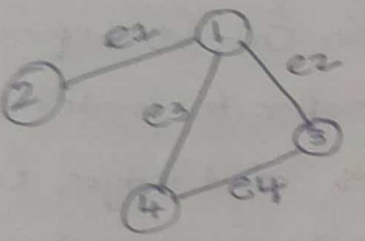
Assignment on Module-I

① How Incidence matrix is different from Adjacency matrix in graph theory?

Ans → These are the techniques to express the graphs Computationally. These are a Couple ways one can turn graph into a format that a Computer Can digest; all of them are different types of matrices. Incidence matrix, Adjacency matrix are one of them

Incidency matrix: (I)

→ The incidency matrix, Commonly denoted with a Capital (I) in research papers, Made up of 1's, 0's, -1's, the incidence matrix Can be made by following a simple pattern



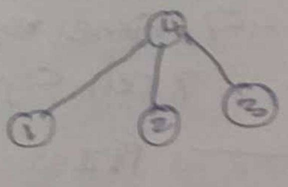
	e1	e2	e3	e4
1	1	1	1	0
2	1	0	0	0
3	0	1	0	1
4	0	0	1	1

$= \begin{bmatrix} 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix}$

Adjacency matrix: (A)

→ Adjacency matrix of a graph is be made of 1s and 0s unless it is otherwise weighted or labelled.

$$a_{ij} = \begin{cases} 1, & \text{if } (v_i, v_j) \in E \\ 0, & \text{otherwise} \end{cases}$$



	1	2	3	4
1	0	0	0	1
2	0	0	0	1
3	0	0	0	1
4	1	1	1	0

$= \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$

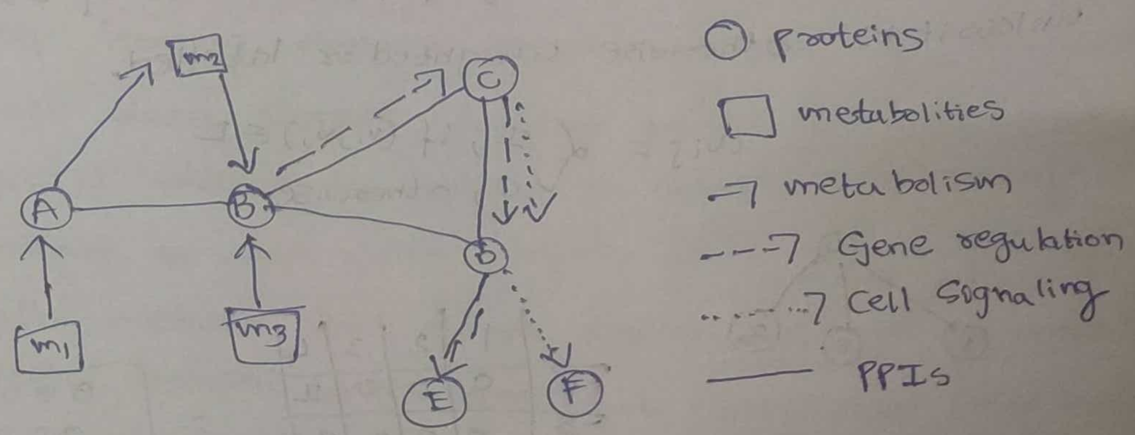
→ An adjacency matrix can be weighted, which basically means each edge has an associated value attached to it, So instead of 1's, the value is put in the respective matrix coordinate.

→ Difference between Adjaceny and Incidence matrix.

→ An incidence matrix is a matrix that shows the relationship between two classes of objects. through the presence of links with the nodes but in Adjacency matrix we represent the link between the nodes through '1' and '0' where if link is present then the value is '1' otherwise '0'.

② Critically analyze the various biological networks with real life examples.

Ans Different types of information can be represented in the shape of networks. in order to model the cell. The meaning of the nodes and edges used in a network representation depends on the type of data used to build the network and this should be taken into account when analysing it.



→ Different types of data will also produce different general network Characteristics in terms of Connectivity, Complexity and structure, where edges and nodes potentially Convey multiple layers of information.

Some of the most Common types of biological networks are:

① protein - protein ~~based~~ interaction networks (PPI)

② Metabolic networks

③ Genetic interaction networks

④ Gene / transcriptional regulatory networks

⑤ Cell signalling networks.

③ Enlist the key Characteristics of biochemical networks, neural networks and ecological networks

Ans Ecological networks are representations of the interactions that occur between Species within a Community. Ecological networks are networks of ecological interactions between species. Species in an ecosystem Can interact in different ways: they Can eat one another, they can parasitize one another, or they Can have any of a variety of mutually advantageous interactions, Such as pollination or seed dispersal.

Biochemical networks represent the molecular-level patterns of interaction and mechanisms of Control in the biological Cell. The principal types of these networks are metabolic networks, protein-protein networks and genetic regulatory networks.

→ Metabolic networks Metabolism is the chemical process by which Cells break down food and nutrients into usable building blocks and then reassemble those building block to form the biologecal molecules the cell needs to Complete its other tasks. Typically this breakdown and reassembly involves chains or pathways, sets of successive chemical reactions that Convert initial inputs into useful end products by a Series of Steps.

→ Neural Networks. one of the main functions of the brain is to process information and the primary information processing element is the neuron, a specialized brain Cell that Combines several inputs to generate a single Output.

Current Science Cannot tell us exactly how the brain performs the more Sophisticated Cognitive tasks that allow animals to Survive, but it is known that the brain Constantly changes the pattern of wiring between neurons in response to inputs and experience, and it is presumed that this pattern - the neural network - holds much of the secret.

At the Simplest level, a neural network Can be represented as a set of vertices, the neurons, Connected by two types of directed edges, one for excitatory inputs and one for inhibiting inputs. In practise neurons are not all the Same. This variation Can be encoded in our network representation by different types of vertices.

(7) Discuss the Concept of Random walk, also illustrate the difference b/w one-dimensional and two-dimensional random walk.

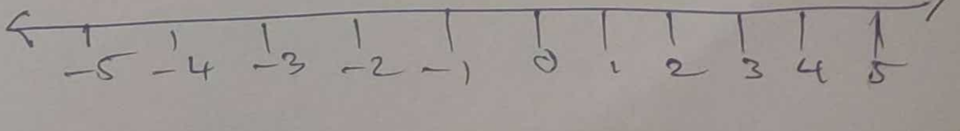
Ans A Random walk Can be defined as a Series of discrete steps an object takes in Some direction. Moreover, we determine the direction and movement of the object in each step probabilistically, In mathematics and probability theory, a random work is a random process.

-> In a random walk, the future position is entirely independent on the Current position Of an object. Additionally its an example of the Markov process. Starting from a position, the Object Can go in any direction. Each step taken by the object in any direction has a probability associated with it. Hence, the final position is completely independent of the point of origin.

-> A simple example of a Random walk is a drunkard's walk, A drunk man has no preferential direction. Therefore, he's equally likely to move in all directions. In the random work Concept, the utmost Significant problem is to finding a probability distribution function that Can estimate the probability of the Current position of an object after taking a random walk for a fixed amount of time.

One Dimensional Random walk

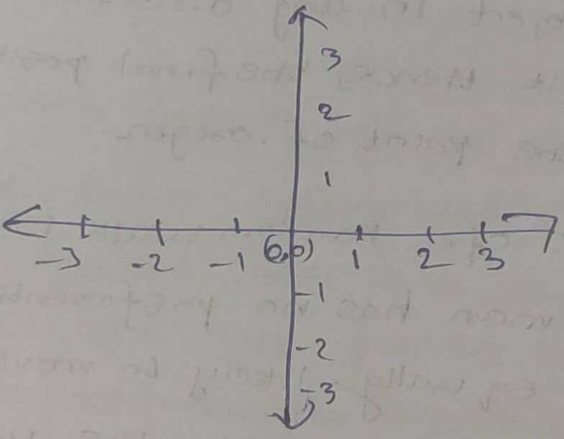
-> The Simplest and basic random walk is 1D wak. lets look at a random walk on integers.



-7 So here an object is Standing at point 'O'. It can move in two directions: forwards and backward. Now we will decide the direction of each step of the object by flipping a Coin. In the Case of head, the object will move forward. If its tail the object will move backward. Here we will flip a coin, move the object one step according to the rule and flip the Coin again.

Two dimensional Random walk

-7 A Random walk Can happen in any dimension. We will discuss the random walk in a two dimensional integer lattice here. let's look at a 2-D integer lattice



-7 In two dimensional random walk, an object Can move in four directions: forward, backwood, left, right. Therefore in this environment in order to move the Object we need to flip a Coin twice at each step. We Can decide whether to move the object forward or backward in first flip, and left or right in Second flip.

(5) Enlist the various applications of Random walk in Computer Science

Ans

-> In biological genetic drift, random walks Can give us a general idea of the statistical processes invdved.

-> In physics we can use them to describe an ideal chain in polymer physics.

-> we can describe fluctuations in the share market with the random walk Concept.

-> Google search engine algorithms use Random walk.

-> It is used in epidemic diffusion of the information, and it is used to generate random samples from a large set.

-> Random walk is used in Computation of aggregate functions on Complex sets.

(6) Discuss the key features of the Tensorflow, also describe the Concept of data flow graph.

Ans Tensorflow is a software library or framework, designed by the google team to implement machine learning and deeplearning Concepts in the easiest manner. It Combines the Computational algebra of optimization techniques for easy Calculation of many mathematical expressions.

Key features of Tensorflow:

-> It includes a feature of that defines, optimizes and Calculates mathematical expressions easily with the help of multi dimensional arrays called tensors.

→It includes a programming ~~setup~~ Support of deep neural networks and machine learning techiques

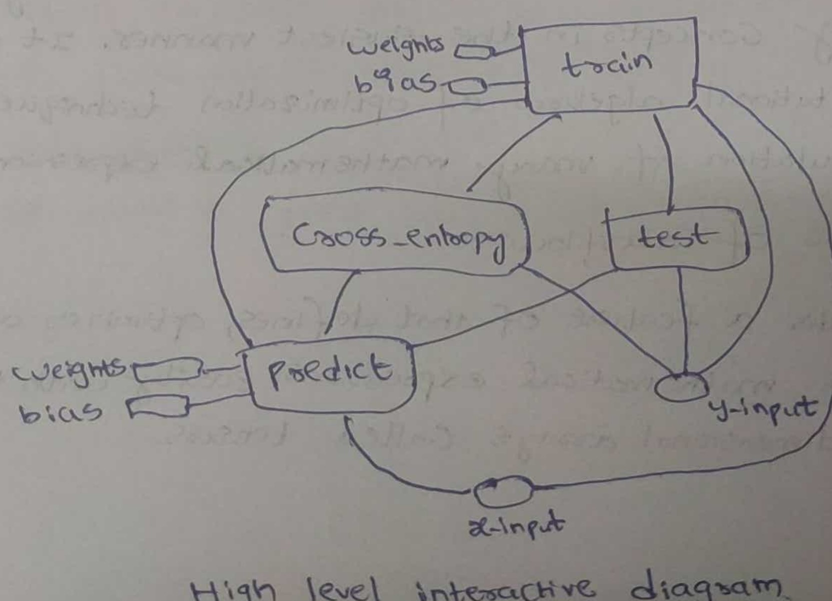
→It includes a high scalable features of Computation with various datasets

→ Tensorflow uses GPU Computing, automating management. It also includes a unique feature of optimization of same memory and the data used.

Data flow Graph:

→Deeplearning models have a very Complex network structure. Creating, understanding and debugging such networks is a very Complicated task. To make this process easier, developers often draw diagram first to help them understand and share the high-level structured modules. Since diagrams are an integral part of the process, developers often wish for a tool that could help them automatically generate these diagrams.

→There is a tool called Tensorflow Graph visualizer as a part of tensorflow library, the main function of this is to Convert low-level data flow diagram into a high level interactive diagram.



High level interactive diagram

→ Tensorflow includes a visualization tool which is Called the TensorBoard. It is used for analyzing Data Flow graph and also used to understand machine-learning models. The important feature of TensorBoard includes a view of different types of statistics about the parameters and details of any graph in vertical alignment.

→ Deep neural network includes up to 36000 nodes. Tensorboard helps in Collapsing these nodes in high-level blocks and highlighting the identical structures. This allows better analysis of graph focusing on the primary sections of the Computation graph. The TensorBoard visualization is Said to be very interactive where a user Can pan, zoom and expand the nodes to display the details.

7) How Tensorflow can be utilised for Machine learning applications?

Ans →Tensorflow is more than just a machine intelligence framework. It is packed with features and tools that make developing and debugging machine learning systems easier than ever.

→ In Tensorflow, Computation is described using data flow graphs. Each node of the graph represents an instance of a mathematical operation (like addition, division or multiplication) and each edge is a multi dimensional dataset on which the operations are performed

Constants

```
z= tf.constant(5.2, name="x", dtye=tf.float32)
```

Variables →These can be used in graph to maintain state across session

```
K= tf.Variable(tf.zeroes([1]), name="K")
```

Session :

Inorder to actually evaluate the nodes in a Computational graph, we must run the Computational graph within a Session. By using Session we can Control the Tensorflow runtime. Session class accepts a graph parameter which is used in that Session to be executed.

```
import tensorflow as tf
import numpy as np

m1= tf.convert_to_tensor(np.array(np.random.rand(3,3),
                                   dtype='float32')
                          , dtype=tf.float32)

m2= tf.constant(np.array([(2,2,2), (2,2,2), (2,2,2)], dtype='int32'))

matrix_product= tf.matmul(m1,m2)
matrix_sum = tf.add (m1, m2)
matrix_inv = tf. matrix_inverse(m2)
m_det = tf.matrix_determinant(m2)
with tf.Session() as session:

        result1= session.run(matrix_product)
        result2= session.run(matrix_sum)
        result3= session.run(matrix_inv)
        result4= session.run(m_det)

print(result1, result2, result3, result4)
```

⑧ Discuss the shape, Rank and Axis in the Context of Tensor

Ans

Tensor Rank

we know a tensor is a n-dimensional Array, So Rank is defined as no. of dimensions of that tensor.

A tensor with rank 1 is a 1-dimensional array.

```
print('Matrix Rank:', session.run(tf.rank(matrix)))
```

Tensor Shape

Tensor shape represents the size of the each dimension like if we Consider a shape of 144px image then it will be $(\underbrace{144,144}_{\text{shape of each dimension.}},\underset{\downarrow\ \text{three dimensions,}}{3})$

```
print('Matrix shape', session.run(tf.shape(matrix)))
```

Tensor Axes

If we have a tensor, we want to refer to a specific dimension with the help of axis.

If we say a tensor rank is 2 then we Can say it has 2 dimensions (or) we Can say that tensor having 2 axes like x and y-axis.

So in Some mathematical functions if we provide axis value then it will do that operation on that Specified axis only like

```
A= np.array ([[1,2], [3,4]])
print(np.mean(A, axis=1))
```