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AN OVERVIEW OF SUPPLY CHAIN MANAGEMENT FOR A SUSTAINABLE WORLD BY GRAPH NEURAL NETWORK

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ABSTRACT: In recent years, there have been so many challenges like, increasing the demand of customers, ever-growing competition, ageing infrastructure and so on. Asset Management is a critical process which includes so many complexities like finance, transportation, effective decision making and alike. There is a significant role of graph neural networks in the field of, life cycle of Asset Management. In this paper, we initiate to give a comprehensive review of the application of graph neural networks in the life cycle delivery of Asset Management.

KEYWORDS: Asset Management, Graph neural network

Introduction

Deep Learning performs well on problems like image recognition, where the algorithms can interpret pixels as part a bigger picture. So-called convolution layers analyse every part of the picture in the context of the neighbouring pixels. This allows generative algorithms to correctly reproduce the structure of photographs and paintings in a realistic and organic manner. Just like pixels in an image, financial assets do not exist in isolation. Their analysis benefits from studying the underlying structure of the markets. For instance, the correlation between assets must be taken in account when controlling a portfolio's exposure to market risk, like copulas. Other types of relationships between assets are also essential to build a complete picture of the market interdependencies. If one wants to build investment portfolios using machine learning, this structural information must be incorporated. The main issue when trying to transcribe a market's structure is that, contrary to images, it is hard to represent it in a Euclidean space. Yet, the convolution layers for vectors, images and shapes are based on the Euclidean distance. Each element to present this diversity of structures is through graphs is convolved with those closest to it. Market relationships are most complex; they occur at different levels, each with different strengths and relevance. Relationships can be Boolean, for instance, if two stocks are from similar sectors, or real-valued if they are linked by correlation. The most natural way.

Nowadays, the relevance of graph neural networks (GNN) is recognized in many fields to model non–Euclidean relationships. Graph neural layers are now fundamental i,n the study of medical molecules and they can model traffic as well as to analyse relationships in bibliography, etc.[1]. They enable the structure of the data to be encoded independently from their features, relying on the propagation of the information through the graph. In particular, graphs arise naturally while looking at supply chain information (Wu and Birge, 2014).

A Primer on Graph Theory

Graphs are a mathematical object reported to have been invented by Leonard Euler in 1735 to model bridges over a river in Konigsberg. It is composed of a set of vertices, V, which are connected by a set of edges E. More specifically, the set E is

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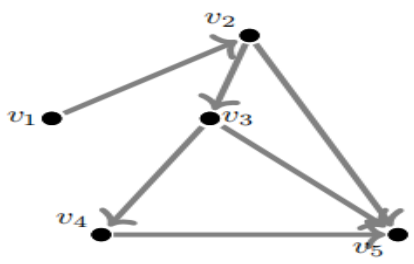
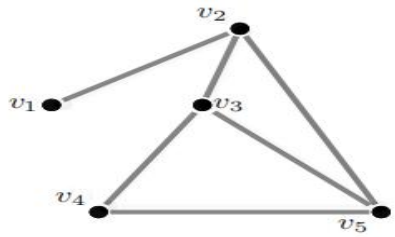
defined as being a subset of VxV, where X is the cartesian product between sets. For i,j∈ V, there exists a connection between i& j if, and only if, (i, j) ∈ E. A graph can also be represented by a square matrix, named the adjacency matrix A, such that $A_{i,j} \neq 0 \Leftrightarrow (i, j) \in E$. The values in the adjacency matrix can act as the weights of the connections where higher values mean a stronger connection. A non-weighted graph will have a binary adjacency matrix. If A is symmetric then the graph is called undirected, since information follows from i to j and from j to i indifferently. Otherwise, it is called a directed graph. Other special kinds of graphs include the bipartite graph, where vertices can be separated into two classes where no two vertices in the same class are connected, and complete graphs, where every vertex is connected to every other.

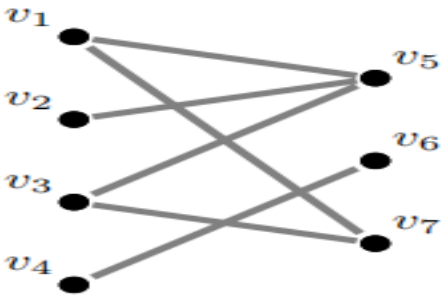
Graph Theory provides several tools for the study of graphs. Subsets like network theory or spectral graph theory focus on propagation in a graph, with applications in epidemiology[10,11] or traffic forecasting [12]. The degree matrix is a matrix fundamental in describing a graph's structure. The degree matrix D is a diagonal matrix which gives the number of neighbours of each vertex. It is directly related to the adjacency matrix, since for every i∈ {1,2,…N}, $D_{i,j}= \Sigma A_{i,j,}$, j = {1,2,….N}. It follows to build the graph Laplacian, which is defined as L = D – A. Since the diagonal in the adjacency matrix is D, it combines with loses the information about the number and the position of each vertex.



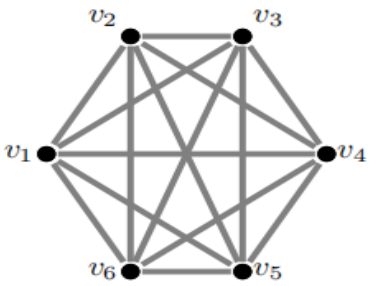
(b) The same graph with directed edges



(a) An undirected graph with five vertices



(c) A bipartite graph



(d) The complete graph with six vertices

What is network asset lifecycle management?

The telecom world is currently at a crossroads where the industry is at the forefront of innovation and technological development. On the other hand, it is one life with challenges such as plateauing revenues, increasing customer demands, increasing capex intensity, and ever–growing competition. Both these aspects play into each other, as CSP's need to invest in new network technologies to provide customers with the latest services; with the best experience. However, investing is network technologies seldom allow CSP's to witness adequate return on their investments. In such a scenario, where ROI is rare, CSP's must ensure that their capex is optimised. One of the critical areas where CSP's can enable

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capex optimization is through the better utilisation of their network assets lifecycle.

Benefits of asset lifecycle management:

- Provides a centralised repository for active, passive and non – serialised network assets.
- Reduces the under – utilisation network of assets
- Reduces the need for manual auditing
- Improves time to value of assets
- Enables monetization of end – of life assets to generate maximum value.
- Optimises asset utilisation

Asset Management and Supply Chain Management:

In the field of asset management, supply chain management has an important role, both are interconnected. The raise and falls of supply chain management will affect the asset management of a business. " A supply chain is the set of the enterprises suppliers and its customers. The principle of supply chain activity is receiving input from firm's suppliers add- value- deliver to customers". The supply chain management includes the processes of supply of row materials into the manufacturing companies and from the manufacturing companies to the consumers.

Effects of Supply Chain Management in Asset Management:

According to the corporate finance institute, asset management is the process of developing, operating, maintaining, and selling assets cost effectively. What you do in terms of asset management directly affects the viability of your supply chain. Ultimately, how you keep track of maintenance issues and the ways in which you interpret trends and data have real consequences.

For example, if part of your responsibilities include being in the loop on warehouse operations, and a driver's post-trip inspection indicates brake issues on one of the delivery trucks in your fleet, your team's ability to spring into action regarding a work order informs how long the vehicle remains out of service. Regular maintenance of your entire fleet ensures that all vehicles get out on the road on time. This highlights just one example of the many scenarios that can call the strength of your supply chain into question.

Asset management can also involve:

- Scheduled maintenance of machines, vehicles, or other physical assets
- Comprehensive work orders that describe critical issues
- Historical and inventory data
- Employee and vendor scheduling
- Institutional knowledge for new team members

Effective asset management in the supply chain can support uptime and in turn, your team's ability to maintain revenue streams. By contrast, relying solely on a reactive approach to asset management or resistance to leveraging newer technologies can stall productivity. It is important to maintain a "birds-eye view" of the supply chain and anticipate challenges before ut a salesman who starts his travel from the starting point and visiting all the cities by the shortest distance you find yourself running damage control.

Travelling Salesman Algorithm:

Travelling Salesman problem (TSP) is an application of graph theory. The mathematical problems related to the TSP were treated in the1880 by the Irish Mathematician Sir William Rowan Hamilton and by the British Mathematician Thomas Penyngton Kirkman".

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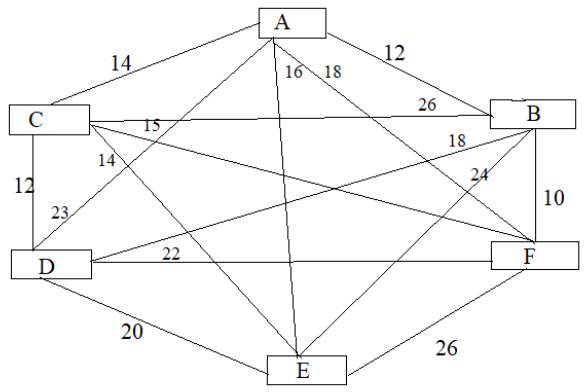
The TSP mainly says about returning back to the starting point.

In this case of supply chain management TSP is very applicable. Because route mapping is a significant part of supply chain management. So for this route mapping TSP we can use. Here we go for an example of a soap manufacturing company and we take consumers of this company for the simplicity. The consumers mean different retail shops. The distance matrix of the consumers are given below. [The distance considered in km.]

	A	B	C	D	E	F
A	0	12	14	23	16	18
B	12	0	26	18	24	10
C	14	26	0	12	14	15
D	23	18	12	0	20	22
E	16	24	14	20	0	26
F	18	10	15	22	26	0

The graphical structure of the given matrix:



Now apply the algorithm on the given graph.

The distribution starts from point A and he wants to visit all the consumer points and wants to visit all the consumer points and wants to return to the starting point (A). The condition is there to visit all the points only at once. Then,

From A, the shortest distance is to B

A → B implies 12

From B, the shortest distance is to F

B → F implies 10

From F, the shortest distance is to C

F → C implies 15

From C, the shortest distance is to D

C → D implies 12

From D, the shortest distance is to E

D → E implies 20

Now, the distribution visited all the points now from E he can return into A.

E → A implies 18

So the direction travelling of the distributer is A → B → F→C →D→E→A. Then the total distance of the traveller is 12 + 10 + 15 + 12 + 20 + 18 = 87 Km

Benefits of TSP in Supply Chain Management:

The application of TSP in supply chain management can make so many benefits. In general,

- Reduces the transportation costs, like reducing the fuel consumption
- Optimising the smallest path for distribution
- Improving the efficiency of transportation
- It helps to make the consumer happy by the efficient distribution
- It helps to reduce the fuel consumption and carbon emissions; it helps the distribution to eco-friendly.

How TSP will be useful for the sustainability

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Travelling salesman's problem is mainly to find out the shortest path of travelling. But it also will be helpful for the sustainability of nature in one way or the other way . How does TSP helps for the sustainable world?

- **Reduces the carbon emission** : when the travelling man does his travel the carbon emission will happen . But by choosing this shortest path by TSP it will be helpful for the reduction of the amount of carbon emission.
- **Waste management** : Effective waste management system is necessary for sustainability. TSP will be helpful to plan the route mapping of waste management in an effective manner.
- **Renewable energy planning** : TSP algorithms can help optimise the placement of renewable energy sources such as wind turbines or solar planets. By strategically planning these sources we can maximise the energy production while minimising environmental disruption , such as habitat fragmentation or visual pollution.

CONCLUSION

In conclusion this paper mainly focuses on how supply chain management can be made easy by using the Travelling salesman problem (TSP), the application of graph theory. The application of Travelling salesman problem in the supply chain management will help the companies and business firms to control the cost and the asset management. And also this helps the companies to minimise the cost of their distribution by finding the shortest route by TSP which makes the distribution easy and makes the consumers happy by the faster distribution.

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