Explores new trends and future directions in computing

Intelligent and emotional machines

Examples for human interest about intelligent and emotion machines,

- 80's tele-series "Knight Rider" had machines that exhibit intelligence and emotion
- Modern fictions such as "2001: A Space Odyssey" by Sir Arthur C Clarke

Artificial Intelligence

- What is Artificial intelligence?

Artificial Intelligence (AI) is usually defined as the science of making computers do things that require intelligence when done by humans.

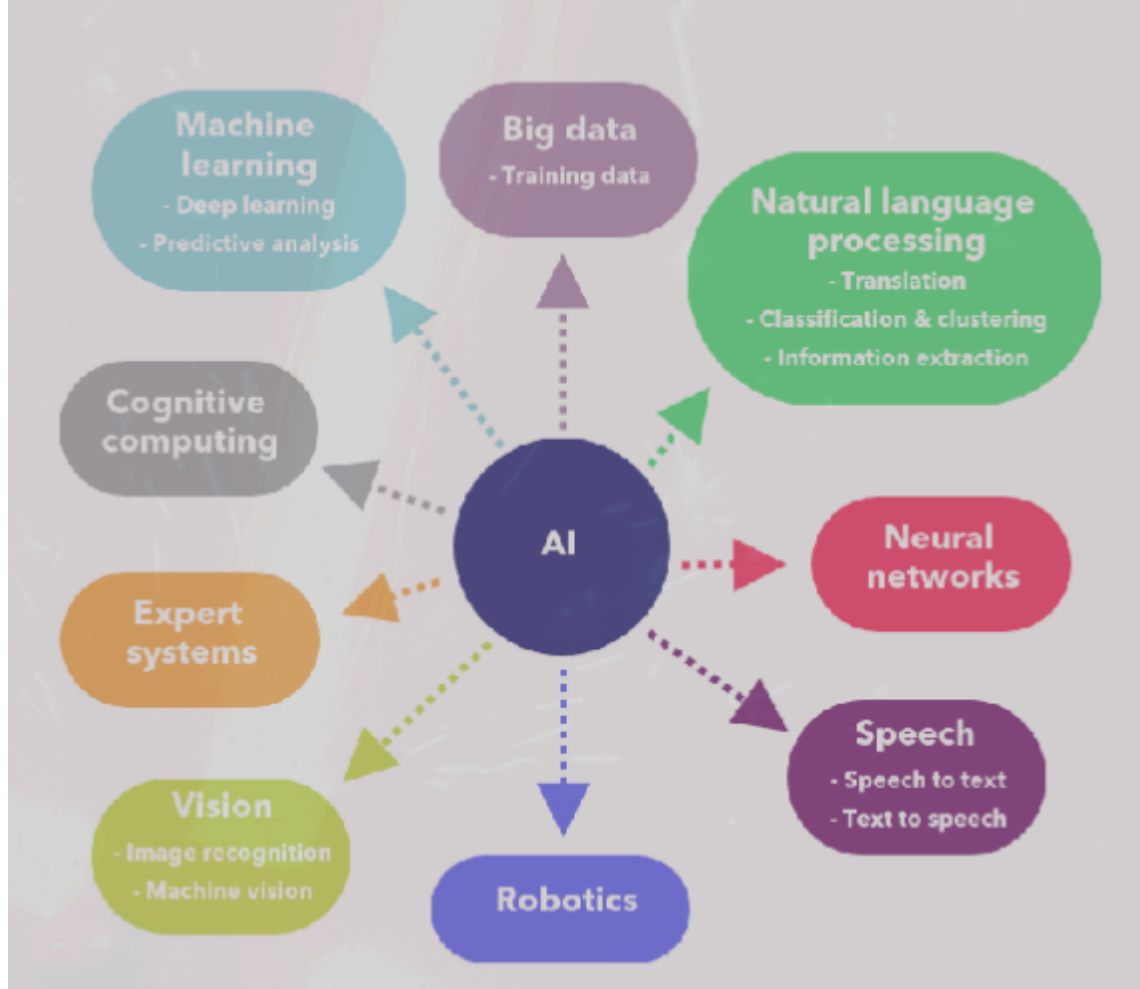> Some important AI Techniques are: Neural Network, Genetic Algorithm, and Expert Systems

- What is Machine intelligence?

Computer which follows problem solving processes as humans do.

> Intelligent systems display machine-level intelligence, reasoning, often learning, and self-adapting

Branches of Artificial Intelligence

Neural Network

> Neural Network are computational models inspired by an animal's central nervous systems (in particular, the brain) which is capable of machine learning as well as pattern recognition.

- Here the behavior, of different animals are studied and used to help develop AI
- Artificial neural networks are generally presented as systems of interconnected "**neurons**" which can compute values from inputs

Applications of Neural Network

- Fingerprint Recognition
- Pattern Identification
- Speech Recognition
- Character Recognition
- Signature Verification Application

> Apart from these, neural networks can **analyze real datasets, and make predictions** based on that. More datasets and experience, it has the better chance of the prediction being correct.

Genetic Algorithms

Genetic Algorithms (GAs) are adaptive heuristic search algorithm premised on the evolutionary ideas of natural selection and genetic

> This follows the principles first laid down by Charles Darwin of **survival of the fittest.**

Hence, this is usually **used to find the best solution out of many**

In GA, combining two good solutions to create better solutions in the next generation.

- Father and mother contribute good features to create better children.
- From multiples ways of getting something done, finding the best way to do it with most efficiency.
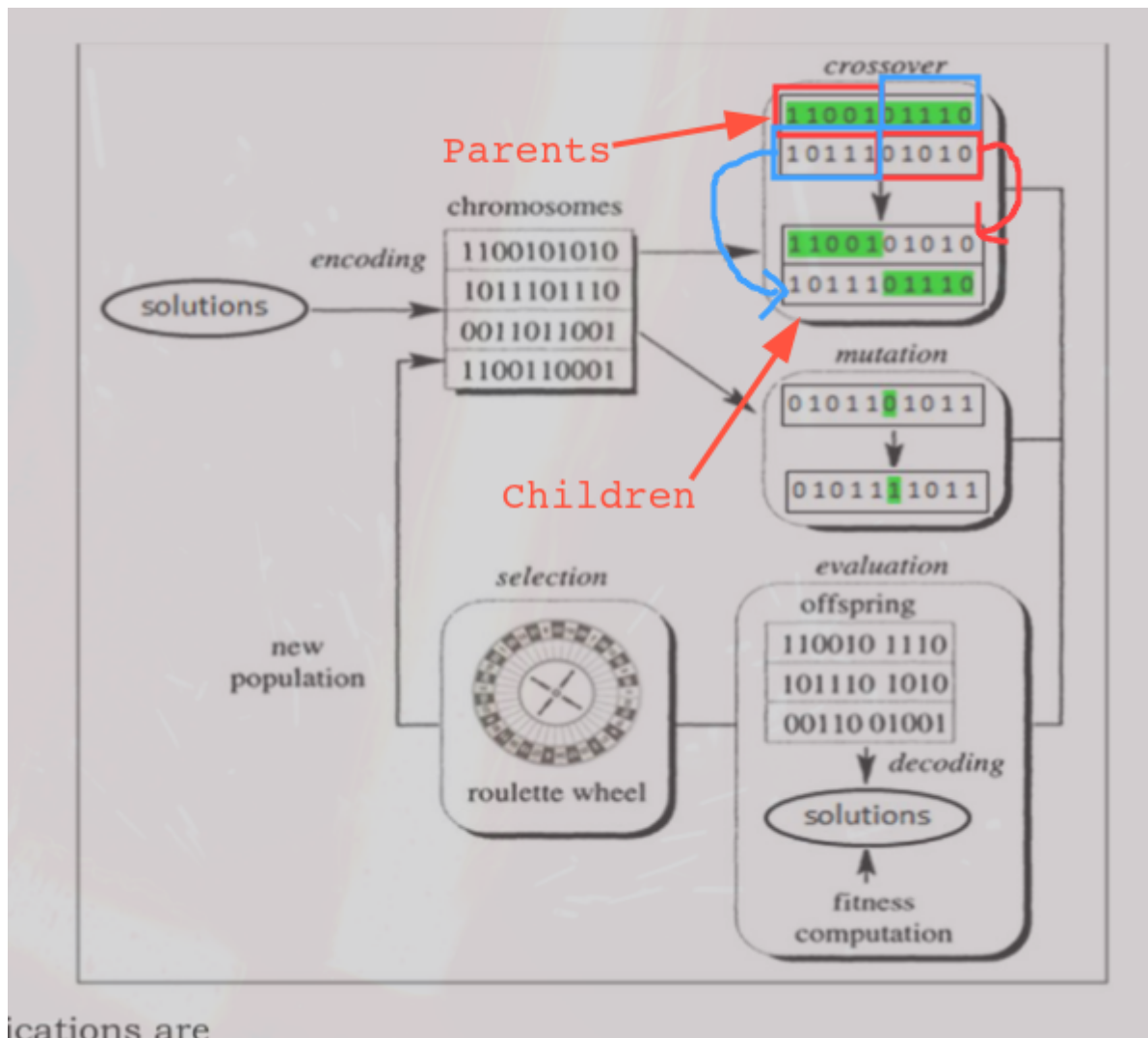

ications are

> The place where the genes are separated from the chromosome is called the crossover point
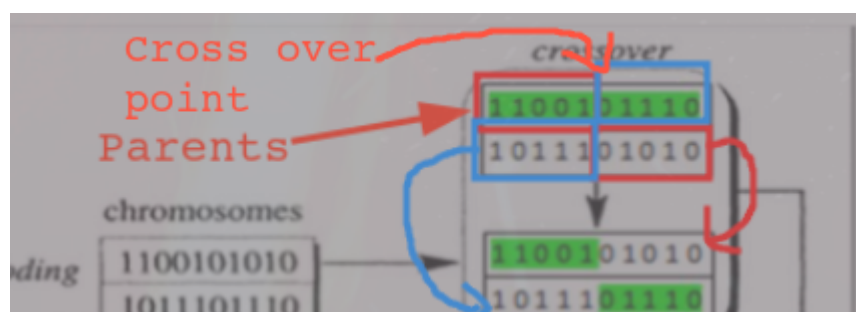
> This process of crossing over is done till a chromosome (child) is made
> that is the fittest and the strongest according to pre-defined set of
> rules

Example 1

(i) In the initialization step we define the population of genetic algorithm. Given below is visual representation of the initialization. Identify A, B and C.

A1	0	0	0	0	0	0	← — A
A2	1	1	1	1	1	1	← — B
A3	1	0	1	0	1	1	
A4	1	1	0	1	1	0	← — C
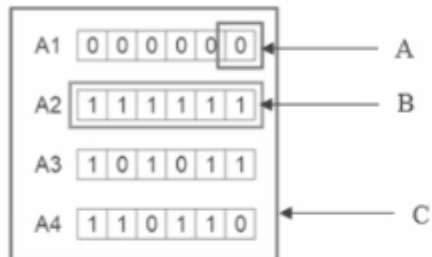
(ii) Briefly describe what goes under selection step.

(iii)Consider the following parents of the genetic algorithm and draw their offsprings.

| 1 | 0 | 0 | 1 | 1 | 1 |

Crossover point

| 1 | 1 | 1 | 1 | 0 | 1 |
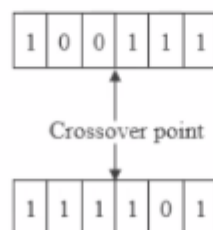
> A - A gene
> B - A chromosome (Made of 2 or more genes)
> C - Population (Mode of set of chromosomes)

> In this example, there are 6 genes per chromosome, which means that this
> population has `2**6 = 64` number of possible solutions

> Here, the process of choosing the strongest and fittest individuals
> (chromosomes) which need to be crossovered is called selection

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Parents
100111 - P1
111101 - P2


Children after crossing over


100101 - C1
111111 - C2
```

Example 2

Find the number with the larges square root using 4 out of 32.

Vocabulary - {0,1}
Fitness function - x**2

1. Get random 4 out of 32

32 is 2**5, which means one chromosome should have 5 genes

A - 00000
B - 00001
C - 00010
D - 00100

2. Calculate the fitness value
A - 00000 - 0 -> 0**2 = 0
B - 00001 - 1 -> 1**2 = 1
C - 00010 - 2 -> 2**2 = 4
D - 00100 - 4 -> 4**2 = 16

We need to represent these as a precentage of all the fitnesses of all chromosome
Total fitness = 0 + 1 + 4 + 16 = 21

Percentage fitness
A = (0/21) * 100 = 0% -> f1
B = (1/21) * 100 = 4% -> f2
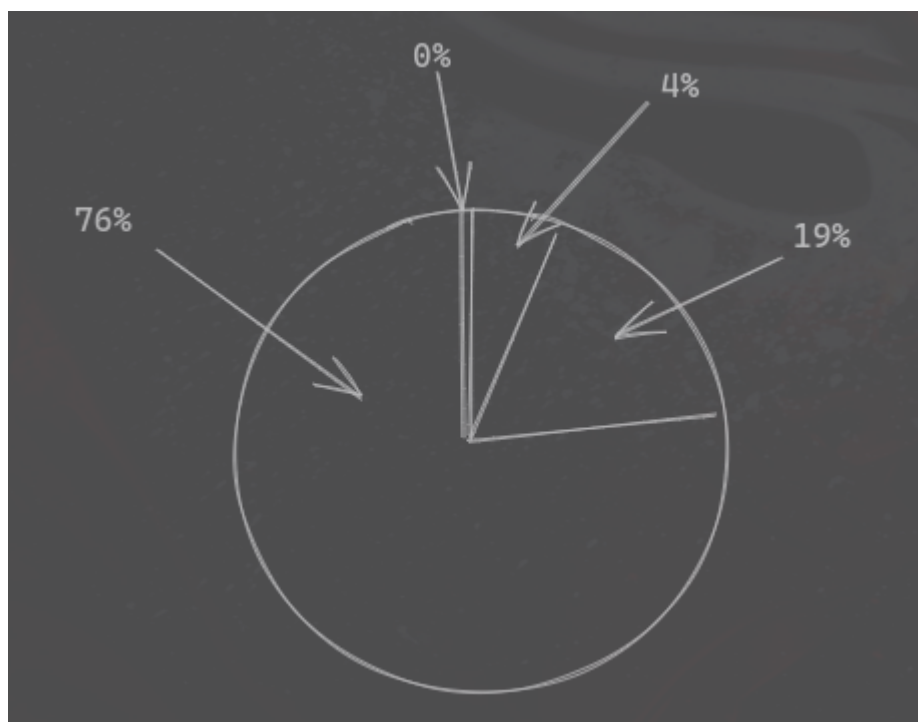C = (4/21) * 100 = 19% -> f3
D = (16/21) * 100 = 76% -> f4

3. Selection using roulette wheel method

We need to mark these perentages in a circle like this

```
Then we select the parents by putting the parble


PB - 00001
PC - 00010


4. Cross over the parents


C1 - 00010
C2 - 00001


5. Then we calculate the fitness function for these 2 children


C1 - 00010 - 2 -> 2**2 = 4 19% -> fc1
C2 - 00001 - 1 -> 1**2 = 1 4% -> fc2


6. Then we add these children to the roulette wheel and arrange them in the
decending order of there fitness



D = (16/21) * 100 = 76% -> f4
C = (4/21) * 100 = 19% -> f3
C1 - 00010 - 2 -> 2**2 = 4 19% -> fc1
B = (1/21) * 100 = 4% -> f2
C2 - 00001 - 1 -> 1**2 = 1 4% -> fc2


7. Then again we do the roulette barble and select 2 to crossover.
This is does untill only the strongest ones are left
```

Expert Systems

This is the same system that's in the Systems lesson ⬜ Expert Systems

Artificial Intelligence Software vs. Conventional Software

AI Software	Conventional Software
Ability to give the computer only the problem, not the steps necessary to solve it	follow a logical series of steps to reach a conclusion based on pre-provided instructions

Artificial Intelligence (Pros)

- Ability to simulate human behavior and cognitive processes.
- Capture and preserve human expertise (Watch, learn and adapt)
- Fast Response.
- The ability to understand large amounts of data quickly.

Artificial Intelligence (Cons)

- No common sense
- Can't easily deal with mixed knowledge
- May have high development costs
- Raise legal and ethical concerns

Technique	Description
Searching	Searching for a goal state in state space. For example, finding the winning state in a board game with a human player
Expert Systems	Rule-based systems that capture knowledge as If-Then rules and help humans in reasoning and advising
Natural Language Processing	Recognizing and even understanding human languages
Speech recognition	Recognizing words and understanding short voice sentences
Computer vision and scene recognition	Interpreting contents of pictures captured by cameras
Machine learning	Learning patterns in data. For example, predicting whether a new customer will default a loan or not by exploring the past data of all customers who obtained a loan
Neural networks	A notable technique in the domain of machine learning based on a massively parallel architecture of information processing. A significant development in the area could be seen with the emergence of deep neural networks
Genetic algorithms	Solving optimization problems based on the natural selection process in biological evolution where a significant optimal solution is obtaining by evolving a population of candidate solutions
Fuzzy logic	Making decisions with fuzzy linguistic statements. For example, if the room temperature is 'hot', turn the fan 'fast'. Here hot and fast are fuzzy statements that cannot be represented as True or False

Man-Machine Coexistence

The word coexistence can be broken into two parts, `co-` and `-exists`. The prefix co- means together, and -exist means to be or to live.

- Man-Machine coexistence

> Man-Machine coexistence is giving assistance to humans in workplaces without disturbing humans

Examples: `Asimo` Robot(Humanoid Robots)
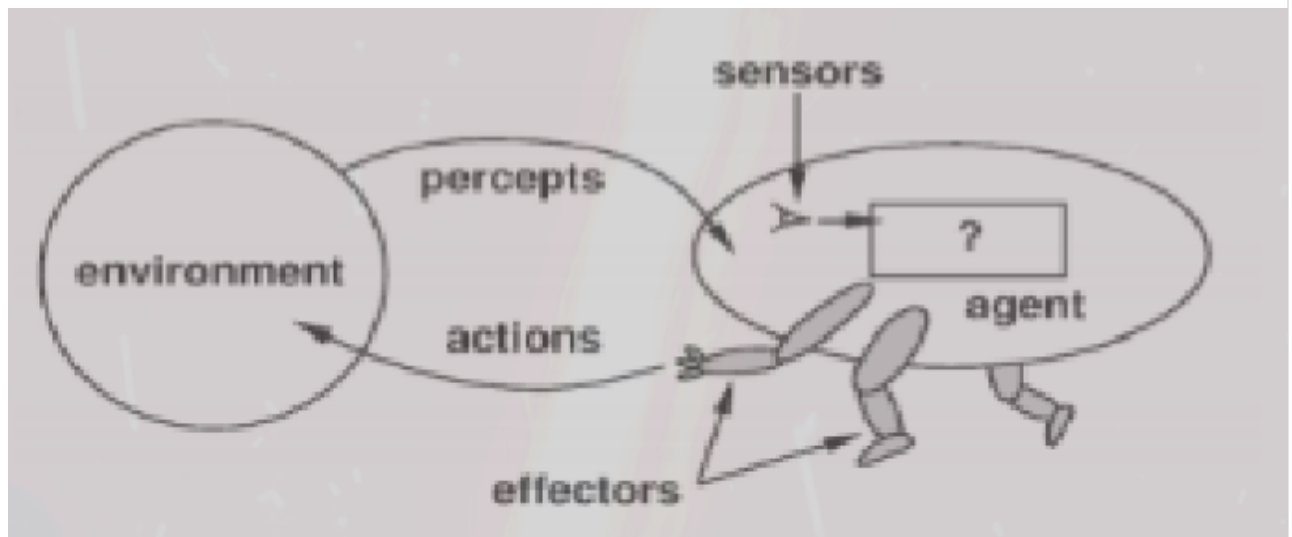
- Machine-Machine coexistence

Machine-Machine coexixtence is the ability of machines to work with multiple other machines

02 - Explores the fundamentals and applications of agent technology

Agent-Based Systems

- What is an agent?

An agent is anything that can perceive its environment (through its sensors) and act upon that environment (through its effectors)

An agent get the precepts from the environment through sensors.
Then they perform actions to the environment from the effectors. Ex:
Siri, Cortana

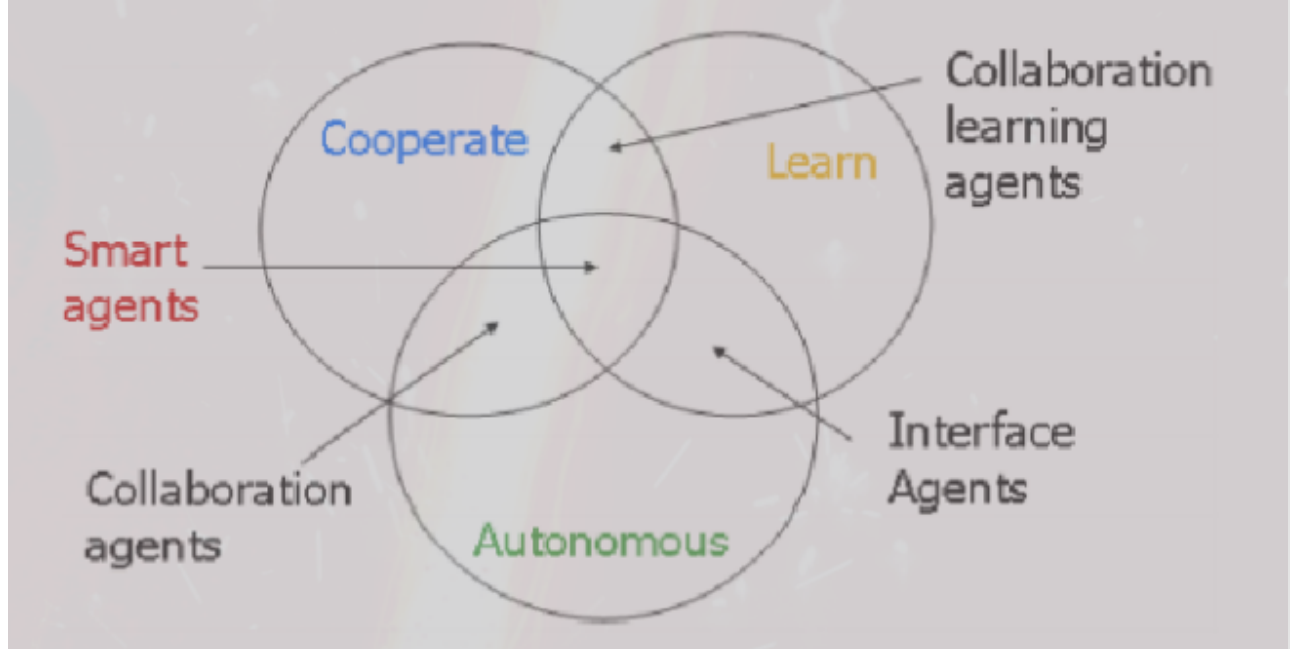An agent can be either software or hardware based

Characteristics of Agents

- Autonomous
- Able to learn
- Proactive
- Cooperative
- Easy to adaptive
- Mobility and versatility

## Classification of software agents

Multi-agent systems

> Software agents that can interact with other software agents to execute a common task.

This is due to the cooperative characteristic of agents.

Characteristics of multi-agent systems

- Autonomous: meaning that they can make independent decisions by being self-aware
- Having only a local view: meaning that they only know how to execute their part and cannot see beyond their scope
- Acting in a decentralized manner: meaning that no agent to control the system

> A user gets some information through an `information broker agent` from multiple sources. Then the user interacts with the broker through an `interface agent`
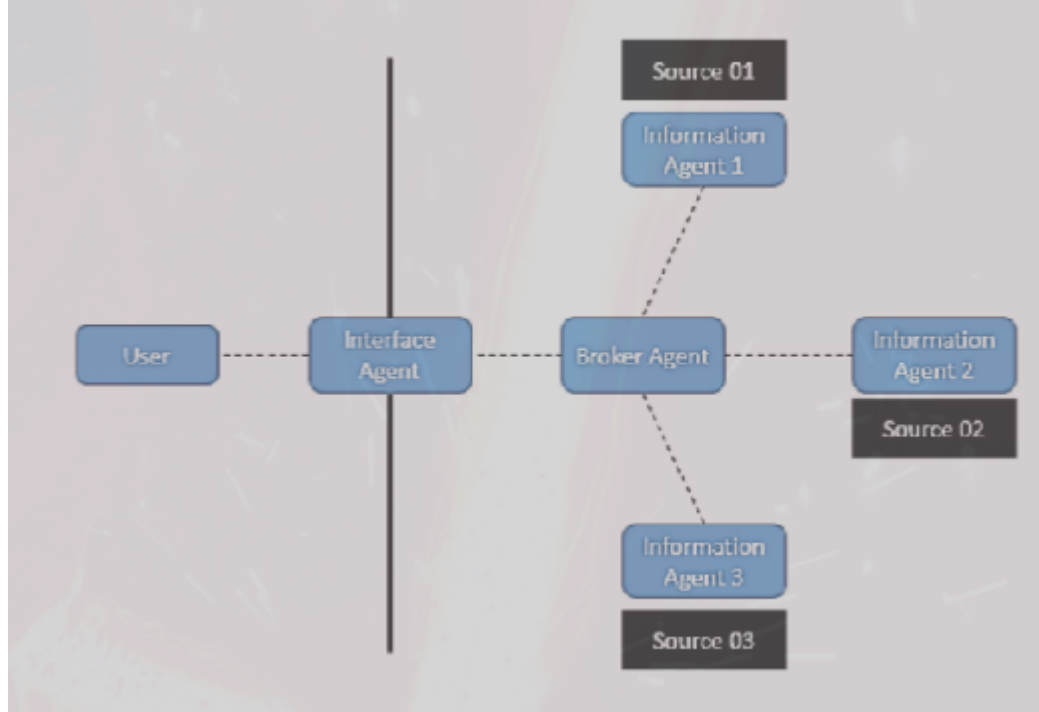
Advantages of multi-agent systems

- Cost effectiveness as it saves transportation and no need of physical presence.
- Convenience to the buyer.

Applications of Agent systems

- Cortana in Windows and Siri on Apple iOS systems are good examples of software agent.
- Agents assist humans in banking, e-learning, e-commerce, booking, and various other similar systems.
- Online booking systems too involve such architecture to filter information on behalf of the users.

Example 1

(b) The following description is about **myShopper**, a multi-agent system which enables a buyer to search the entire online marketplace for the best products. In addition to the price, reviews by other buyers, special offers, reputations of the merchants and the lengths and types of warranties are also considered.

When a **user** (buyer) accesses the **myShopper** website, a **chat-bot** agent starts interacting with the user. User can use voice or text as the input medium to give his/her requirements for a product. During the interaction, the **chat-bot** passes the extracted information to a **search-agent** who will takeover the search for the best product for the user. For this, the **search-agent** will start several **domain-agents** specifying each of them the requirements of the user and specific domains (web sites) to search in. To speedup the search, each **domain-agent** will start several **sub-agents** to search sub-domains under its main domain. After the search, each **sub-agent** will pass the appropriate results back to its parent **domain-agent**. Once all such results from the sub-agents are received, each **domain-agent** compares them and submits the best results to the **search-agent**. The **search-agent** will then compare all such results and gives the details of the best product back to the **chat-bot**. The **chat-bot** will then display it to the **user** as text.

(i) Draw a simplified agent diagram for the above multi-agent system. Name all the entities in your diagram and clearly indicate the interactions between them. **[06 marks]**

(ii) Write **one** major advantage of this multi-agent system. **[01 mark]**

(iii) Write down **one** ICT related challenge which has to be faced when developing a sub-agent. **[02 marks]**

i)
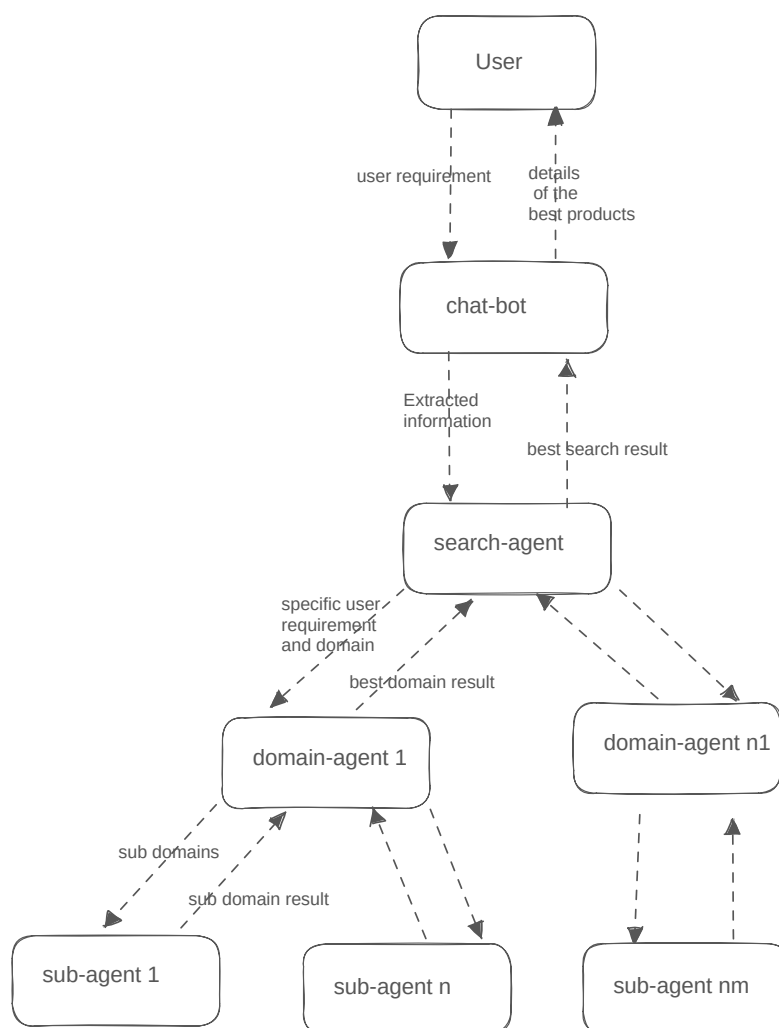
ii) Being able to cooperatively work together and provide information to the user efficiently and faster
iii) sub-agents should be compatible to interact with the domain-agents that they are operated under.

Example 2

(b) Multi agent systems can be used to replace some of the work that require humans. The following scenario explains about **myTours** multi-agent system used to build customized travel packages including flight booking, hotel room reservation and taxi booking for local travel during the tour.

A prospective traveler (user) can access **myTours** website over the Internet and a chat-bot agent starts interacting with the user. User can use voice or text as the input medium. During this interaction chat-bot passes the extracted information to a search-agent who will take over from the chat-bot agent and proceed to search for travel packages for the user. The search-agent has a group of agents each specializing for particular type of travel service such as flight search, hotel search etc. Once the search results are obtained the search-agent prepares the list of travel packages with details and displays to the user for confirmation.

(i) Draw a simplified agent diagram of the above explained multi-agent system. Name the important entities in your diagram.

(ii) Which agent **cannot** be considered as self-autonomous?

(iii) Write a **disadvantage** of using a multi-agent system for the given example user requirement.

i)
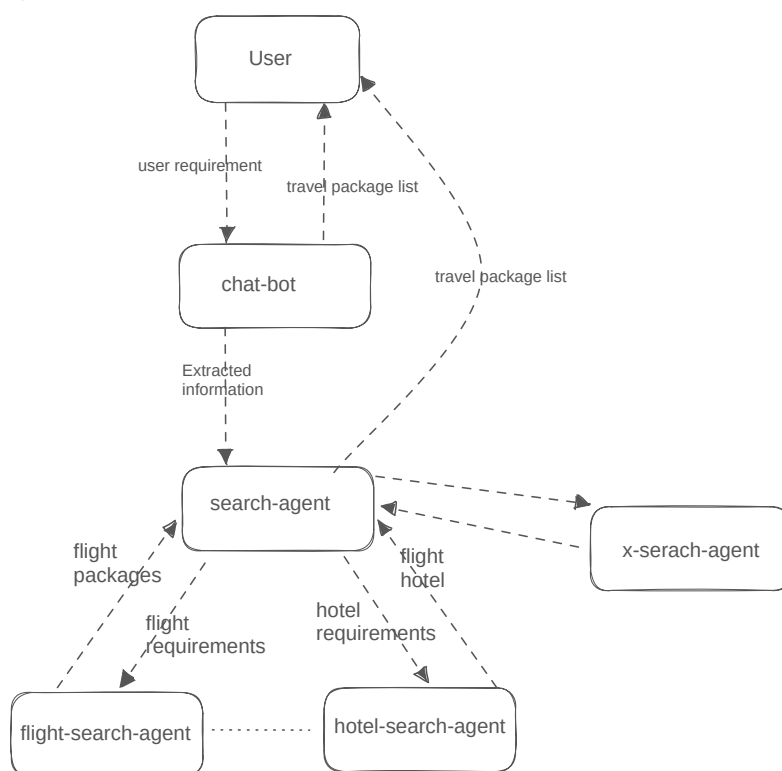
ii) flight-search-agent

iii) sub-agents (flight, hotel) would give packages that are from different countries which violate the search requirement