Chapter 9
Application and Some Fundamental Study of GNN In Forecasting

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ABSTRACT

The chapter consists of the application of GNN with all applied fundamentals in different fields of application. Firstly, the discussion will be about the graph using graph theory connection to the mathematical aspect. Secondly, the basis of the data set will be for forecasting and predictive analysis, application, and fundamental concepts, which will help in decision making regarding the different unsolved problems. Third, knowledge about the models of the graph neural network with the examples will be a very important part of the chapter. This chapter is useful for fulfilling the research gap in the field of some forecasting models using graph neural networks with the application of machine learning on data analysis with a large number of examples.

INTRODUCTION

This chapter discussed the application of the neural network, such as Graph Neural Networks (GNN). Which is used in the process of the graph, but it is not the only application for the process of the graph of Neural Networks. Two types of neural network applications apply for the process of the graph as; Graph Neural Networks and Recursive Neural Networks. So, Graph Neural Networks is the process of the graph it is clear from the above lines, before see, some ideal knowledge of graph, neural network and then come on to the main point of Graph neural network and application of Graph neural network, understand by examples and case study, etc.

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GRAPH

A graph is a binary relation to a set of objects. Graphs arose as diagrams representing specific relations among a set of objects. They have the great expressive power to describe the complex relationship among data objects. They can be used to model situations that occur within certain kinds of problems. Such as; In computer science, graphs are used to represent networks for communication, computational devices, etc.

"Graphs are everywhere."

A graph is a type of data structure made up of vertices and edges. It serves as a mathematical framework for examining the relationships between objects and entities pairwise. A graph is typically defined as G= (V, E), where V is a collection of nodes and E denotes the connections between them.

Definition (Undirected Graph). Let G be an undirected graph, $G = (V, E, \mathrm{A})$, V is a set of m vertices, as $V = \{1, 2,3,\ldots, \mathrm{m}\}$, $S \subseteq V \times V$ is the set of edges and $\mathrm{A} \in \mathbb{R}^{m \times m \times k}$ contains the node and edge features with its diagonal components $\mathrm{A}_{i,i,u}$ denoting node attributes and off-diagonal components $\mathrm{A}_{i,j,u}$ denoting edge attributes. Adjacency matrix, $\mathrm{A} \in \{0,1\}^{m \times m}$ of G with $\mathrm{A}_{i,j}$ equal to one, iff (i, j) $\in$ S. let's suppose there is no given node or edge feature, then use $\mathrm{A} = \mathrm{A}$. Otherwise, A can be considered as the first part of A, i.e., $A = \mathrm{A}_{u,u,1}$. Graph Laplacian denoted by L and defined as, $L = \mathrm{A}_{i,i,u} - A$.

Basically, two types of graphs an undirect graph and a direct graph, see Figure 1. And some other kinds of graphs are null graph, connected graph, regular graph, cyclic graph, acyclic graph, Trivial graph, Simple graph, dis-connected graph, complete graph, bipartite graph, complete bipartite graph, star graph, weighted graph, multi-graph, planar and non-planar graph.

Figure 1. Graph of un-direct and direct

Figure 2 shows different types of graphs plotted by use of jupyter notebook (python 3). Useful command in jupyter notebook as:

In discreate mathematics, study of the graph is known as Graph Theory. Mathematical structure of the connection of points by lines, which is represented into the form of graph. or vertices (nodes), which is connected with the edges (lines). Graph theory not only used in mathematics but also in computer science, physics, chemistry, linguistics, electrical engineering, computer network, social science, biology, etc.