Lecture 8 – Graph Neural Networks

Provide short answers (max. 25 words each) to the following questions.

- What are the two fundamental components of a graph?
- Give two real-world examples of data represented as graphs.
- What is an undirected graph?
- What is a directed graph?
- What is a heterogeneous graph?
- What is a spatio-temporal graph?
- What does an Adjacency matrix represent?
- What is the size of an Adjacency matrix for a graph with N nodes?
- What is permutation invariance in graph representation?
- What are node embeddings?
- What are edge embeddings?
- What inputs does a Graph Convolutional Network (GCN) layer require?
- Why are GCN layers permutation invariant?
- What is the main idea of a GCN layer? What is the GCN layer's formula?
- What is a k-hop neighborhood?
- What is mean aggregation in GCNs?
- What is attention-based aggregation?
- Why are residual connections used in GCNs?
- What is a graph-level task?
- What is a node-level task?
- What is an edge prediction task?
- What loss function is commonly used for graph classification?
- What is Transductive Learning in graphs?
- Why is neighborhood sampling used in GCN training?
- What is graph partitioning?
- What is an edge graph?
- What is Spatio-Temporal GCN (ST-GCN) used for?
- What does temporal convolution in ST-GCN capture?
- What is the main idea of Co-STGCN?

Multiple-choice questions

What are the two fundamental components of a graph?

A) Nodes and layers
B) Nodes and edges
C) Edges and weights
D) Layers and embeddings

Which of the following is an example of graph-structured data?

A) Image pixels
B) Social networks
C) Audio signals
D) Tabular data

What type of graph has edges without direction?

A) Undirected graph
B) Directed graph
C) Hypergraph
D) Weighted graph

What type of graph includes multiple types of nodes and edges?

A) Simple graph
B) Homogeneous graph
C) Heterogeneous graph
D) Bipartite graph

What is a spatio-temporal graph?

A) A graph with weighted edges
B) A graph that changes over time
C) A graph with only spatial edges
D) A graph with fixed topology

What does an Adjacency matrix represent?

A) Node features
B) Loss function
C) Graph embeddings
D) Edge weights and connectivity

What is the size of an Adjacency matrix for N nodes?

A) N × D
B) N × N
C) D × N
D) N × E

What does permutation invariance mean for graphs?

A) Node order does not affect the graph structure
B) Node order affects the graph structure
C) Edge weights change with node order

D) Graph embeddings depend on node order

What are node embeddings?

A) Representations of edges
B) Adjacency matrix rows
C) Feature vectors for nodes
D) Loss function parameters

What are edge embeddings?

A) Representations of nodes
B) Feature vectors for edges
C) Graph pooling outputs
D) Attention weights

What inputs does a GCN layer require?

A) Node embeddings and Adjacency matrix
B) Edge embeddings only
C) Loss function and optimizer
D) Attention weights

Why are GCN layers permutation invariant?

A) They ignore adjacency matrix
B) They aggregate based on graph structure
C) They use fixed node order
D) They normalize embeddings

What is the main idea of a GCN layer?

A) Apply convolution on images
B) Aggregate neighbor information and transform node features
C) Compute attention weights only
D) Normalize adjacency matrix

What is a k-hop neighborhood?

A) Nodes connected by k edges
B) Nodes within k layers
C) Nodes with k features
D) Nodes sampled randomly

What is mean aggregation in GCNs?

A) Sum of neighbor features
B) Average of neighbor features

C) Maximum of neighbor features
D) Weighted sum using attention

What is attention-based aggregation?
A) Equal weighting of neighbors
B) Using random weights
C) Ignoring neighbors with low degree
D) Weighting neighbors based on similarity

Why are residual connections used in GCNs?
A) To remove Adjacency matrix
B) To improve gradient flow and stability
C) To normalize embeddings
D) To reduce computation

What is a graph-level task?
A) Predict a label for each node
B) Predict edge weights
C) Predict a label for the entire graph
D) Compute adjacency matrix

What is a node-level task?
A) Predict a label for each node
B) Predict a label for the entire graph
C) Predict edge embeddings
D) Compute pooling

What is an edge prediction task?
A) Predict node features
B) Predict whether an edge exists between two nodes
C) Predict graph-level label
D) Compute adjacency matrix

Which loss function is commonly used for graph classification?
A) Mean squared error
B) KL divergence
C) Hinge loss
D) Cross-entropy

What is Transductive Learning in graphs?
A) Uses only labeled nodes

B) Uses both labeled and unlabeled nodes
C) Ignores graph structure
D) Requires multiple graphs

Why is neighborhood sampling used in GCN training?

A) To increase receptive field
B) To limit receptive field and reduce computation
C) To remove adjacency matrix
D) To normalize embeddings

What is graph partitioning?

A) Splitting graph into smaller subgraphs for mini-batch training
B) Removing edges from graph
C) Normalizing Adjacency matrix
D) Aggregating node features

What is an edge graph?

A) A graph where edges become nodes
B) A graph with no edges
C) A graph with weighted nodes
D) A graph with directed edges only

What does temporal convolution in ST-GCN capture?

A) Spatial patterns
B) Node embeddings
C) Motion patterns across time
D) Edge weights

What is the main idea of Co-STGCN?

A) Batch processing of graphs
B) Continual spatio-temporal convolution for online inference
C) Removing temporal edges
D) Using only spatial edges

Which aggregation method uses attention weights?

A) Mean pooling
B) Max pooling
C) Attention-based aggregation
D) Kipf normalization