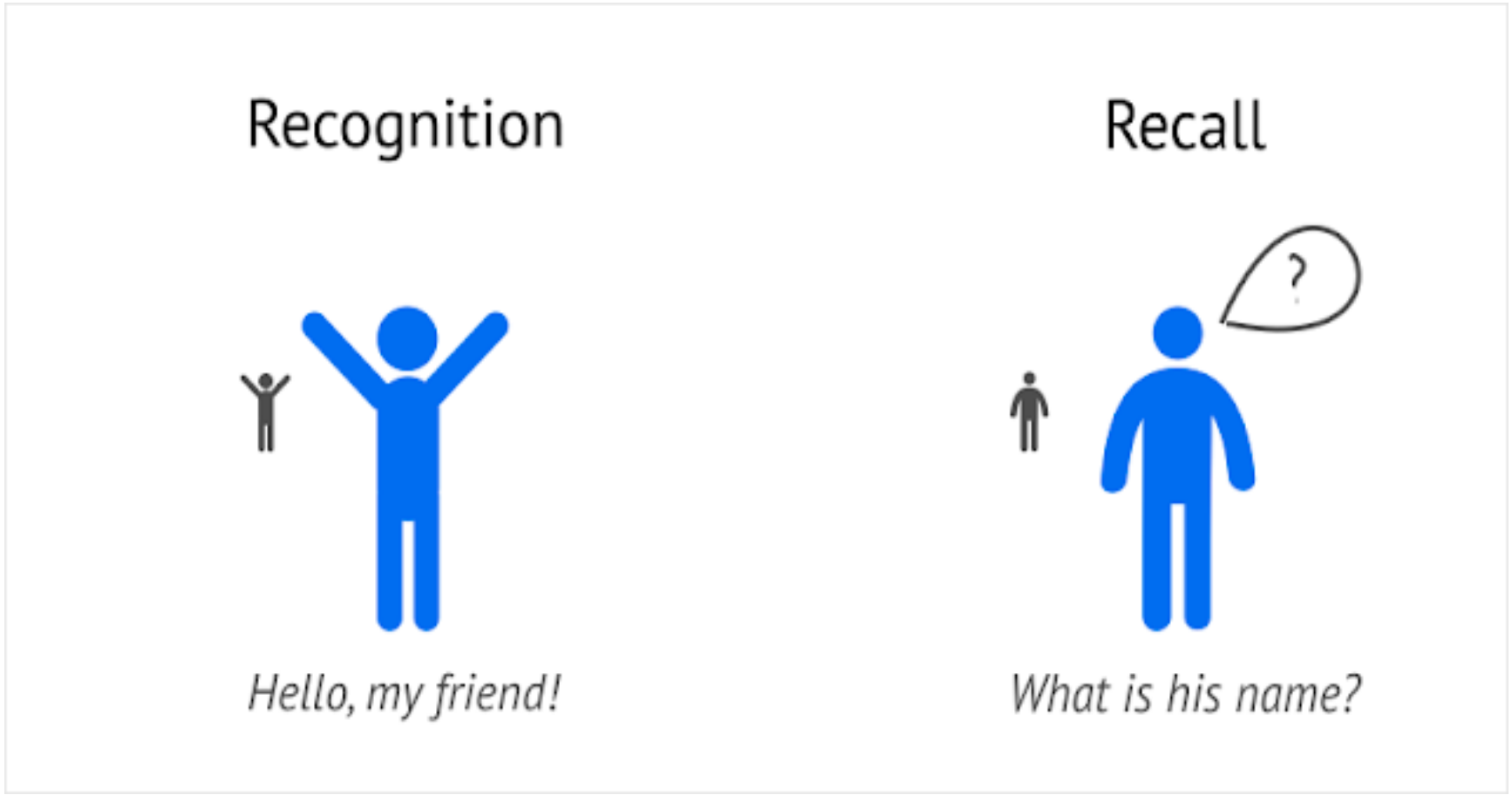
Memory Retrieval processes– recognition and recall



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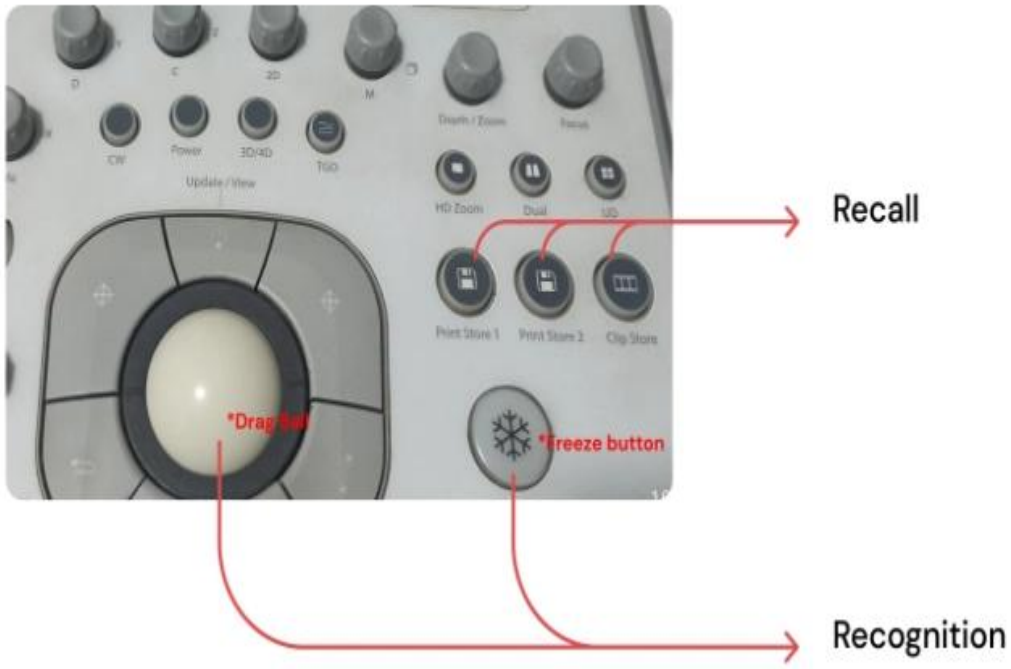
Simplistic Application of Cognition to Design



Recognition in user interfaces pertains to the user's adeptness in identifying or selecting the correct option when confronted with a range of choices or prompts within the interface. Recognition relies on the user's capability to acknowledge familiar options or elements within the interface.

Incorporating distinctive visual elements **(visual cues)** such as icons, colors, or symbols to represent different functions or categories within the interface can aid in memory recognition.

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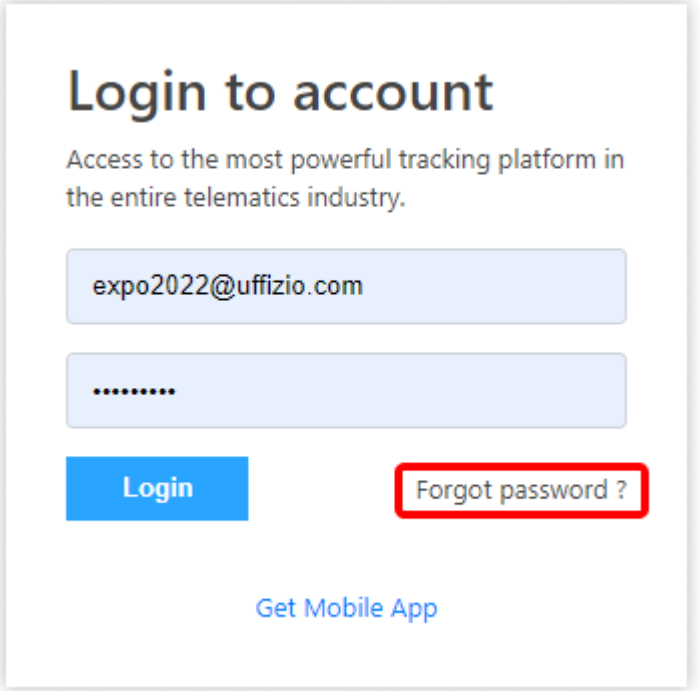
Recognition vs Recall

Recall is like trying to remember something without any help, while recognition is like picking out the right answer when you see it.

Recall in user interfaces denotes the user's capability to retrieve specific information or perform a task from memory autonomously, without external assistance or cues. It encompasses the process of summoning previously acquired knowledge or actions and applying them to the ongoing context within the interface.

A prime example of Recall is evident in the retrieval of login credentials.



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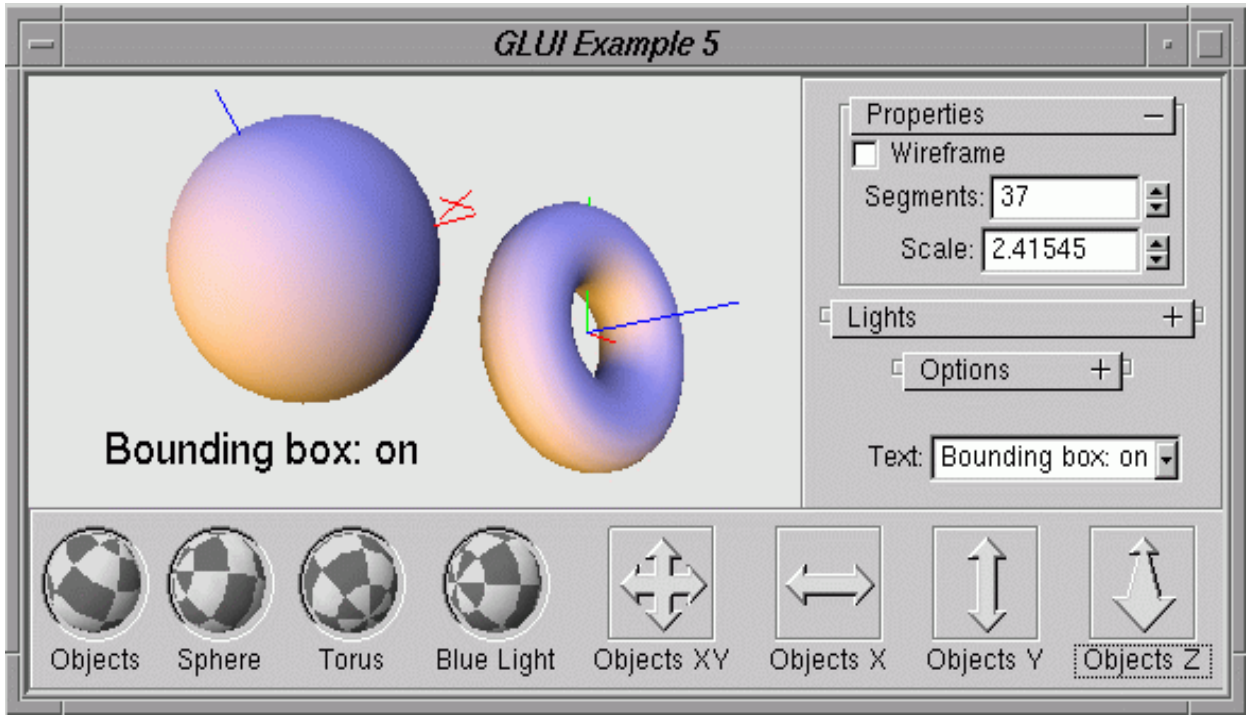
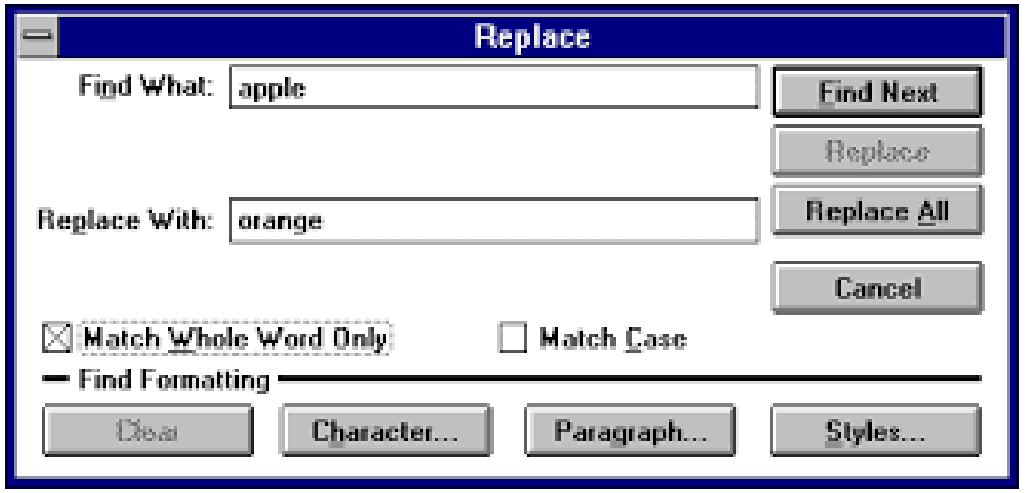
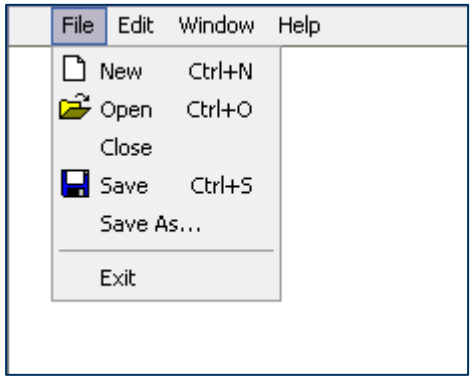
Clear and Concise Labeling -> memory recognition

Using clear and concise labels for buttons, menus, and navigation elements can aid in memory recognition. Descriptive labels that accurately represent the function or purpose of each element can help users remember the actions associated with them.







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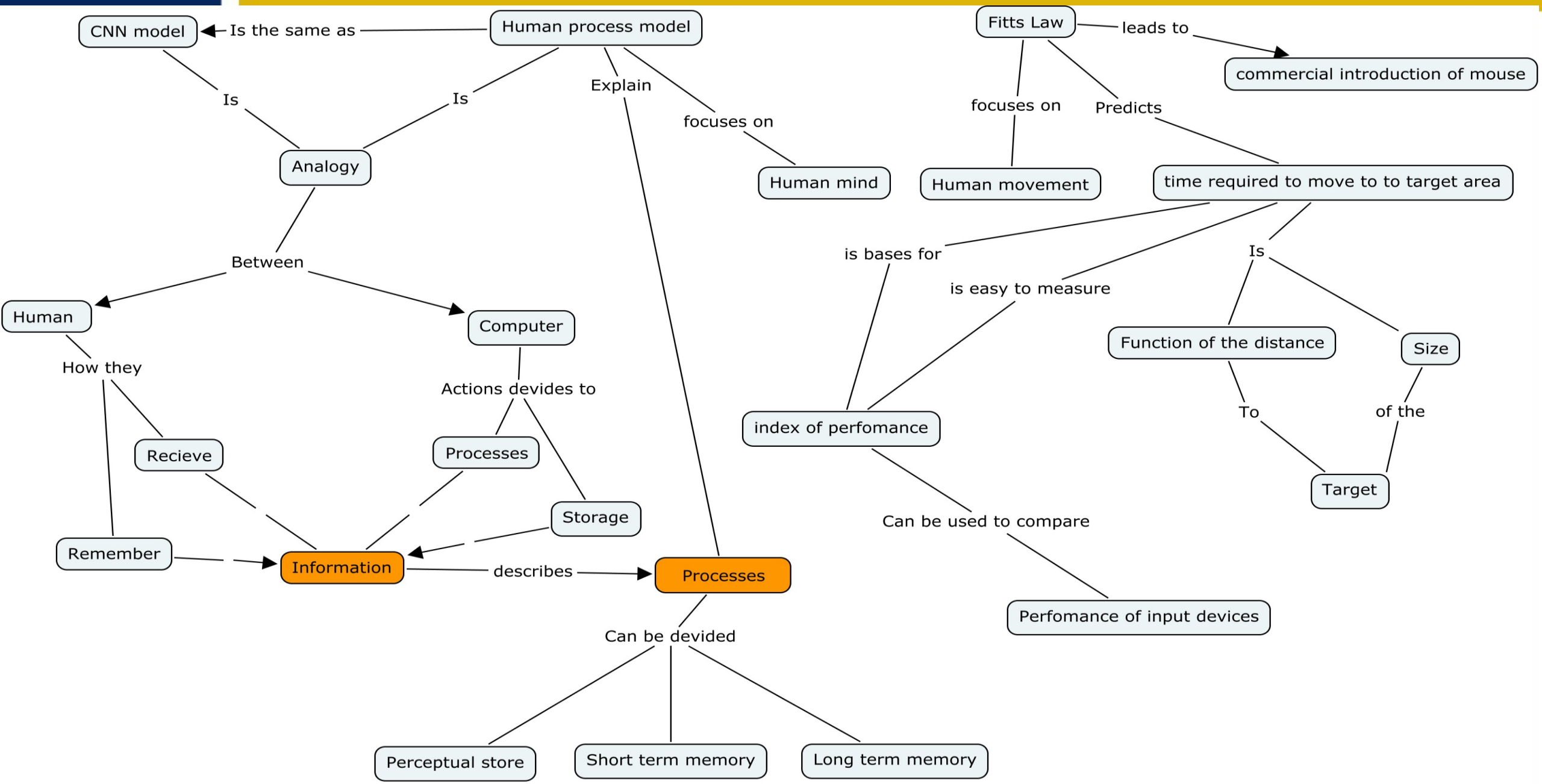
Recognition vs Recall

We can deduce that _____ is easier than _____ and allow users to select commands from a set (such as a menu) rather than input them directly.

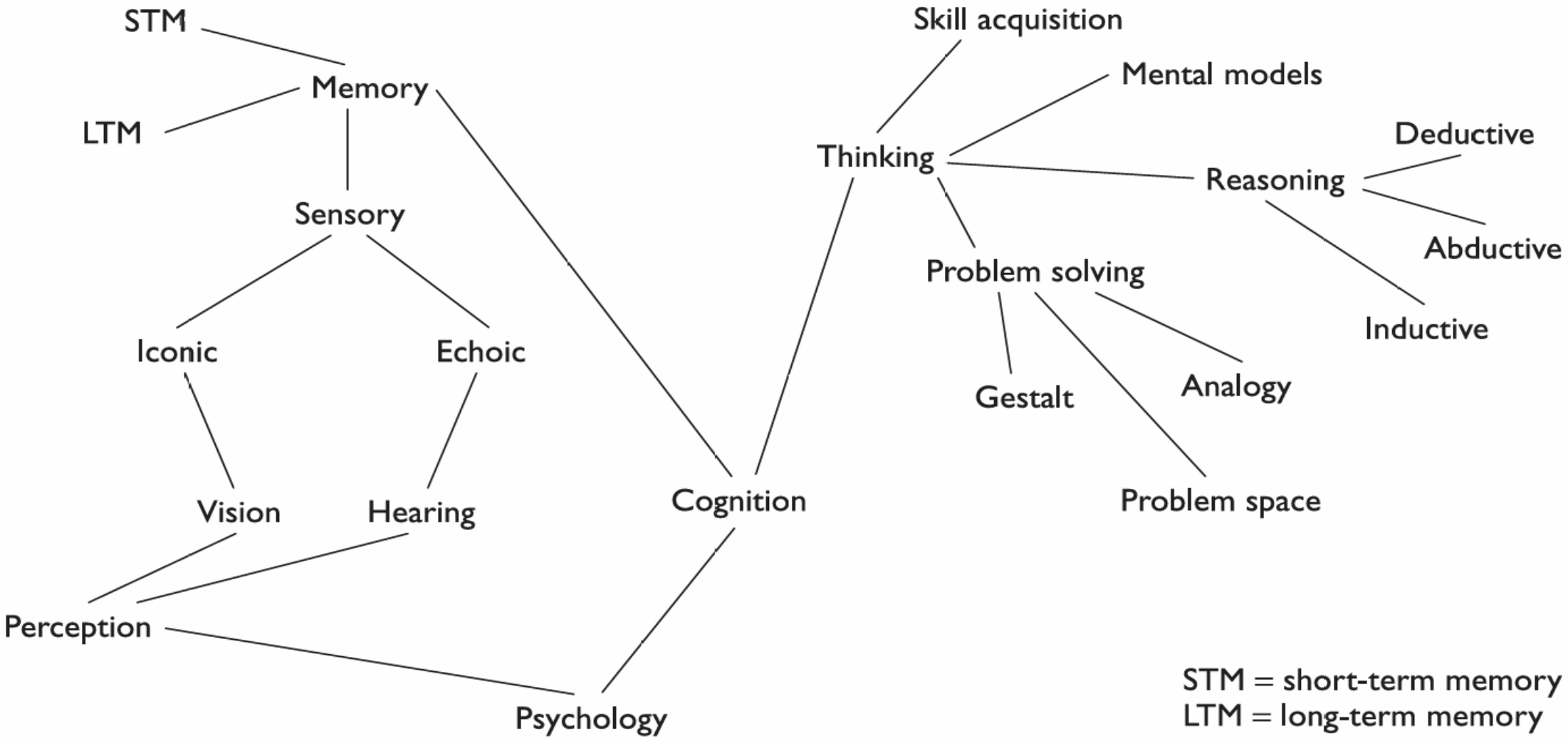
Assignment Week 1

Read/understand the given semantic networks and prepare minimum 10 points or preferably a paragraph summarizing it.

1983, Card, Moran & Newell, Model Human Processor



Top-Down View (Dix Chap 1)



STM = short-term memory
LTM = long-term memory

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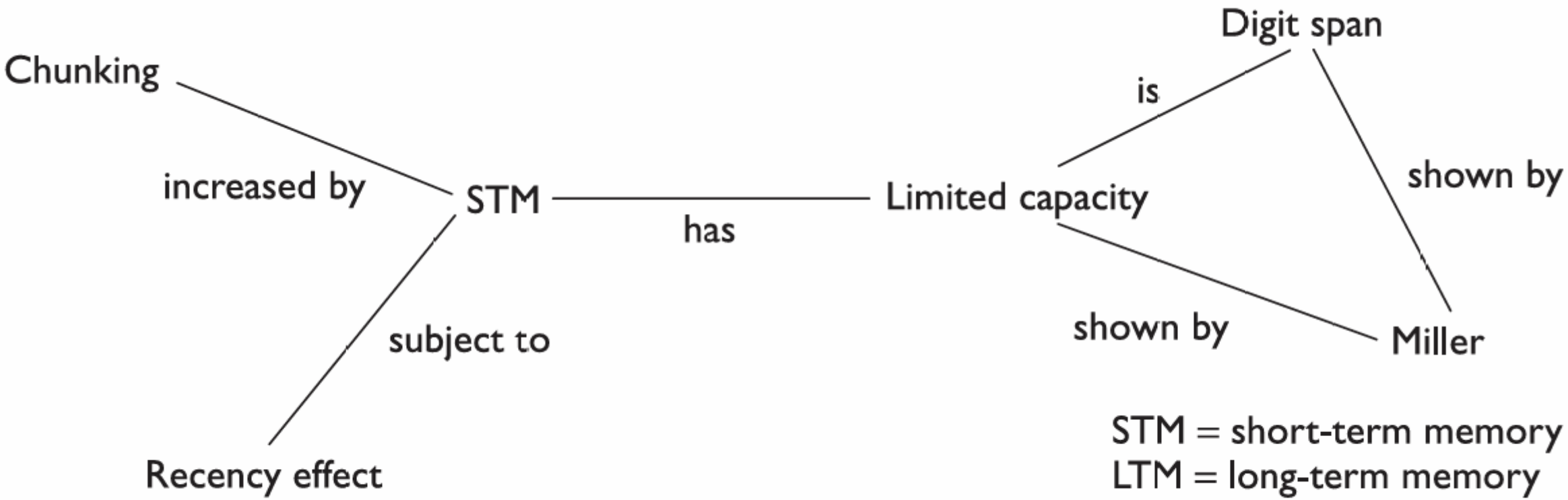
Bottom-up View



Bottom-up view

Week 1-Lab 1

Usability Failure

Millers Law 1956
(STM Limitation =>chunking)

7 ± 2 is not absolute but akin of guideline for UI & memory related tasks

Reference : Dix book

1.3 Human memory pg no. 29

5.6 Navigation design pg no. 209

1.3.2 Short-term memory (STM)

You may have heard of Miller's law, which says people can generally remember *7 +/-2* items of information. This is often misunderstood and misapplied. This law *only* applies to working memory, where we store the information, we are actively using. If you hear someone suggest that a menu should have less than 7 items because of Miller's law, you can kindly explain that a menu does not burden working memory since it can be readily seen on the screen.

Which Interface Respect Millers Law ?

× Wrong

Selection
Direct Selection
Magic Wand
Lasso
Pen Tool
Curvature Tool
Type Tool
Line Tool
Rectangle Tool
Paintbrush Tool
Shaper Tool
Scissors Tool
Rotate Tool
Scale Tool
Width Tool
Free Transform Tool
Shape Builder Tool
...

Canvas

The functions on the left are organized in chunks that exceed 9. This is a replica interface of Adobe Illustrator. Although one of my favorite tools, they are breaking the rule that Miller's Law has taught us.

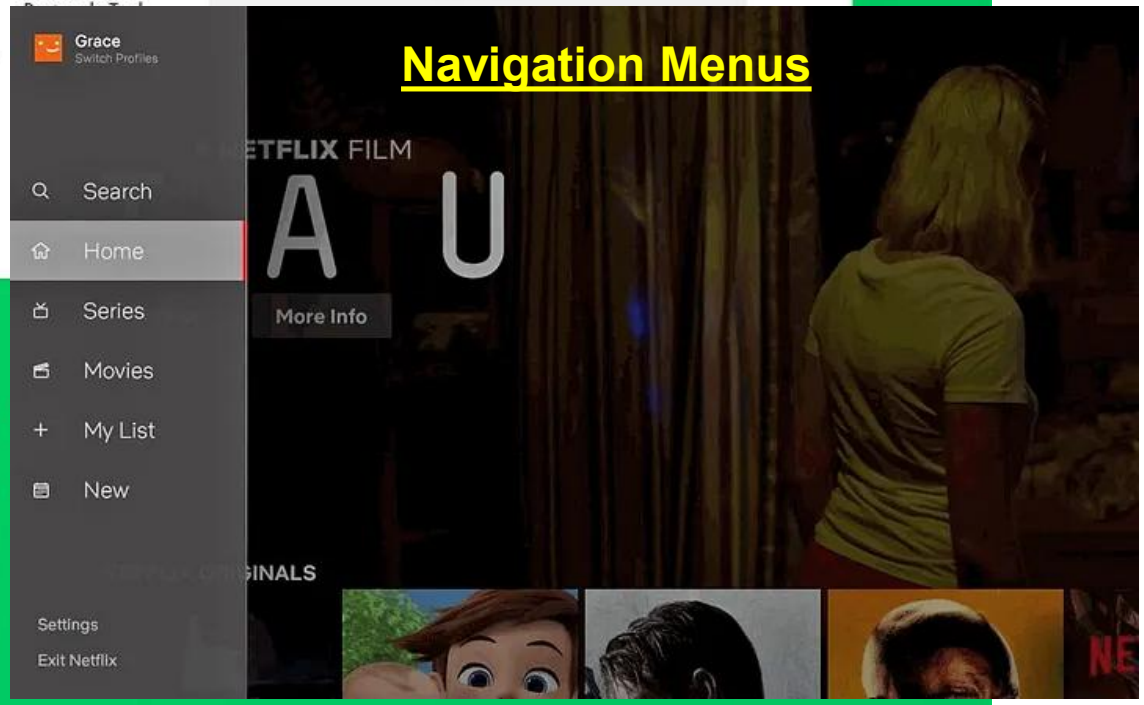
✓ Right

1 Selection
Direct Selection
Magic Wand
Lasso

2 Pen Tool
Curvature Tool
Type Tool
Line Tool

3

Canvas

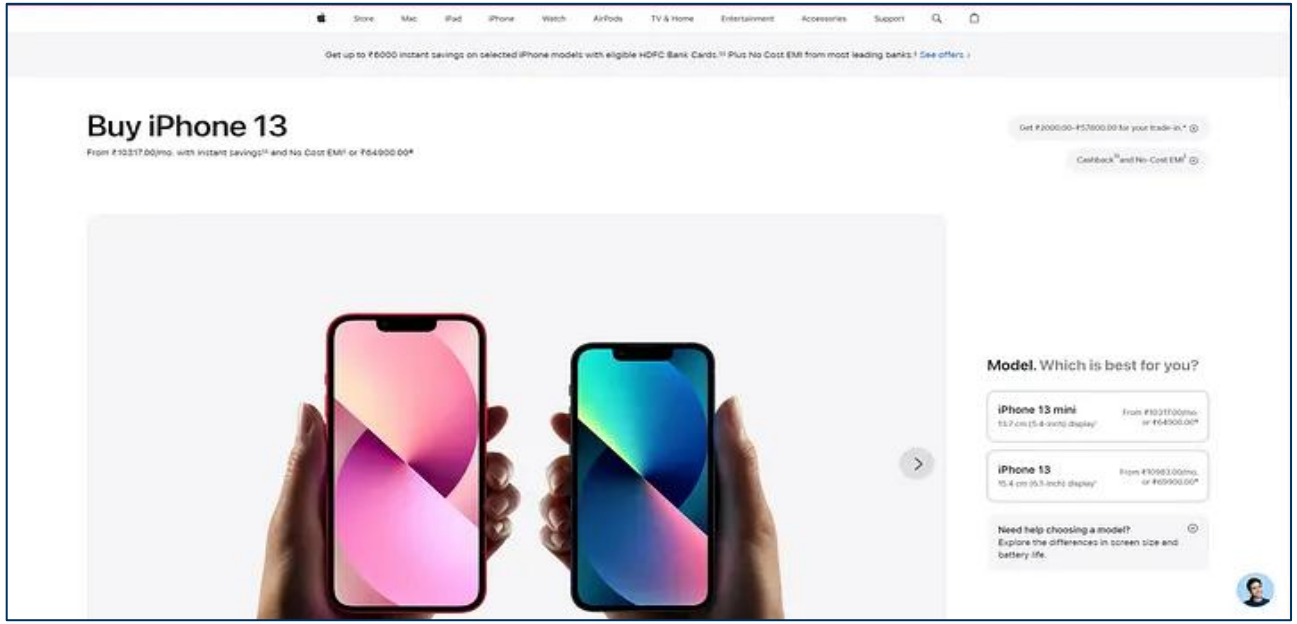


Navigation Menus

Which Interface Respect Millers Law ?

E-commerce Checkouts

Online stores like ASOS divide their checkout process into multiple stages to avoid overwhelming the customer and improve the shopping experience.



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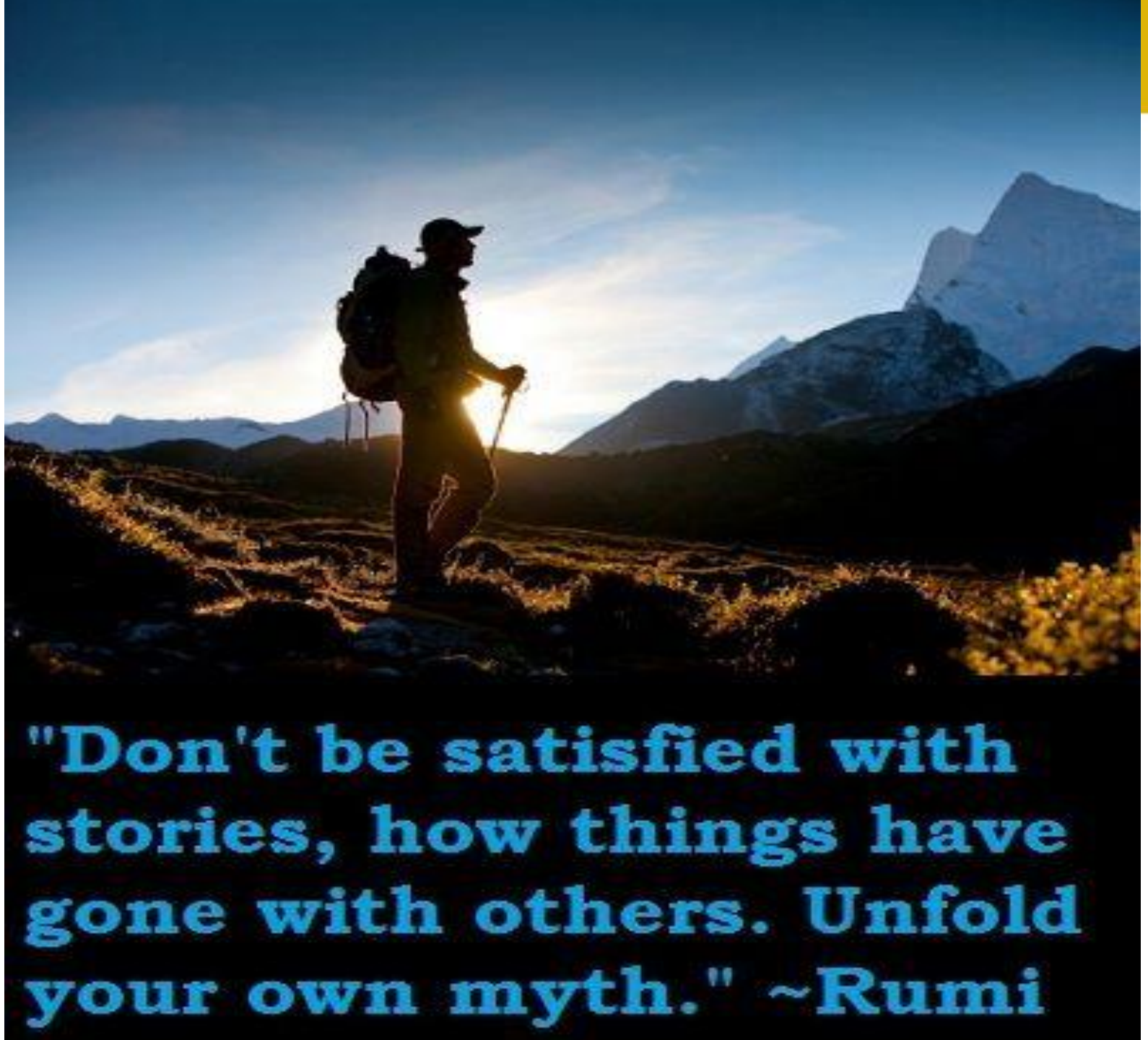

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Department of Compute Science (UBIT Building), Karachi, Pakistan.

1200 Acres (5.2 Km sq.)
53 Departments
19 Institutes
25000 Students

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My Homeland Pakistan