

**BCSE202P**

**DATA STRUCTURES AND ALGORITHMS**

**DIGITAL ASSIGNMENT – 4**

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## Graph Neural Networks

Graph Neural Networks are a class of deep learning methods designed to perform inference on data contained in the graph data structure.

GNNs are neural networks that can be directly applied to graphs, and provide an easy way to edge-level, node-level, and graph level prediction tasks.

Performing CNN on a graph is very difficult because of the arbitrary size and complex topology of graphs.

Also, graphs are invariant to node ordering, which makes sure that the labelling of the nodes doesn't affect the results.

## Applications of Graph Neural Networks

Graph Neural Networks can solve different types of problems in Graph-structured data such as:

- Node Classification: To determine the labelling of nodes based on the labels of the neighbouring nodes.
- Graph Classification: Classifying the complete graph into different categories. Some applications of Graph Classification include determination of enzyme nature of a protein in bioinformatics, categorizing documents in social network analysis, or in Natural Language Processing.
- Link Prediction: To understand the relationship between entities in graphs, and to also predict whether there is a connection between the two entities. An essential application of this is in social networks to infer social interactions or to suggest possible friends to the users, and can also be used in predicting criminals.
- Graph Clustering: To cluster the data into the form of graphs in one of two ways. One is vertex clustering, which clusters the nodes of the graph into groups of densely connected regions based on edge weights or distances. The other way is to treat the graphs as objects to be clustered and cluster the objects with similarity.

- Graph Visualization: It is concerned with the visual representation of graphs which can help identify structures and anomalies in the data.

## **Applications of GNNs in different domains**

### **Graph Neural Networks in Natural Language Processing(NLP):**

Naturalness and ease of use of graphs makes them ideal for using in various NLP tasks such as text classification, user geolocation, relation extraction and question answering.

### **Graph Neural Networks in forecasting traffic:**

Smart and efficient transportation systems can be designed with the help of Spatial-Temporal Graph Neural Networks (STGNN), wherein sensors installed on roads can represent the nodes and, the distance between nodes, which have the average traffic speed in a time period as their dynamic input feature, as the edges.

An Interesting application of Graph Neural Networks is in the field of Computer Vision:

GNN architectures can be applied to image classification problems such as scene graph generation. GNN is also used in computer vision to model relationships between objects detected by CNN based detectors.

In the scene graph generation problem, the model aims to parse an image into a semantic graph consisting of objects and the semantic relationships between them. In essence, given an image, the scene graph generation model can detect and recognize individual objects, and can also predict the semantic relationships between pairs of objects.

Other applications of Graph Neural Networks in Computer Vision include few-shot image classification and human-object interactions.