Nadar Saraswathi College of Engineering & Technology

# NSCET E-LEARNING PRESENTATION

**LISTEN … LEARN… LEAD…**

# COMPUTER SCIENCE AND ENGINEERING

## IV YEAR / VII SEMESTER

## CS8079 – HUMAN COMPUTER INTREACTION


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# UNIT I

# FOUNDATIONS OF HCI

# Introduction

•HCI (human-computer interaction) is the study of how people interact with computers and to what extent

•computers are or are not developed for successful interaction with human beings.

•As its name implies,

•HCI consists of three parts:

•the user, the computer itself, and the ways they work together.

# The Human

- Information i/o …

– visual, auditory, haptic, movement

- Information stored in memory

– sensory, short-term, long-term

- Information processed and applied

– reasoning, problem solving, skill, error

- Emotion influences human capabilities

- Each person is different

# The Eye - physical reception

- mechanism for receiving light and transforming energy
- light reflects from objects
- images are focused upside-down on retina
- retina contains rods for low light vision and cones for
- ganglion cells (brain!) detect pattern and movement

# Interpreting the signal

Size and depth

- visual angle indicates how much of view object occupies

  (relates to size and distance from eye)

- visual acuity is ability to perceive detail (limited)
- familiar objects perceived as constant size

  (in spite of changes in visual angle when far away)

- cues like overlapping help perception of size and depth

# Interpreting the signal (cont)

## Brightness

- subjective reaction to levels of light
- affected by luminance of object
- measured by just noticeable difference
- visual acuity increases with luminance as does flicker

## Colour

- made up of hue, intensity, saturation
- cones sensitive to colour wavelengths
- blue acuity is lowest
- 8% males and 1% females colour blind

# Interpreting the signal (cont)

The visual system compensates for:

- movement
- changes in luminance.

Context is used to resolve ambiguity

Optical illusions sometimes occur due to over compensation

# Reading

- Several stages:
    - visual pattern perceived
    - decoded using internal representation of language
    - interpreted using knowledge of syntax, semantics, pragmatics

- involves saccades and fixations
- Perception occurs during fixations
- Word shape is important to recognition
- Negative contrast improves reading from

# Hearing

Provides information about environment:

distances, directions, objects etc.

Physical apparatus:

- outer ear – protects inner and amplifies sound
- middle ear – transmits sound waves as vibrations to inner ear
- inner ear – chemical transmitters are released and cause impulses in auditory nerve

Sound

- pitch – sound frequency
- loudness – amplitude
- timbre – type or quality

# Hearing (cont)

Humans can hear frequencies from 20Hz to 15kHz

- less accurate distinguishing high frequencies than low.

Auditory system filters sounds

- can attend to sounds over background noise.
- for example, the cocktail party phenomenon.

# Touch

- Provides important feedback about environment.
- May be key sense for someone who is visually impaired
- Stimulus received via receptors in the skin:

| | |
|---|---|
| thermoreceptors | – heat and cold |
| nociceptors | – pain |
| mechanoreceptors | – pressure |
| | (some instant, some continuous) |

- Some areas more sensitive than others e.g. fingers
- Kinethesis - awareness of body position

affects comfort and performance.

Time taken to respond to stimulus:

reaction time + movement time

Movement time dependent on age, fitness etc.

Reaction time - dependent on stimulus type:

| | |
|---|---|
| visual | ~ 200ms |
| auditory | ~ 150 ms |
| pain | ~ 700ms |

Increasing reaction time decreases accuracy in the unskilled operator but not in the skilled operator.

# Movement (cont)

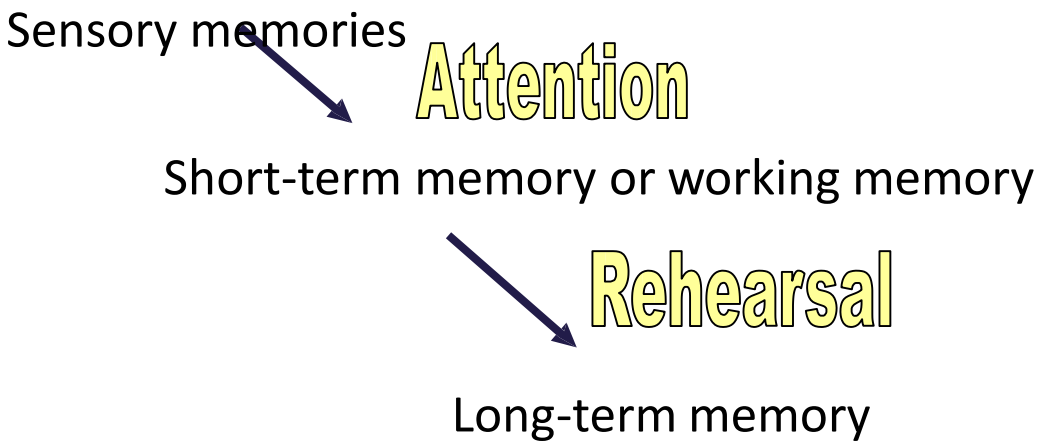
Fitts Law describes the time taken to hit a screen

$$Mt = a + b \log_2(D/S + 1)$$

where: a and b are empirically determined constants
Mt is movement time
D is Distance
S is Size of target

targets as large as possible
distances as small as possible

There are three types of memory function:




Selection of stimuli governed by level of arousal.

# sensory memory

Buffers for stimuli received through senses

- iconic memory: visual stimuli
- echoic memory: aural stimuli
- haptic memory: tactile stimuli

Examples

- “sparkler” trail
- stereo sound

Continuously overwritten

# Short-term memory (STM)

Scratch-pad for temporary recall

rapid access ~ 70ms

rapid decay ~ 200ms

limited capacity - 7± 2 chunks

## Long-term memory (LTM)

Repository for all our knowledge

- slow access ~ 1/10 second
- slow decay, if any
- huge or unlimited capacity

Two types

- episodic – serial memory of events
- semantic – structured memory of facts,concepts, skills

semantic LTM derived from episodic LTM

## Semantic memory structure

- provides access to information
- represents relationships between bits of information
- supports inference

## Model: semantic network

- inheritance – child nodes inherit properties of parent nodes
- relationships between bits of information explicit
- supports inference through inheritance

# LTM - Storage of information

- rehearsal
  information moves from STM to LTM
- total time hypothesis
  amount retained proportional to rehearsal time
- distribution of practice effect
  optimized by spreading learning over time
- structure, meaning and familiarity
  information easier to remember

# LTM - Forgetting

decay

information is lost gradually but very slowly

interference

new information replaces old: retroactive interference

old may interfere with new: proactive inhibition

so may not forget at all memory is selective …

… affected by emotion – can subconsciously `choose' to forget

# LTM - retrieval

recall

- information reproduced from memory can be assisted by cues, e.g. categories, imagery

recognition

information gives knowledge that it has been seen before

less complex than recall - information is cue

# Problem solving

Process of finding solution to unfamiliar task using knowledge.

Several theories.

Gestalt

problem solving both productive and reproductive

productive draws on insight and restructuring of problem

attractive but not enough evidence to explain `insight' etc.

move away from behaviourism and led towards information processing theories

# Problem solving (cont.)

## Analogy

analogical mapping:

- novel problems in new domain?
- use knowledge of similar problem from similar domain

analogical mapping difficult if domains are semantically different

## Skill acquisition

skilled activity characterized by chunking

- lot of information is chunked to optimize STM

conceptual rather than superficial grouping of problems

information is structured more effectively

# Errors and mental models

## Types of error

### slips

right intention, but failed to do it right
causes: poor physical skill,inattention etc.
change to aspect of skilled behaviour can cause slip

### mistakes

wrong intention
cause: incorrect understanding
humans create mental models to explain behaviour
if wrong (different from actual system) errors can occur

# THE COMPUTER

# The Computer

- a computer system is made up of various elements
- each of these elements affects the interaction

input devices – text entry and pointing
output devices – screen (small&large), digital paper
virtual reality – special interaction and display devices
physical interaction – e.g. sound, haptic, bio-sensing p
aper – as output (print) and input (scan)
memory – RAM & permanent media, capacity & access
processing – speed of processing, networks

# text entry devices

keyboards (QWERTY et al.)

chord keyboards, phone pads

handwriting, speech

# Keyboards

Most common text input device

Allows rapid entry of text by experienced users

Keypress closes connection, causing a character code to be sent

Usually connected by cable, but can be wireless

# layout – QWERTY

Standardised layout

but …

non-alphanumeric keys are placed differently

accented symbols needed for different scripts minor differences between UK and USA keyboards

QWERTY arrangement not optimal for typing

– layout to prevent typewriters jamming!

Alternative designs allow faster typing but large social base of QWERTY typists produces reluctance to change.

# Chord keyboards

only a few keys - four or 5

letters typed as combination of keypresses

compact size

– ideal for portable applications

short learning time

– keypresses reflect letter shape

fast

– once you have trained

BUT - social resistance, plus fatigue after extended use

NEW – niche market for some wearables

# phone pad and T9 entry

use numeric keys with
multiple presses

| | |
|---|---|
| 2 – a b c | 6 - m n o |
| 3 - d e f | 7 - p q r s |
| 4 - g h i | 8 - t u v |
| 5 - j k l | 9 - w x y z |

hello = 4433555[pause]555666

surprisingly fast!

T9 predictive entry

- type as if single key for each letter
  use dictionary to ‘guess’ the right word
  hello = 43556 …
  but 26 -> menu ‘am’ or ‘an’

# Handwriting recognition

Text can be input into the computer, using a pen and a digesting tablet

- natural interaction

Technical problems:

capturing all useful information - stroke path, pressure, etc. in a natural manner
segmenting joined up writing into individual letters
interpreting individual letters
coping with different styles of handwriting

Used in PDAs, and tablet computers …
… leave the keyboard on the desk!

# Speech recognition

Improving rapidly

Most successful when:

- single user – initial training and learns peculiarities
- limited vocabulary systems

Problems with

external noise interfering
imprecision of pronunciation
large vocabularies
different speakers

# memory

short term and long term

speed, capacity, compression

formats, access

# Short-term Memory - RAM

Random access memory (RAM)

- on silicon chips
- 100 nano-second access time
- usually volatile (lose information if power turned off)
- data transferred at around 100 Mbytes/sec

Some *non-volatile RAM* used to store basic information

Typical desktop computers:

64 to 256 Mbytes RAM

# Long-term Memory - disks

## magnetic disks

- floppy disks store around 1.4 Mbytes
- hard disks typically 40 Gbytes to 100s of Gbytes
  access time ~10ms, transfer rate 100kbytes/s

## optical disks

use lasers to read and sometimes write

more robust that magnetic media

CD-ROM

- same technology as home audio, ~ 600 Gbytes

DVD - for AV applications, or very large files

# Speed And Capacity

what do the numbers mean?

some sizes (all uncompressed) ...

this book, text only ~ 320,000 words, 2Mb

the Bible ~ 4.5 Mbytes

scanned page ~ 128 Mbytes

- (11x8 inches, 1200 dpi, 8bit greyscale)

digital photo ~ 10 Mbytes

- (2–4 mega pixels, 24 bit colour)

video ~ 10 Mbytes *per second*

- (512x512, 12 bit colour, 25 frames per sec)

# Virtual Memory

Problem:

- running lots of programs + each program large
- not enough RAM

Solution - Virtual memory :

- store some programs temporarily on disk
- makes RAM appear bigger

But … swopping

program on disk needs to run again
copied from disk to RAM
s l o w s  t h i n g s  d o w n

# Compression

reduce amount of storage required

lossless

- recover exact text or image – e.g. GIF, ZIP
- look for commonalities:
  - text: AAAAAAAAAABBBBBCCCCCCCC 10A5B8C
  - video: compare successive frames and store change

lossy

recover something like original – e.g. JPEG, MP3

exploit perception

- JPEG: lose rapid changes and some colour
- MP3: reduce accuracy of drowned out notes

# Storage formats - text

ASCII - 7-bit binary code for to each letter and character

UTF-8 - 8-bit encoding of 16 bit character set

RTF (rich text format)
- text plus formatting and layout information

SGML (standardized generalised markup language)
- documents regarded as structured objects

XML (extended markup language)

simpler version of SGML for web applications

# Storage Formats - Media

Images:

- many storage formats :
  (PostScript, GIFF, JPEG, TIFF, PICT, etc.)
- plus different compression techniques
  (to reduce their storage requirements)

Audio/Video

again lots of formats :
(QuickTime, MPEG, WAV, etc.)

compression even more important

also ‘streaming’ formats for network delivery

# Methods Of Access

large information store

long time to search => use index

what you index -> what you can access

simple index needs

forgiving systems:

- Xerox “do what I mean” (DWIM)
- SOUNDEX – McCloud ~ MacCleod

access without structure …

- free text indexing (all the words in a document)
- needs lots of space!!

# Processing And Networks

Finite Speed (But Also Moore's Law)

Limits Of Interaction

Networked Computing

# Finite processing speed

Designers tend to assume fast processors, and make interfaces more and more complicated

But problems occur, because processing cannot keep up with all the tasks it needs to do

- cursor overshooting because system has buffered keypresses
- icon wars - user clicks on icon, nothing happens, clicks on another, then system responds and windows fly everywhere

Also problems if system is too fast - e.g. help screens may scroll through text much too rapidly to be read

# Moore's Law

computers get faster and faster!

1965 …

Gordon Moore, co-founder of Intel, noticed a pattern
processor speed doubles every 18 months
PC … 1987: 1.5 Mhz, 2002: 1.5 GHz

similar pattern for memory

- but doubles every 12 months!!
- hard disk … 1991: 20Mbyte : 2002: 30 Gbyte

baby born today

- record all sound and vision
- by 70 all life's memories stored in a grain of dust!

# Limitations On Interactive Performance

Computation bound

- Computation takes ages, causing frustration for the user

Storage channel bound

- Bottleneck in transference of data from disk to memory

Graphics bound

- Common bottleneck: updating displays requires a lot of effort - sometimes helped by adding a graphics co-processor optimised to take on the burden

Network capacity

- Many computers networked - shared resources and files, access to printers etc. - but interactive performance can be reduced by slow network speed

# Networked Computing

Networks allow access to …

- large memory and processing
- other people (groupware, email)
- shared resources – esp. the web

Issues

- network delays – slow feedback
- conflicts - many people update data
- unpredictability

# The Interaction

# The Interaction

interaction models

– translations between user and system

ergonomics

– physical characteristics of interaction

interaction styles

– the nature of user/system dialog

context

– social, organizational, motivational

# Models Of Interaction

## Terms Of Interaction
## Norman Model

## Interaction Framework

# Some terms of interaction

domain – the area of work under study
e.g. graphic design

goal – what you want to achieve
e.g. create a solid red triangle

task – how you go about doing it ultima
– tely in terms of operations

Note
- traditional interaction …
- use of terms differs a lot especially task/goal !!!

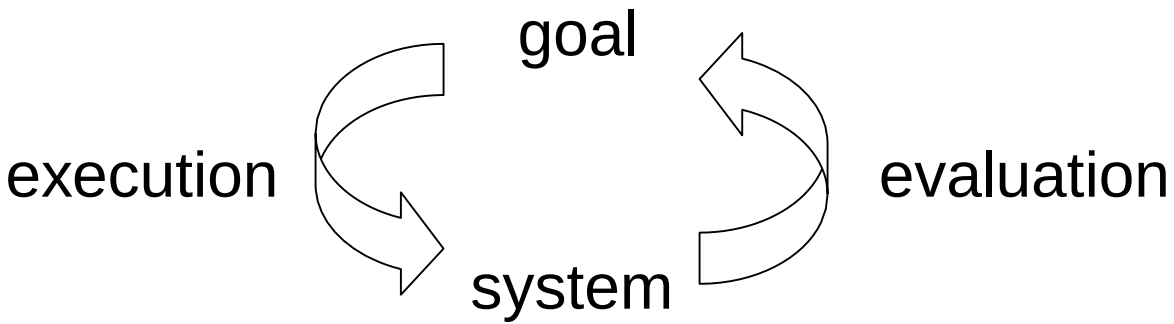
# Donald Norman's Model

Seven stages

- user establishes the goal
- formulates intention
- specifies actions at interface
- executes action
- perceives system state
- interprets system state
- evaluates system state with respect to goal

Norman's model concentrates on user's view of the interface

# execution/evaluation loop




user establishes the goal
formulates intention
specifies actions at interface
executes action
perceives system state
interprets system state
evaluates system state with respect to goal

# Using Norman's Model

Some systems are harder to use than others

Gulf of Execution

user's formulation of actions

≠ actions allowed by the system

Gulf of Evaluation

user's expectation of changed system state

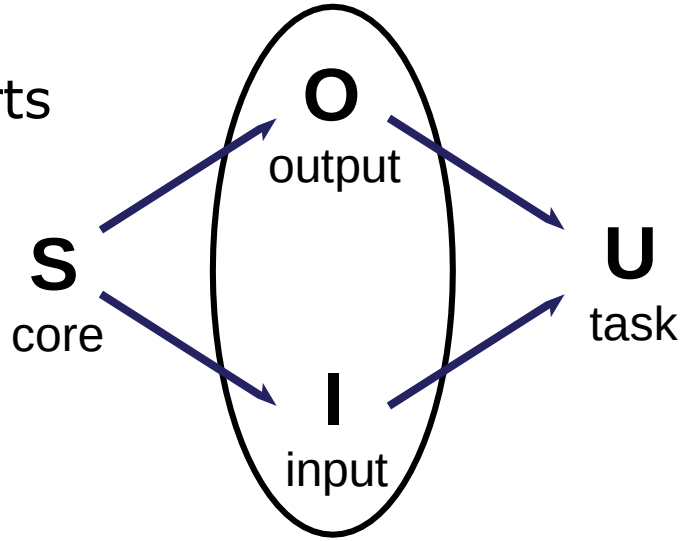
≠ actual presentation of this state

# Abowd And Beale Framework

extension of Norman…

their interaction framework has 4 parts

- user
- input s
- ystem
- output




each has its own unique language

interaction  translation between languages

problems in interaction = problems in translation

# Using Abowd & Beale's Model

user intentions
- translated into actions at the interface
  - translated into alterations of system state
    - reflected in the output display
      - interpreted by the user

general framework for understanding interaction

not restricted to electronic computer systems

identifies all major components involved in interaction

allows comparative assessment of systems

an abstraction

# Ergonomics

Study of the physical characteristics of interaction

Also known as human factors – but this can also be used to mean much of HCI!

Ergonomics good at defining standards and guidelines for constraining the way we design certain aspects of systems

# Ergonomics - Examples

arrangement of controls and displays

e.g. controls grouped according to function or frequency of use, or sequentially

surrounding environment

e.g. seating arrangements adaptable to cope with all sizes of user

health issues

e.g. physical position, environmental conditions (temperature, humidity), lighting, noise,

use of colour

e.g. use of red for warning, green for okay, awareness of colour-blindness etc.

# Interaction Styles

- Command Line Interface
- Menus
- Natural Language
- Question/Answer And Query
- Form-fills And Spreadsheets
- WIMP
- Point And Click
- Three–dimensional Interfaces

# Command Line Interface

- Way Of Expressing Instructions To The Comp uter Directly
  - Function Keys, Single Characters, Short Abbreviations, Whole Wo rds, Or A Combination

- Suitable For Repetitive Tasks
- Better For Expert Users Than Novices
- Offers Direct Access To System Functionality
- Command Names/Abbreviations Meaningful!

Typical Example: The Unix System

# Menus

- Set of options displayed on the screen
- Options visible
  - less recall - easier to use
  - rely on recognition so names should be meaningful
- Selection by:
  - numbers, letters, arrow keys, mouse
  - combination (e.g. mouse plus accelerators)
- Often options hierarchically grouped
  - sensible grouping is needed
- Restricted form of full WIMP system

# Query interfaces

- Question/answer interfaces

  user led through interaction via series of questions

  suitable for novice users but restricted functionality

  often used in information systems

- Query languages (e.g. SQL)
  - used to retrieve information from database
  - requires understanding of database structure and language syntax, hence requires

# Form-fills

- Primarily for data entry or
- Screen like paper form.
- Data put in relevant
- Requires

  good design

  obvious correction facilities

# WIMP Interface

Windows

Icons

Menus

Pointers

… or windows, icons, mice, and pull-down menus!

default style for majority of interactive computer systems, especially PCs and desktop machines

# Interactivity

**Easy To  Focus  On Look**
**What  About  Feel?**

# Speech–driven Interfaces

- rapidly improving …
  … but still inaccurate
- how to have robust dialogue?
  … interaction of course!

e.g. airline reservation:
reliable “yes” and “no”
+ system reflects back its understanding
“you want a ticket from New York to Boston?”

# Look And … Feel

- WIMP systems have the same elements:

  windows, icons., menus, pointers, buttons,

- but different window systems
  … *behave* differently

  e.g. MacOS vs Windows menus

appearance + behaviour = look and feel