5.1 Paradigms for Interaction

- The paradigm does not necessarily describe reality and at best only describes one aspect of reality. Our paradigms may be true or not. We cannot tell which until we change our paradigm ! Then we can select a paradigm from our possible choices. The change is not a result of disproving a paradigm, but a decision.
- Does everyone use the same paradigm ?

Paradigm shift

- Paradigm shift is the way of looking at something differently. A paradigm shift is a sudden change in point of view. When we make a paradigm shift, we can see, think, feel and behave differently.
- New computing technologies arrive, creating a new perception of the human computer relationship. We can trace some of these shifts in the history of interactive technologies.
- Paradigms are strategies for building interactive systems. Different interaction styles are based upon different paradigms.
- New computing technologies arrive, creating a new perception of the human computer relationship. We can trace some of these shifts in the history of interactive technologies.
- A paradigm is a model of understanding consistently free of significant contradictions. It guides our expectations and helps us to sort, organize and classify information.
- It affects the way information is processed by the brain and the types of questions we ask when trying to understand the world around us incorporating as it does, all of the knowledge and experiences we have acquired since birth. We all build internal models of our world, which we rely upon to understand it and to assure our survival in it.
- Our brain uses paradigms to classify, sort and process information received by the senses. It is consistently free of significant contradictions and even when it isn't, it still works, because we can shift in and out of various paradigms, although not always as well as we would like.

  It guides our expectations and helps us to sort, organize and classify information that we receive from our five senses. A paradigm may be personal or cultural and we each have many different paradigms for different contexts.

Example of paradigm shift

1. The introduction of the personal computer and the internet have impacted both personal and business environments and is a catalyst for a paradigm shift.

2. Newspaper publishing has been reshaped into web sites, blogging and web feeds.
3. The Internet has enabled or accelerated the creation of new forms of human interactions through instant messaging, Internet forums and social networking sites.
4. We are shifting from a mechanistic, manufacturing, industrial society to an organic, service based, information centered society and increases in technology will continue to impact globally.

5.1.1 Time Sharing

- A single computer could support multiple users in 1940 - 1950. Previously, human (programmer) was restrict to batch session, in which complete job were submitted on punch cards or paper tape to the operator who run them individually on the computer.
- Time - sharing systems of the 1960s made programming a truly interactive scheme.
- The purpose of the first interactive time - sharing systems was simply to augment the programming capabilities of the early hackers, it marked a significant stage in computer applications for human use.
- Mechanical relays were replaced by vacuum electron tubes. Tubes were replaced by transistors and transistors by integrated chips, all of which meant that the amount of sheer computing power was increasing by orders of magnitude.

5.1.2 Video Display Units

- Display screens could provide a more suitable medium than a paper printout for presenting vast quantities of strategic information for rapid assimilation.
- Computers are used for visualizing and manipulating data. One person's contribution could drastically change the history of computing.
- To enhance human interaction, the information within the computer was made more amenable to human consumption.

5.1.3 Programming Toolkits

- The power of programming toolkits is small, well understood components can be composed in fixed ways in order to create larger tools.
- Engelbart's idea was to use the computer to teach humans, which complex technology only the intellectually privileged were capable of manipulating.
- Engelbart wrote of how humans attack complex intellectual problems like a carpenter who produces beautifully complicated pieces of woodwork with a good set of tools.

- The idea of building components of a computer system that will allow you to rebuild a more complex system is called bootstrapping and has been used to a great extent in all of computing.
- The right programming toolkit provides building blocks to producing complex interactive systems.

5.1.4 Personal Computing

- Graphic programming language for children called LOGO to control turtle that dragged a pen along a surface to trace its path.
- As technology progresses, it is now becoming more difficult to distinguish between what constitutes a personal computer or workstation and what constitutes a mainframe
- By adapting the graphical programming language to a model which children could understand and use.
- A system is more powerful as it becomes easier to user. Future of computing in small, powerful machines dedicated to the individual.

5.1.5 Window Systems and the WIMP Interface

- When you use a program such as a word processor that has a WIMP interface it is often the case that the document you are creating looks exactly the same on the screen as it will when it is printed out. If this is the case then the program is described as being WYSIWYG. This stands for What You See Is What You Get.

Advantages

1. Most operations are self - explanatory so that you do not have to remember lots of commands. This makes GUIs particularly suitable for inexperienced users.
2. Some operations are much easier using a GUI with a pointer. e.g. selecting text or drawing pictures.
3. Often you can have more than one program running at the same time, each of them using different windows.
4. Often GUIs are WYSIWYG. What you see on the screen is what you get if you do a printout.
5. Often with a GUI many programs use a similar interface, so it is easier to learn how to use a new program.
6. Most GUIs provide good help facilities.

Disadvantage :

GUIs can take up a lot of memory and need to be run on a fast computer.

5.1.6 Metaphor

- It is used quite successfully to teach new concepts in terms of ones, which are already understood.
- Metaphors are a technique used to simplify interface design. A carefully chosen metaphor can assist a user new to a particular interface. One of the most common and successful metaphors is the desktop, files and folders.
- Comparing a computer's system for organizing textual documents to a desk and filing cabinet helps a user picture how their files are being stored.
- A text - driven command line interface offers no metaphor, making it more difficult for a beginner user. There are folders which hold other folders or files. There is a trash, which can be used to delete files.
- The use of metaphors in the design of human - computer interaction has been increasing as the Graphic User Interfaces (GUIs) have become popular in recent years.
- The main advantage of using metaphors in HCI design is to utilize and extend the concepts that already exist in computer users' long - term memory, to analog represent the functions and operations of the computer systems and reduce the users' mental workload.

5.1.7 Direct Manipulation

- Direct Manipulation (DM) is an interaction style in which users act on displayed objects of interest using physical, incremental, reversible actions whose effects are immediately visible on the screen.
- It involves continuous representation of objects of interest and rapid, reversible and incremental actions and feedback.
- Example of direct - manipulation is resizing a graphical shape, such as a rectangle, by dragging its corners or edges with a mouse.
- Features of direct manipulation :
  a. Visibility of the objects of interest.
  b. Incremental action at the interface with rapid feedback on all actions.
  c. Reversibility of all actions, so that users are encouraged to explore without severe penalties.

d. Syntactic correctness of all actions, so that every user action is a legal operation.

e. Replacement of complex command language with actions to manipulate directly the visible objects.

❑ **Advantages :**

- Visually presents task concepts
- Reduces syntax
- Allows easy learning
- Allows easy retention
- Allows errors to be avoided
- Encourages exploration
- Affords high subjective satisfaction

5.1.8 Computer Supported Cooperative Work (CSCW)

- The study of how people work together using computer technology.
- Computer Supported Cooperative Work (CSCW) consists of software tools and technology that supports a group of individuals working on projects at different sites.
- It is based on the principle of group coordination and collaborative activities supported through computer systems.
- The main distinction between CSCW systems and interactive systems designed for a single user is that designers can no longer neglect the society within which any single user operates.
- Electronic mail is an instance of an asynchronous CSCW system because the participants in the electronic exchange do not have to be working at the same time in order for the mail to be delivered

5.1.9 Agent-based Interfaces

- Software agents likewise act on behalf of users within the electronic world. Examples include email agents which filter your mail for you and web crawlers which search the world wide web for documents you might find interesting.
- Agents can perform repetitive tasks, watch and respond to events when the user is not present and even learn from the user's own actions.

5.1.10 Hypertext

- Hypertext is text which contains links to other texts. The term was coined by Ted Nelson around 1965. HyperMedia is a term used for hypertext which is not constrained to be text : it can include graphics, video and sound, for example. Apparently Ted Nelson was the first to use this term too.
- Hypertext consists of nodes connected by links to form networks or webs. Depending on the system, a node can be restricted to one medium (text, graphics, sound, animation or video) or can include multiple media.
- Links can be unidirectional or bidirectional, labeled or typed and can store other information, such as author and creation date.
- Anchors are points or regions in a node to which a link attaches, often represented by a button or other marking that indicates a navigational possibility.
- When a user navigates to a new node, a new window may open or the existing window may expand to incorporate the new information.
- Like hypertext, multimedia began with experiments in the 1960s and 1970s that matured into vigorous commercial activity in the 1980s and 1990s.

Example 5.1.1 : Discuss the ways in which a full - page word - processor is or is not a direct manipulation interface for editing a document using Shneiderman's criteria.

Solution : Visibility of the objects of interest :

- The most important objects of interest in a word - processor are the words themselves. Indeed, the visibility of the text on a continual basis was one of the major usability advances in moving from line - oriented to display - oriented editors.
- Depending on the user's application, there may be other objects of interest in word - processing that may or may not be visible.
- For example, are the margins for the text on screen similar to the ones which would eventually printed ? Is the spacing within a line and the line - breaks similar ? Are the different fonts and formatting characteristics of the text visible ?
- Incremental action at the interface with rapid feedback on all actions : We expect from a modern word - processor that characters appear in the text as we type them it at the keyboard, with little delay.
- If we are inserting text within a paragraph, we might also expect that the format of the paragraph adjust immediately to accommodate the new changes.

- Various word processors do this reformatting automatically, whereas others do it occasionally or only at the explicit request of the user.
- One of the other important actions which require incremental and rapid feedback is movement of the insertion point, usually by means of arrow keys.
- If there is a significant delay between the input command to move the insertion point down one line and the actual movement of the cursor on screen, it is quite possible that the user will "overshoot" the target when repeatedly pressing the down - arrow key to move down a few lines on the screen.
- Reversibility of all actions, so that users are encouraged to explore without severe penalties : Single step undo commands in most word - processors allow the user to recover from the last action performed.
- One problem with this is that the user must recognize the error before doing any other action. More sophisticated undo facilities allow the user to retrace back more than one command at a time.
- Syntactic correctness of all actions, so that every operation is a legal operation WYSYWYG : Word - processors usually provide menus and buttons which the user uses to articulate many commands.
- These interaction mechanisms serve to constrain the input language to only allow legal input from the user.
- Replacement of complex command languages with actions to manipulate directly the visible objects : The case for word processors is similar to that described above for syntactic correctness. In addition, operations on portions of text are achieved many times by allowing the user to directly highlight the text with a mouse (or arrow keys).
- Subsequent action on that text, such as moving it or copying it to somewhere else, can then is achieved more directly by allowing the user to "drag" the selected via the mouse to its new location.

5.2 Ubiquitous Computing

- Ubiquitous computing is an emerging paradigm for interaction between people and computers. The term ubiquitous computing was first used by Mark Weiser (1991) to describe the concept in which small cheap computers are integrated into most of the objects surrounding the user.
- The purpose of these devices is to assist users in their daily routines and perform automation of their environments. As examples, coffee machines that make coffee automatically when the user wakes up.

...shows examples of computing devices at the foot scale.

Fig. 5.2.1 : Examples of computing devices at the foot scale

...rious example of inch - scale devices in Ubiquitous computing. It is shown in Fig. 5.2.2.

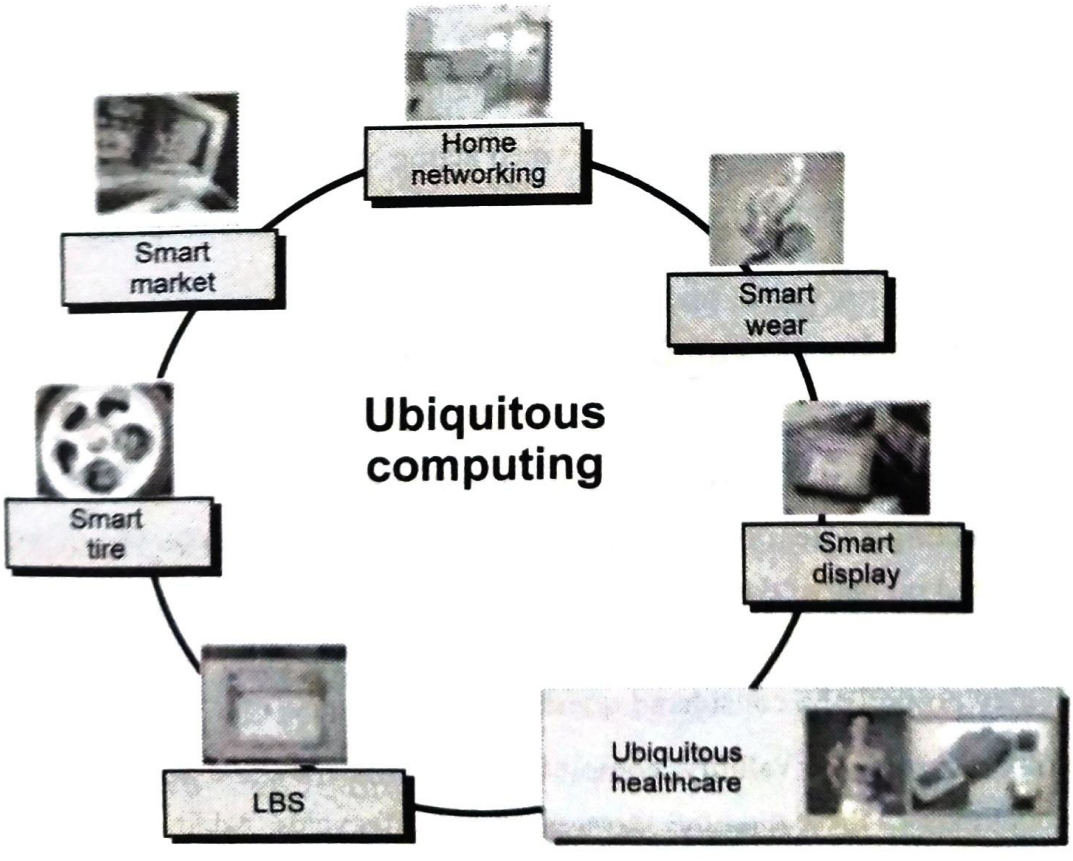


Fig. 5.2.2 : Example of inch - scale devices

- Many different technologies are converging to make the dream of ubiquitous computing possible. These technologies include wireless networking, voice recognition, camera and vision systems, pen - based computing and positioning systems.

5.2.1 Sensor-based and Context-aware Interaction

- Context is any information that can be used to characterize the situation of an entity. Location, identity, time and activity are context types for characterizing the situation of a particular entity.
- Context aware systems are those systems that are aware about the environment and perform productive functions automatically by reducing human computer interactions.
- Context aware systems can be implemented depending on various aspects like the location of sensors, the number of users, the availability of resources and the distribution of components. Also, the process of context data acquisition and processing is very important in designing a context aware system.
- In context-aware computing the interaction is more implicit. The computer or sensor-enhanced environment, is using heuristics and other semi-intelligent means to predict what would be useful for the user. The data used for this inference and the inference itself are both fuzzy, probabilistic and uncertain.
- Context-aware applications should follow the principles of appropriate intelligence :
  1. Be right as often as possible and useful when acting on these correct predictions.
  2. Do not cause inordinate problems in the event of an action resulting from a wrong prediction.

5.3 Data Integrity versus Data Immunity

- Data entry refers to user actions involving input of data to a computer and computer responses to such inputs. The simplest kind of data entry consists merely of pointing at something , selecting an item or designating a position on a computer-generated display. In more complicated modes of data entry, a user may have to control the format of data inputs as well as their contents. Thus questions of format control in text entry/editing and graphic interaction may properly be considered questions of data entry.
- Data integrity refers to the validity, completeness, consistency and accuracy of data. Data integrity encompasses these qualities throughout data lifecycles. Additionally, data integrity refers to data security and safety regarding regulatory compliance.

- The software must maintain a vigilant watch for bad data. All data is validated at its point of entry.
- To protect software from bad data and keeping it out of the system, the programmer needs to make the system immune to inconsistencies and gaps in the information. This method involves creating much smarter, more sophisticated applications that can handle all permutations of data, giving the application a kind of data immunity.
- When a user enters incorrect data, it is often close to being correct; applications should be designed to provide as much assistance in correcting the situation as possible.

5.3.1 Handling Missing Data

- These dirty data will affects on mining procedure and led to unreliable and poor output. Therefore, it is important for some data cleaning routines.
- Users may not have access to all the data needed. the software should accommodate the users' work flow. Data items that should NOT be entered in free text fields. For example :

  a) Aadhar number : xxxx – xxxx – xxxx

  i) Credit card : xxxx – xxx – xxxx – xxxx

  Information processing systems do tolerate missing information.

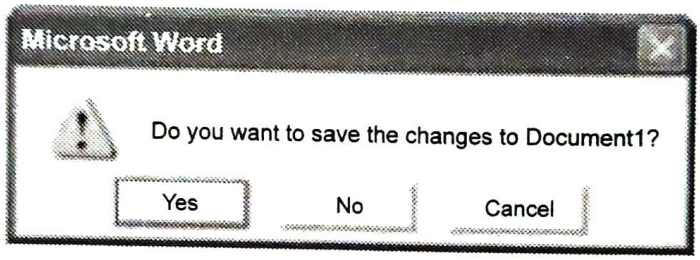
5.3.2 Data Entry and Fudgeability

- If a system is too rigid, it can't model real - world behaviors. A system that rejects the reality of its users is not helpful, even if the net result is that all its fields are valid.
- The people who manage the database and create the data - entry applications that feed it are often serving only the CPU. This is a significant conflict of interest that good interaction design can help resolve.
- Fudge ability can be difficult to build into a computer system because it demands a considerably more capable interface.
- Let users do what they want, but keep detailed records of those actions so that full accountability and recovery is possible. The technical goal of data integrity should not be our users' problem to solve.

5.3.3 Auditing versus Editing

- The application should accept what the user "tells" it, whatever the user enters should be acceptable. An error may not be your application's fault, but it is its responsibility.

- Applications can provide warnings as long as they don't stop the proceedings. Warnings should clearly inform users of what they have done, much as the speedometer silently reports our speed violations.
- When a user does something that the application thinks is wrong, the best way to protect him is to make it clear that there may be a problem, but to do this in an unobtrusive way that ultimately relies on the user's intelligence to figure out the best solution.
- Opening an application provides access to the set of documents created using it, i.e.in chronological order like Word, Excel, PowerPoint.
- Microsoft Word has an excellent example of auditing.



- Saving changes dialog appears when user requests close or quit. Assuming that "yes" and "no" are equally likely choices. User needs to understand the file system & how the file can be retrieved or where the default directory can be found.
- In the real world, humans accept partially and incorrectly filled - in documents from each other all the time. We make a note to fix the problems later and we usually do. If we forget, we fix it when we eventually discover the omission. Even if we never fixit, we somehow survive.

5.3.4 Retrieval in Physical World

- Storage system is a method for safely keeping things in a repository. It is composed of a container and the tools necessary to put objects in and take them back out again.
- Retrieval system is a method for finding things in a repository according to some associated value, such as name, position or some other attribute of the contents.
- How can we make it easy for people to find what they're looking for and find what they need ? Crafting an appropriate solution must start with a good understanding of users' mental models and usage contexts.
- Storage versus retrieval : The use of folders and directories as a retrieval mechanism requires users to know where an item has been stored in order to locate it.
- In the physical world, the actual location of a thing is the means to finding it. The storage system is the same as the retrieval system and both require remembering locations.

- When we look for a book, we either go to where we left the book or we guess that it is stored with other books. We don't find the book by association. That is, we don't find the book by referring to its contents.
- **Indexed retrieval :** The world of books and paper on library shelves. Every book has a unique "call number" based on its subject Books are "arranged" numerically and by author's last name The user "participates" in this system of storage using the storage system.
- Traditional library card catalogs provide lookup by three attributes : author, subject and title. When the book is entered into the library system and assigned a number, three index cards are created for the book, including all particulars and the Dewey Decimal number. Each card is headed by the author's name, the subject or the title.
- You physically retrieve the book by participating in the system of storage, but you logically find the book you want by participating in a system of retrieval.

5.3.5 Retrieval in Digital World

- To find a file, you need to know its name and place. The user's memory assumes 100 % of the burden of file retrieval.
- Digital retrieval methods are Positional retrieval, Identity retrieval and Associative / Attribute - based retrieval.
  a) **Positional retrieval :** You can find it by remembering where you left it in the file structure.
  b) **Identity retrieval :** You can also find it by remembering its identifying name.
  c) **Associative or attribute - based retrieval :** It is based on the ability to search for a document based on some inherent quality of the document itself.

Attribute-based retrieval systems

- An **attribute-based retrieval system** enables users to find documents by their contents and meaningful properties. The purpose of such a system is to provide a mechanism for users to express what they're looking for according to the way they think about it.
- The ease of finding files should match the ease of keeping files. A file system based on its single storage location must store each document by a single attribute rather than multiple characteristics. As storage and retrieval system does have access to information at the time of creation and subsequent use of what is stored.

- A retrieval system that learns and remembers

1. The user that created or the users that contributed to the document
2. The device that created the document
3. The app that created the document
4. The document's contents & format
5. Which app last opened the document
6. The document's size and whether it is exceptionally large or small
7. Whether the document has been untouched for a long time
8. The length of time the document was last open
9. The amount of information added or deleted in the last edit
10. If the document was created from scratch or cloned from another.

5.3.6 Constrained Natural Language Output

- Natural Language Interaction (NLI) is the convergence of a diverse set of natural language principles that enables people to interact with any connected device or service in a humanlike way.
- Language is ambiguous at a number of levels. First, the syntax or structure, of a phrase may not be clear. If we are given the sentence :

The boy hit the dog with the stick

- We cannot be sure whether the boy is using the stick to hit the dog or whether the dog is holding the stick when it is hit.
- Even if a sentence's structure is clear, we may find ambiguity in the meaning of the words used. Natural Language Interaction technology takes Natural Language Processing (NLP) and Natural Language Understanding (NLU) to the next level.
- An analysis of "Carry Me" airlines conversational data, a fictitious name for an airline, but based on real data, showed that questions about baggage are one of the more frequent topics, however, when we drill down, it's possible to see that customers use "baggage" and "luggage" differently.
- Luggage is much more likely to refer to carry - on bags. This type of information is tremendously useful when building an NLI app that is sensitive to the expectations of customers.

This is where analysis on unstructured data using NLI comes into its own because human intuitions about conversational data are often wrong. Businesses need the facts that NLI provides to guide them, otherwise enterprises risk misunderstanding the voice of the customer.

- It allows enterprises to create advanced dialogue systems that utilize memory, personal preferences and contextual understanding to deliver a proactive natural language interface. Natural language interaction removes the need for your customers to know and understand your terminology.

5.4 Five Stage Search Framework

- A five-stage search framework help to coordinate design practices and satisfy the needs of all users

a) Formulation
b) Initiation of action
c) Review of results
d) Refinement
e) Use

- Five - stages can be repeated until users' needs are met. If users are unsatisfied with the results, they should be able to have additional options and change their queries easily.

a) Formulation

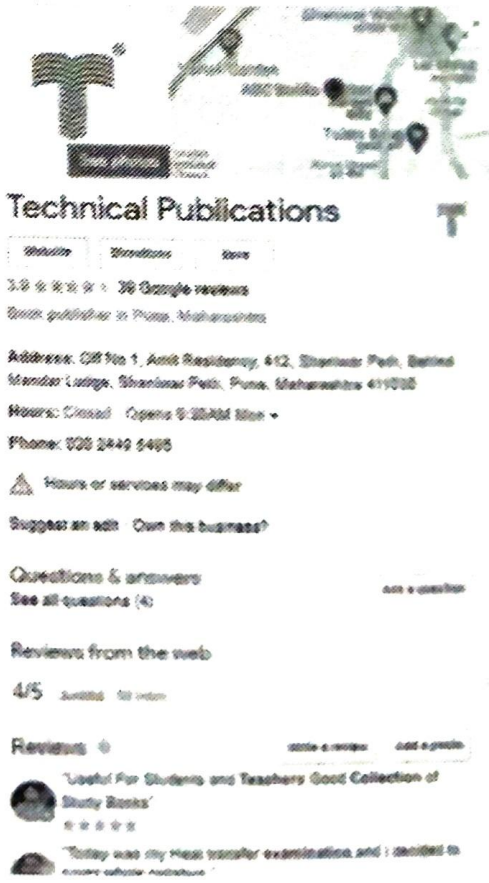
- This stage includes identifying the *source* of the information. The limitation of the source can lead to better results or failures. Users prefer to search a specific library using *keywords*, *phrases* and *structured fields* to limit the search scope. Users or service providers should have *stop lists*.
- When users are unsure of the exact value of the field, variants can be accepted. The result list can be displayed as users' type. *Auto-completion* can speed data entry, help users recall terms of interest and limits misspelling. Mobile applications may use context information such as location to narrow down the auto-completion

b) Initiation of action

- Initiation of action include explicit actions initiated by buttons with consistent labels (such as "Search "), locations, sizes and colors.
- It also includes implicit actions initiated by changes to a parameter of the formulation phase that immediately produce a new set of search results.

❑ c) Review of results

- Users review results in textual list, on geographical maps, timelines or other specialized visual overviews of results. It also presents explanatory messages.
- A Google Search result list
  a) A summary is provided at the top (the total number of results)
  b) Each result includes preview information (or snippet)
  c) Search terms are highlighted, including "Human-Computer Interaction Lab" which is the expanded variant of the search term HCIL
  d) The name of the top-level organization was added to help users judge the trustiness of the information.
- View an overview of the results and previews of items. It manipulates visualizations. Adjust the size of the result set and which fields are displayed.



❑ d) Refinement

- Search interfaces can provide meaningful messages to explain search outcomes and to support progressive refinement.

- Use meaningful messages to guide users in progressive refinement; for example, if the two words in a phrase are not found near each other, then offer easy selection of individual words or variants.
- Ask "Did you mean xxxxxxx ?" when a term is misspelled. Fig. 5.4.1 shows Google misspelled correction.
- If multiple phrases were used, items containing all phrases should be shown first and identified, followed by items containing subsets. Users can do progressive refinement by changing the search parameters.

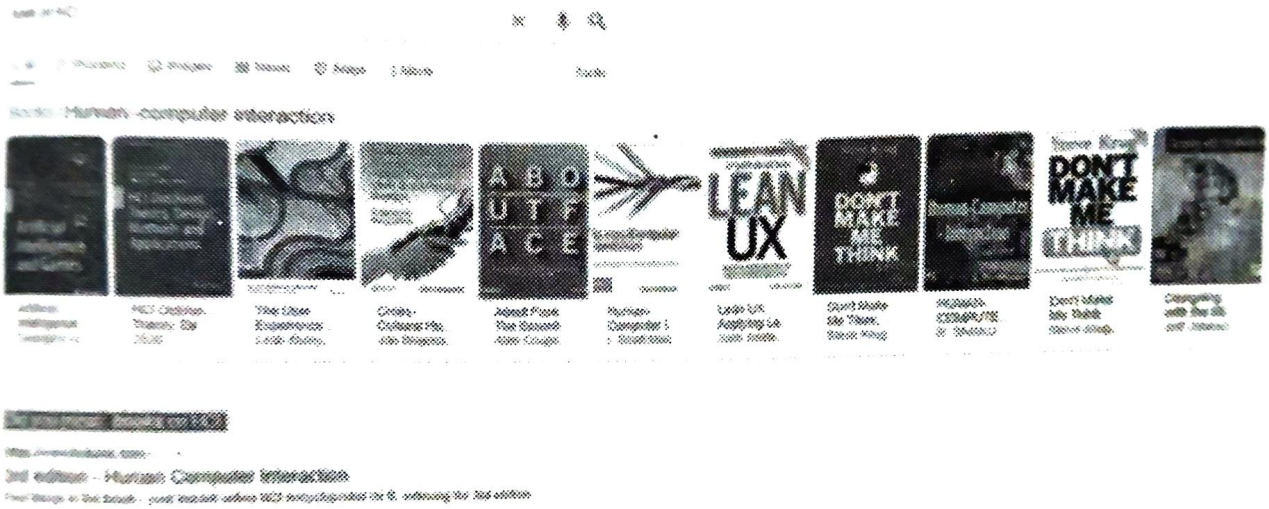
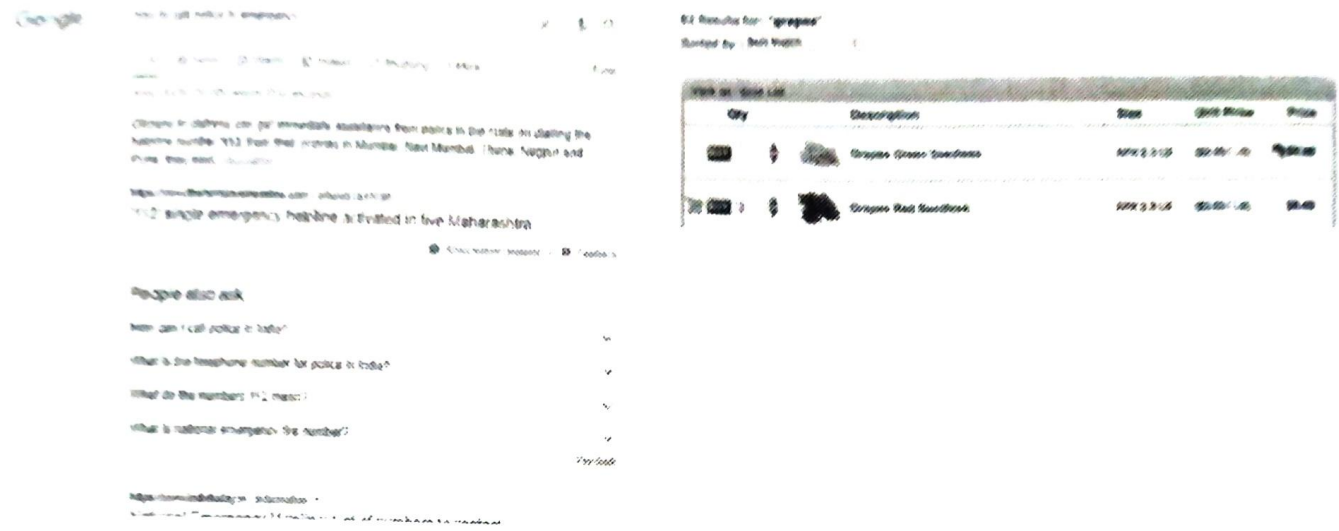


Fig. 5.4.1 : Google misspelled correction

e) Use

- Allow queries, the setting of each parameter and results to be saved and annotated, sent by e - mail or used as input to other programs, such as visualization or statistical tools.
- Results may be merged and saved, disseminated by email or shared in social media.
- When possible and important provide information or simple actions without requiring users to leave the search results page.
- On the left users get the answer to their safety critical question at the top of the result list.
- On the right shoppers looking for groceries can specify quantity and buy directly from the list of results after a search on "grapes".
- Most often search is only one of many components of a more complex analysis tool. A variety of tools such as node and link diagramming, automatic source attribution, recursive evidence marshalling, timeline construction, etc. provide support for analysis and reporting



5.4.1 Dynamic Queries and Faceted Search

- Dynamic queries refer to queries that are built dynamically by drupal rather than provided as an explicit query string. All insert, update, delete and merge queries must be dynamic. Select queries may be either static or dynamic. Therefore, "dynamic query" generally refers to a dynamic select query.

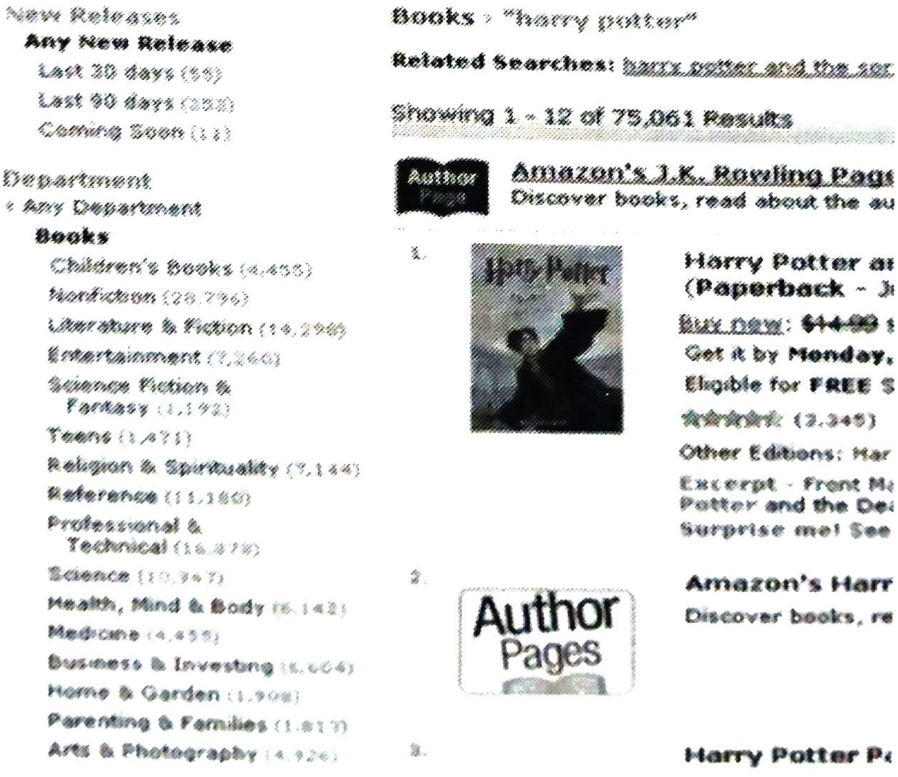


Fig. 5.4.2 : Fetched search

- Faceted search is a technique that involves augmenting traditional search techniques with a faceted navigation system, allowing users to narrow down search results by applying multiple filters based on faceted classification of the items.

When metadata is available, dynamic query interfaces provide

a) A visual representation of the possible actions

b) A visual representation of the objects being queried

c) Rapid, incremental and reversible actions and immediate feedback.

- The dynamic query approach is appealing as it prevents errors and encourages exploration. Fig. 5.4.2 shows fetched search.
- Fig. 5.4.3 uses check boxes to limit search results to specific airlines. It shows how faceted search combines a text - oriented search with faceted navigation.

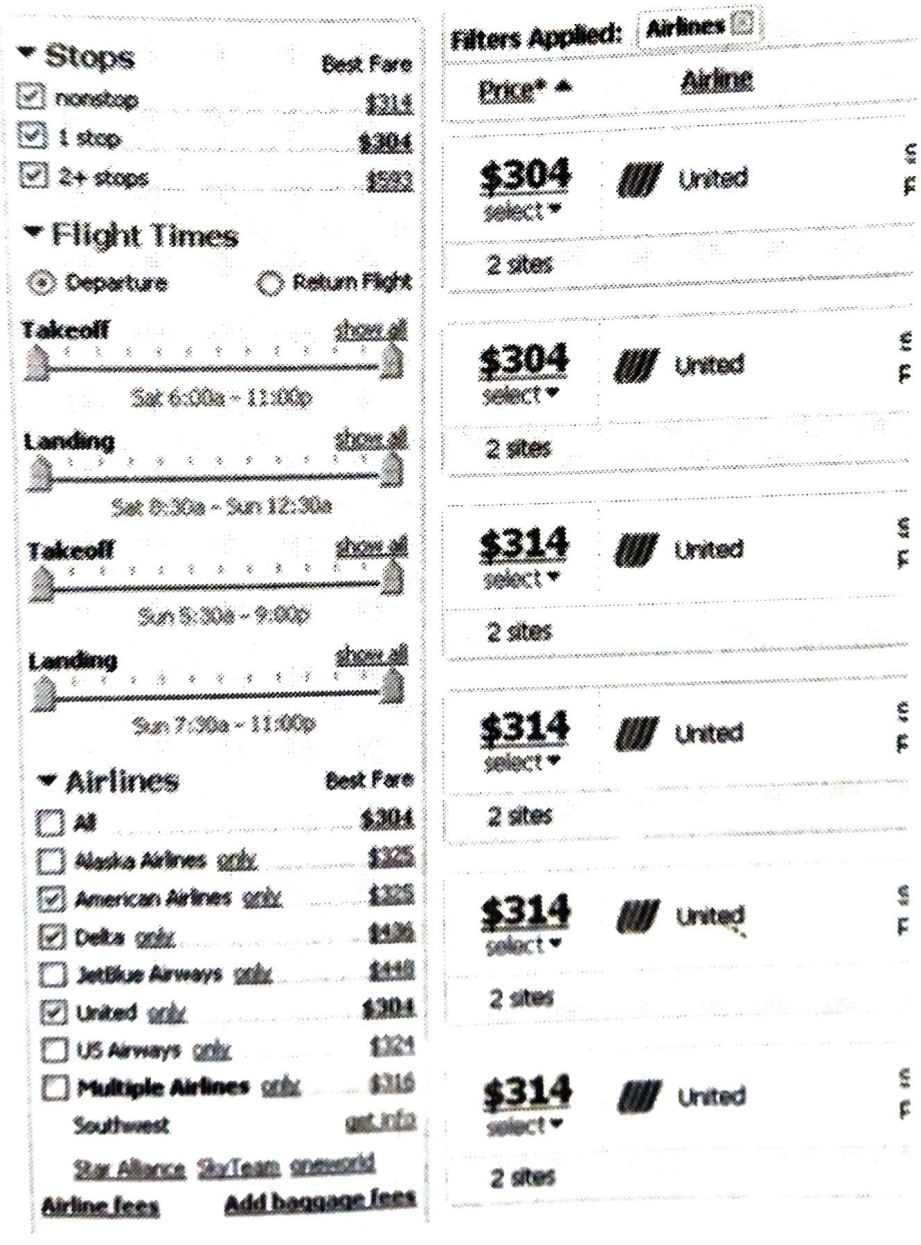


Fig. 5.4.3

- This time, the user does not start by using the facets but rather performs a free - text search for airlines in their description. The user then uses the price facet to narrow these results to those airline prices less than $320. The system returns the few airline that match these filters, sorted by rating (another facet). The user can further refine this query by selecting values from other facets, such as type, country and so on.
- A preview of the price of available flights guides users narrow down the time range for take-off. The preview eliminates empty result sets and avoids high expenses.

5.4.2 The Social Aspects of Search

- Social search is "an umbrella term" describing search acts that make use of social interactions with others. It may be explicit or implicit, co-located or remote, synchronous or asynchronous.
- Personalized search built on user profiles, e.g. past site visits.
- Collaborative filtering and recommender systems, e.g Netflix
- Music recommendation, e.g. Pandora

5.5 Pattern Recognition

- Pattern is defined as composite of features that are characteristic of an individual.
- Pattern recognition can be defined as the categorization of input data into identifiable classes via the extraction of significant features or attributes of the data from a background of irrelevant detail.
- The basic functions of a pattern recognition system are to detect and extract common features from the patterns describing the objects that belong to the same pattern class and to recognize this pattern in any new environment and classify it as a member of one of the pattern classes under consideration.
- Pattern is represented by vector, string, logical descriptions, fuzzy and rough pattern set.
- Pattern is represented as a vector. Each elements of the vector can represent one attribute of the pattern. Here, the training dataset may be represented as a matrix of size (n × d), where each row corresponds to a pattern and each column represents a feature.
- Each attribute / feature / variable is associated with a domain. A domain is a set of numbers, each number pertains to a value of an attribute for that particular pattern. The class label is a dependent attribute which depends on the 'd' in-dependent attributes.
- Each element of the vector can represent one attribute of the pattern. The first element of the vector will contain the value of the first attribute for the pattern being considered.

While representing spherical objects, (25, 1) may be represented as an spherical object with ... units of weight and 1 unit diameter. The class label can form a part of the vector.

If spherical objects belong to class 1, the vector would be (25, 1, 1), where the first element represents the weight of the object, the second element, the diameter of the object and the third element represents the class of the object.

5.5.1 Components of Pattern Recognition

Fig. 5.5.1 shows pattern recognition system.

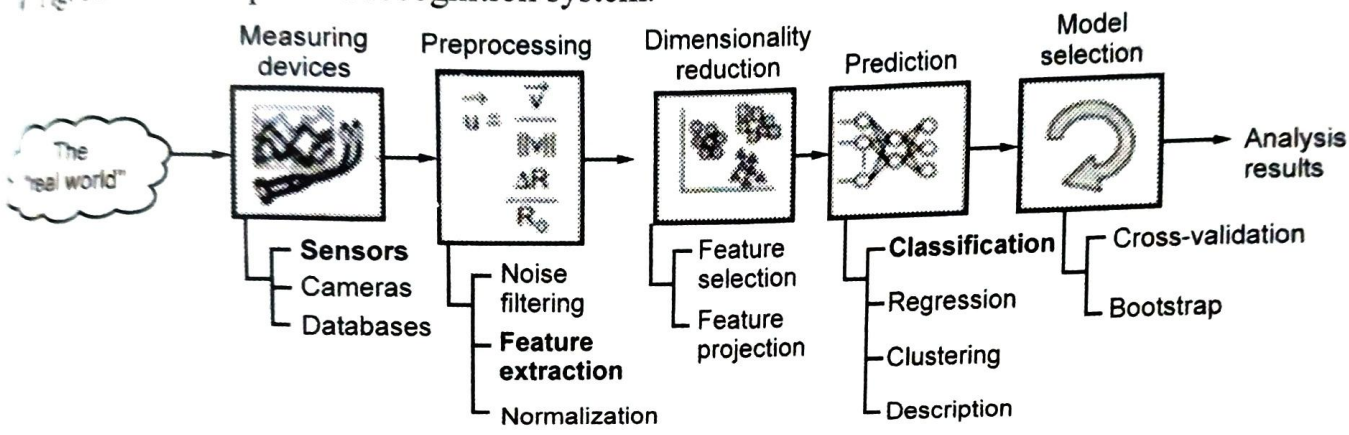


Fig. 5.5.1

1. Sensing

- There must be some device to sense the actual physical object and output representation of it for processing by machine. Most often, the sensor is selected from existing sensors built for a larger class of problems.
- Device used for this purpose of transducer, such as a camera or a microphone array.
- Pattern reorganization system depends on the bandwidth, the resolution, sensitivity distortion of the transducer.

2. Segmentation and grouping

- Break up the image into meaningful or perceptually similar regions. Compact representation for image data in terms of a set of components.
- Components share "common" visual properties. Properties can be defined at different level of abstractions. Patterns should be well separated and should not overlap.

3. Feature extraction

- A set of characteristic measurements (numerical or non - numerical) and their relations are extracted to represent patterns for further process.

- The traditional goal of the feature extractor is to characterize an objects to be recognized by measurements whose value are very similar for objects in the same category and very different for objects in different categories.
- **Two types of criteria are commonly used :**
  - **a) Signal representation :** The goal of feature selection is to accurately represent the samples accurately in a lower - dimensional space.
  - **b) Classification :** The goal of feature selection is to enhance the class - discriminatory information in the lower - dimensional space.

❑ 4. Classification

- The process or events with same similar properties are grouped into a class. The number of classes is task - dependent. The task of a classifier is to partition feature space into class - labeled decision regions.
- The borders between decision regions are called decision boundaries. The classification of feature vector x consists of determining which decision region it belongs to and assigns x to this class.
- A classifier can be represented as a set of discriminant functions.

❑ 5. Post processing

- Considering the effects of context and the cost of errors.
- The post - processor uses the output of the classifier to decide on the recommended action.

5.5.2 Design Process

- Fig. 5.5.2 shows design process of pattern recognition.

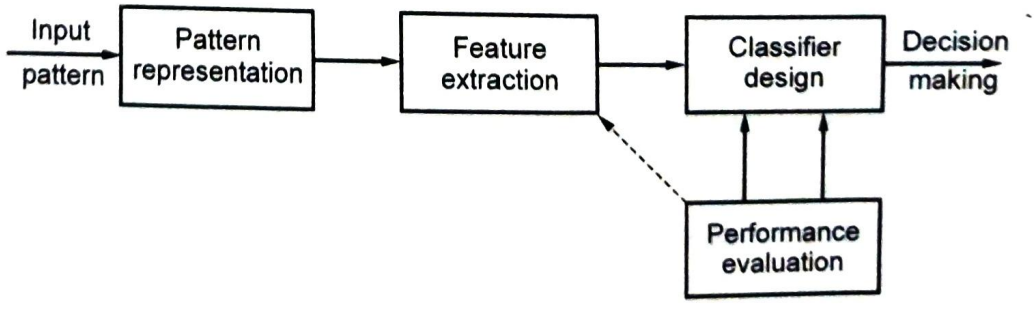


Fig. 5.5.2 : Design process

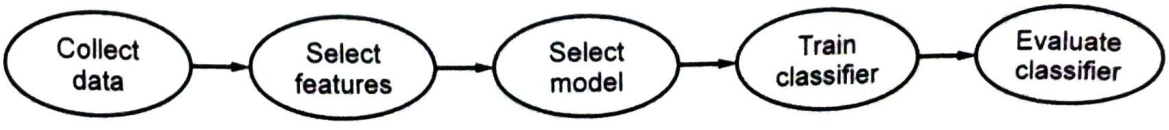


Fig. 5.5.3 : Design steps

Steps	Description
Data collection	• Collecting training and testing data. • It is difficult to identify an adequately large and representative set of samples.
Feature selection	• Domain dependence and prior information. • Computational cost and feasibility. • Discriminative features : Similar values for similar patterns and different values for different patterns. • Invariant features with respect to translation, rotation and scale. • Robust features with respect to occlusion, distortion, deformation and variations in environment.
Model selection	• Definition of design criteria. • Parametric vs. Non - parametric models. • Handling of missing features. • Computational complexity. • Types of models : Templates, decision-theoretic or statistical, syntactic or structural, neutral and hybrid.
ining	• How can we learn the rule from data ? • Supervised learning : A teacher provides a category label or cost for each pattern in the training set. • Unsupervised learning : The system forms clusters or natural groupings of the input patterns. • Reinforcement learning : No desired category is given but the teacher provides feedback to the system such as the decision is right or wrong.
Evaluation	• How can we estimate the performance with training samples ? • How can we predict the performance with future data ?

5.5.3 Types of Pattern Recognition

- **Statistical pattern recognition** attempts to classify patterns based on a set of extracted features and an underlying statistical model for the generation of these patterns.
- **Structural pattern recognition** assumes that pattern structure is quantifiable and extractable so that structural similarity of patterns can be assessed
- **Difference between statistical and structural approaches of pattern recognition :**

Statistical approaches	Structural approaches
Statistical pattern recognition attempts to classify patterns based on a set of extracted features and an underlying statistical model for the generation of these patterns	Structural pattern recognition assumes that pattern structure is quantifiable and extractable so that structural similarity of patterns can be assessed
It depends upon statistical decision theory	It depends upon human perception and cognition
It ignores feature relationships	It captures primitive relationship
Semantics from feature position	Semantics from primitive encoding
Classification is statistical classifiers	Classification is semantics from primitive encoding

5.5.4 Role of Machine Learning

- The goal of Machine learning is never to make "perfect" guesses because Machine learning deals in domains where there is no such thing. The goal is to make guesses that are good enough to be useful.
- Machine learning is a method of data analysis that automates analytical model building. Machine learning is a field that uses algorithms to learn from data and make predictions.
- A Machine learning algorithm then takes these examples and produces a program that does the job. Machine Learning builds heavily on statistics.
- For example, when we train our machine to learn, we have to give it a statistically significant random sample as training data. If the training set is not random, we run the risk of the Machine learning patterns that aren't actually there.

- **Differences between Machine Learning and Pattern Recognition**

Machine learning	Pattern recognition
Machine learning is a method of data analysis that automates analytical model building.	Pattern recognition is the engineering application of various algorithms for the purpose of recognition of patterns in data.
Machine learning is more on the practical side..	Pattern recognition is more on the theoretical side.
It can be a solution of real time problem.	It can be a real time problem.
We need machines / computers to apply Machine learning algorithms.	Pattern recognition may be outside the machine.

5.6 Multiple Choice Questions

Q.1 _____ could provide a more suitable medium than a paper printout for presenting vast quantities of strategic information for rapid assimilation.

[a] Display screens [b] Monitor

[c] Memory [d] Keyboard

Q.2 Graphic programming language for children called _____ to control turtle that dragged a pen along a surface to trace its path.

[a] BASIC [b] POGO

[c] LOGO [d] LALA

Q.3 The use of metaphors in the design of human - computer interaction has been increasing as the _____ have become popular in recent years.

[a] text - driven command line [b] graphic User Interfaces

[c] menu - driven command line [d] WIMP Interface

Q.4 _____ consists of software tools and technology that supports a group of individuals working on projects at different sites.

[a] Computer supported complex work

[b] Computer supported cooperative workload

[c] Computer supported cooperative window

[d] Computer supported cooperative work