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An Overview of Supply Chain Management for Sustainable world by Graph Neural Network

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ABSTRACT

In the recent years, there are so many challenges like, increasing the demand of customers, ever growing competition, aging 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 significant role of graph neural networks in the field, life cycle of Asset Management. In this paper, we initiate to give a comprehensive review of the application of graph neural network in the life cycle delivery of Asset Management.

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1 Introduction

Problems like image recognition, where algorithms may interpret pixels as parts of a larger picture, are well suited for deep learning. Convolution layers examine each component of the image in relation to its surrounding pixels. This makes it possible for generative algorithms to accurately and naturally replicate the structure of artworks and photos. Financial assets are not isolated entities, much like pixels in an image. Examining the markets' basic structure helps their analysis. For example, while managing a portfolio's exposure to market risk, such as copulas, it is necessary to consider the correlation between assets. To create a comprehensive picture of the interdependencies in the market, other kinds of linkages between assets are also necessary. This structural information must be included if one want to use machine learning to construct investment portfolios.The primary problem in attempting to describe the structure of a market in writing is that, in contrast to pictures, it is challenging to depict it in Euclidean space. However, the Euclidean distance serves as the foundation for the convolution layers for vectors, pictures, and forms. The elements that are closest to each other are convoluted. The most complicated interactions are those in the market; they exist at several levels and vary in strength and significance. Relationships can be real-valued if they are connected by correlation, or they can be Boolean, such as when two stocks belong to the same industry. Graphs are the most natural way to display this variety of structures.

Researchers from a variety of disciplines have recently begun to use graph neural networks (GNNs) to represent non-Euclidean interactions. These days, graph neural layers are essential for studying medical compounds [1, 3]. They can also

analyze linkages in bibliographies and model traffic [2]). By relying on the information's propagation across the network, they make it possible to encode the data's structure separately from its individual aspects. Specifically, when examining supply chain data, graphs emerge organically [4].

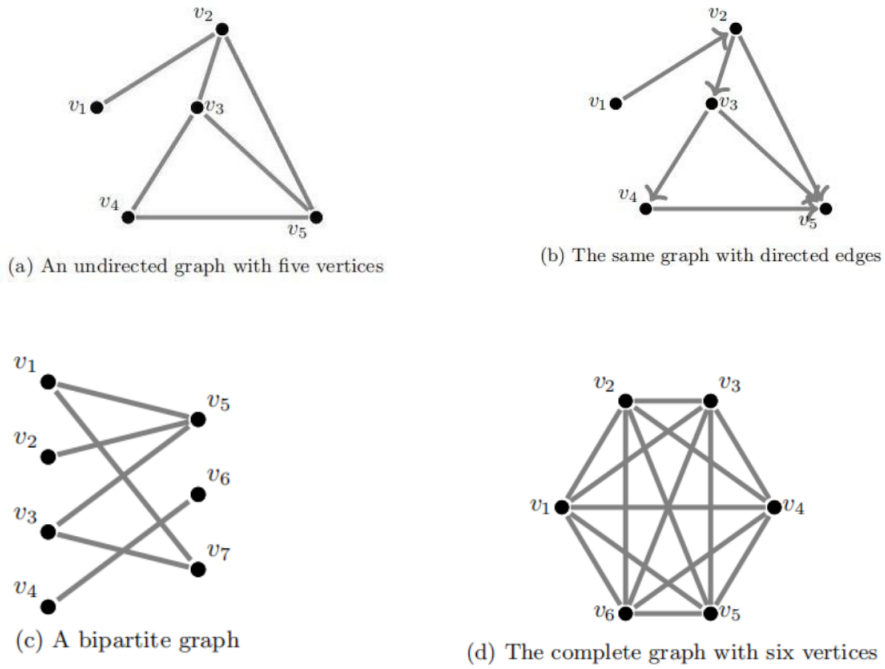
2 An Introduction to Graph Theory

Leonard Euler is credited for creating graphs, a mathematical tool, in 1735 to simulate bridges across a river near Königsberg. It is made up of a set of edges (E) connecting a set of vertices (V). The set E is defined more precisely as a subset of V x V, where x is the cartesian product of the two sets. If and only if (i, j) ∈ E, then i & j are connected for i, j ∈ V. A square matrix, known as the adjacency matrix A, can also be used to represent a graph if Ai, j $\neq 0 \leftrightarrow$ (i, i) ∈ E.

The values in the adjacency matrix can act as the weights of the connections where higher values mean a stronger connection. The adjacency matrix of a non-weighted graph will be binary. Since information flows indifferently from i to j and from j to i, a graph is said to be undirected if A is symmetric. It is referred to as a directed graph otherwise. Additional unique graph types include complete graphs, in which every vertex is connected to every other vertex, and bipartite graphs, in which vertices can be divided into two classes, with no two vertices in the same class being connected.[5]

Graph theory offers a number of resources for graph analysis. Propagation in a graph is the subject of subsets such as network theory and spectral graph theory, which have applications in traffic predictions and epidemiology. The degree matrix is a matrix fundamental in describing a graphs structure.

Each vertex's number of neighbors is shown by the diagonal degree matrix D. Every time an 'i' falls inside {1,2,.....N}, it has a direct connection to the adjacency matrix j = {1,2,3,....N}, Di,j = $\sum Ai, j$, j = {1,2,3,....N}. The graph Laplacian, which is defined as L = D – A, can then be constructed. Given that the adjacency matrix's diagonal is D, the number and location of each vertex are combined with loss.



(a) An undirected graph with five vertices

(b) The same graph with directed edges

(c) A bipartite graph

(d) The complete graph with six vertices

Figure 1: Graphs

3 Network asset lifecycle management

The telecom world is currently at a cross road on the other hand, the industry is at 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 completion. 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 capex optimization is through the better utilization of their network assets lifecycle.

3.1 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

3.2 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.

3.3 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 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.[15]

4 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". The TSP mainly says about returning back to the starting point.[6, 7, 8]

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.[9] 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

Figure 2: Distance Matrix

The graphical structure of the given matrix is shown in Figure 3.

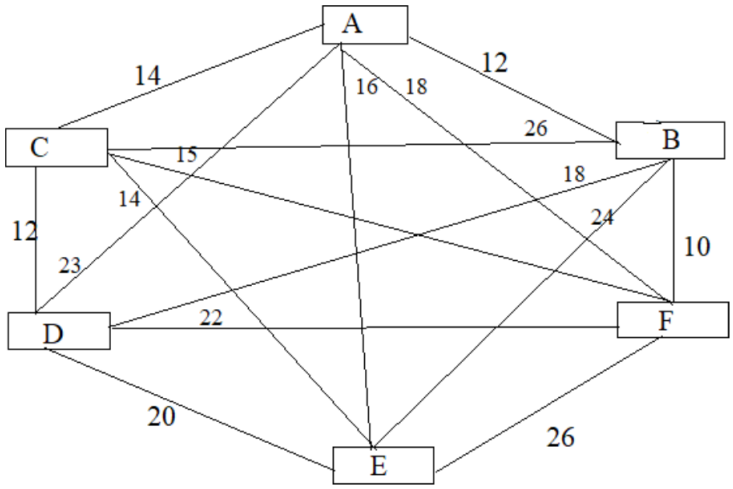


Figure 3: Graphical reprensentation

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 $\rightarrow$ B implies 12
From B, the shortest distance is to F
B $\rightarrow$ F implies 10
From F, the shortest distance is to C
F $\rightarrow$ C implies 15
From C, the shortest distance is to D
C $\rightarrow$ 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

4.1 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.[8, 10, 11, 12]

4.2 How TSP will be useful for the sustainability

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?[13, 14]

- *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.

5 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.

References

[1] Rai, K., Madan, L., & Anand, K. (n.d.). Research paper on travelling salesman problem and its solution using genetic algorithm. International Journal of Innovative Research in Technology, 1(11).

[2] Rabbani, M., Mobini, M., Sabbaghnia, A., & Ramzi, J. (2020). A graph theory-based algorithm for a multi-echelon, multi-period responsive supply chain network design with lateral transshipments. Operational Research, December.

[3] Dahiya, C., & Sangwan, S. (2018). Literature review on travelling salesman problem. International Journal of Research, 5(16), June.

[4] Figueroa, J., Miller, B., & Okimoto, M. (2012, December 12). A modern application of the travelling salesman problem: Understanding Wal-Mart.

[5] Kumar, P., & Anuradha, J. (2016). An overview of application of graph theory. International Journal of Chemtech Research.

[6] Hoffman, K. L., Padberg, M., & Rinaldi, G. (2001). Travelling salesman problem. Kluwer Academic Publishers.

[7] Johnson, D. S., & McGeoch, L. A. (n.d.). The travelling salesman problem: A case study in local optimization.

[8] Applegate, D. L., Bixby, R. E., Chavatal, V., & Cook, W. J. (2007). The travelling salesman problem. Princeton University Press.

[9] Applegate, D. L., Bixby, R. E., Chavatal, V., & Cook, W. J. (1998). On the solution of travelling salesman problems. Document Mathematica.

[10] Power, D. (2005). Supply chain management integration and implementation: A literature review. Supply Chain Management: An International Journal.

[11] Stadtler, H., & Kilger, C. (2005). Supply chain management and advanced planning. Springer.

[12] Silva, C. A., Sousa, J. M. C., Runkler, T. A., & Sá da Costa, J. M. G. (2008). Discrete optimization distributed supply chain management using ant colony optimization. European Journal of Operational Research.

[13] Kharisma, M. L., Ahmad, A., & Malik, R. (2024, May 1). Product distribution route optimization using the travelling salesman problem (TSP) method at PT. Inbisco Niagatama Semesta (Mayor Group) in Makassar. Journal of Industrial System Engineering and Management.

[14] Iscan, H., & Gunduz, M. (2016, December). An application of fruit fly optimization algorithm for travelling salesman problem. Elsevier B.V.

[15] Griffis, S. E., Bell, J. E., & Closs, D. J. (2012). Metaheuristics in logistics and supply chain management. Journal of Business Logistics.

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Leo Anto T A is a passionate mathematician with a strong academic background, having completed his Bachelor's in Mathematics from Calicut University. He pursued his Master of Science in Mathematics from St. Francis de Sales College under Bangalore University.

Leo has contributed to the field of mathematics through published work on graph theory. With a deep interest in teaching, he currently works as a JEE tutor, helping students understand complex mathematical concepts. Leo's dedication to both research and teaching continues to inspire students and peers in the world of mathematics. He can be reached on leoanto2bscrb@gmail.com

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Shanmugapriya is currently working as an Assistant Professor in the Department of Physical Sciences & Mathematics at St. Francis de Sales College (Autonomous), Electronic City, Bangalore. A distinguished mathematician with a strong academic foundation, she holds an M.Sc., M.Phil., B.Ed., and she is currently pursuing her Ph.D. known for her expertise in applying mathematical principles to address complex real-world problems.

Her contributions to academic literature include a published book chapter titled "Successful Landing of Women: Challenges and Opportunities" in the edited volume "Gender Practical Concerns in Women Psychology". Additionally, her research article, "Magdam Problem with Neutrosophic Fuzzy Set", was featured in the Indian Journal of Natural Sciences, indexed under Web of Science.

In recognition of her innovative approach to mathematics education, Ms. R Shanmugapriya published a patent titled "Closing the Gender Divide in Mathematics Education: Innovative Strategies and Frameworks" in February 2024. Beyond research, Ms. R Shanmugapriya has mentored 12 postgraduate students in topics related to topology and graph theory, fostering the next generation of mathematical thinkers.