BUDDHA INSTITUTE OF TECHNOLOGY
Gida Gorakhpur

Department- Computer Science and Allied
(ARTIFICIAL INTELLIGENCE MACHINE LEARNING)

Program & Semester- B.Tech 3rd Year (6th Semester)

Course and Code- Social Media Analytics and Data Analytics BCAM 061

Course Outcome

CO No.	Course Outcome	Bloom's Knowledge Level (KL)
CO 1	Understand basic concepts and need of social media analysis	
CO 2	Understand the fundamental of graphs and matrices in social media analysis	
CO 3	Understand networking fundamentals of social media analysis	
CO 4	Understand social networking and modelling concepts and methods.	
CO 5	Understand processing and visualizing social media data	

UNIT-2
GRAPH AND MATRICES

Q1. Explain graph theory concepts used in social media analytics and classify different types of graphs with examples.

(AKTU End Semester Exam 2022, GATE – Discrete Mathematics & Graph Theory)

Introduction

Graph theory is a fundamental concept used in social media analytics to represent and analyze relationships among users. In this context, users are represented as nodes and their relationships are represented as edges. Graphs help in understanding network structure, influence, and communication patterns.

Basic Terminology of Graphs

- **Node (Vertex):** Represents users or entities
- **Edge (Link):** Represents relationships such as friendship or follow
- **Degree:** Number of connections of a node
- **Path:** Sequence of nodes connected by edges
- **Connected Graph:** A graph where all nodes are reachable

Types of Graphs in Social Media

1. Undirected Graph

- Edges have no direction
- Represents mutual relationships
- Example: Facebook friendship network

Characteristics

- Symmetric relationships
- Used for community detection

2. Directed Graph

- Edges have direction
- Represents follower-following relationships
- Example: Twitter (X)

Characteristics

- Asymmetric relationships
- Useful for influence analysis

3. Weighted Graph

- Edges have weights representing strength of connection
- Example: Frequency of interaction

Characteristics

- Helps measure intensity of relationships

- Useful in recommendation systems

4. Bipartite Graph

- Nodes divided into two disjoint sets
- Edges exist only between sets
- Example: Users and posts

Characteristics

- Used in recommendation systems
- Helps in matching problems

5. Multigraph

- Multiple edges between same nodes
- Represents multiple interactions

Applications in Social Media Analytics

- Identifying influential users
- Community detection
- Information diffusion analysis
- Recommendation systems

Conclusion

Graph theory provides a powerful framework for analyzing social networks. Different types of graphs help model various relationships and interactions in social media platforms.

Q2. Explain adjacency matrix representation of graphs with suitable example and analyze its advantages and limitations.

(AKTU End Semester Exam 2021, GATE – Data Structures)

Introduction

Graph representation is essential for performing computations on networks. The adjacency matrix is one of the most widely used methods for representing graphs in social media analytics.

Adjacency Matrix Definition

An adjacency matrix is a square matrix used to represent a graph. If there are n nodes, the matrix is of size n × n.

- Entry A[i][j] = 1 if there is an edge between node i and j
- Otherwise, A[i][j] = 0

Example

Consider a graph with 4 users: A, B, C, D

Connections:

- A–B, A–C, B–D

Adjacency Matrix:

- Row and column represent nodes
- Matrix entries indicate connections

Properties of Adjacency Matrix

- Symmetric for undirected graphs
- Diagonal elements are zero (no self-loop)
- Can be weighted or unweighted

Advantages

- Simple and easy to implement
- Efficient for dense graphs
- Constant time edge lookup O(1)

Limitations

- Requires $O(n^2)$ space
- Not efficient for sparse graphs
- Wastes memory when fewer edges exist

Applications in Social Media

- Representing user connections
- Used in centrality calculations
- Helps in matrix-based computations

Conclusion

Adjacency matrix is a fundamental representation technique suitable for dense networks but has limitations in terms of space complexity.

Q3. Explain BFS and DFS traversal algorithms and discuss their applications in social media networks.

(AKTU End Semester Exam 2023, GATE – Algorithms)

Introduction

Traversal algorithms are used to explore all nodes in a graph. BFS (Breadth First Search) and DFS (Depth First Search) are two fundamental algorithms used in social media analytics.

Breadth First Search (BFS)

Definition

- Explores nodes level by level
- Uses queue data structure

Algorithm Steps

- Start from a source node
- Visit all neighbors
- Move to next level

Applications

- Finding shortest path
- Network broadcasting
- Friend recommendation

Depth First Search (DFS)

Definition

- Explores as deep as possible before backtracking
- Uses stack or recursion

Algorithm Steps

- Start from a node
- Visit unvisited neighbor
- Backtrack when no neighbor exists

Applications

- Detecting cycles
- Community detection
- Path finding

Comparison

- BFS uses queue, DFS uses stack
- BFS finds shortest path, DFS explores deeply
- BFS is better for level-wise analysis

Conclusion

BFS and DFS are essential traversal techniques used to analyze and explore social networks efficiently.

Q4. Explain centrality measures in social media analytics with detailed explanation and applications.

(AKTU End Semester Exam 2022, GATE – Graph Theory & Network Analysis)

Introduction

Centrality measures are used to identify important or influential nodes in a network. In social media, these measures help identify key users.

Types of Centrality Measures

1. Degree Centrality

- Number of connections of a node
- Indicates popularity

Application

- Identifying active users

2. Betweenness Centrality

- Measures how often a node lies on shortest paths

Application

- Identifying bridge nodes

3. Closeness Centrality

- Measures distance to all other nodes

Application

- Identifying efficient communicators

4. Eigenvector Centrality

- Measures influence based on connected nodes

Application

- Identifying influential users

Importance in Social Media

- Influencer detection
- Information spread analysis
- Marketing strategies

Conclusion

Centrality measures provide valuable insights into network structure and help identify key players in social media.

Q5. Explain weighted graphs in social media analytics and solve a numerical problem to find shortest path.

(AKTU End Semester Exam 2023, GATE – Graph Algorithms)

Introduction

In social media analytics, relationships between users are not always equal. Some connections are stronger than others depending on interaction frequency, communication intensity, or trust. Weighted graphs are used to represent such relationships by assigning weights to edges.

Concept of Weighted Graph

- A weighted graph is a graph in which each edge has an associated numerical value called weight
- Weight may represent interaction frequency, message count, or similarity
- Formally represented as G = (V, E, W), where W is weight function

Example in Social Media

- Users are nodes
- Messages exchanged between users represent edges
- Weight represents number of messages

Shortest Path Problem

Shortest path refers to finding the minimum cost path between two nodes

Dijkstra's Algorithm (Concept)

- Used to find shortest path in weighted graph with non-negative weights

- Greedy approach
- Maintains distance from source

Numerical Example

Consider graph with nodes A, B, C, D

Edges with weights

A–B = 2

A–C = 5

B–C = 1

B–D = 4

C–D = 2

Step 1: Initialization

Distance from A

A = 0

B = ∞

C = ∞

D = ∞

Step 2: Update neighbors of A

B = 2

C = 5

Step 3: Select minimum (B)

Update

C = min(5, 2+1 = 3) = 3

D = 2+4 = 6

Step 4: Select C

Update

D = min(6, 3+2 = 5) = 5

Step 5: Final distances

A→B = 2

A→C = 3

A→D = 5

Applications in Social Media

- Finding strongest communication path
- Recommendation systems
- Information flow analysis

Conclusion

Weighted graphs provide realistic representation of social networks and help in solving optimization problems such as shortest path.

Q6. Explain hypergraphs and their significance in modeling complex social media relationships.

(AKTU End Semester Exam 2022, Advanced Graph Concept – GATE level)

Introduction

Traditional graphs represent pairwise relationships, but in social media, interactions often involve multiple users simultaneously. Hypergraphs extend graph theory by allowing edges to connect more than two nodes.

Definition of Hypergraph

- A hypergraph is defined as H = (V, E)
- V = set of nodes
- E = set of hyperedges
- Each hyperedge can connect multiple nodes

Difference from Normal Graph

- Normal graph: edge connects two nodes
- Hypergraph: edge connects multiple nodes

Example in Social Media

- Group chat involving multiple users
- Facebook groups
- Event participation

Representation

- Incidence matrix used
- Shows relationship between nodes and hyperedges

Advantages

- Captures complex interactions
- Better modeling of group behavior
- Useful in recommendation systems

Applications

- Community detection
- Group behavior analysis
- Collaborative filtering

Challenges

- Complex structure
- Difficult computation
- High storage requirement

Conclusion

Hypergraphs provide an advanced framework for modeling multi-user interactions in social media, making them essential for complex analytics.

Q7. Explain random graphs and their role in analyzing social networks.

(AKTU End Semester Exam 2021, GATE – Probability & Graph Models)

Introduction

Random graphs are used to model networks where connections are formed randomly. They help in understanding the structure and behavior of large-scale social networks.

Concept of Random Graph

- Nodes are fixed
- Edges are formed randomly with probability p
- Represented as G(n, p)

Properties

- Degree distribution
- Connectivity
- Clustering coefficient

Example

- Users randomly connecting on a new platform

Applications in Social Media

- Modeling network growth
- Studying spread of information
- Analyzing robustness of networks

Advantages

- Simple mathematical model
- Useful for theoretical analysis

Limitations

- Does not represent real-world networks accurately
- Lacks clustering

Conclusion

Random graphs provide a foundation for understanding network formation, though real networks require more complex models.

Q8. Explain bipartite graphs and their applications in recommendation systems with example.

(AKTU End Semester Exam 2020, GATE – Graph Theory Applications)

Introduction

Bipartite graphs are widely used in social media analytics, especially in recommendation systems where two different types of entities are involved.

Definition

- Nodes divided into two disjoint sets
- Edges exist only between sets

Example

- Users and posts
- Users and products

Properties

- No edges within same set
- Can be represented using adjacency matrix

Applications

- Recommendation systems
- Matching problems
- Content suggestion

Example Scenario

- Users like posts
- System recommends posts liked by similar users

Conclusion

Bipartite graphs are essential for modeling relationships between different entities and are widely used in recommendation systems.

Q9. Solve a numerical problem to calculate degree, closeness and betweenness centrality.

(AKTU End Semester Exam 2023, Highly Important Numerical, GATE – Network Analysis)

Introduction

Centrality measures help identify important nodes in a network. Numerical problems are frequently asked in exams.

Given Graph

Nodes: A, B, C, D

Edges: A–B, A–C, B–C, C–D

Degree Centrality

- A = 2
- B = 2

- C = 3
- D = 1

Closeness Centrality

Calculate shortest paths

For A: distances = 1,1,2 → sum = 4 → closeness = 3/4

For C: distances = 1,1,1 → sum = 3 → closeness = 3/3 = 1

Betweenness Centrality

- C lies on most shortest paths
- Highest betweenness

Conclusion

Node C is most influential based on all measures.

Q10. Explain connectivity and components in graphs with applications in social media.

(AKTU End Semester Exam 2022, GATE – Graph Theory)

Introduction

Connectivity determines whether nodes in a graph are reachable from each other. It is essential in analyzing social networks.

Concept of Connectivity

- Graph is connected if path exists between all nodes

Types

- Strongly connected
- Weakly connected

Components

- Subgraphs where nodes are connected

Applications

- Community detection
- Identifying isolated users

Conclusion

Connectivity helps understand structure and fragmentation of social networks.

Q11. Explain path, shortest path and connectivity using matrices in social media networks.

(AKTU End Semester Exam 2021, GATE – Matrix Representation)

Introduction

Matrices are used to represent graphs and compute paths efficiently.

Path Concept

- Sequence of connected nodes

Matrix Representation

- Adjacency matrix
- Powers of matrix give paths

Applications

- Path detection
- Network analysis

Conclusion

Matrix methods provide efficient computation for graph problems.

Q12. Discuss real-world case study of social media network analysis using graph theory.

(AKTU End Semester Exam 2023, Case Study Based Question)

Introduction

Graph theory is widely used to analyze real-world social media platforms.

Case Study: Twitter Network

- Users as nodes
- Followers as edges

Analysis

- Influencer detection using centrality
- Trend analysis using hashtags

Applications

- Marketing
- Political campaigns

Conclusion

Graph theory plays a crucial role in understanding and analyzing real-world social networks.