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Performance improvement model for Airlines connectivity system using Network Science

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ABSTRACT
In recent years analytics plays an important role in understanding and increasing profits of any business. There are different types of analytic models available in market. Some of them are descriptive analytics, predictive analytics, prescriptive analytics, big data analytics etc. In this paper two different airline systems are selected and Graph analytics were applied. In initial process AirAsia and SpiceJet datasets are converted into graphs G_{air} (V_1, E1) and G_{spice} (V_2, E2). Graph analytics were applied on the above graphs and found that one i.e.,G_{spice} is weakly connected over G_{air}. A model was proposed to increase the connectivity of G_{spice} so that the performance of G_{spice} can be increased. So that G_{spice} can increase the business by adding trips in an incremental order from one trip to 15 trips. Finally, we compared the above airline companies with the proposed model generated results and it was observed that proposed model is giving a feasible solution to G_{spice} by adding trips in an incremental order.

Key words: Graph analytics, TGO topology, topology optimization, NetworkX, python

1. INTRODUCTION

In solving many engineering applications, the best way is to represent problem in the form of diagram or a graph. In this research connectivity of two airline systems are analyzed theoretically by using network science parameters. Connectivity places an important role in increasing services to customers and also increases profits to the company. This is one of the oldest techniques inherited from Konigsberg bridge problem. We are making a new attempt to solve this problem using graph theory [1], [2].

Topology plays an important role in modern wireless technologies like WSN, adhoc networks, cyber-physical system and IOT [3]. We have basic topologies like bus, ring, star, mesh, tree, etc., which are not fulfilling all the requirements of the modern engineering problems. In this paper we are studying different models like Random network model, BARABASI-ALBERT model, Hierarchical model [4],[5],[6]. Paper was divided into three parts, in first part introduction and literature survey was discussed followed by proposed methodology, finally results are discussed in detail.

2. RELATED WORK

[7] author has explained about Network science methods are applied to SCN model for growth and subsequently analyze various topological features, such as robustness attributable to highly complex and interconnected nature .The presented paper provides a comprehensive review of the methodologies adopted in literature for modeling the topology and robustness of SCNs, topological features of the real world SCNs , limitations of existing network growth models to realistically represent the observed topological characteristics and a novel perspective is proposed to impersonate the SCN topologies reported in studies, through fitness based generative network models.
[8] author has given importance of dynamic scenarios in Animals, humans, and multi-robot systems as they operate in dynamic environments they have the ability to respond to changing circumstances is paramount. An effective response requires suitable information transfer to agents this totally depend upon the interaction network. For analyzing the collective response consider an archetypal model of distributed decision-making and study the capacity of the system to follow a driving signal for varying topologies and system sizes. Experiments with a swarm of robots reveal a nontrivial relationship between frequency of the driving signal and optimal network topology. Slow- changing confusion increases with the degree of the interaction network, but the opposite is true for the response to fast-changing ones. These results are reaching implications for the design and understanding of distributed systems a dynamic rewiring of the interaction network is essential to effective collective operations at different time scales.

[9] Here the author has reviewed that complex networks have an important part in science as it mainly tells about our cultural background, perceive human interactions and consume media. The main motive behind this paper is to define the signature of a novel's story based on the topological analysis of its social network of characters, for this the author

has built an automated tool that analyses the dialogs in novels, identifies characters and computes their relationships in time-dependent manner in order to assess the network's evolution over the course of the story.

Complex networks are characterized by highly heterogeneous distributions of links in the presence of key properties such as robustness. Several correlation measures are taken to define the characterized structure of the nets. These measures are computed for a number of real networks and analytically estimated for some simple standard models. It shows that how real networks are clustered in a well-defined domain of the entropy noise space. By using simulated annealing optimization, we suggest that constraints are actually operated on the possible complex networks [10], [11].

3. PROPOSED TGO METHODOLOGY

Initially air Asia and spice Jet datasets are converted into graphs, Gair(V1, E1) and Gspice(V2,E2) respectively and considered as inputs [12]. We analyse them using standard network science parameters like (n, d, E, D, K, C,T,l) which are in table 1. Detail flow of the model was explained in figure1 .After analyzing them we will find out the less efficient network. If Gspice is less efficient than Gair, we will store Gair values into temporary variables and consider each edge Eiin Gair which is not Gspice and check the network with standard network science parameter. If it has better performance than previous network, consider the edge Ei otherwise donot consider it. Similarly, if Gairis less efficient than Gspice, we will store Gspice values into temporary variables and consider each edge Ei in Gspice which is not Gairand check the network with standard network science parameter. If it has better performance than previous network, consider the edge Eiotherwise donot consider it. Finally show the output for in incremental order [13], [14],[15].

Table 1: Notations used in the proposed algorithms	
Symbol	**Description**
Gair	airAsia network graph
Gspice	spiceJet network graph
V1	Nodes of airAsia
E1	Edges of airAsia
V2	Nodes of spiceJet
E2	Edges of spiceJet
n	Number of nodes
d	diameter
E	Edges
D	Density
K	Average degree
C	Average clustering coefficient
T	Transitivity
l	Average shortest path length

3.1 Flowchart for TGO Methodology

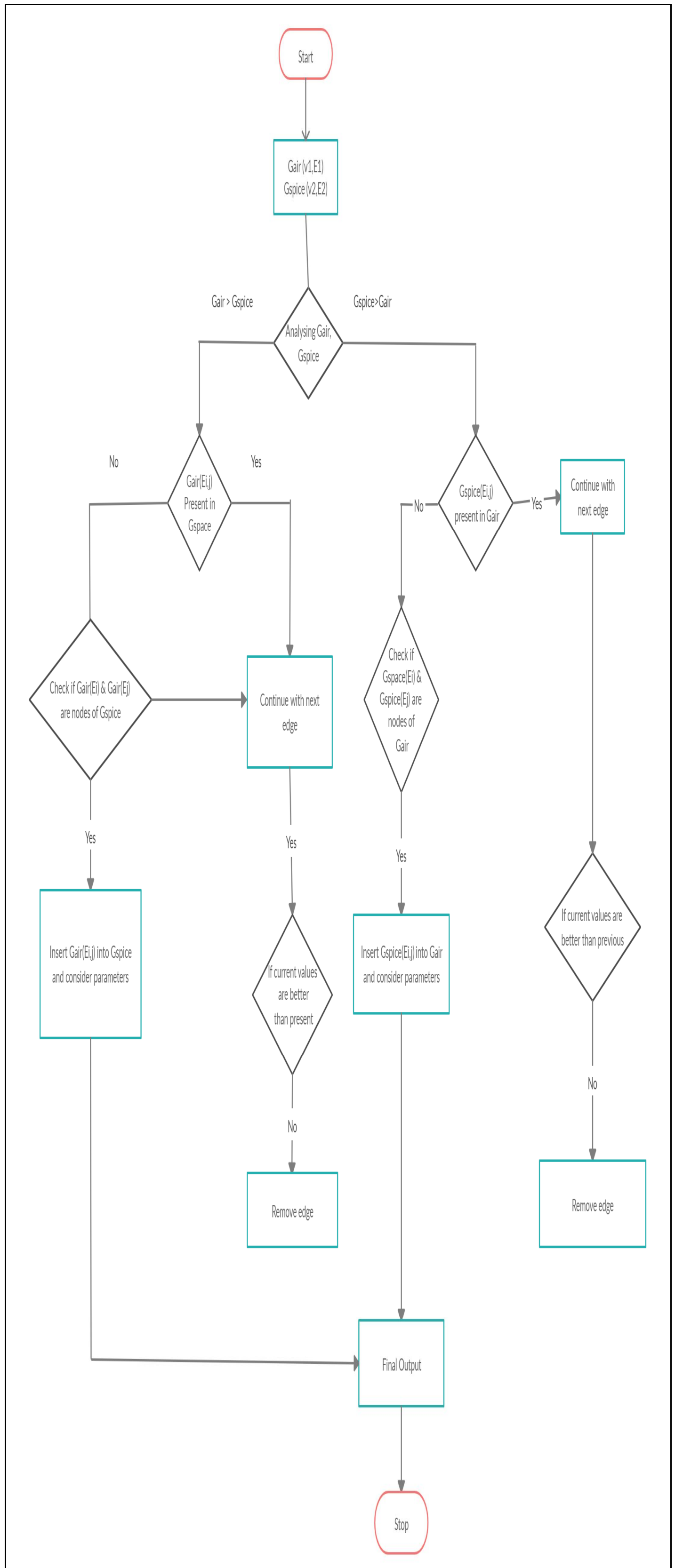


Figure 1 Flow chart for TGO model

3.2 Algorithm for TGO Methodology

Input: G_{air}, G_{spice}
Output: $G_{spice'}$

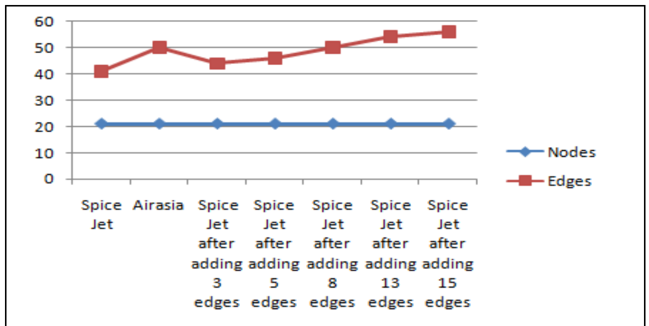
1. Start
2. Let us consider G_{air} (V_1, E_1) and G_{spice} (V_2, E_2) as inputs
3. Analyzing G_{air}, G_{spice} by using standard network science parameters like (n, d, E, D, K, C,T,l)
4. Identifying less efficient graph from G_{air} and G_{spice}
5. Improving the performance of less efficient graph
6. If G_{spice} is less efficient than G_{air}:
Consider the factors of air Asia and store them in temporary variables
for each edge G_{air} (V_i,E_i) in G_{air}:
if G_{air}(V_i,E_i) not in G_{spice} and V_i nodes present in G_{spice}:
insertEi into Gspice and consider the parameters, (n,d,E,D,K,C,T,l)
consider flag=0
if current parameters values are much efficient than values stored in temporary variables:
update temporary variables values with current factor values
update flag=1
if flag==1:
afterE_i print the efficiency
else:
remove$E_i$from G_{spice}
else:
Continue with next edge
7. Else If G_{air} is less efficient than G_{spice}:
Consider the factors of SpiceJet and store them in temporary variables
for each edge G_{spice}(V_i,E_i) in G_{spice}:
if G_{spice}(V_i,E_i) not in G_{air} and V_i nodes present in G_{air}:
insert$E_i$into G_{air} and consider the parameters ,(n,d,E,D,K,C,T,)
consider flag=0
if current parameters values are much efficient than values stored in temporary variables:
update temporary variables values with current factor values
update flag=1
if flag==1:
afterE_i print the efficiency
else:
removeE_i from G_{air}
else:
Continue with next edge
8. Finally show output of the improved Graph
9. Stop

4. RESULTS AND DISCUSSION

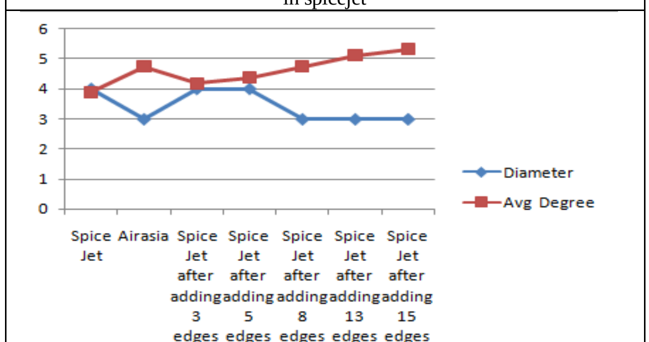
In figure 2. a) Same number of nodes (n) are considered and edges (E) are compared with previous airasia, spice Jet. Results of spice Jet is low so our algorithm slowly increases the performance of spice jet, at the end spice jet has good number of edges for better performance. In fig b) Diameter (d) is decreasing and similarly average degree (K) of a network is increasing which proves the closeness and connectivity of locations is improving. In fig c) average clustering(C), transitivity (T) and density (D) of spice jet are increasing by adding edges to a network which indicates number of locations associated with respective location is increasing when compared to previous network. In fig d) the average shortest path length (l) is decreasing which shows that pathlenth for traveling from one location to another location is low. Finally we can observe detail comparison was in the below table 2.

Table 2: Results Generated by Air Asia and Spice Jet

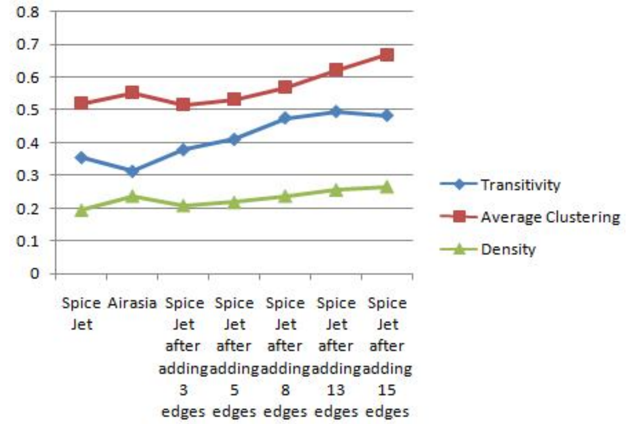
Parameter	Spice Jet	Air Asia	Spice Jet adding 3 edges	Spice Jet adding 5 edges	Spice Jet adding 8 edges	Spice Jet adding 13 edges	Spice Jet adding 15 edges
Nodes	21	21	21	21	21	21	21
Edges	41	50	44	46	50	54	56
Diameter	4	3	4	4	3	3	3
Avg Degree	3.9	4.76	4.1905	4.3810	4.7619	5.14	5.33
Transitivity	0.355	0.313	0.3791	0.4109	0.4764	0.4961	0.4845
Avg Clustering	0.52	0.552	0.5164	0.5329	0.5693	0.6231	0.6696
Density	0.195	0.238	0.2095	0.219	0.238	0.2571	0.267
Avg shortest Path length	2.09	1.857	2.03	2.009	1.96	1.9285	1.8809



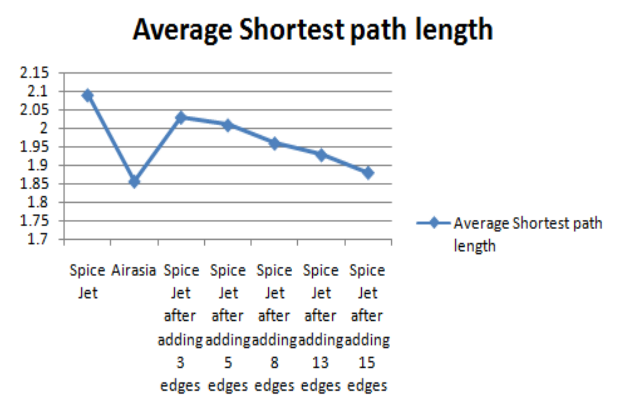
a)comparing nodes and edges of spicejet ,airAsia and improvements taken in spicejet



b)comparing diameter and average degree of spicejet ,airAsia and improvements taken in spicejet



c)comparing average clustering, transitivity and density of spicejet ,airAsia and improvements taken in spicejet



d)comparing average shortest path length of spicejet ,airAsia and improvements taken in spicejet

Figure2.comparision of network science parameters like nodes, edges, diameter, average degree, transitivity, average clustering, average shortest path length for both airlines.

5. CONCLUSION

Graph analytics is one of the important techniques used for solving complex problems. In this research a complex problem will be converted into networks, for these networks standard graph theory and network science techniques was applied to get a feasible solution. In this research parameters like node, edge, and diameter, average degree, density, transitivity, average clustering, average shortest path length are used for analyzing spiceJet and airAsia. After performing graph analytics with above parameters it was observed that airAsia is well connected over spiceJet. To enhance the performance of the spiceJet a model was proposed by adding edges in an incremental order. Finally, the proposed model was compared with airAsia and spiceJet networks and it was observed that performance of proposed model shows a greater impact for giving a feasible solution to the weak connected network.

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