ADVANCES IN COMPUTING

In this chapter, we will discuss advanced computing paradigms to meet the ever changing computing needs in various fields. The distributed computing system uses multiple computers to solve largescale problems over internet. In distributed computing the main stress is on large scale resource sharing and always goes for the best performance. Social media sites like Facebook, Twitter, etc., search engine website like Google, Bing, etc. are implemented on the on the concept of largely distributed computing systems. Cyberneticsis the study of the interaction between humans and machines. Many technologies such as biometrics, Natural Language Processing (NLP), robotics, etc. implement artificial intelligence in varying degrees. Bioinformatics is the application of computer technology to the management of biological information.
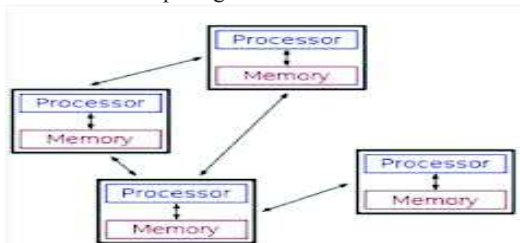
Distributed computing paradigms

Distributed computing is a method of computer processing in which different parts of a program are run simultaneously on two or more computers that are communicating with each other over a network. The term paradigm means a pattern or a model in the study of any subject of complexity. Advanced computing paradigm includes parallel computing, cluster computing, gridcomputing, cloud computing, etc.

1. Distributed Computing

World WideWeb (WWW) is the best example of a large distributed system. Distributedcomputing is a method of computing in which large problems can be divided into many small problems which are distributed to many computers. Later all the small results are assembled to get the desired overall solution. Distributed computing is a method of computing in which differentparts of a program are run simultaneously on two or more computers that are communicating with each other over a network. The information is exchanged between processors on the basis of messages.

Distributed computing architecture:-

Advantages of distributed computing:

Economical: It reduces overall computing cost.

Speed: By spreading the computational load across different nodes, eachlocation is under less stress, asa resultof which speed increases.

Reliability: Distributed systems can continue to function even if one node ceases to function.

Scalability: ln distributed computing the number of nodes can vary according to the demand.

Disadvantages:

The limitations of distributed computing are listed below.

Complexities: A lot of extra programming is required to set up a distributed system.

Security: Informationcan be tracked and can be used for illegal purpose.

Network reliance: In case of network failure, the entire system may become unstable.

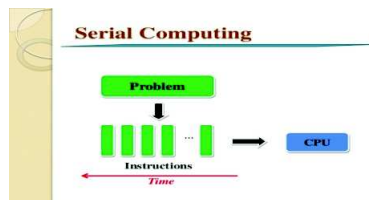## Various types distributed computing

1. Parallel computing   2.Grid computing   3.Cluster computing   4.Cloud computing

1. **Parallel computing:**

   Serial Computing: A problem is broken into a series of instructions and the instructions are executed one by one sequentially. Only one instruction is executed at a time.it is referred to as serial computing.

   Parallel Computing: Parallel computing is a type of computation in which many calculations or the execution of processes are carried out simultaneously. Large problems can often be divided into smaller ones, which can then be solved at the same time. In parallel computing different processors can share same memory.
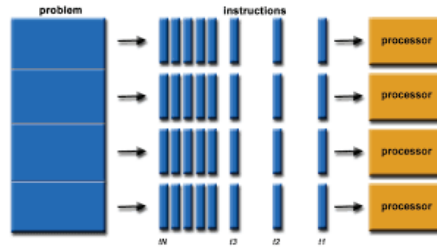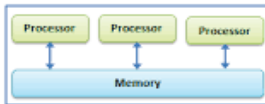
Serial computing	Parallel computing
A single processor is used.	Multiple processors are used.
A problem is broken into a discrete series of instructions.	A problem is broken into discrete parts that can be solved concurrently.
Instructions are executed sequentially one after another.	Instructions from each part execute simultaneously on different processors.
Only one instruction is executed on a single processor at a time.	More than one instruction is executed on multiple processors at any moment of time.

Comparison between Serial and parallel computing

Advantages of parallel computing:

1.Fault tolerance-When one or more node fails,the whole system still work with reduced performance.
2.Each user can share the computing power and storage resourcesin the system with other users.
3.Load sharing-Distributing several tasks to different nodes.
4.It is easily expandable and scalable.

Disadvantages of parallel computing:
1.More complex than serial computing.
2.When a program ported to a different computer significant changes must be made in order to allow the program to run.

2.Grid computing:

Grid computing is a paradigm of distributed computing in which more number of computers and instruments like mobile phones,telescopes,sensors,etc owned by thousands of different people are connected together to form a single huge powerful computer.Grid computing is described as world in which computational power(resources,services,data) is readily available like electrical power.

Computers on a grid have a program on them,that allows unused resources to be used by another computer on the grid.In grid the processing tasks are broken up into independent parts and sent out to different computers.When a computer completes its part it sends the results back to the server.

Types of grids:- knoweldge grid,Data grid,Computational grid.

Application areas:-1.Disaster management   2.Weather forecasting   3.Market forecasting
                                    4.Bio-informatics.
Advantages: 1.Capable to solve larger,more complex problems in a short time.
                                  2.Makes better use of existing hardwares.
                                  3.Scalable.
Disadvantages: 1.Processing speed depends on the speed of interconnection.
                                  2.Licensing issues across different servers may affect working of certain applications.

Grid computing environment

3.Cluster computing:
Cluster computing is a form of computing in which a group of personal computers,storage devices,etc are linked together so that they can work like a single computer.The components of a cluster are connected through fast LANs.Clusters provide computational power through parallel processing.Linux operating system is widely used for cluster computers.

It is a relatively low cost form of a parallel processing machine used for scientific and other applications.It provides fault tolearance, i.e to ensure computational power always available.

Application areas:- e-commerce,high performance database applications.

Advantages:-   1.Price performance ratio:reduces the cost of processing power

2.Availability:If one system fails, the system as a whole stays highly available.

3.Scalability:Processors and nodes can be added to a cluster whenever demand increases.

Disadvantages:- 1.Programmability issues: Issues while connecting different computers having different softwares.

2.Problem in finding fault: difficulty in identifying problematic component.

Example:- Beowulf cluster.

4.Cloud computing:

Cloud computing refers to the use of computing resources that resides on a remote machine and are delivered to the end users as a service over network.eg:-   e-mail service.

Cloud computing is a computing model where resources such as computing power,storage,network and software are combined and provided as a services on the internet in a remotely accessible fashion.Cloud computing is so named because the information being accessed is found in the 'clouds' or a remote place just like clouds in the sky.Cloud computing is subscription based service and to use this cloud services we need internet access and an account with cloud serviceprovider is required.

Cloud service models:-
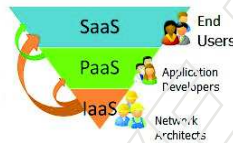
1.SaaS(Software as Service)
2.PaaS(Platform as Service)
3.IaaS(Infrastructure as Service)

1.SaaS:

A SaaS provider gives subscribers access to both resources and applications as a service on demand.
SaaS providers:- Adobe,Microsoft,facebook.com etc

2.PaaS:

A PaaS provider gives subscribers access to the components that they require to develop and operate applications over the Internet,i.e the platforms used to design,develop,build and test applications are provided by the cloud infrastructutre.
PaaS providers:- Google's App Engine,Microsoft Azure,Force.com

3.IaaS:

It deals primarily with computational infrastructure.IaaS provides basic storage and computing capabilities as standardised services over the network.Servers,storage systems,networking equipment,data centre space etc are pooled and made available to handle workloads.
IaaS prividers:- Amazon Web Services,Joyent,AT&T,GoGrid.

Advantages of Cloud computing:

1.Cost savings:- For increasing computing capabilities companies can use operational expenditure,hence they canreduce capital expenditure.

2.Scalability/Flexibility:- Companies can start with a small deployment and grow to large deployment fairly rapidly,and then scale back if necessary.Flexibility alloes companies to use extra resources at peak times to satisfy consumer demands.

3.Reliabilty: Multiple reduntant sites help in disaster recovery.

4.Maintenance: Service providers do the same maintenance thus reducing maintenance requirements.

5.Mobile accessible: Services are accessible from anywhere.

Disadvantages:

1.Security and privacy: There is a danger of stealing or corrupting the data in the disk storage as it uses shared disk system.

2.Lack of standards.

Artificial Intelligence

The term Artificial Intelligence was first coined by John McCarthy in 1956.Alan Turing believed that intelligent machines solves complex problems by mimicking human reasoning process.

Knowledge pyramid:
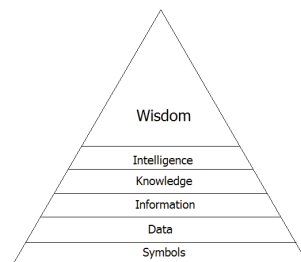
Knowledge pyramid

Knowledge and intelligence are the major areas of study under AI. The underlying thrust force behind every intelligent system is knowledge.

Symbols - which form the basis means of representation.

Data- A collection of more symbols.

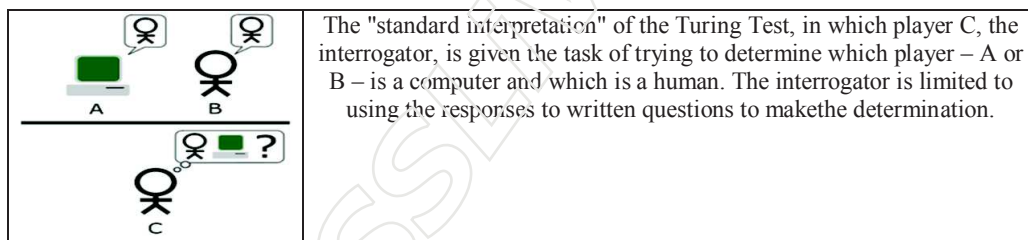Information- Processed data.

Knowledge- Organized information.

Intelligence- The ability to draw useful inferences from the available knowledge.

Wisdom- It is the maturity of mind that directs its intelligence to achieve desirable goals.

Turing test and its approach to AI:

The Turing test is a test, developed by Alan Turing in 1950, of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.

Turing defined intelligence as the ability to achieve human level performance in all cognitive tasks, sufficient to fool an interrogator. The test he proposed is that the computer should be interrogated by a human via a teletype. The computer passes the test if the interrogator cannot distinguish between computer and human being.

The "standard interpretation" of the Turing Test, in which player C, the interrogator, is given the task of trying to determine which player – A or B – is a computer and which is a human. The interrogator is limited to using the responses to written questions to make the determination.

Turing test

To pass the total Turing Test, the computer would need to possess the following capabilities:-

1. Natural Language Processing (NLP): To enable to communicate successfully in English.

2. Knowledge representation: To incorporate human knowledge before or during the interrogation.

3. Automated reasoning: To use the knowledge to answer question and to draw new conclusions.

4. Machine learning: To adapt to new circumstances and to detect and deduce patterns.

5. Computer vision: The capability to observe objects. It must also perform the activities like image acquisition, transformation, processing, analysis, understanding and interpretation.

6. Robotic activities: To move them about; to cope with the changing environment, intelligent sensors which can sense the environment and supply necessary signals for its intelligent control unit.

Example for Some intelligent algorithms: Artificial Neural Networks (ANN), Evolutionary Computation(EC), Swarm Intelligence (SI), Fuzzy logic.

Computational Intelligence(CI)

Cybernetics is defined as the study of control and communication between man and machines.

Computational intelligence focus on problems that are difficult to solve using artificial systems, but are solved by humans and some animals using intelligence.

Computational Intelligence paradigms:

Computational Intelligence (CI) is the study of algorithms to facilitate intelligent behavior in complex and changing environment so as to solve real life problems.

Paradigms of CI: -   a) Artificial Neural Networks (ANN) b) Evolutionary Computation (EC)
c) Swarm Intelligence (SI)   d) Fuzzy Systems (FS)

a) *Artificial Neural Networks (ANN):*

In ANN the brain is a complex, nonlinear and parallel computer. It has the ability to perform tasks such as pattern recognition, perception, motor control(body movements), ability to learn, memorize, still generalize and prompted research in algorithmic of biological neural systems.

b) *Evolutionary Computation(EC):*

Evolutionary Computation(EC) has its objective to mimic processes from natural evolution, where the main concept is survival of the fittest, i.e., the weak must die. In natural evolution, survival is achieved through reproduction. In computer science, evolutionary computation is a family of algorithms for global optimization inspired by biological evolution, and the subfield of artificial intelligence and soft computing studying these algorithms. Evolutionary Computation has been used successfully in real-world applications like data mining, fault diagnosis, classification, scheduling etc.

c) *Swarm Intelligence(SI):*

SI is the study of colonies or swarms of self-organized social organism, which leads to the design of several efficient algorithms.

Examples:1. Choreography of bird flocks led to the design of Particle Swarm Optimization algorithm.
2. Foraging behaviour of ants resulted in Ant Colony Optimization (ACO) algorithms.

d) *Fuzzy systems:*

Fuzzy logic allows reasoning with uncertain facts to infer new facts, with a degree of certainty associated with each fact. Fuzzy sets and logic allows the modelling of common sense. Fuzzy systems have been applied to control gear transmission and raking systems in vehicles, controlling lifts, home appliances, controlling traffic signals etc.

Applications of Computational Intelligence:

Some of the latest applications of computational Intelligence are:
a) Biometrics
b) Robotics
c) Computer vision
d) Natural Language Processing
e) Automatic Speech Recognition
f) Optical Character Recognition and handwritten Character Recognition Systems
g) Bioinformatics
h) Geographic Information System

a) **Biometrics:**

Biometrics refers to metrics (measurements) related to human characteristics and traits. *Biometric authentication* is used in identification of individuals. Biometric identifiers are distinctive, measurable characteristics used to label and describe individuals. Biometric identifiers are often categorized as physiological and behavioral characteristics.
Physiological characteristics: finger print, palm veins, face, hand geometry, iris, retina and odour.
Behavioral characteristics: typing rhythm, speed and voice.
Applications of biometrics identification: Attendance management systems, authentication in computers and other devices, Aadhar card etc.

b) **Robotics**:

Robot is an electromechanical device which is capable of reacting in some way to its environment and take autonomous decisions or actions in order to achieve a specific task.
Robotics can be defined as the scientific study associated with the design, fabrication, theory and application of robots. Robotics deals with design, construction, operation and application of robots as well as computer systems for their control, sensory feedback and information processing.
Robots are used in the following areas:-
☞*Uses in vehicle manufacturing industry:* Robotic arms are able to perform multiple tasks such as welding, cutting, lifting, sorting and bending.
☞ *Exploration of outer space:* Manipulative arms are used to unload the docking bay of space shuttles to launch satellites or to construct a space station.
☞ *In intelligent homes:* Automated systems can monitor home security, environmental conditions and energy usage. Door, windows and home appliances can be preprogrammed to

be activated.

☞ **Exploration in difficult environment:** Robots can visit environments that are harmful to humans.
Ex: environment inside volcano, deepest ocean, and for planetary exploration.

☞ **Uses in military:** Airborne robots (drones) are used by armies for surveillance purpose and aerial attacking in hostile environment. Automated aircrafts and vehicles could be used to carry fuel and ammunition or clear minefields.

☞ **Uses in agriculture:** Automated harvesters cut and gather crops. Robotic dairies allow operators to feed and milk animals remotely.

c) **Computer vision:**

Computer vision is concerned with the theory and technology for building artificial systems that obtain information from images or multi-dimensional data. The purpose of this branch to allow computers to understand the physical world by visual media means. Sub-domain of computer vision includeScene reconstruction,Event detection,Video tracking,Object recognition,learning,indexing,motion estimation and Image restoration.

Eg: Mars rover-Curiosity which uses computer vision to explore Mars.

d) **Natural Language processing(NLP):**

Natural language processing is the branch of computer science focused on developing systems that allow computers to communicate with people using any human language such as English, Malayalam etc. It allows people to interact with computers in their own language.

NLP computer does two things:

1.Natural Language Understanding (NLU)-It is about understanding and reasoning the input, which is any natural language.

2.Natural Language Generation (NLG)- It deals with creation of output.

There are voice recognition systems that can convert spoken sounds into written words.

e) **Automatic Speech Recognition(ASR):**

Automatic Speech Recognition(ASR) system allows a computer to identify the words that a person speaks into a microphone or telephone and convert it into written text. ASR is a mode of interaction between human and computers.

The ASR system support many applications like dictation, command and control, voice dialing, spoken database querying, office dictation devices and automatic voice translation into foreign language etc.

Ex: The mobile applications like Siri of AppleiOS, Cortana of Microsoft phone and Google Now of Android.

f) **Optical Character Recognition(OCR) and Handwritten Character Recognition Systems(HCR):**

OCR and HCR is used for pattern recognition.

OCR converts the scanned images of printed text (numerals,letters or symbols) into computer processable format.

Two different approaches to HCR

On-line: data are captured during writing process by a special pen on an electronic surface.

Off-line: Data are acquired after writing process is over.

Ex:-Google's online handwriting recognition application 'google handwriting input' can recognize handwritten scripts of 82 languages in mobile devices.

g) **Bioinformatics:**

Bioinformatics is the application of computer technology to the management of biological information. Computers are used to gather, store, analyse and integrate biological and genetic information which can be then be applied to gene based drug discovery and development.

The aims of bioinformatics are three-fold:-

1.Organise biological data in a way that allows researchers to access existing information and to submit new entries as they are produced.

2.To develop tools and resources that aid in the analysis of data.

3.To use these tools to analyze the data and interpret the results in a biologically meaningful manner.

h) **Geographic Information System(GIS):**

Geographic Information System(GIS) technology is developed from digital cartography and Computer Aided Design(CAD) database management system.

GIS is a computer system for capturing, storing, checking and displaying data related to various positions on earth's surface.

GIS application areas:

☞Soil mapping ☞Agricultural mapping
☞Forest mapping ☞E-Governance
☞Water resource management ☞Natural disaster assessment

☞Strategic urban planning   ☞Infrastructure planning
☞Precision agriculture planning

Benefits of GIS:
  ◆Better information management   ◆Higher quality analysis
  ◆Ability to carry out 'what if' scenarios   ◆Improve project efficiency

Remote Sensing: means sensing things from a distance. Remote sensing is the art and science of obtaining information about an object without being in direct contact with the object.

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