Airplane Crash Analysis Using LDA

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Abstract - *Data mining is defined as a process used to extract usable data from a larger set of any raw data. It is used in the many area, like medicine, environment, education, crime, etc. In this research work crash investigation and analysis of the flights are done. Flight crashes may be caused due to pilot error, mechanical failure, bad weather, sabotages or human error. This research paper investigates international flight crashes since 1908 to 2009 through K-Means clustering data mining technique and LDA. Clustering helps to put objects into the same group. LDA measure helps in finding similarity among different texts. The research work is done for identifying aboard/ground fatality rate with location as well as to find comparison among the flight crashes.*

Key Words: Clustering, data mining, LDA,K-Means clustering.

1. INTRODUCTION

Air accident is caused due to pilot error, mechanical error, bad weather, sabotages or human error. these error can be happened any time. air accident is also called flying mischance. aeronautics misfortunes can happened at any time .flying mischance cases have a Great degree complexity .aircraft crashes cause harm to the population as it may lead to the deaths of people or may even cause Injuries to the people. crash investigation is a major research area and the major techniques used for this investigation are statistics ,grid computing, cloud computing, digital image processing and data mining .with data mining ,we can parse through extremely large amount of data and find out unknown patterns of air mischance. The Major of our project is to use data mining techniques to find out unknown patterns in the international flight crash dataset. the research is carried on aircraft crash and fatalities data collected from the year 1908 to 2009.This work is carried out using k-mean clustering data mining technique and cosine similarity measure.

The paper is further structured as follows theoretical background, methodology, experimental setup, analysis and conclusion Aircraft crashes are fundamental to weather (thunderstorm, strong winds, etc.), pilot error, etc. There is a necessity to study these issues. The study helps to understand who all are suffering, what is the reason for the crash and what harm is it causing to the general population and how can we prevent them. The crashes may cause loss of human life as well as loss of natural resources.

Finding designs in the aeronautical data physically is impracticable because of the mass measure of data delivered each day. This vast amount of data can be analyzed and measured using various computing techniques. Data mining is a computing technique that can be used to discover unknown patterns from the massive dataset. , produced to make expectations for future data in light of examples found in gathered data. Data Mining techniques can be classified as classification, prediction, association and clustering. The table given below depicts the various techniques used to analyze aircraft related issues (Refer Table I).

Clustering is a procedure of forming a group of abstract objects into categories of similar objects. Clustering algorithms can be split into partitioned and hierarchical clustering. Partitioned clustering algorithms aims to find out the groupings present in the data by optimizing a specific objective function and iteratively enhancing the quality of the partitions. They are also called prototype-based clustering algorithms [2].

2. THEORETICAL BACKGROUND

The most common reasons for plane accidents are pilot error, mechanical failure, human error, etc. These parameters are explained as follows:

1. Pilot Error – Roughly 50% of the aircraft losses incur due to pilot error. There are many chances for The pilots to cause errors from failing to program correctly to miscalculation of the required fuel.

2. Mechanical Failure - Despite developments in model and manufacturing standards of the aircrafts, mechanical failures account for 20% of aircraft losses.

3. Weather - Despite of having multiple electronic aids, aircrafts still struggle to function properly when the weather turns out to be unpleasant like in storms, snow and fog.

4. Sabotage - The dangers posed by sabotage are much less than many people seem to believe. Approximately 10% of aircraft losses occur due to sabotage.

5. Human Error – Mistakes can be made by humans operating when required to work for longer hours. Air traffic controllers, dispatchers, loaders, etc are some of the jobs that are operated by humans. [1].

3. LITERATURE SURVEY

- "Flight Crash Investigation Using Data Mining Techniques". The research work is done for identifying aboard/ground fatality rate with operators and locationas well as to find similarity among the plane crashes [3].

- Analysing relationships between aircraft accidents and incidents. In proceedings of the international conference on research in air transportation. In this research he employed a data mining technique to conduct the holistic analysis of aircraft incident data in relation to the accident data. The analysis identifies the relation between the accident and incident data and finds the patterns of casual and contributory factors which are significantly associatively with the aircraft accident [4].

- Improvement of aircraft accident investigation through expert systems. In this research presented in this paper shown that expert system methodology is a robust approach to analyzing the aircraft accident investigation [3].

- " data clustering algorithms and applications ",CRC press. In this research the data clustering algorithm and application provides complete coverage of area of clustering from the basic method to more refined and data clustering approaches.it pays special attention to the in graphs, social networks [6].

4. METHODOLOGY

In natural language processing, Latent Dirichlet allocation (LDA) is a generative statistical model that allows sets of observations to be explained by unobserved groups that explain why some parts of the data are similar. For example, if observations are words collected into documents, it posits that each document is a mixture of a small number of topics and that each word's creation is attributable to one of the document's topics.

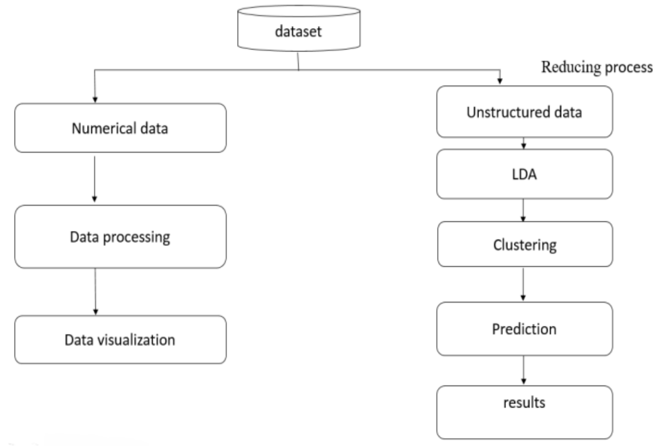


Fig -1: methodology.

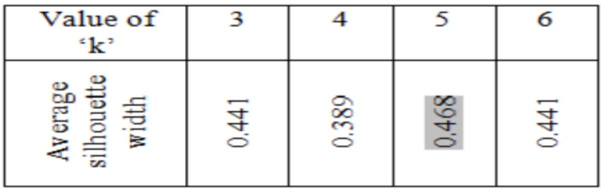
The methodology to be adopted for the research is depicted in Flight Crash Dataset - The flight crash dataset contains structured as well as unstructured dataset. It contains various attributes like date, time, location, operator, flight number, route, plane type, registration, cn/ln, aboard, fatalities, ground and summary. It was collected from opendata.socrata.com [7].

Latent Dirichlet allocation (**LDA**) -is a generative statistical model that allows sets of observations to be explained by unobserved groups that explain why some parts of the data are similar. For example, if observations are words collected into documents, it posits that each document is a mixture of a small number of topics and that each word's creation is attributable to one of the document's topics.

Data Reduction/Pre-processing - The dataset has structured (date, time, location, etc.) and unstructured (summary of the airplane crash) data. The dataset is reduced by considering certain attributes for the analysis and by removing the empty rows. The reduced numerical dataset contains the following attributes: location, operator, route, aboard, fatalities and ground while the reduced unstructured dataset contains only 1 attribute, i.e. summary. The numerical dataset is used to find out the fatality rate of air crashes while the unstructured dataset is used for finding content similarity from the summary.

Identifying the value of 'k' - The value of 'k' is verified using the average silhouette operator. The value of 'k' which has the highest average silhouette width is selected. In this case, 'k'='5' is selected (Refer Table I).

Table -1: selecting the value of 'k'.



Value of 'k'	3	4	5	6
Average silhouette width	0.441	0.389	0.468	0.441

K-Means clustering - is the most broadly utilized partitioned clustering algorithm. It begins by randomly taking 'K' representative points as the initial centroids. Each point is then appointed to the nearest centroid based on a particular proximity measure picked. Once the clusters are formed, the centroids for every cluster are updated. The algorithm iteratively repeats until the centroids don't change. K-Means clustering is a greedy algorithm which is guaranteed to converge to a local minimum, but the minimization of its score function is known to be NP-Hard.

Algorithm for K-Means clustering:

1. Select K points as initial centroids.

2. Repeat

a. Form K clusters by assigning each point to its closest centroid.

b. Re-compute the criterion of each cluster.

3. Until the convergence criterion is met.

5. EXPERIMENTAL SETUP

A. Dataset Used

The flight crash dataset was taken from the website [7]. It consists of flight crash details dated from 1908 to 2009. The attributes of the dataset are date, location, operator, summary, etc.

Original Dataset:-

Total number of rows in dataset are 5269.

Total number of columns in the dataset are 21.

Attributes in the dataset are date, time, location, operator, flight number, route, plane type, registration, cn/ln, aboard, fatalities, ground and summary.

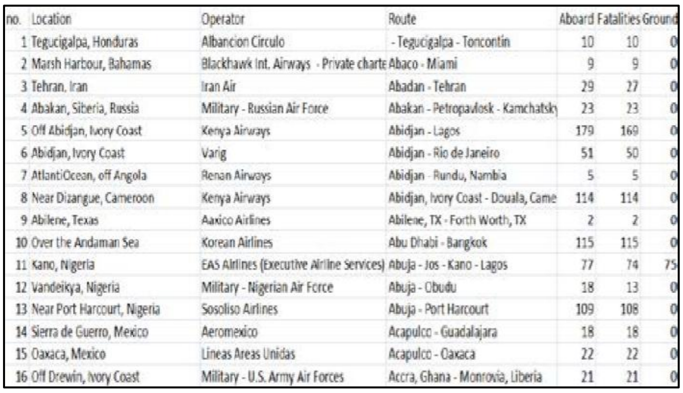
Reduced/Pre-processed Numerical Dataset:-

The number of rows considered after data cleaning is 3535.

The number of columns considered for analysis is 6. The attributes considered for analysis after data reduction are location, operator, route, aboard, fatalities and ground. A screenshot of the pre-processed numerical dataset is shown in Fig. 2.

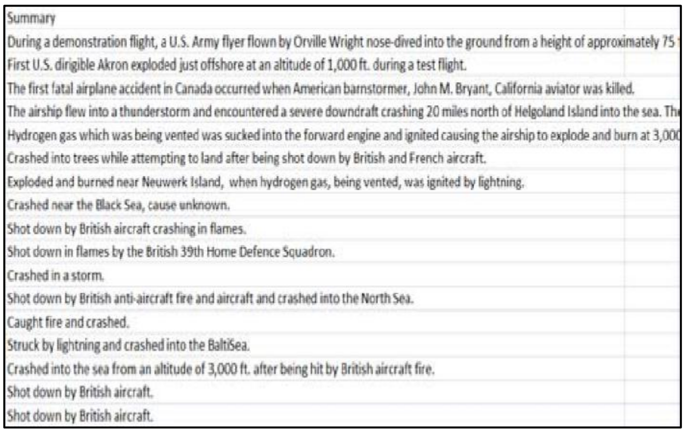
Reduced/Pre-processed Unstructured Dataset:- The number of rows considered after data cleaning is 3535.

The number of column considered for analysis is 1. The attribute considered for the analysis after data reduction is summary. A screenshot of the pre-processed unstructured data is shown in Fig. 3.



no.	Location	Operator	Route	Aboard	Fatalities	Ground
1	Tegucigalpa, Honduras	Albancion Circulo	- Tegucigalpa - Toncontin	10	10	0
2	Marsh Harbour, Bahamas	Blackhawk Int. Airways - Private charte	Abaco - Miami	9	9	0
3	Tehran, Iran	Iran Air	Abadan - Tehran	29	27	0
4	Abakan, Siberia, Russia	Military - Russian Air Force	Abakan - Petropavlosk - Kamchatsky	23	23	0
5	Off Abidjan, Ivory Coast	Kenya Airways	Abidjan - Lagos	179	169	0
6	Abidjan, Ivory Coast	Varig	Abidjan - Rio de Janeiro	51	50	0
7	AtlantiOcean, off Angola	Renan Airways	Abidjan - Rundu, Nambia	5	5	0
8	Near Dizangue, Cameroon	Kenya Airways	Abidjan, Ivory Coast - Douala, Came	114	114	0
9	Abilene, Texas	Aaxico Airlines	Abilene, TX - Forth Worth, TX	2	2	0
10	Over the Andaman Sea	Korean Airlines	Abu Dhabi - Bangkok	115	115	0
11	Kano, Nigeria	EAS Airlines (Executive Airline Services)	Abuja - Jos - Kano - Lagos	77	74	75
12	Vandeikya, Nigeria	Military - Nigerian Air Force	Abuja - Obudu	18	13	0
13	Near Port Harcourt, Nigeria	Sosoliso Airlines	Abuja - Port Harcourt	109	108	0
14	Sierra de Guerro, Mexico	Aeromexico	Acapulco - Guadalajara	18	18	0
15	Oaxaca, Mexico	Lineas Areas Unidas	Acapulco - Oaxaca	22	22	0
16	Off Drewin, Ivory Coast	Military - U.S. Army Air Forces	Accra, Ghana - Monrovia, Liberia	21	21	0

Fig -2: Pre-processed Numerical Dataset.



Summary
During a demonstration flight, a U.S. Army flyer flown by Orville Wright nose-dived into the ground from a height of approximately 75
First U.S. dirigible Akron exploded just offshore at an altitude of 1,000 ft. during a test flight.
The first fatal airplane accident in Canada occurred when American barnstormer, John M. Bryant, California aviator was killed.
The airship flew into a thunderstorm and encountered a severe downdraft crashing 20 miles north of Helgoland Island into the sea. The
Hydrogen gas which was being vented was sucked into the forward engine and ignited causing the airship to explode and burn at 3,000
Crashed into trees while attempting to land after being shot down by British and French aircraft.
Exploded and burned near Neuwerk Island, when hydrogen gas, being vented, was ignited by lightning.
Crashed near the Black Sea, cause unknown.
Shot down by British aircraft crashing in flames.
Shot down in flames by the British 39th Home Defence Squadron.
Crashed in a storm.
Shot down by British anti-aircraft fire and aircraft and crashed into the North Sea.
Caught fire and crashed.
Struck by lightning and crashed into the BaltiSea.
Crashed into the sea from an altitude of 3,000 ft. after being hit by British aircraft fire.
Shot down by British aircraft.
Shot down by British aircraft.

Fig -3: Pre-processed Unstructured Dataset.

5.1. Clustering of Numerical Dataset

The factors considered in the analysis are as follows:

1. Fatality rate with operator

2. Fatality rate with location

The above factors were considered for ground/aboard fatality.

5.1.1. Case Study 1: Fatality rate with Operator

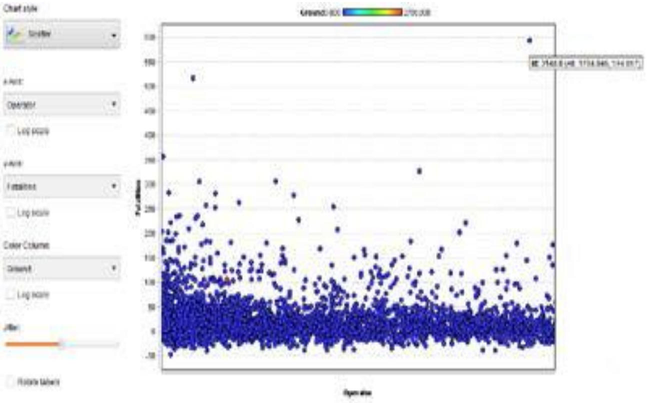


Fig -4: operator v/s fatality with respect to ground.

The ID 3148 refers to the highest fatality rate, i.e. 583, that was caused by the Pan American World Airways/KLM at

Tenerife, Canary Island while travelling from Tenerife to Las Palmas. The Id 3148 resides in cluster 2. The range for ground is 0 to 2750 (Refer Fig. 4) which can be referred from the different colors scaled above the graph (blue, green, red).

5.1.2. Case Study 2: Fatality rate with Location The range for the ground is 0 to 2750 while for aboard is 1 to 644 (Refer Figure 6), which can be referred from the different colors scaled above the graph.

5.1.2.1. Result Analysis for Cluster 0.

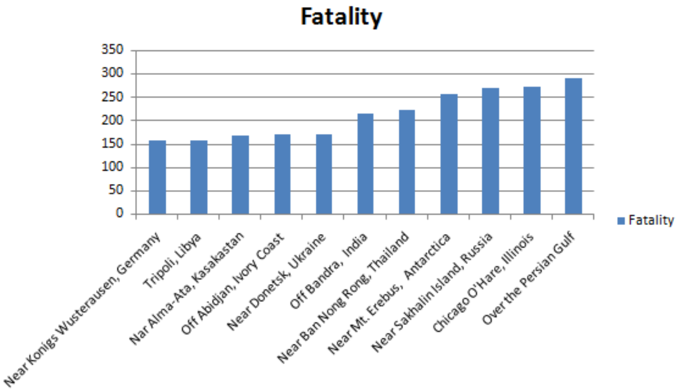


Fig -5: location v/s fatality with respect to ground/aboard.

The countries having equal to or greater than 50% of 290(50% of the highest fatality rate from cluster 0) were considered

(Refer Fig. 5). The highest fatality rate is 290 over the Persian Gulf, near Bandar Abbas in Iran. Chicago O'Hare, Illinois in

USA with 271, near Sakhalin Island in Russia with 269, near Mt. Erebus in Antarctica with 257, near Ban Nong Rong in

Thailand with 223, off Bandra in India with 213, near Donetsk in Ukraine with 170, off Abidjan in Ivory Coast with 169, near

Alma-Ata Kazakhstan with 166, Tripoli in Libya with 157 and near Konigs Wusterausen, Germany with 156.

5.1.2.2. Result Analysis for Cluster 1

The countries having equal to or greater than 50% of 329(the highest fatality rate from cluster 1) were considered (Refer

Fig. 6).

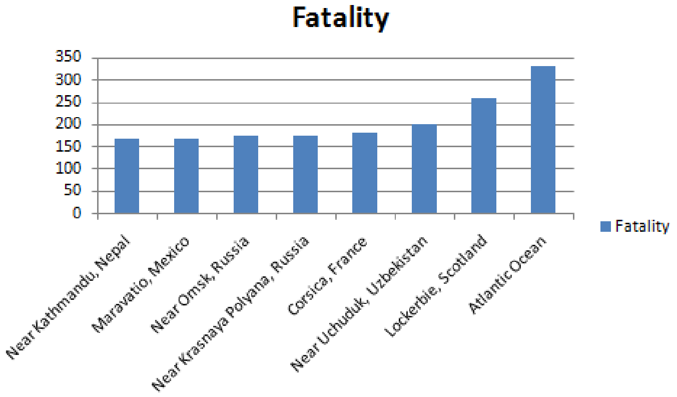


Fig -6: location v/s fatality with respect to ground/aboard.

The highest fatality rate is 329 over the Atlantic Ocean, 110 miles west of Ireland. Lockerbie in Scotland with 259, near

Uchuduk in Uzbekistan with 200, Mt. San Pietro, near Ajaccio, Corsica in France with 180, near Krasnaya Polyana,

Russia with 174, near Omsk in Russia with 174, Maravatio in Mexico with 167 and near Kathmandu in Nepal with 167.

5.1.2.3. Result Analysis for Cluster 2

The countries having equal to or greater than 50% of 583(the highest fatality rate from cluster 2) were considered (Refer

Fig. 7). The highest fatality rate is 583 at Tenerife in Canary Islands and the second highest fatality is 520 at Mt. Osutaka

near Ueno Village in Japan. The countries having equal to or greater than 50% of 583(the highest fatality rate from cluster 2) were considered (Refer Fig. 7). The highest fatality rate is 583 at Tenerife in Canary Islands and the second highest fatality is 520 at Mt. Osutaka near Ueno Village in Japan. The countries having equal to or greater than 50% of 583(the

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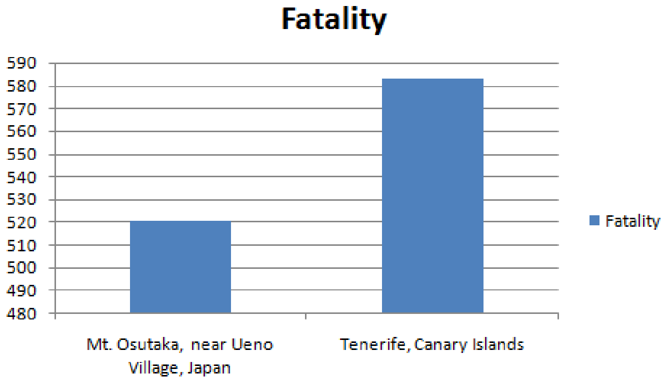

Fig -7: location v/s fatality with respect to ground/aboard.

The countries having equal to or greater than 50% of 583(the highest fatality rate from cluster 2) were considered (Refer

Fig. 7). The highest fatality rate is 583 at Tenerife in Canary Islands and the second highest fatality is 520 at Mt. Osutaka near Ueno Village in Japan.

6. CONCLUSION

The K-Mean clustering technique was used to find the clusters and fatality for the flight crash investigation. The fatality of ground is more than aboard. Aeroflot has the maximum fatality, i.e. 4266, of all the other operators. The route Tenerife - Las Palmas has got the maximum number of fatalities. The research work can be extended using other clustering techniques like Density Based, Hierarchical clustering. The summary report of the dataset is used to identify better clusters using distance measures like cosine similarity. Cosine similarity is used for finding the similarity among the crashes. Majority of the flights crashed in *USA*. The flights with id This study covered accidents and incidents pertaining to commercial flights within the United States. A similar study could be conducted on the General Aviation (GA). Depending on the availability of the data, the studies could be extended to regions in other countries.

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