LECTURE 1: INTRODUCTION TO AI

Fields of Artificial Intelligence

- Expert systems.

- vision systems.

- Natural language processing.

- Distinguish sound systems

- Smart chip industry.

- Robots.

Vision systems

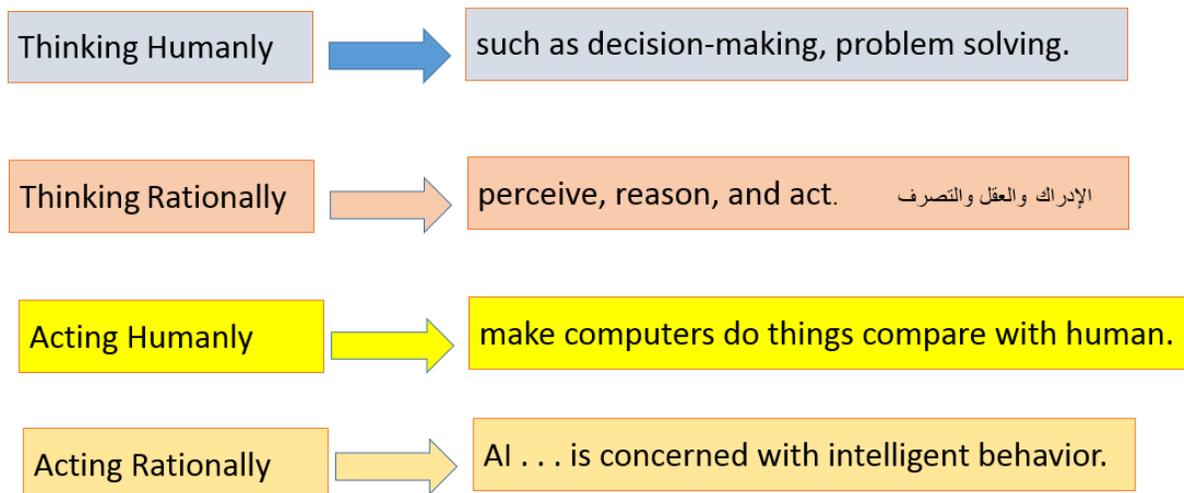- Taking specific pictures, identify objects inside it them, then make appropriate decisions.

   Natural language processing

- Interaction between computers and humans using natural language.

- The goal is to read, understand and perceive human languages in a valuable way.

- Distinguish sound systems

- How can the computer know speech or sounds and how to process them.

Applications of artificial intelligence in life

- The environment
- Mines
- Factories
- Space Science
- Engineering
- Economy
- Games
- Animations

Four categories of AI behaviors

| Thinking Humanly | → | such as decision-making, problem solving. |

| Thinking Rationally | → | perceive, reason, and act. الإدراك والعقل والتصرف |

| Acting Humanly | → | make computers do things compare with human. |

| Acting Rationally | → | AI . . . is concerned with intelligent behavior. |

Types of AI

- **Narrow AI or Weak**
  - **General AI**
  - **(Super AI)**

AI types according to its objectives

- **الآلات التفاعليّة Reactive Machines**
- **الذاكرة المحدودة(Limited Memory)**
- **نظريّة العقل: (Theory of Mind)**
- **الإدراك الذّاتي (Self-Awareness)**

AI subfields

الحقول الفرعيّة للذكاء الاصطناعي

1-Machine

2-Data Mining

3-Logical Reasoning and Probabilistic Reasoning

LECTURE 2 : AI applications

1. AI Application in E-Commerce

Personalized Shopping

Artificial Intelligence technology is used to create recommendation engines through which you can engage better with your customers. These recommendations are made in accordance with their browsing history, preference, and interests. It helps in improving your relationship with your customers and their loyalty towards your brand.

AI-Powered Assistants

Virtual shopping assistants and chatbots help improve the user experience while shopping online. Natural Language Processing is used to make the conversation sound as human and personal as possible. Moreover, these assistants can have real-time engagement with your customers. Did you know that on amazon.com, soon, customer service could be handled by chatbots?

Fraud Prevention

Credit card frauds and fake reviews are two of the most significant issues that E-Commerce companies deal with. By considering the usage patterns, AI can help reduce the possibility of credit card fraud taking place. Many customers prefer to buy a product or service based on customer reviews. AI can help identify and handle fake reviews.

2. Applications Of Artificial Intelligence in Education

Although the education sector is the one most influenced by humans, Artificial Intelligence has slowly begun to seep its roots into the education sector as well. Even in the education sector, this slow transition of Artificial Intelligence has helped increase productivity among faculties and helped them concentrate more on students than office or administration work.

Some of these applications in this sector include:

Administrative Tasks Automated to Aid Educators

Artificial Intelligence can help educators with non-educational tasks like task-related duties like facilitating and automating personalized messages to students, back-office tasks like grading paperwork, arranging and facilitating parent and guardian interactions, routine issue feedback facilitating, managing enrollment, courses, and [HR-related topics.](#)

Creating Smart Content

Digitization of content like video lectures, conferences, and textbook guides can be made using Artificial Intelligence. We can apply different interfaces like animations and learning content through customization for students from different grades.

Artificial Intelligence helps create a rich learning experience by generating and providing audio and video summaries and integral lesson plans.

Voice Assistants

Without even the direct involvement of the lecturer or the teacher, a student can access extra learning material or assistance through Voice Assistants. Through this, printing costs of temporary handbooks and also provide answers to very common questions easily.

Personalized Learning

[Using top AI technologies](#), hyper-personalization techniques can be used to monitor students' data thoroughly, and habits, lesson plans, reminders, study guides, flash notes, frequency or revision, etc., can be easily generated.

3. Applications of Artificial Intelligence in Lifestyle

Artificial Intelligence has a lot of influence on our lifestyle. Let us discuss a few of them.

Autonomous Vehicles

Automobile manufacturing companies like Toyota, Audi, Volvo, and Tesla use machine learning to train computers to think and evolve like humans when it comes to driving in any environment and object detection to avoid accidents.

Spam Filters

The email that we use in our day-to-day lives has AI that filters out spam emails sending them to spam or trash folders, letting us see the filtered content only. The popular email provider, Gmail, has managed to reach a filtration capacity of [approximately 99.9%.](#)

Facial Recognition

Our favorite devices like our phones, laptops, and PCs use facial recognition techniques by using face filters to detect and identify in order to provide secure access. Apart from personal usage, facial recognition is a widely used Artificial Intelligence application even in high security-related areas in several industries.

Recommendation System

Various platforms that we use in our daily lives like e-commerce, entertainment websites, social media, video sharing platforms, like youtube, etc., all use the recommendation system to get user data and provide customized recommendations to users to increase engagement. This is a very widely used Artificial Intelligence application in almost all industries.

Also Read: How Does Artificial Intelligence (AI) Work and Its Applications

4. Applications of Artificial Intelligence in Navigation

Based on research from MIT, GPS technology can provide users with accurate, timely, and detailed information to improve safety. The technology uses a combination of Convolutional Neural Networks and Graph Neural Networks, which makes lives easier for users by automatically detecting the number of lanes and road types behind obstructions on the roads. AI is heavily used by Uber and many logistics companies to improve operational efficiency, analyze road traffic, and optimize routes.

5. Applications of Artificial Intelligence in Robotics

Robotics is another field where Artificial Intelligence applications are commonly used. Robots powered by AI use real-time updates to sense obstacles in its path and pre-plan its journey instantly.

It can be used for:

- Carrying goods in hospitals, factories, and warehouses

- Cleaning offices and large equipment

- Inventory management

6. Applications of Artificial Intelligence in Human Resource

Did you know that companies use intelligent software to ease the hiring process?

Artificial Intelligence helps with blind hiring. Using machine learning software, you can examine applications based on specific parameters. AI drive systems can scan job candidates' profiles, and resumes to provide recruiters an understanding of the talent pool they must choose from.

7. Applications of Artificial Intelligence in Healthcare

Artificial Intelligence finds diverse applications in the healthcare sector. [AI applications are used in healthcare](#) to build sophisticated machines that can detect diseases and identify cancer cells. Artificial Intelligence can help analyze chronic conditions with lab and other medical data to ensure early diagnosis. AI uses the combination of historical data and medical intelligence for the discovery of new drugs.

8 puzzle Problem

Given a 3×3 board with 8 tiles (every tile has one number from 1 to 8) and one empty space.

The objective is to place the numbers on tiles to match final configuration using the empty space. We can slide four adjacent (left, right, above and below) tiles into the empty space.

1	2	3
5	6	-
7	8	4

1	2	3
5	8	6
-	7	4

final state

طريق الحل هي تحريك المكان الفارغ(المربع الفارغ) الذي يمثل ب _ او 0 ..للانتقال **من الحالة الأساس الى الحالة الهدف**

How to solve this problem of 8 puzzle?

1	2	3
5	6	-
7	8	4

➡

1	2	3
5	8	6
-	7	4

initial state

1	2	3
5	-	6
7	8	4
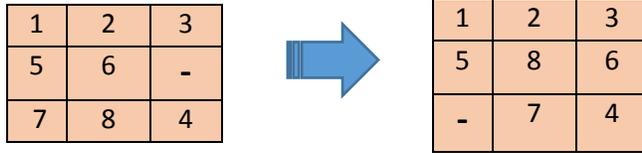
Initial state A={(1,2,3),(5,6, _), (7,8,4)}

First move A={(1,2,3),(5, _ ,**6**), (7,8,4)} h=1

1	2	3
5	8	6
7	-	4

Second move A={(1,2,3),(5, **8 ,6**), (7, _ ,4)} h=2

Third move A={(1,2,3),(5, **8 ,6**), (_ , **7** ,4)} h=3

1	2	3
5	8	6
-	**7**	4

<u>What are the main criteria to find the best solution ?</u>
   1- Time of solution وقت الحل
   2- Cost التكلفة
   3- Complicity of solution تعقيد خوارزمية الحل

successive moves can take us away from the goal rather than bringing closer. The search of state space tree follows the leftmost path from the root regardless of the initial state. An answer node may never be found in this approach.

The state-transition system

is divided in to <u>1- deterministic</u> and <u>2- non-deterministic.</u>
we can use these two types to solve problem
Examples
Towers of Hanoi puzzle

It consists of three places and number of the objective is to move an entire stack of disks from the source position to another position. Three simple rules are followed: Only one disk can be moved at a time. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack.

The objective of the game is to shift the entire stack of disks from one rod to another rod following these three rules :

1. Only one disk can be moved at a time.

2. Only the uppermost disk from one stack can be moved on to the top of another stack or an empty rod.

3. Larger disks cannot be placed on the top of smaller disks.

The minimal number of moves required to solve the Tower of Hanoi puzzle of n disks would be (2^n) – 1.

**The logic behind solving the Tower of Hanoi for three disks :**

Objective : To solve the Tower of Hanoi puzzle that contains three disks. The stack of disks has to be shifted from Rod 1 to Rod 3 by abiding to the set of rules that has been mentioned above.
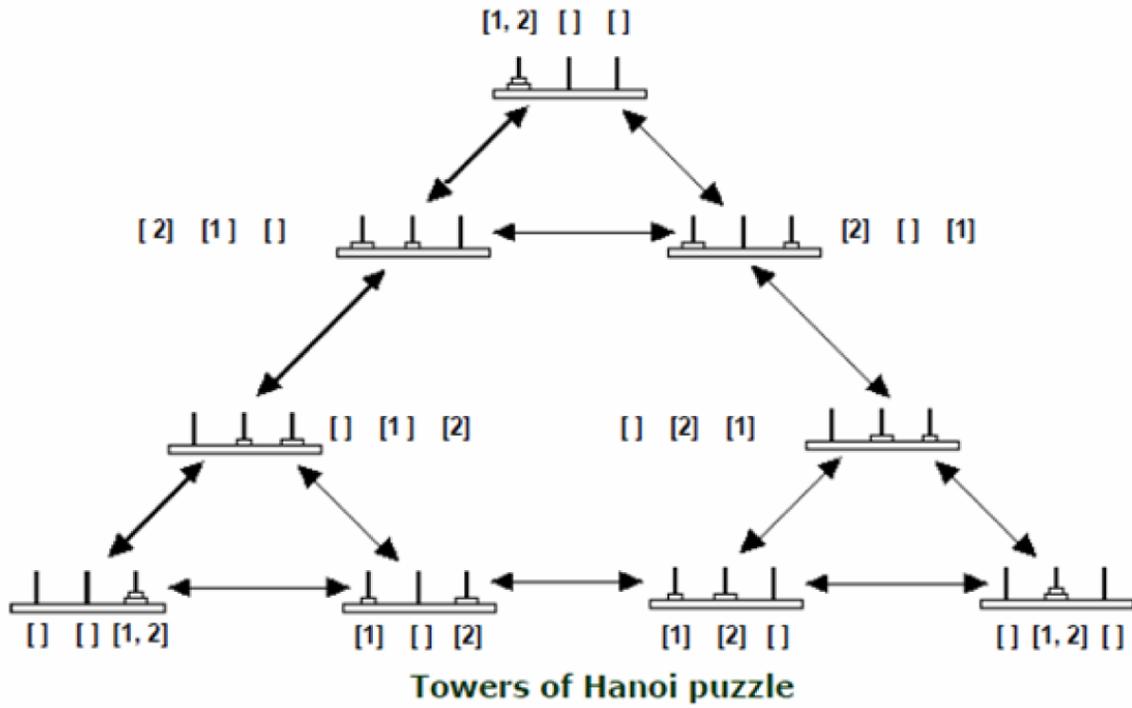
+ لا تضع القرص الأكبر فوق القرص الأصغر .
+الوتد الأوسط يستخدم ك مخزن متوسط للاقراص .
+حرك قرص واحد في المرة من وتد الى اخر.
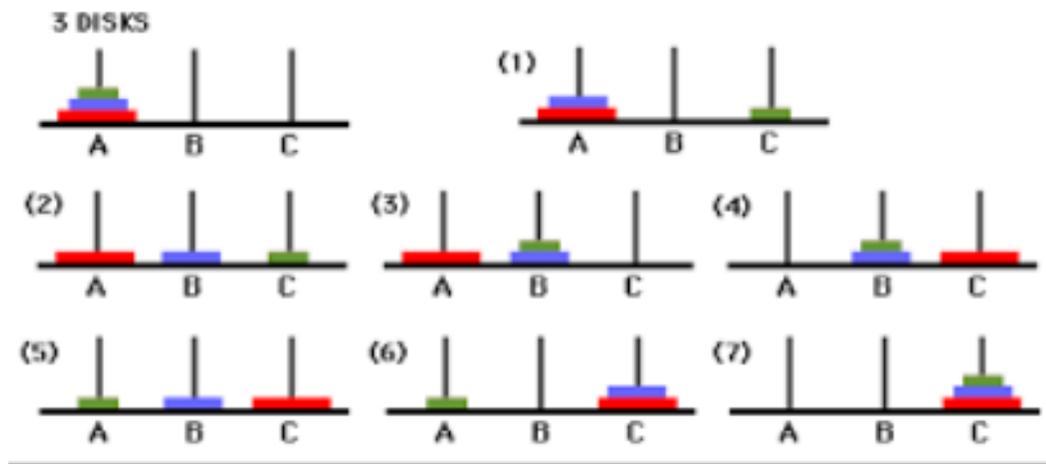
المطلوب : نفذ اللعبة لتحقق الهدف بأقل عدد ممكن من الخطوات.

Initial state

Goal state

Solution

Towers of Hanoi puzzle
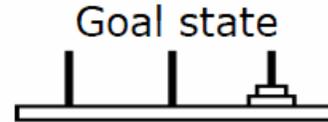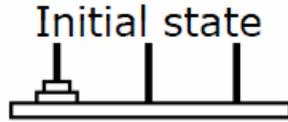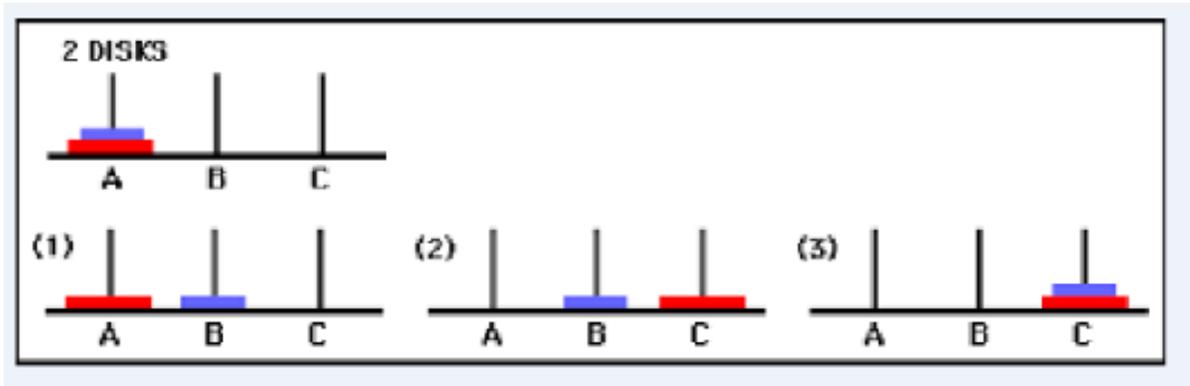
More: Three discs

Lecture 5: introduction to search

Problem-solving agents:

In Artificial Intelligence, Search techniques are universal problem-solving methods. **Rational agents** or **Problem-solving agents** in AI mostly used these search strategies or algorithms to solve a specific problem and provide the best result. Problem-solving agents are the goal-based agents and use atomic representation. In this topic, we will learn various problem-solving search algorithms.

- o **Search:** Searchingis a step by step procedure to solve a search-problem in a given search space. A search problem can have three main factors:
    - a. **Search Space:** Search space represents a set of possible solutions, which a system may have.
    - b. **Start State:** It is a state from where agent begins **the search**.
    - c. **Goal test:** It is a function which observe the current state and returns whether the goal state is achieved or not.
- o **Search tree:** A tree representation of search problem is called Search tree. The root of the search tree is the root node which is corresponding to the initial state.
- o **Actions:** It gives the description of all the available actions to the agent.
- o **Transition model:** A description of what each action do, can be represented as a transition model.
- o **Path Cost:** It is a function which assigns a numeric cost to each path.
- o **Solution:** It is an action sequence which leads from the start node to the goal node.
- o **Optimal Solution:** If a solution has the lowest cost among all solutions.

Properties of Search Algorithms:

Search in AI is the process of navigating from a starting state to a goal state by transitioning through intermediate states. Almost any AI problem can be defined in these terms. Transition — The act of moving between states. Starting State — Where to start searching from.
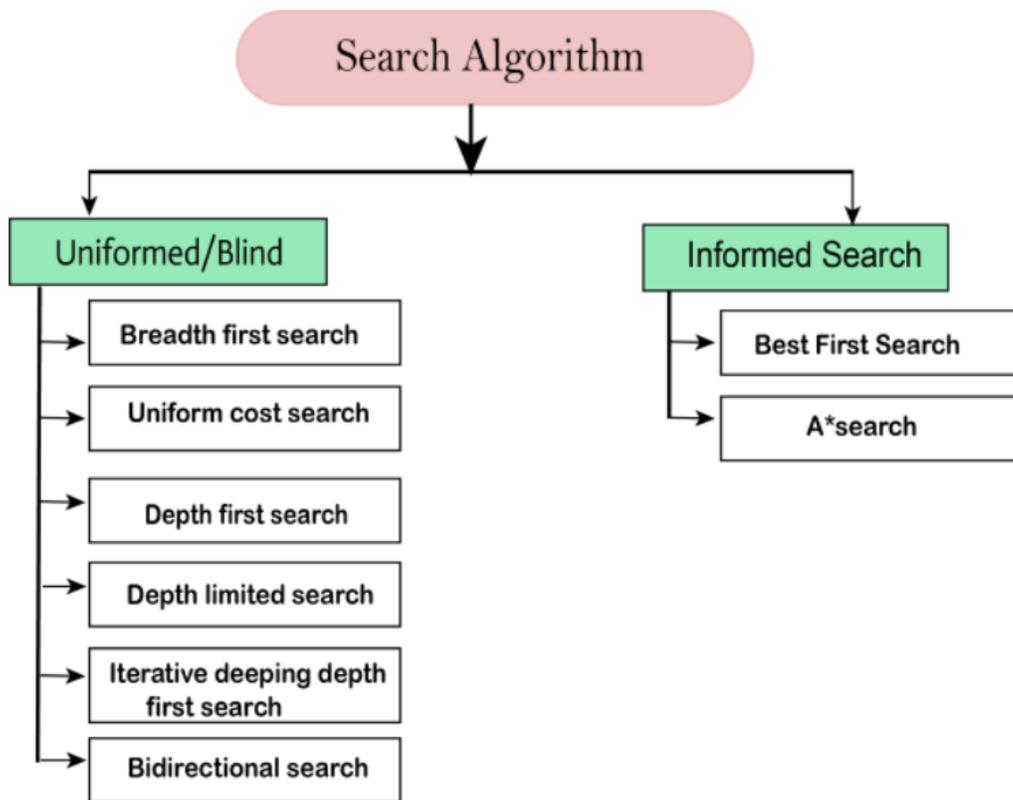
Search Tree :

A search tree is used to model the sequence of actions. It is constructed with initial state as the root. The actions taken make the branches and the nodes are results of those actions. A node has depth, path cost and associated state in the state space.
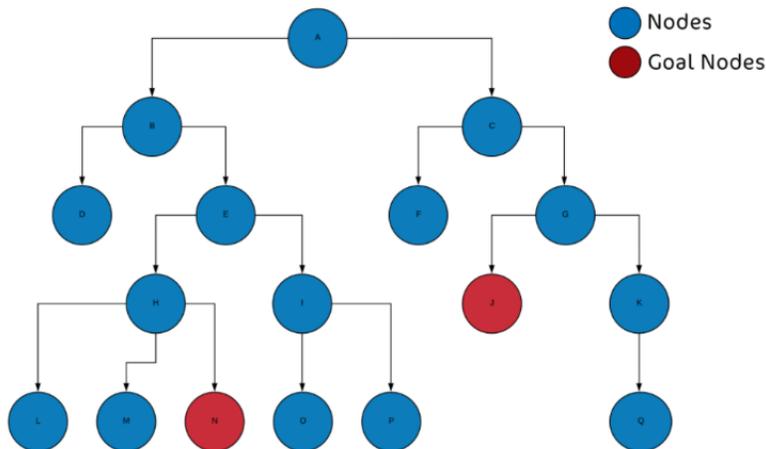
following are the four essential properties of search algorithms to compare the efficiency of these algorithms:

1. **Completeness:** A search algorithm is said to be complete if it guarantees to return a solution if at least any solution exists for any random input.
2. **Optimality:** If a solution found for an algorithm is guaranteed to be the best solution (lowest path cost) among all other solutions, then such a solution for is said to be an optimal solution.
3. **Time Complexity:** Time complexity is a measure of time for an algorithm to complete its task.
4. **Space Complexity:** It is the maximum storage space required at any point during the search, as the complexity of the problem.

Uninformed/Blind Search:

The uninformed search does not contain any domain knowledge such as closeness, the location of the goal. It operates in a brute-force way as it only includes information about how to traverse the tree and how to identify leaf and goal nodes. Uninformed search applies a way in which search tree is searched without any information about the search space like initial state operators and test for the goal, so it is also called blind search.It examines each node of the tree until it achieves the goal node.

It can be divided into five main types:

o   Breadth-first search

- o   Uniform cost search

- o   Depth-first search

- o   Iterative deepening depth-first search

- o   Bidirectional Search

Informed Search

Informed search algorithms use domain knowledge. In an informed search, problem information is available which can guide the search. Informed search strategies can find a solution more efficiently than an uninformed search strategy. Informed search is also called a Heuristic search.

A heuristic is a way which might not always be guaranteed for best solutions but guaranteed to find a good solution in reasonable time.

Informed search can solve much complex problem which could not be solved in another way.

An example of informed search algorithms is a traveling salesman problem.
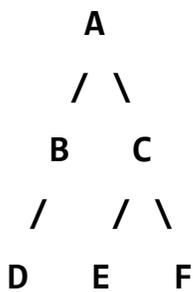
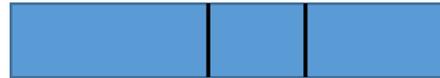1. Greedy Search
2. A* Search

1- Breadth First Search BFS

it is a vertex based technique for finding a shortest path in graph. It uses a Queue data structure which follows first in first out. In BFS, one vertex is selected at a time when it is visited and marked then its adjacent are visited and stored in the queue.

Example :

```
        A
       / \
      B   C
     /   / \
    D   E   F
```

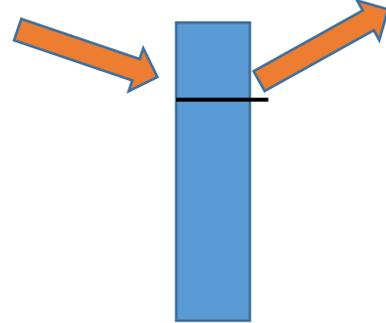**Output:**   A, B, C, D, E, F

Queue data structure

2. Depth First Search DFS

It is a edge based technique. It uses the Stack data structure, performs two stages, first visited vertices are pushed into stack and second if there is no vertices then visited vertices are popped.

```
EX1:    A
       / \
      B   C
     /   / \
    D   E   F
```


[Stack data structure](),

	in	out	DFS Stack
1	[A]	[ ]	[A]
2	[B]	[ ]	[A, B]
3	[D]	[ ]	[A, B, D]
4	[ ]	[D]	[A, B]
5	[ ]	[B]	[A]
6	[C]	[ ]	[A, C]
7	[E]	[ ]	[A, C, E]
8	[ ]	[E]	[A, C]
9	[F]	[ ]	[A, C, F]

Ex3: solve the following 8 puzzle problem then apply BFS and DFS on it. A:initial state and G: final or goal state.

A (circled):

_	1	2
3		5
6	7	8

B:

1	_	2
3	4	5
6	7	8

E:

3	1	2
_	4	5
6	7	8

C:

1	2	_
3	4	5
6	7	8

No:

_	1	2
3	4	5
6	7	8

D:

1	4	2
3	_	5
6	7	8

No:

_	1	2
3	4	5
6	7	8

F:

3	1	2
4	_	5
6	7	8

G:

3	1	2
6	4	5
_	7	8
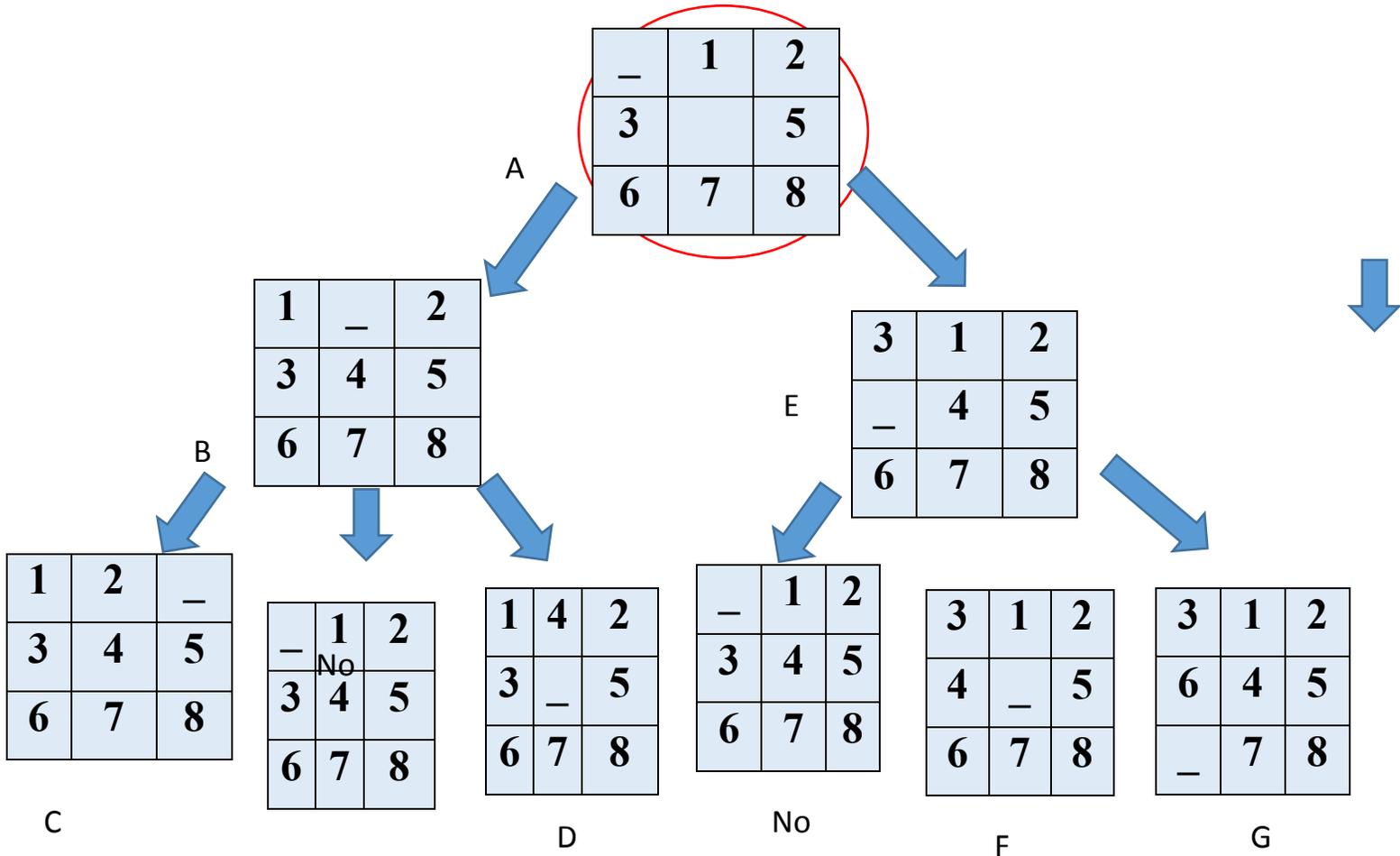
After find the tree of solution then give each state a symbol then we can apply the search algorithms.

```
        A
       / \
      B   C
     / \ / \
    C  D F  G
```
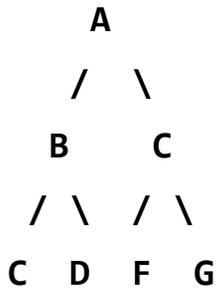
BFS: A B E C D F G

	in	out	DFS Stack
1	[A]	[ ]	[A]
2	[B]	[ ]	[A, B]
3	[C]	[ ]	[A, B, C]
4	[ ]	[C]	[A, B]
5	[D]	[ ]	[A, B, D]
6	[ ]	[D]	[A, B]
7	[ ]	[B]	[A]
8	[E]	[ ]	[A, E]
9	[F]	[ ]	[A, E, F]
10	[ ]	[F]	[A, E]
11	[G]	[ ]	[A, E, G]

https://www.youtube.com/watch?v=0uCr1g89J9c

3- Hill climbing algorithm

Hill climbing is a mathematical optimization algorithm, which means its purpose is to find the _best_ solution to a problem which has a (large) number of _possible_ solutions.

In the [Travelling salesman problem](#), we have a salesman who needs to visit a number of cities exactly once, after which he returns to the first city. The distances between each pair of cities are known, and we need to find the shortest route. As you can imagine, there is (often) a large number of possible solutions (routes) to a specific

Travelling salesman problem; the goal is to find the best (i.e. the shortest) solution.

طريقة بحث تعتمد على حساب التكلفة وافضل مثال لها هو رجل المبيعات الذي يسافر بين المدن, يجب
حساب المسار ذو التكلفة الأقل. cost

Features of Hill Climbing

- o **Generate and Test variant:** Hill Climbing is the variant of Generate and Test method. The Generate and Test method produce feedback which helps to decide which direction to move in the search space.

- o **Greedy approach:** Hill-climbing algorithm search moves in the direction which optimizes the cost.

- o **No backtracking:** It does not backtrack the search space, as it does not remember the previous states.

In numerical analysis, hill climbing is a mathematical optimization technique which belongs to the family of local search. It is an iterative algorithm that starts with an arbitrary solution to a problem, then attempts to find a better solution by making an incremental change to the solution.

Example : for the following tree find the cost of travelling from node A to nod J using Hill liming search algorithm?
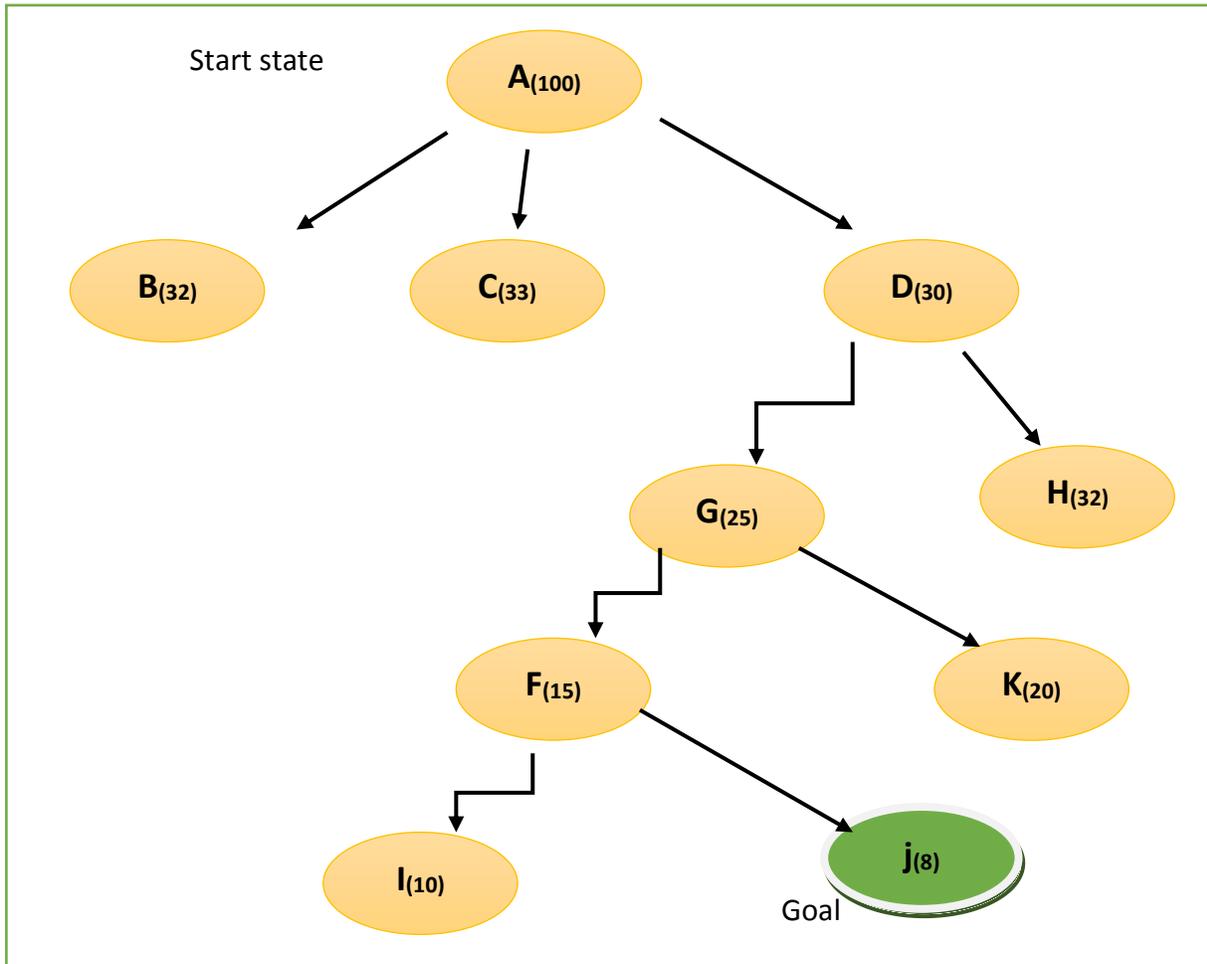
Solution: Hill liming search algorithm

open	close	ملاحظات
[A(100)]	[ ]	**تبدا من Start state**
[D(30), B(32), C(33)]	[A(100)]	نرتب تصاعدي حسب الكلفة وندخل node ذات اقل قيمة ونخرج من البقية
[G(25), H(32)]	[A(100), D(30)]	
[F(15), K(20)]	[A(100), D(30), G(25)]	
[j(8), I(10)]	[A(100), D(30) G(25), F(15)]	
Stop	[A(100), D(30) G(25), F(15), j(10)]	

Total Cost for the bath =100+30+25+15+10=180

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What is an Expert System?

An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert. It performs this by extracting knowledge from its knowledge base using the reasoning and inference rules according to the user queries.

The expert system is a part of AI, and the first ES was developed in the year 1970, which was the first successful approach of artificial intelligence. It solves the most complex issue as an expert by extracting the knowledge stored in its knowledge base. The system helps in decision making for compsex problems using **both facts and heuristics like a human expert**. It is called so because it contains the expert knowledge of a specific domain and can solve any complex problem of that particular domain. These systems are designed for a specific domain, such as **medicine, science,** etc.

The performance of an expert system is based on the expert's knowledge stored in its knowledge base. The more knowledge stored in the KB, the more that system improves its performance. One of the common examples of an ES is a suggestion of spelling errors while typing in the Google search box.

- » **Inheritance:** categories serve to organize and simplify the knowledge base through inheritance. If we say that all instances of the category Food are edible, and if we assert that Fruit is a subclass of Food and Apples is a subclass of Fruit , then we can infer that every apple is edible. We say that the individual apples inherit the property of edibility, in this case from their membership in the Food category.

- **Heuristics**

- **When there is no clear solution to the problem and there are no deterministic steps to find the solution.**

- **Uncompleted information or data**

- **The ability to learn**

- **Conflicting Data**
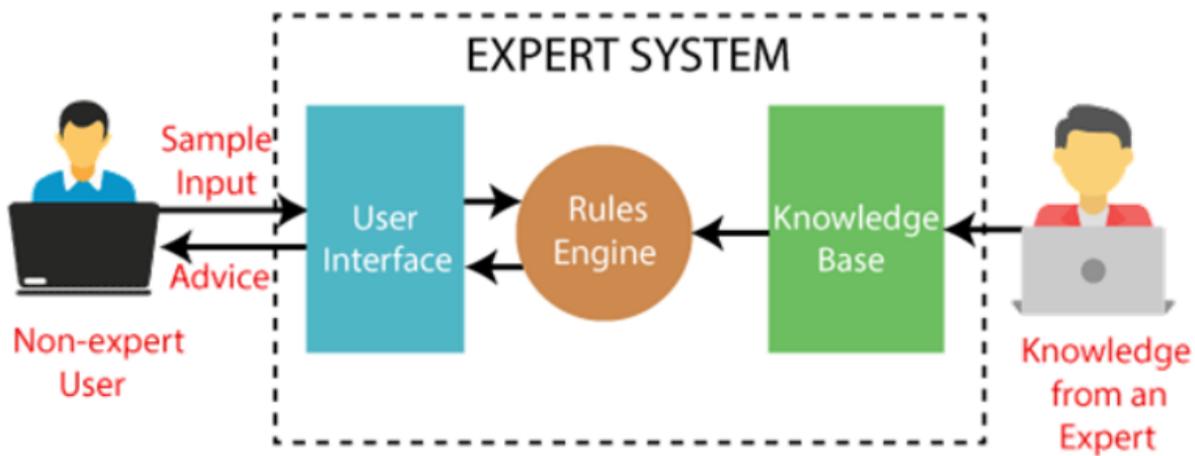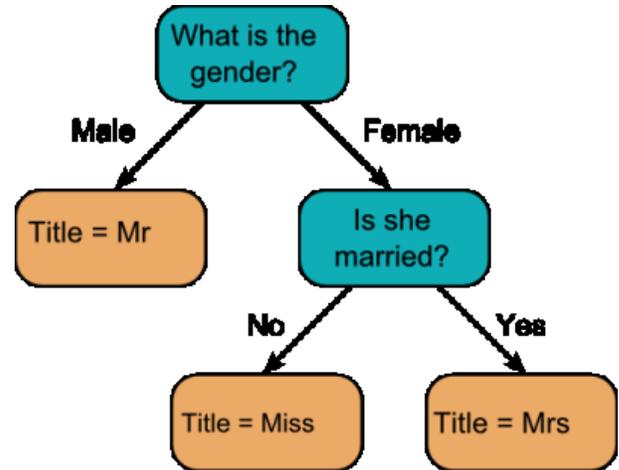
Lecture 9/ Expert Systems

Expert Systems : Tree of solution

What is Expert System?

- **Expert System** is an interactive and reliable computer-based decision-making system which uses both facts and heuristics to solve complex decision-making problems. It is considered at the highest level of human intelligence and expertise. The purpose of an expert system is to solve the most complex issues in a specific domain.
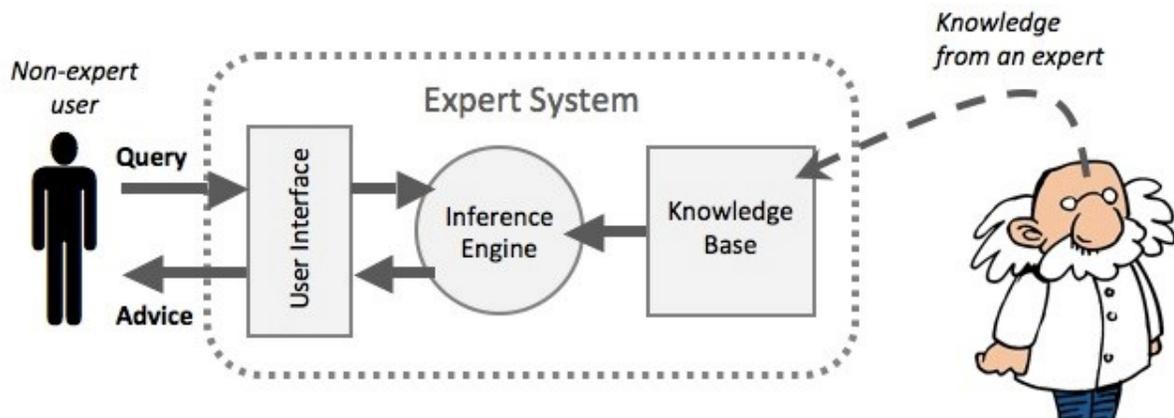
Examples of Expert Systems

- امثلة عن النظم الخبيرة
- **MYCIN:** It was based on backward chaining and could identify various bacteria that could cause acute infections. It could also recommend drugs based on the patient's weight. It is one of the best Expert System Example.

- **DENDRAL:** Expert system used for chemical analysis to predict molecular structure.
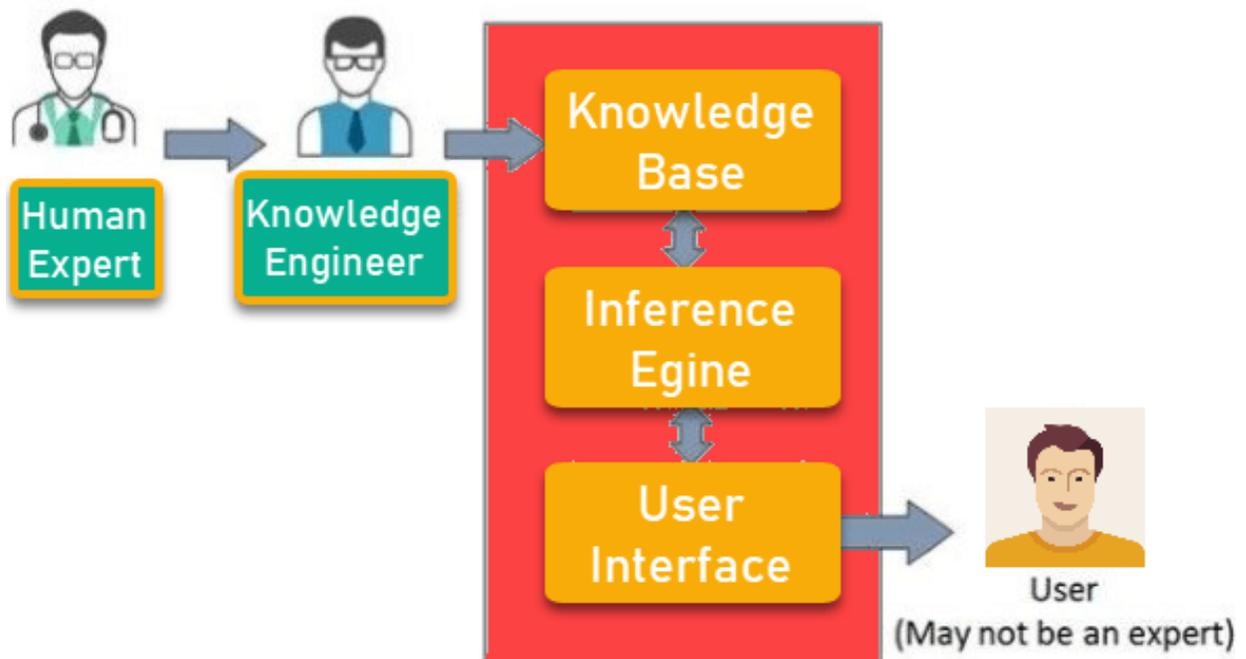
نظام خبير يستخدم للتحليل الكيميائي للتنبؤ بالتركيب الجزيئي.

- **PXDES:** An Example of Expert System used to predict the degree and type of lung cancer.

نظام خبير يستخدم للتنبؤ بدرجة ونوع سرطان الرئة

- **CaDet:** One of the best Expert System Example that can identify cancer at early stages

نظام خبير يستخدم لتحديد السرطان في مراحله المبكرة

Components of the Expert System

1. User Interface: it is the most important part of the Expert System Software. it's an interface that helps the user communicate with the expert system.

تعد واجهة المستخدم أهم جزء في برنامج Expert System Software. إنها واجهة تساعد المستخدم على التواصل مع النظام الخبير.

2. Inference Engine: is the brain of the expert system. It contains rules to solve a specific problem. It refers the knowledge from the Knowledge Base. It selects facts and rules to apply when trying to answer the user's query. This is helpful for conclusions.

هو عقل النظام الخبير. يحتوي على قواعد لحل مشكلة معينة. إنه يشير إلى المعرفة من قاعدة المعرفة. يحدد الحقائق والقواعد لتطبيقها عند محاولة الإجابة على استعلام المستخدم. هذا مفيد للاستنتاجات.

3. Knowledge Base

: It stores all the knowledge about the problem domain. It is like a large container of knowledge which is obtained from different experts of a specific field.

يخزن كل المعرفة حول مجال المشكلة. إنه مثل حاوية كبيرة من المعرفة يتم الحصول عليها من خبراء مختلفين في مجال معين.

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Knowledge gain

- **it means how to get required domain knowledge by the expert system. The process starts by extracting knowledge from a human expert, converting the acquired knowledge into rules and injecting the developed rules into the knowledge base.**

Why Expert System ?

- No emotion
- High Efficiency
- Expertise in a domain
- No Memory limitation
- Regular updates improve the performance
- High Security
- Considers all facts

Lecture 10/ Introduction to Genetic Algorithms

1- The Genetic Algorithm

- Provide efficient, effective techniques for optimization and machine learning applications
- Widely-used today in business, scientific and engineering circles.

Simple Genetic Algorithm

Population جيل العينات

Evaluate تقييم

Reproduction تكاثر

Recombination إعادة التركيب

Offspring النسل

Mutation الطفرة

Simple Genetic Algorithm

{ initialize population; انشاء الجيل للعينات

evaluate population; تقييم الجيل

while Termination Criteria Not Satisfied

معايير الإنهاء العينات غير الراضية}

select parents for reproduction;تكاثر

**perform recombination and mutation;**إعادة التركيب والطفرة

evaluate population; تقييم الجيل   }

2- Components of a GA

A problem to solve, and ...

- ✓ **Encoding technique** (*gene, chromosome*) **تقنية الترميز**

- ✓ **Initialization procedure** **إجراءات التوليد (creation الخلق)**

- ✓ **Evaluation function** (environment **بيئة) دوال التقييم**

- ✓ **Selection of parents** (reproduction**اعادة الانتاج) اختيار الوالدين**

- ✓ **Genetic operators** (mutation, recombination) **العمليات الجينية**

- ✓ **Parameter settings** (practice and art)**اعدادات المتغيرات**

The GA Cycle of Reproduction

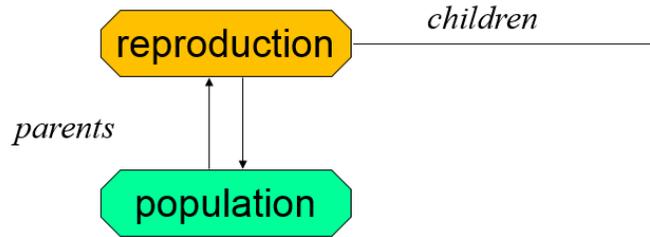
1

→ population
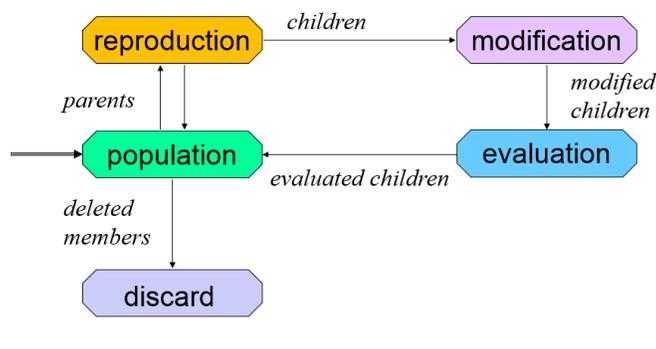
Chromosomes could be:

- ♦ Bit strings   (0101 ... 1100)
- ♦ Real numbers   (43.2 -33.1 ... 0.0 89.2)
- ♦ Permutations of element   (E11 E3 E7 ... E1 E15)
- ♦ Lists of rules   (R1 R2 R3 ... R22 R23)
- ♦ Program elements   (genetic programming)
- ♦ ... any data structure ...

Reproduction

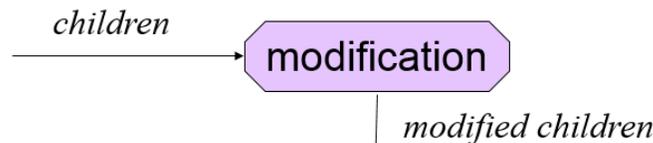reproduction → *children*

parents

population

Parents are selected at random with selection chances biased in relation to chromosome evaluations.

يتم اختيار الآباء بشكل عشوائي مع وجود فرص اختيار على أساس علاقات تخص تقييمات الكروموسوم.

Chromosome Modification

children → modification

modified children

- Modifications are randomly triggered
- Operator types are:
  - Mutation
  - Crossover (recombination)

- يتم تشغيل التعديلات عشوائياً
- أنواع المشغلات
- الطفرة
- التزاوج(إعادة التركيب)

Mutation: Local Modification

Before: (1 0 1 1 0 1 1 0)

After: (0 1 1 0 0 1 1 0)

Before: (1.38 -69.4 326.44 0.1)

After: (1.38 -67.5 326.44 0.1)

- Causes movement in the search space
  حركة في مجال البحث (local or global)
- Restore lost information to the population
  استعادة المعلومات المفقودة للسكان

Crossover: Recombination

```
            *
P1  (0 1 1 0 1 0 0 0)         (0 1 0 0 1 0 0 0)  C1
P2  (1 1 0 1 1 0 1 0)   →     (1 1 1 1 1 0 1 0)  C2
```
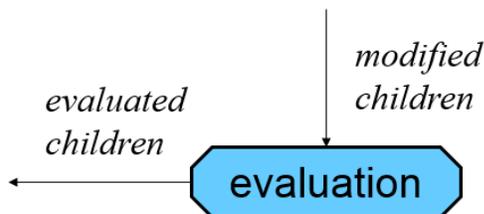
4

Crossover is a critical feature of genetic algorithms:

- ◆ It greatly accelerates search early in evolution of a population
- ◆ It leads to effective combination of schemata (subsolutions on different chromosomes)

Evaluation

evaluated children   *modified children*

← evaluation

5

- The evaluator decodes a chromosome and assigns it a fitness measure المقيم يفك شفرة الكروموسوم ويعين لها مقياس محدد
- The evaluator is the only link between a classical GA and the problem it is solving يعتبر المقيم هو الرابط الوحيد بين الخوارزمية و المشكلة المراد حلها

Deletion

```
┌─────────────────┐
│   population    │
└─────────────────┘
        │
discarded members │
        ↓
┌─────────────────┐
│    discard      │
└─────────────────┘
```
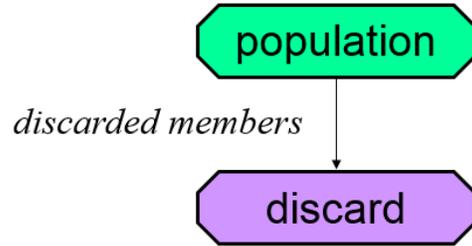
- *Generational* GA:entire populations replaced with each iterationفي كل تكرار يتم استبدال الجيل بلكامل
- *Steady-state* GA:القليل من الأعضاء يتم استبدالهم في الجيل
  a few members replaced each generation

Genetic Algorithms

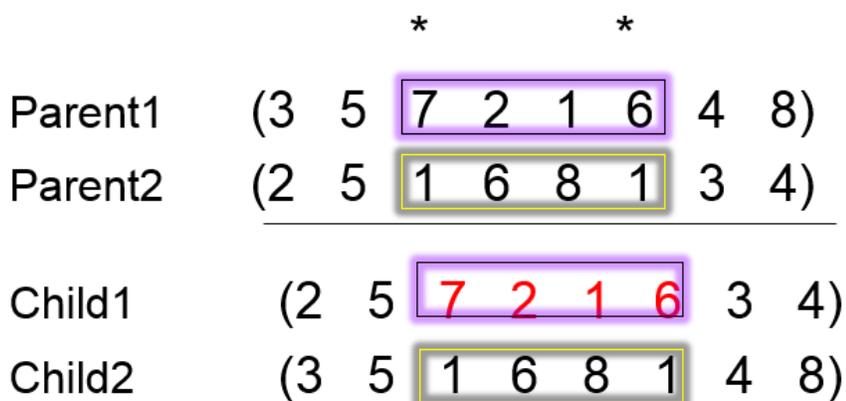|	
Representation التمثيل	Binary strings
Recombination التزاوج	N-point or uniform نقاط محددة او توزيع ثابت
Mutation الطفرة	Bitwise bit-flipping with fixed probability يتم في نقطة محددة التبادل وحسب احتمالية
Parent selection اختيار الولدين	Fitness-Proportionate لياقة متناسبة
Survivor selection اختيار الناجيين	All children replace parents استبدال كل الوالدين ب الجيل الجديد
Specialty تخصص	Emphasis on crossover التركيز على العبور

Genetic Algorithms

1. *Select parents for the mating pool* حدد الوالدين لحوض التزاوج
   (size of mating pool = population size)
2. *Shuffle the mating pool* خلط بركة التزاوج
3. *For each consecutive pair apply crossover with probability* p_c , *otherwise copy parents*

لكل زوج متتالي تطبيق تقاطع مع احتمالية محددة ، وإلا نسخ الوالدين

4. *For each offspring apply mutation (bit-flip with probability* p_m *independently for each bit)* لكل نسل تطبيق طفرة (قلب بت مع احتمال محدد بشكل مستقل لكل بت)

5. *Replace the whole population with the resulting offspring*

استبدل جميع السكان بالنسل الناتج

Crossover التزاوج

Crossover combines inversion and recombination:

```
                    *                 *
Parent1   (3   5   7   2   1   6    4   8)
Parent2   (2   5   1   6   8   1    3   4)
_____

Child1    (2   5   7   2   1   6    3   4)
Child2    (3   5   1   6   8   1    4   8)
```

Select parents & Mutation

$2^0 2^1 2^2 2^3 2^4$	$2^0 2^1 2^2 2^3 2^4$	$2^0 2^1 2^2 2^3 2^4$	$2^0 2^1 2^2 2^3 2^4$	
13 ⟷	24	8 ⟷	19	الوالدين
01101	11000	01000	10011	تزاوج
01100	11001	01011	10000	جيل جديد
		Mutation		
01110	10001	01010	00000	الطفرة

Survivor selection

$2^0 2^1 2^2 2^3 2^4$				
01110	10001	01010	00000
8+4+2=14	16+1=17	8+2=10	0

Survivor selection

10001	01010	جيل جديد
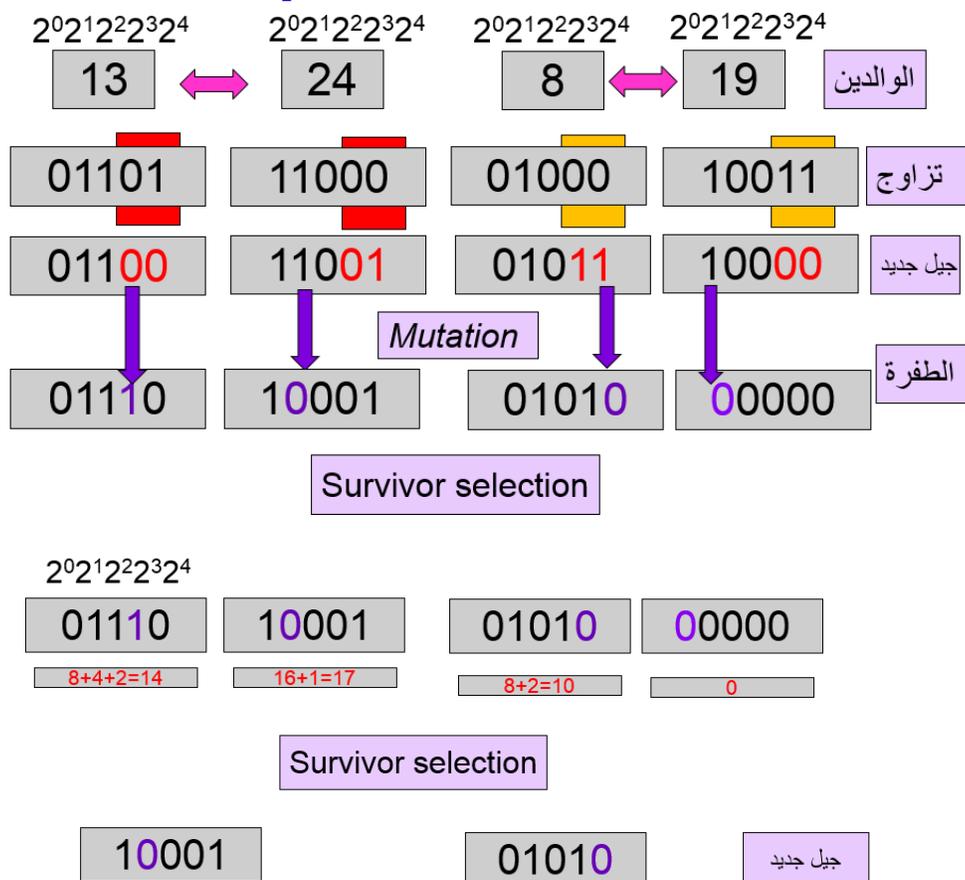
Probability الاحتمالات

هناك ثلاث احتمالات للجيل الناتج

1. Select new population from old offspring with new population.

اختر السكان الجدد من النسل القديم مع السكان الجدد.

1. Chose only from Survivor. الاختيار فقط من الناجيين

2. Mix from all populations. مزج بين جميع الاجيال

➢ **Evaluate population**

When we will stop the GA?

GA will stop when we get the result that satisfied the criteria

Some GA Application Types

Domain	Application Types
Control	gas pipeline, pole balancing, missile evasion, pursuit
Design	semiconductor layout, aircraft design, keyboard configuration, communication networks
Scheduling	manufacturing, facility scheduling, resource allocation
Robotics	trajectory planning
Machine Learning	designing neural networks, improving classification algorithms, classifier systems
Signal Processing	filter design
Game Playing	poker, checkers, prisoner's dilemma
Combinatorial Optimization	set covering, travelling salesman, routing, bin packing, graph colouring and partitioning

Lecture 12/ Artificial Neural Network ANN

**Artificial Neural Network ANN**

- Information processing paradigm inspired by biological nervous systems

    o ANN is composed of a system of neurons connected by synapses

- *Neuron Model*

- **Neuron collects signals from dendrites**

- **Sends out the electrical activity through an axon, which splits into thousands of branches.**
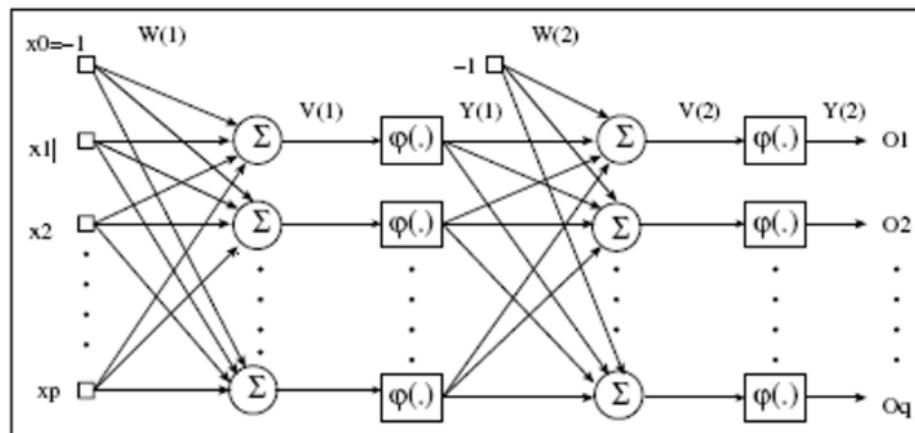
Neuron Model
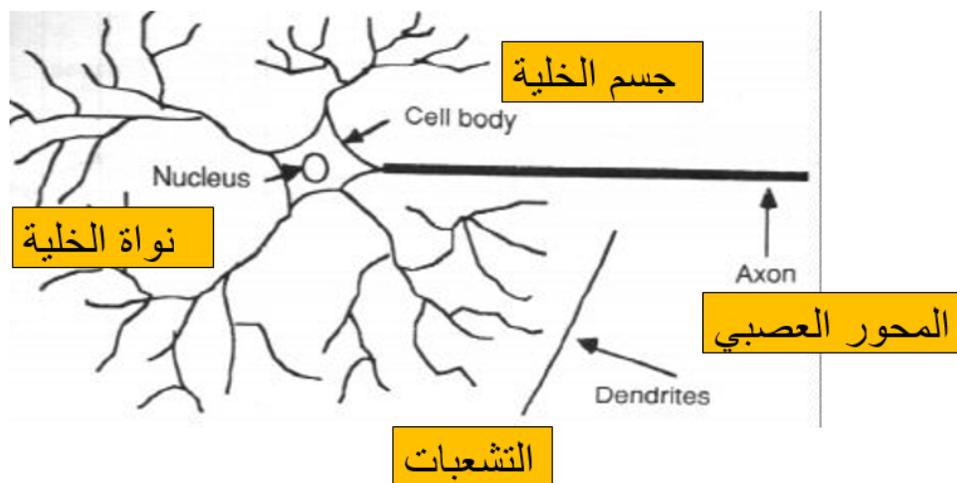
- **At end of each brand, a synapse converts activity into either exciting or inhibiting activity of a dendrite at another neuron..**
- **Neuron fires when exciting activity surpasses inhibitory activity**
- **Learning changes the effectiveness of the synapses**

- *Abstract neuron model:*

جسم الخلية

Cell body

التشعبات

Dendrites

Threshold

Axon

المحور العصبي

Summation

المحصل
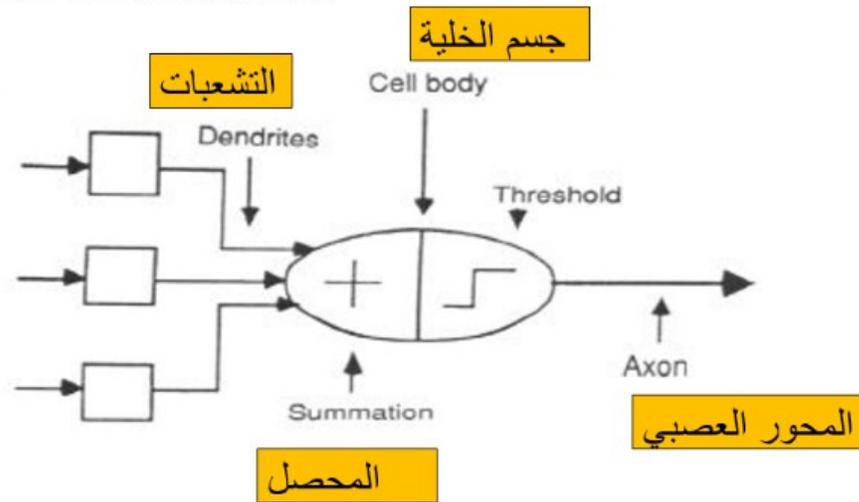
ANN Forward Propagation
الانتشار الى الامام

Neuron Model

- Bias Nodes
  - ◆ Add one node to each layer that has constant output إضافة عقدة واحدة ذات مخرج ثابت
- Forward propagation التقدم الى الامام
  - ◆ Calculate from input layer to output layer كيف تحسب من مستوى الادخال الى مستوى الاخراج
  - ◆ For each neuron: لكل خلية عصبية
    - » Calculate weighted average of input احسب معدل وزن المخرجات
   - » Calculate activation function احسب دالة التفعيل

- ➢ Firing Rules: قوانين الاطلاق
  - ➢ Threshold rules: قواعد العتبة
    - ➢ Calculate weighted average of input احسب معدل وزن المدخلات
    - ➢ Fire if larger than threshold اطلق اذا كان اكثر من العتبة
  - ➢ Perceptron rule:
    - ➢ Calculate weighted average of input
    - ➢ Output activation level is

$$\phi(v) = \begin{cases} 1 & v \geq \frac{1}{2} \\ v & 0 \leq v \leq \frac{1}{2} \\ 0 & v < 0 \end{cases}$$

8

ANN Forward Propagation
الانتشار الى الامام

- Example: ADALINE Neural Network
  - Calculates **and** of inputs

$w_{0,3}=.6$

$w_{1,3}=.6$

$w_{2,3}=-.9$

Bias Node

threshold function is step function
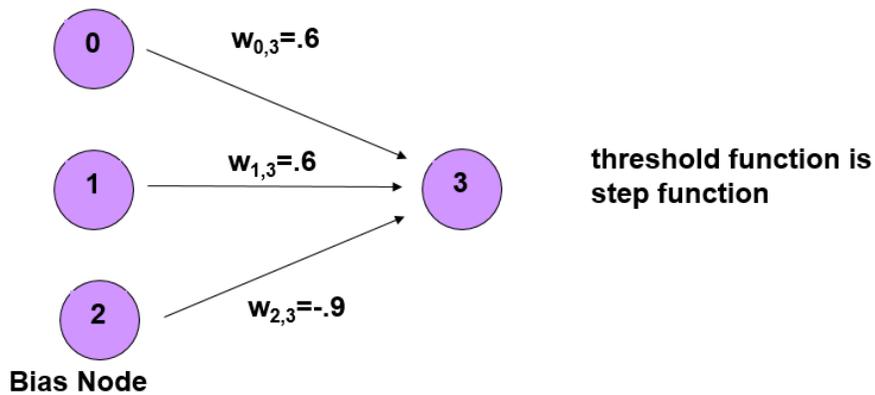
Threshold=positive value

Input 0	input1	input2	ouput3
1	1	1	Yes
1	1	0	Yes
1	0	1	No
0	0	0	No or yes
0	1	1	No
0	1	0	Yes
1	0	1	No
1	0	0	Yes

ANN Training

■ **Weights are determined by training**

☐ **Back-propagation:**

■ **On given input, compare actual output to desired output.**

■ **Adjust weights to output nodes..**

■ **Work backwards through the various layers**

☐ **Start out with initial random weights**

■ **Best to keep weights close to zero (10>>) دائما من الأفضل حفظ الاوزان قريبة من الصفر**

ANN Applications

- **Pattern recognition تمييز الاشكال**
- **Network attacks تحديد هجوم على الشبكة**
- **Breast cancer سرطان الصدر**
- **handwriting recognition تمييز الكتابة**
- **Pattern completion تكملة الكتابة**

lecture 13   Fuzzy Logic

Fuzzy Logic is a method of reasoning that resembles human reasoning.

The approach of FL imitates the way of decision making in humans that involves all intermediate possibilities between digital values YES and NO.

Fuzzy Logic Idea

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based.

The idea of fuzzy logic was first advanced by Lotfi Zadeh of the University of California at Berkeley in the 1960s. Zadeh was working on the problem of computer understanding of natural language. Natural language -- like most other activities in life and indeed the universe -- is not easily translated into the absolute terms of 0 and 1. Whether everything is ultimately describable in binary terms is a philosophical question worth pursuing, but in practice, much data we might want to feed a computer is in some state in between and

so, frequently, are the results of computing. It may help to see fuzzy logic as the way reasoning really works and binary, or Boolean, logic is simply a special case of it.

Fuzzy logic applications

Various types of AI systems and technologies use fuzzy logic. This includes vehicle intelligence, consumer electronics, medicine, software, chemicals and aerospace.

- In automobiles, fuzzy logic is used for gear selection and is based on factors such as engine load, road conditions and style of driving.

- In dishwashers, fuzzy logic is used to determine the washing strategy and power needed, which is based on factors such as the number of dishes and the level of food residue on the dishes.

- In copy machines, fuzzy logic is used to adjust drum voltage based on factors such as humidity, picture density and temperature.

- In aerospace, fuzzy logic is used to manage altitude control for satellites and spacecrafts based on environmental factors.

- In medicine, fuzzy logic is used for computer-aided diagnoses, based on factors such as symptoms and medical history.

- In chemical distillation, fuzzy logic is used to control pH and temperature variables.

- In natural language processing, fuzzy logic is used to determine semantic relations between concepts represented by words and other linguistic variables.

- In environmental control systems, such as air conditioners and heaters, fuzzy logic determines output based on factors such as current temperature and target temperature.

- In a business rules engine, fuzzy logic may be used to streamline decision-making according to predetermined criteria.

- **A robot is a programmable mechanical device that can perform tasks and interact with its environment, without the aid of human interaction.**

- Robotics is a separate entity in Artificial Intelligence that helps study the creation of intelligent robots or machines. Robotics combines electrical engineering, mechanical engineering and computer science & engineering as they have mechanical construction, electrical component and programmed with programming language. Although, Robotics and Artificial Intelligence both have different objectives and applications, but most people treat robotics as a subset of Artificial Intelligence (AI). Robot machines look very similar to humans, and also, they can perform like humans, if enabled with AI.

-

ROBOT components

- **The components of a robot are:**

- **the body/frame.**

- **control system.**

- **manipulators,**

- **drivetrain.**
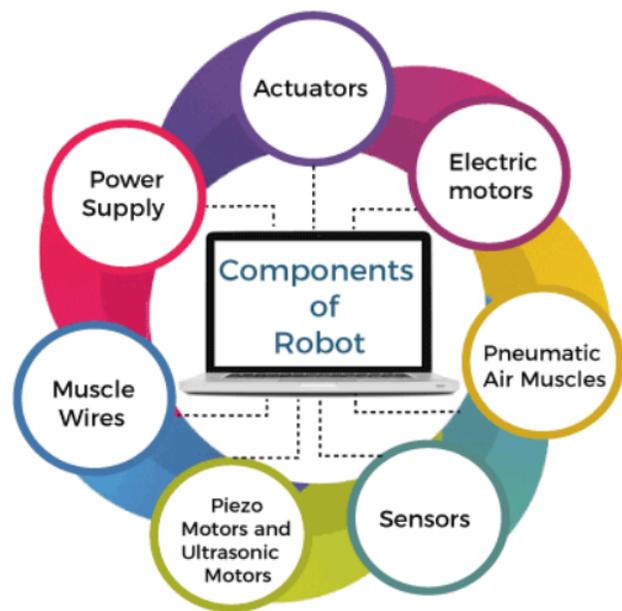
Applications of Robotics

Robotics have different application areas. Some of the important applications domains of robotics are as follows:

- **Robotics in defence sectors:** The defence sector is undoubtedly the one of the main parts of any country. Each country wants their defence system to be strong. Robots help to approach inaccessible and dangerous zone during war. DRDO has developed a robot named **Daksh** to destroy life-threatening objects safely. They help soldiers to remain safe and deployed by the military in combat scenarios. Besides combat support, robots are also deployed in ***anti-submarine operations, fire support, battle damage management, strike missions, and laying machines.***

- **Robotics in Medical sectors:** Robots also help in various medical fields such as laparoscopy, neurosurgery, orthopaedic surgery, disinfecting rooms, dispensing medication, and various other medical domains.

- **Robotics in Industrial Sector:** Robots are used in various industrial manufacturing industries such as cutting, welding, assembly, disassembly, pick and place for printed circuit boards, packaging & labelling, palletizing, product inspection & testing, colour coating, drilling, polishing and handling the materials.

  Moreover, Robotics technology increases productivity and profitability and reduces human efforts, resulting from lower physical strain and injury. The industrial robot has some important advantages, which are as follows:

  - Accuracy
  - Flexibility
  - Reduced labour charge
  - Low noise operation
  - Fewer production damages
  - Increased productivity rate.

- **Robotics in Entertainment:** Over the last decade, use of robots is continuously getting increased in entertainment areas. Robots are being employed in entertainment sector, such as movies, animation, games and cartoons. Robots are very helpful where repetitive actions are required. A camera-wielding robot helps
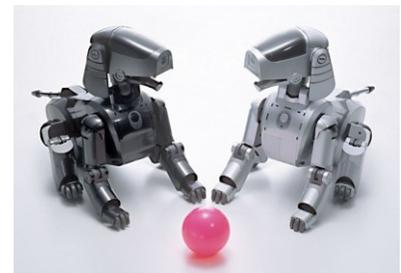
shoot a movie scene as many times as needed without getting tired and frustrated. A big-name **Disney** has launched hundreds of robots for the film industry.

o **Robots in the mining industry:** Robotics is very helpful for various mining applications such as robotic dozing, excavation and haulage, robotic mapping & surveying, robotic drilling and explosive handling, etc. A mining robot can solely navigate flooded passages and use cameras and other sensors to detect valuable minerals. Further, robots also help in excavation to detect gases and other materials and keep humans safe from harm and injuries. The robot rock climbers are used for space exploration, and underwater drones are used for ocean exploration.

Types of Robots

Mechanical bots come in all shapes and sizes to efficiently carry out the task for which they are designed. All robots vary in design, functionality and degree of autonomy. From the 0.2 millimeter-long "RoboBee" to the 200 meter-long robotic shipping vessel "Vindskip," robots are emerging to carry out tasks that humans simply can't. Generally, **there are five types of robots:**

1) Pre-Programmed Robots

It operates in a controlled environment where they do simple, tasks. For example a mechanical arm on an automotive (car) assembly line. The arm serves one function — to weld a door on, to insert a certain part into the engine, etc. — and its job is to perform that task longer, faster, and more efficiently than a human.

2) Humanoid Robots

They are robots usually perform human-like activities (like running, jumping and carrying objects), and are sometimes designed to look like us, even having human faces and expressions.

3) Autonomous Robots

it works independently of human operators. These robots are usually designed to carry out tasks in open environments that do not require human supervision. They are employ decision-making structures (usually a computer) to take the optimal next step based on their data and mission.

EXAMPLES OF AUTONOMOUS ROBOTS

- Cleaning Bots (for example, Roomba)
- Lawn Trimming Bots
- Hospitality Bots
- Autonomous Drones
- Medical Assistant Bots

4) Teleoperated Robots

use a wireless network to enable human control from a safe distance. These robots usually work in extreme geographical conditions, weather, circumstances, etc. Examples of it are used to fix underwater pipe leaks or drones used to detect landmines on a battlefield.

5) Augmenting Robots

Augmenting robots either enhance current human capabilities or replace the capabilities a human may have lost.

https://builtin.com/robotics/vr-robots.