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# Analysis of Airline Connectivity using Network Science

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***Abstract---*** *The airline industry is quite booming nowadays, as the need for faster connectivity increases day by day, Challenges faced by the airline industry are familiar and persistent—Cyclical nature of business, slowing down of global economy, uncertainty of fuel prices, technology, crew cost, Environment, and slow pace of liberalization. India has been projected to be the second-fastest-growing country in the world for passenger traffic by the Airports Council International (ACI) in its traffic forecasts between 2017-40. This industry needs to be consistently profitable, this can be achieved by increasing the connectivity by adopting the concepts of graph theory. The stockpile is converted into a graph by representing all the airports as vertices, and the route between them as edges. This could be consummated by using python as the scripting language and NetworkX package for creating and visualizing graphs. This paper reflects that our proposed model comes with higher performance and less maintenance when compared to the other existing decision-making models.*

***Keywords---****Graph analytics, TGO topology, topologyoptimization, NetworkX, python*

## I. INTRODUCTION

An airline is a company that provides air transport services for traveling passengers and freight. Currently, Aviation in India, is the fastest-growing aviation market in the world and Bangalore with 65% national share is the largest aviation manufacturing hub of India. India has become the third largest domestic aviation market in the world and is expected to overtake the UK to become the third largest air passenger market by 2024. The UDAN (UdeDeshkaAam Naagrik) scheme is driving the growth of civil aviation connectivity and infrastructure in India, the connectivity can be increased as there can often be multiple paths from one airport to another, and the aim is to find the shortest possible path between all the airports There are two ways in which we can define a path as the shortest i.e. by distance and by air time. In our paper we have analysed two Indian low cost carrier i.e. AirAsia and SpiceJet. AirAsia is an Indian airline headquartered in Bangalore, India. The airline is a joint venture with Tata Sons holding 51% stake in the airline and AirAsia Investment Limited holding 49% stake. AirAsia India commenced operations on 12 June 2014 with Bangalore as its primary hub, And SpiceJet is an Indian airline headquartered in Gurgaon, India. It is the second largest airline in the country by number of domestic passengers Carried, with a market share of 13.6% as of March 2019. The airline operates 630 daily flights to 64 destinations, including 54 Indian and 10

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international destinations from its hubs at Delhi, Kolkata, Mumbai and Hyderabad.Network science is mainly used for studying complex networks [1]. social networks consider the definite elements or can be represented as nodes (or vertices) and the connection between them as links (or edges) [2]. Networks have undeniable attributes that can be used to analyses the properties and the characteristics of the network. The network properties are mainly used to define the network models which can be used to analyses how the models disparity to each other [3]. The defined properties are size, density, planar network density, average degree, average shortest path length, diameter of network, clustering coefficient, connectedness, node centrality and nodeinfluence [4].

## II. LITERATURE SURVEY

In [5] author discussed about the major reasons for the increasing demand of python. Even though python is slower in runtime compared to the compiled languages like C,C++,it is preferred by developers in the field of data analytics, numerical computations and almost all technical domains like AI,ML,Deep Learning etc. Author [6] had explained about the python importance in the world of programming. He discussed the important libraries and packages that are available in python.Python provides many tools to ease exploration of scientific problems. One of its strength is NetworkX in conjunction with packages Scipy, Numpy, Matplotlib and their connections to LINPACK, ODE integration tools and other tools written in FORTRAN and C allows analysis and implementation of algorithms for analyzing dynamics of network coupled oscillation [7].

Small world phenomenon has been observed and applied in many types of networks. A study of two small-world network models in clustering formation and routing in wireless network gives their properties in term of average node degree and path length. This study provides awareness on how wireless networks behave under small world network models withdistributed routing protocols [8]. In[9] complex network theory was used in construction of the topological structure of airline alliance route network by using the adjacency matrix between the nodes. The three basic statistical indicators: degree and degree distribution, average path length and clustering coefficient are used to make an empirical analysis of the alliance network of Air china.

[10] explained about the graph representations and graph applications and applying graph knowledge to typical engineering applications like truss and explained about the concepts like cut set matrix, circuit matrix, flow law and potential law for checking the validity of truss. A model generates a scale free networks in a deterministic fashion which shows that the tail of the degree distribution follows a power law. The construction of the model follows a hierarchical rule. In order to show that the proposed model is scale free author has used the parameter degree distribution p(k) [11].

In [12] author discussed about an approach to address the challenge of working with machine learning by using lower level features i.e., mainly the description of the network architecture that can be achieved by applying deep learning on network topologies via the use of graph gated neural networks.

## III. PROPOSED METHODOLOGY

Initially air Asia and spice Jet datasets are in .csv files. With the help of the NetworkX package in python, we converted into graphs, Gair (V1, E1) and Gspice (V2, E2) respectively and considered them as inputs. We

Visualized the graphs, Gair (V1, E1) and Gspice (V2, E2) by using matplotlib (Networkx provides basic functionality for visualizing graphs, but its main goal is to enable graph analysis rather than perform graph visualization.) package.

We apply the standard network science parameters like (n, d, E, D, K, C, T, l) which are in table 1, to both the graphs, Gair (V1, E1) and Gspice (V2, E2) [13]. We compare the results of standard network science parameters like (n, d, E, D, K, C, T, l) which are applied to both the graphs, Gair (V1, E1) and Gspice (V2, E2), We further analyzed the graphs, Gair (V1, E1) and Gspice (V2, E2) based on features that are proportional to network science parameters, they are Cost (n, E, K), Maximum Latency(d), Average latency(l), Network Connectivity (D, C, T).

### 3.1 Flowchart for Proposed Model

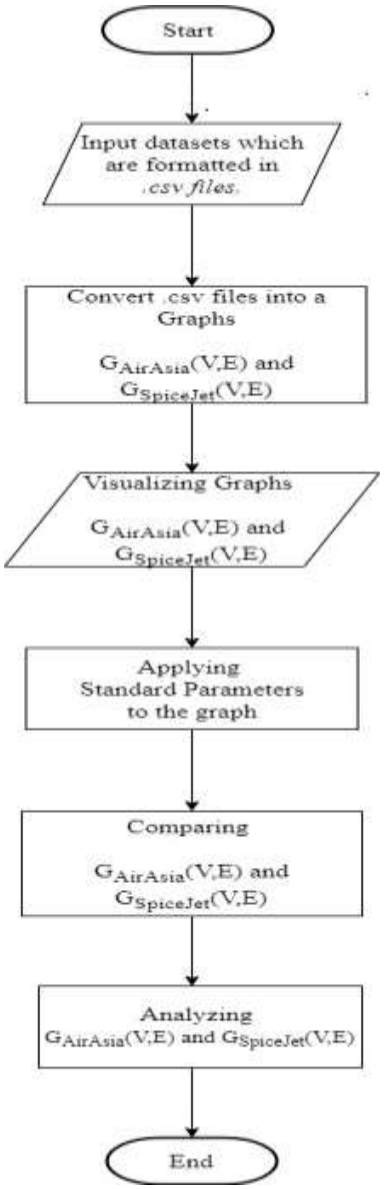


**Figure 1Flow chart for Airline Analysis**

### 3.2 Algorithm for Airline Analysis model

1. Start.
2. We have taken two airlines namely AirAsia and SpiceJet.
3. Input datasets of airlines which are formatted in .csv files.
4. Convert the .csv files into graphs GAirAsia (V1, E1) and GSpiceJet (V2, E2) of AirAsia and SpiceJet respectively.
5. Visualize GAirAsia (V1, E1) and GSpiceJet (V2, E2) by using matplotlib. pyplot package in python.
6. Apply standard parameters like (n, d, E, D, K, C, T, l) for GAirAsia (V1, E1) and GSpiceJet (V2, E2).
7. Comparing GAirAsia (V1, E1) and GSpiceJet (V2, E2) through standard parameters.
8. Analyzing GAirAsia (V1, E1) and GSpiceJet (V2, E2) through standard parameters.
9. Stop.

**Table -1: Notations used in the proposed algorithms**

| Symbol | Description |
|---|---|
| Gair | AirAsia network graph |
| Gspice | Spice Jet network graph |
| V1,V | Nodes of AirAsia |
| E1 | Edges of AirAsia |
| V2 | Nodes of Spice Jet |
| E2 | Edges of Spice Jet |
| d | diameter |
| E | Edges |
| D | Density |
| K | Average degree |
| C | Average clustering coefficient |
| T | Transitivity |
| l | Average shortest path length |

## IV. RESULTS AND DISCUSSION

Airline companies AirAsia andSpice jetwere analyzed with network science parameters like nodes,diameter, edges, density,average degree,average clustering coefficient,transitivity and average shortest path length [14]. While comparing we have observed that nodes and edges of AirAsia is higher than the SpiceJet. diameter of AirAsia is 3 and SpiceJet is 4, the diameter of AirAsia is less than Spice Jet then it is said to be AirAsia is well connected.average degree,transitivity is high for AirAsia, on the other side,Average clustering coefficient and Average shortest path length is less for AirAsia than Spice jet. In figure 2 analysis of AirAsia andSpice jet parameters are represented.

## V. CONCLUSION

In this research we have considered graph theory as our intrinsic technique as the airline analysis is a complex

network. Graph theory helps us to schedule airplane routing and has solved problems such as finding the maximum flow per unit time from a source to a sink in a network of pipes. Statistics shows that, AirAsia India operates over 300 flights daily to over 46 destinations across India, market share of around 23.7%. Since AirAsia India entered the already competitive low-cost carrier sector in the country, airfares have only become more affordable. SpiceJet operates over 250 flights to around 40 destinations in India around the world with a market share of 13.2%.In this research parameters like number of nodes, edges, diameter, average degree, density, transitivity, average clustering coefficient, are used for analyzing the networks of AirAsia and SpiceJet.After in-depth theoretical analysis was determined with above parameters. It was observed that AirAsia is well connected over Spice Jet, which is exactly matching with the real time statistics. Finally, a well-connected network with the shortest distance will have more profits.

## VI. ACKNOWLEDGEMENT

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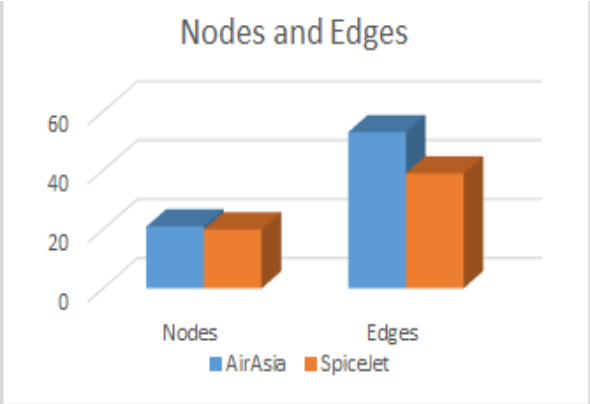
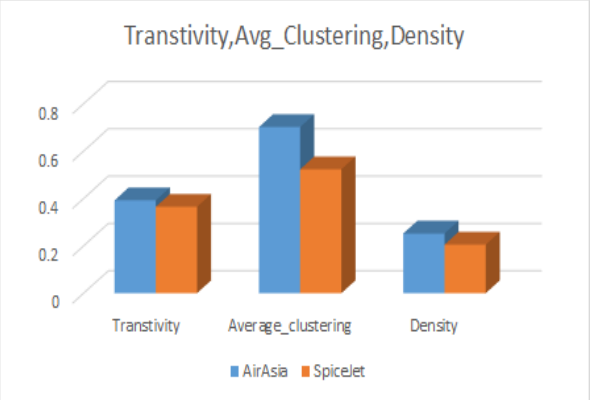
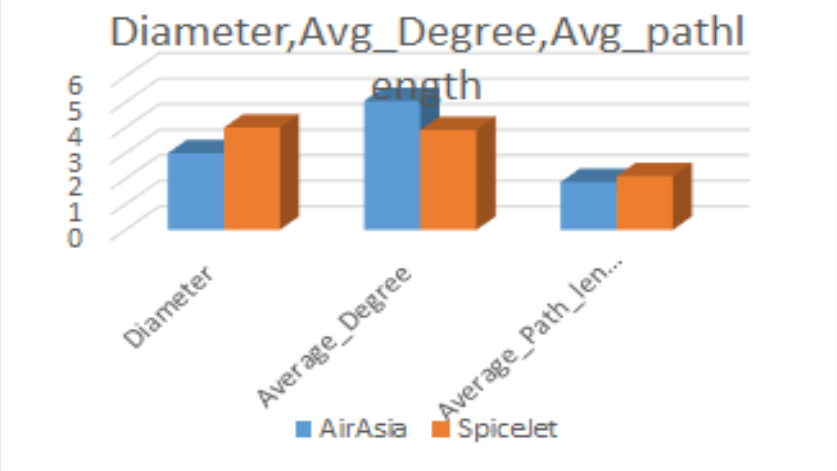



**a) Comparison of nodes and edges**




**b) Comparison of Transitivity, Average clustering, Density**




**c) Comparison of diameter, average degree and average path length**

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**Figure 2 Comparison of AirAsia andSpice jet parameters with network science**

## REFERENCES

[1] S. S. Amiripalli and V. Bobba, "Impact of trimet graph optimization topology on scalable networks," IFS, vol.36, no. 3, pp. 2431–2442, Mar. 2019.

[2] S. S. Amiripalli, V. Bobba, "Research on network design and analysis of TGO topology". International Journal of Networking and Virtual Organisations, 19(1), pp. 72-86.2018

[3] S. S. Amiripalli, V. Bobba, "A Fibonacci based TGO methodology for survivability in ZigBee topologies". INTERNATIONAL JOURNAL OF SCIENTIFIC &TECHNOLOGY RESEARCH, 9(2), pp. 878-881. 2020.

[4] Amiripalli, S. S., Kollu, V. V. R., Jaidhan, B. J., SrinivasaChakravarthi, L., & Raju, V. A. (2020). Performance improvement model for airlines connectivity system using network science. International Journal of Advanced Trends in Computer Science and Engineering, 9(1), 789-792. doi:10.30534/ijatcse/2020/113912020

[5] Python for Data Analytics, Scientific and Technical Applications, Abhinav Nagpal1, Goldie Gabrani21School of Computer Science and Engineering, Vellore Institute of Technology, Vellore,2School of Engineering and Technology, BML Munjal University, Gurugram.M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[6] A Survey: How Python Pitches in IT-World,Arun Kumar, Supriya.P.Panda, Department of CSE, MRIIRS, Faridabadarunk.fet@mriu.edu.in, supriya.fet@mriu.edu.in

[7] Exploring network structure, dynamics, and function using NetworkX, Aric Hagberg and Pieter J.Swart Mathematical Modeling and Theoretical Division,Los Alamos National Laboratory,Los Alamos, NM 87545 Daniel A. Schult, Department of Mathematics, colgateUniversity,Hamilton, NY 13346.

[8] An Experimental Study of Small World Network Models for Wireless Networks,Ziqian Dong1, Zheng Wang1, Wen Xie1, Obinna Emelumadu1, Chuan-Bi Lin2 and Roberto Rojas-Cessa3 1.Department of Electrical and Computer Engineering, New York Institute of Technology, New York, NY10023. 2.Department of Information and Communication Engineering Chaoyang University of Technology, Taichung, Taiwan 41349. 3.Department of Electrical and Computer Engineering, New Jersey Institute of Technology, Newark, NJ 07102 Email: ziqian.dong@nyit.edu; cblin@cyut.edu.tw; rojas@njit.edu

[9] Evolution of Airlines Alliance Route Network Efficiency Based on Complex Network, JiajiaShao, College of Civil Aviation, Nanjing University of Aeronautics and Astronautics, Nanjing, China shaojiajia1995@163.com, 2019 4th International Conference on Electromechanical Control Technology and Transportation (ICECTT)

[10] Graph theory representations of engineering systems and their embedded knowledge O. Shaia1, K.Preiss2. 1. Department of Solid Mechanics, Materials and Structures, Tel Aviv University, Tel Aviv 69978, Israel. 2. Department of Mechanical Engineering and School of Management, Ben Gurion University, Beer Sheva 84105, Israel. Received 10 July 1998; received in revised form 25 November 1998; accepted 12 December 1998.

[11] Deterministic scale-free networks,Albert-Laszlo Barabasi1; Erzsebet Ravasz1 , Tamas Vicsek2 1.Department of Physics, College of Science, University of Notre Dame, 225, Nieuwland Science Hall, Notre Dame, IN 46556-5670, USA 2. Department of Biological Physics, Eotvos University, P many P eterSetany 1-A, Budapest,Hungary H-1117.Received 18 July 2001.

[12] Performance Evaluation of Network Topologies using Graph-Based Deep Learning, FabienGeyer, Technical University of Munich, fgeyer@net.in.tum.de

[13] Amiripalli, S. S., &Bobba, V. (2019). Trimet graph optimization (TGO) based methodology for scalability and survivability in wireless networks. International Journal of Advanced Trends in Computer Science and Engineering, 8(6), 3454-3460. doi:10.30534/ijatcse/2019/121862019.

[14] S.S. Amiripalli and V. Bobba, "An Optimal TGOTopology Method for a Scalable and Survivable Networkin IOT Communication Technology," Wireless PersCommun, vol. 107, no. 2, pp. 1019–1040, Jul. 2019.https://doi.org/10.1007/s11277-019-06315-z

[15] Garg, A., & Negi, A. (2019). Multi operator based affine transformation function for fractal image generation with minimal distortion. International Journal of Advanced Science and Technology, 28(20), 1223-1238. Retrieved from www.scopus.com

[16] Kingsly, A. A. S., & Mahil, J. (2019). Effective approach of learning based classifiers for skin cancer diagnosis from dermoscopy images. International Journal of Advanced Science and Technology, 28(20), 1016-1026. Retrieved from www.scopus.com