PROJECT REPORT

project ID : PNT2022TMID22532

Project Name : AIRLINES DATA ANALYTICS FOR AVAITION INDUSTRY

TEAM LEAD :

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1. INTRODUTION

1.1 Project Overview :

Big data technology facilitates the utilization of high volumes of external and internal data to create new products, services and improve business operations. In the era of big data, airlines can provide services that are more satisfying to customers and to stay competitive in their fierce marketplace.

With the advent of digitalization, more enterprises are adopting big data and business analytics to analyze available data in order to improve their products, services and sustain smart decision-making (Maroufkhani et al., 2019). The development of big data management research has generated a range of analytical tools that could be utilized to better respond to such sudden 'black swan' risks, like COVID-19 pandemic (Ienca and Vayena, 2020). Big data was described as the massive volume of both structured and unstructured data, difficult to process using common software techniques or by using traditional statistical methods (Baggiom, 2016). Big data is being generated through different sources including internet traffic, mobile transactions, user generated content, and social media (George et al., 2014).

There are few studies of big data technology in the airline industry; the present study attempts to contribute to the debate on this topic. This research adopts a qualitative approach to explore the application of big data analytics for airlines in Egypt. The objectives of this study are to discover the airlines' concept of big data, and to determine the different opportunities and challenges of big data in this context. Finally, the discussion, conclusion and future research avenues are illustrated.

1.2 Purpose

- What are the main applications of big data technology in the airline industry?
- What are the sources and types of big data in airlines?
- What are the opportunities that airlines can reap from adopting big data?
- What are the challenges that airlines can face in adopting big data?

2. LITERATURE SURVEY
2.1 Existing Solution
2.2 References

1.Applying Machine Learning to Aviation Big Data for Flight Delay Prediction
Authors :Yushan Jiang, Liu Yongxin, Dahai Liu, Houbing Song
Year : 2021
Link : https://ieeexplore.ieee.org/document/9389876
Flight delay has been a serious and widespread problem that needs to be solved. One promising solution is the flight delay prediction. Although big data analytics and machine learning have been applied successfully in many domains, their applications in aviation are limited. This paper presents a comprehensive study of flight delay spanning data pre-processing, data visualization and data mining, in which we develop several machine learning models to predict flight arrival delays. Two data sets were used, namely Airline On-Time Performance (AOTP) Data and Quality Controlled Local Climatological Data (QCLCD). This paper aims to recognize useful patterns of the flight delay from aviation data and perform accurate delay prediction. The best result for flight delay prediction (five classes) using machine learning models is 89.07% (Multilayer Perceptron). A Convolution neural network model is also built which is enlightened by the idea of pattern recognition and success of neural network method, showing a slightly better result with 89.32% prediction accuracy.

2.Learning Machine Model - based Prediction of Flight Delay
Authors : Lakshmi Kalyani, G.Jeshmitha, Bindu Sri Sai U, M.Samanvitha, J.Mahesh, B.V.Kiranmayee
Year : 2020
Link : https://ieeexplore.ieee.org/document/9243339
Prior prediction of flight arrival delays is necessary for both travelers and airlines because delays in flights not only trigger huge economic loss but also airlines end up losing their reputation that was built for several years and passengers lose their valuable time. Our paper aims at predicting the arrival delay of a scheduledindividual flight at the destination airport by utilizing available data. The predictive model presented in this work is to foresee airline arrival delays by employing supervised machine learning algorithms. US domestic flight dataalong with the weather data from July 2019 to December 2019 wereacquired and are used while training the predictive model. XGBoost and linear regression algorithms were applied to develop the predictive model that aims at predicting flight delays. The performance of each algorithm was analyzed. Flight data along with the weather data was given to the model. Using this data, binary classification was carried out by the XGBoost trained model to predict whether there would be any arrival delay or not, and then linear regression model predicts the delay time of the flight.

3.Multi-Task Local-Global Graph Network for Flight Delay Prediction
Authors : Tianyi Wang, Shu-Ching Chen
Year : 2022
Link : https://ieeexplore.ieee.org/document/9874045/authors#authors
Airline on-time performance has always been a key factor in evaluating the punctuality of the civil aviation industry and has a profound impact on airlines, airports, and passengers. As a

result, there have been increasing demands for the systematic analysis of flight delays and the development of accurate and efficient tools for flight delay prediction. In this paper, a deep learning framework based on graph convolutional networks and multi-task learning is proposed for flight delay prediction. We first use graph convolutional networks to capture the local and global spatial dependencies among the airports. A multi-decoder sequence-to-sequence model is developedto extract the temporal correlation from the data. We further apply a herarchical graph fusion approach to combine features at different levels of the network to exploit their cross-modality correlations. The model is trained using a dynamic multi-task learning strategy to predict flight arrival and departure delays at the same time to boost the model's generalization and performance. The proposed model is evaluated on a large-scale public flight record dataset against several state-of-the-art methods. The experimental results demonstrate that our model can outperform all baseline methods in predicting short to medium-term flight delays.

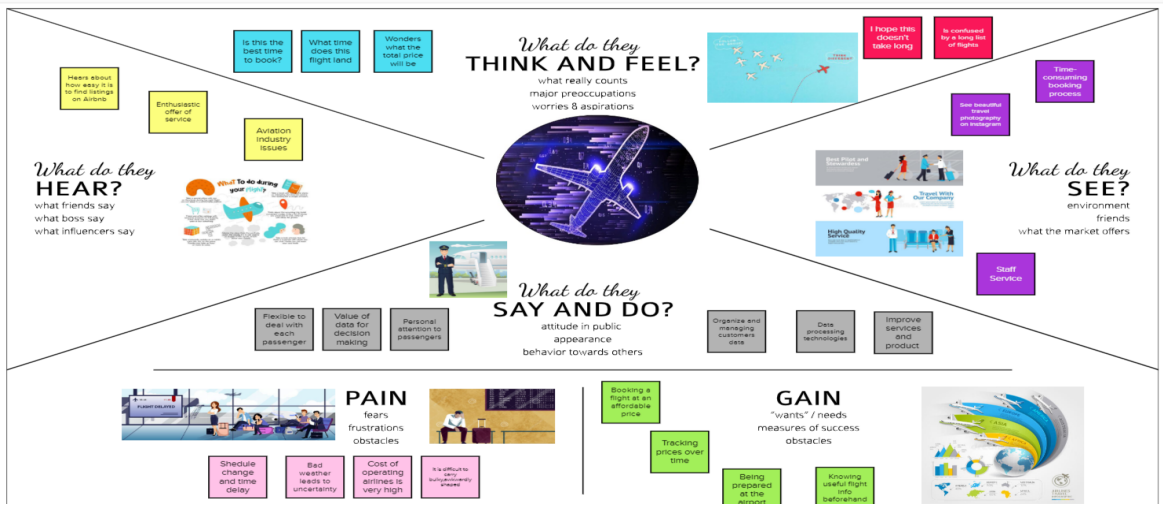
4.Outlier Analysis of Airport Delay Distributions in US and China
Author : Jingyi Qu, Jinjie Zhang
Year : 2021
Link : https://ieeexplore.ieee.org/document/9389876/authors#authors
By analyzing the historical data of flight delay, the delay problem can be effectively prevented and controlled. The spread of delay propagation in continuous flights often leads to large-scale flight delays. Aiming at the problems of flight delay propagation, a flight chain model is proposed to evaluate flight delays. Because flight data has the characteristics of time and space, the flight delay visualization analytics system is put forward to directly interpret the spatiotemporal pattern of flight delay. The time-varying delay trend is shown by the time line chart and sequence histogram. At the same time, it analysis the time sequence of the impact of flight delays on the consecutive flights through the thermal sequence diagram of flight and parallel coordinate chart. The spatial model reflects the spatial distribution rule and spatial clustering results of delay in airports in different regions by thermal map and rectangular tree diagram. Simultaneously, through the tree diagram of flight propagation delay from the perspective of spatial spread, the delay sweep problems are intuitively analyzed. According to the results of the delay spread assessment and visualization, it can provide corresponding suggestions for various departments to control the delay propagation.
5.State-Of-Art Machine Learning Techniques to Predict Airlines Delay
Authors : Sai Sharan, M.Sriniketh, Harsha Vardhan, Dannana Jayanth
Year : 2021
Link : https://ieeexplore.ieee.org/document/9702590/authors#author
Nowadays everyone is becoming extremely busy that makes them follow the time very precisely. In the commercial aviation sector, flight delays are a significant cause of dissatisfaction with customers. So, the prediction of flight delays plays a pivotal role in travelers’ comfort and alleviates the airline’s economic losses. This paper analyzes the performance of the machine learning algorithms such as Random Forest, AdaBoost, and XGBoost classifier to handle the delay time prediction of flight by considering multiple parameters such as weather conditions, flight schedule, etc., that are responsible for flight delay. The paper does a detailed comparative analysis of the algorithms used. Our study can also be applied to various other applications, such as predicting demand-based airline fares.

2.3 Problem Statement Definition

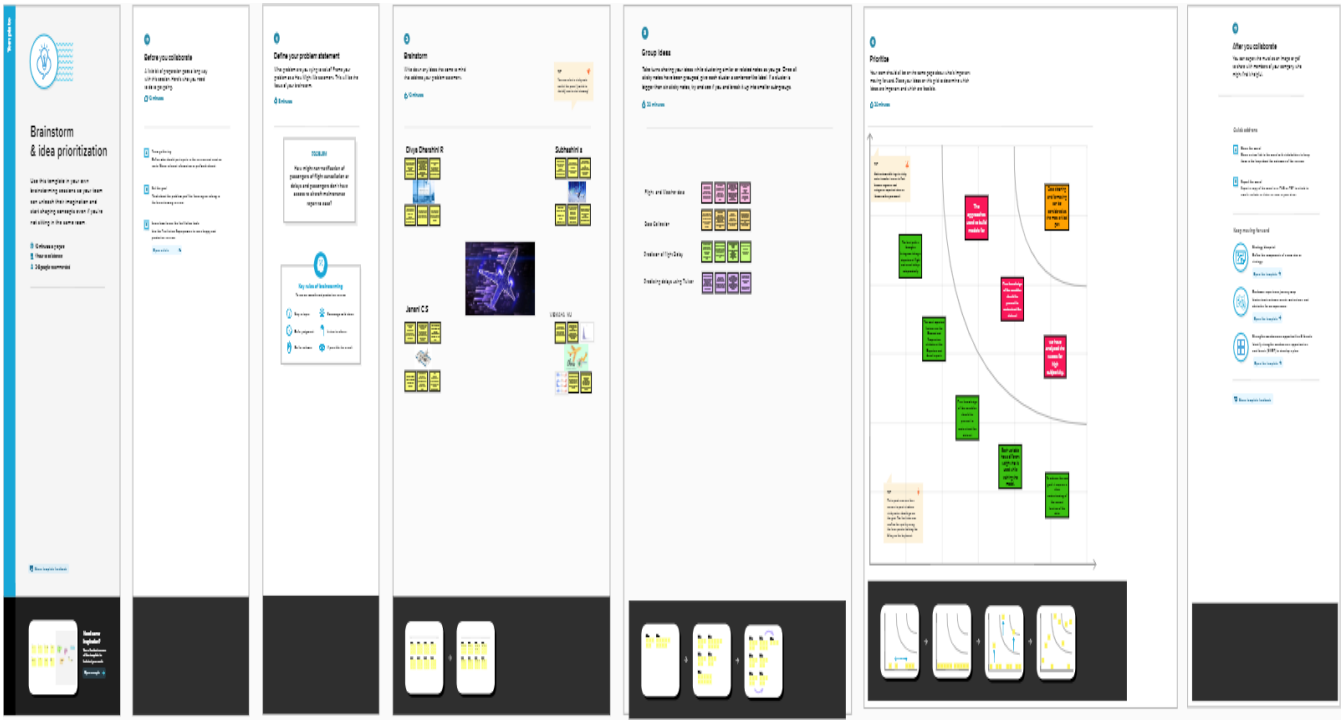
1. The Aviation System Performance Metrics (ASPM) data from the FAAoperations performance data website contains airport specific weather, flight demand, and airport capacity information.
2. Disproportionately, leisure travellers value the former, business travellers the latter.
3. The optimization for business travel extends beyond this to full service network carriers focus on premium cabins, frequent flyer programs, airport services and more.
4. The reason is why American flight routes through one of their hubs-by consolidating travellers onto more regular flights to fewer destinations.
5. They can offer far more choices of flight itineraries.
6. There are some stark differences between airlines made for leisure travellers and those for business travellers.
7. Many of the world's largest airlines fall into that second category. Historically, however, it's been worth it. They represent a more reliable client base for airlines.

IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

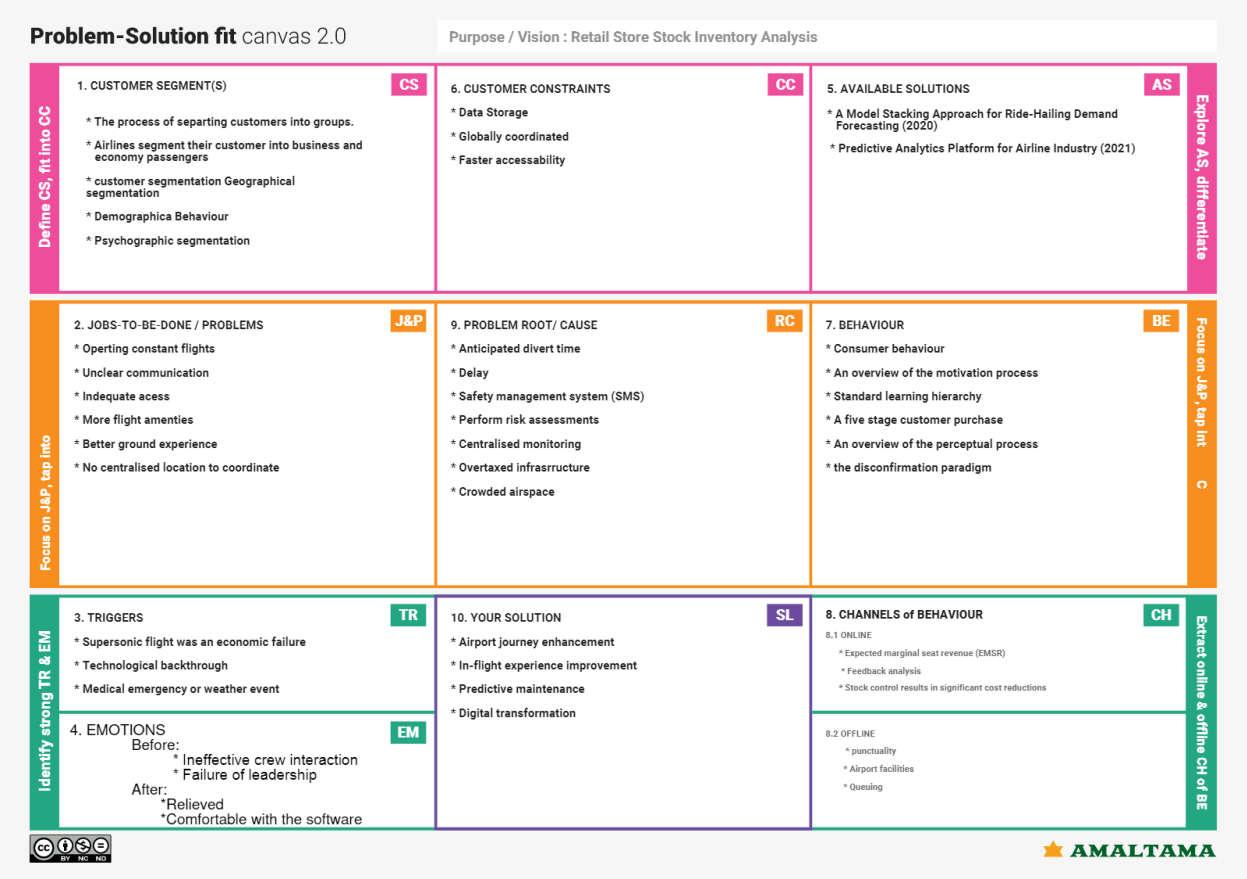


3.3 Proposed Solution

S.No	Parameter	Description
1.	Problem statement	The spread of delay propagation in continuous flights often leads to large-scale flight delays.
2.	Idea/Solution description	By analyzing the historical data of flight delay, the delay problem can be effectively prevented and controlled.
3.	Novelty/Uniqueness	Where the existing system using a flight chain model to evaluate flight delays. But our goal is to use exploratory analysis and to build machine learning models to predict airline departure and arrival delays.
4.	Social impact/Customer satisfaction	The customer experience is not only based on traveling in flight, its everything from purchasing the ticket on the website, checking luggage in airport.

5.	Business Model (Revenue model)	Additional loyalty points for pass/ voucher purchase. Expanding the choice of air transport to consumers at the lowest cost. It is made leveraging their cost efficiency and innovation to remain in a leading position.
6.	Scalability of the solution	1. Integrating new services into the current model and enhancing customer service. 2. Crossing international borders and experimenting with long-haul segments. 3. Airline assets (network, fleet) and revenue management strategies need to be optimised. 4. The revenue management solutions you rely on must support the dynamic pricing environment of the hybrid Carrier

3.4 Problem Solution fit



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	customer Registration	customer can make Registration through Gmail
FR-2	User Confirmation	After the Registration the customer will get confirmation through mail.
FR-3	Visualizing data	User can visualize the Regular trends of delay of flights Using IBM Cognos Analytics
FR-4	Generating Report	User can view the flight delay report

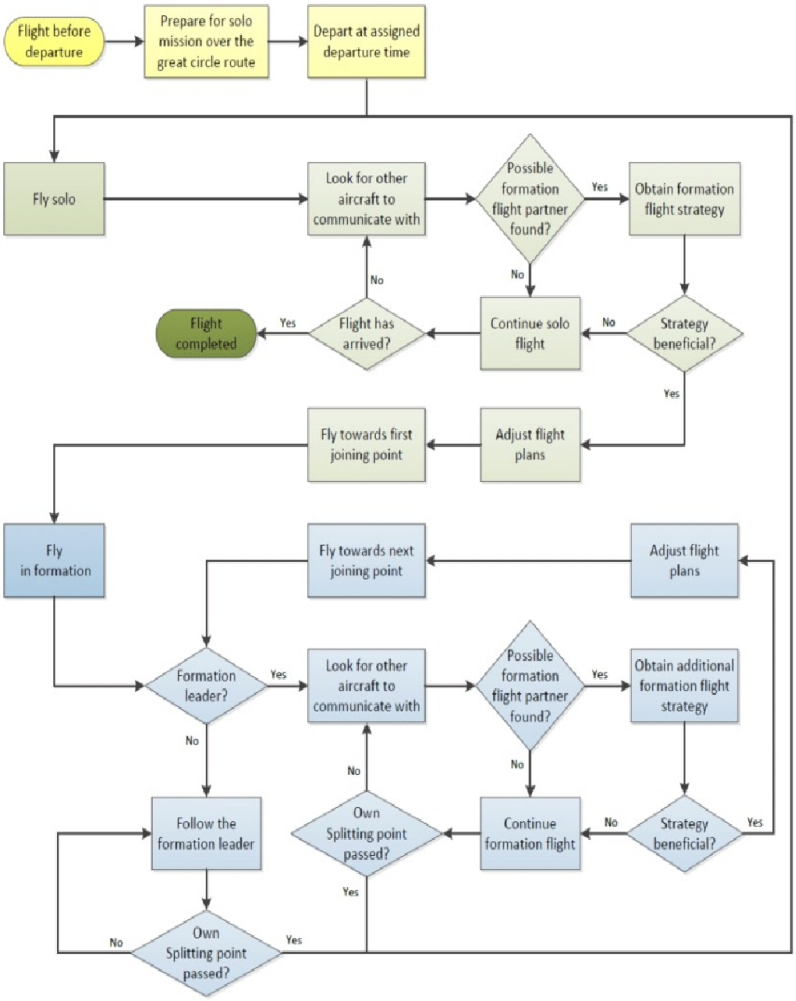
4.2 Non-Functional requirements

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The application will have a simple and user-friendly graphical interface. Users will be able to understand and use all the features of the application easily. Any action has to be performed with just a few clicks.
NFR-2	Security	The main security concern is for users account hence proper login mechanism should be used to avoid hacking. The organization system should not disclose personal information of users and other organization details to public.
NFR-3	Reliability	When the system is disconnected or frozen due to over access at the same time, it should save all the process of the users made up to the point of abnormal happenings.

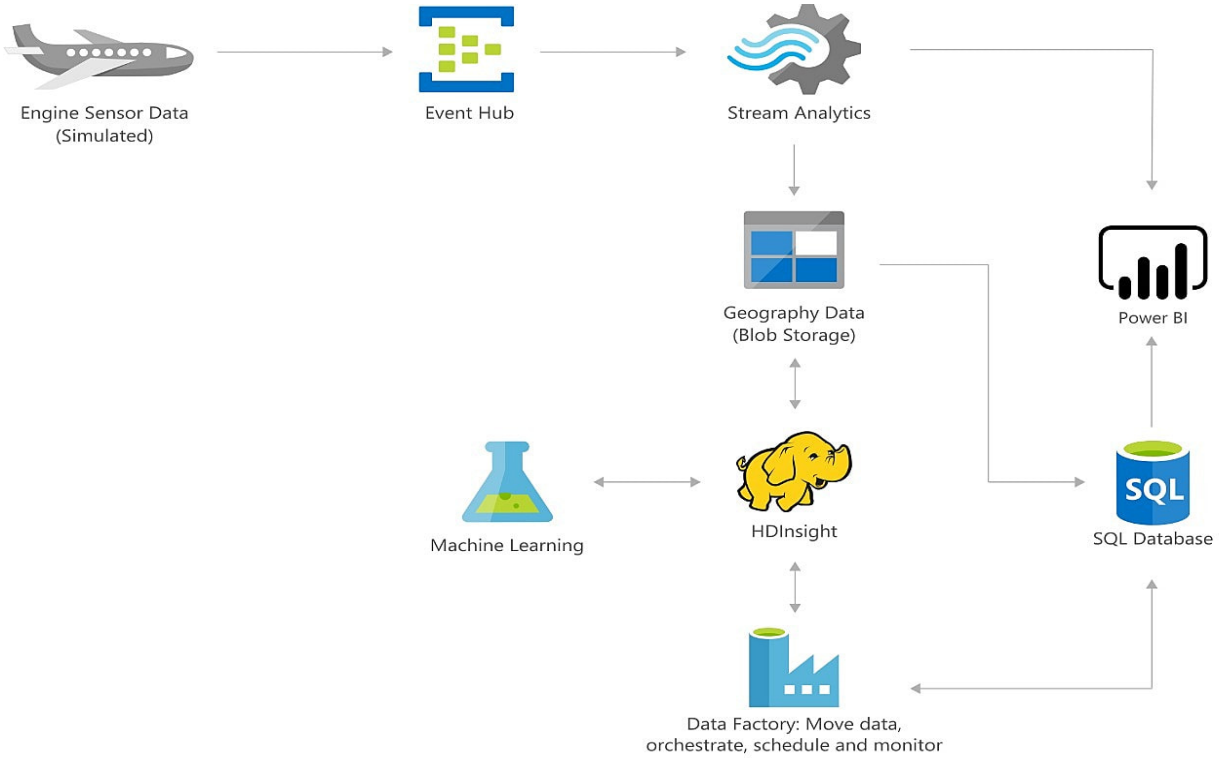
NFR-4	Performance	The system should require a fair amount of speed especially while browsing through the catalogue.
NFR-5	Availability	The system shall be available 24 hours a day 7 days a week. User can access at anytime.
NFR-6	Scalability	Large Number of users can access the website

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



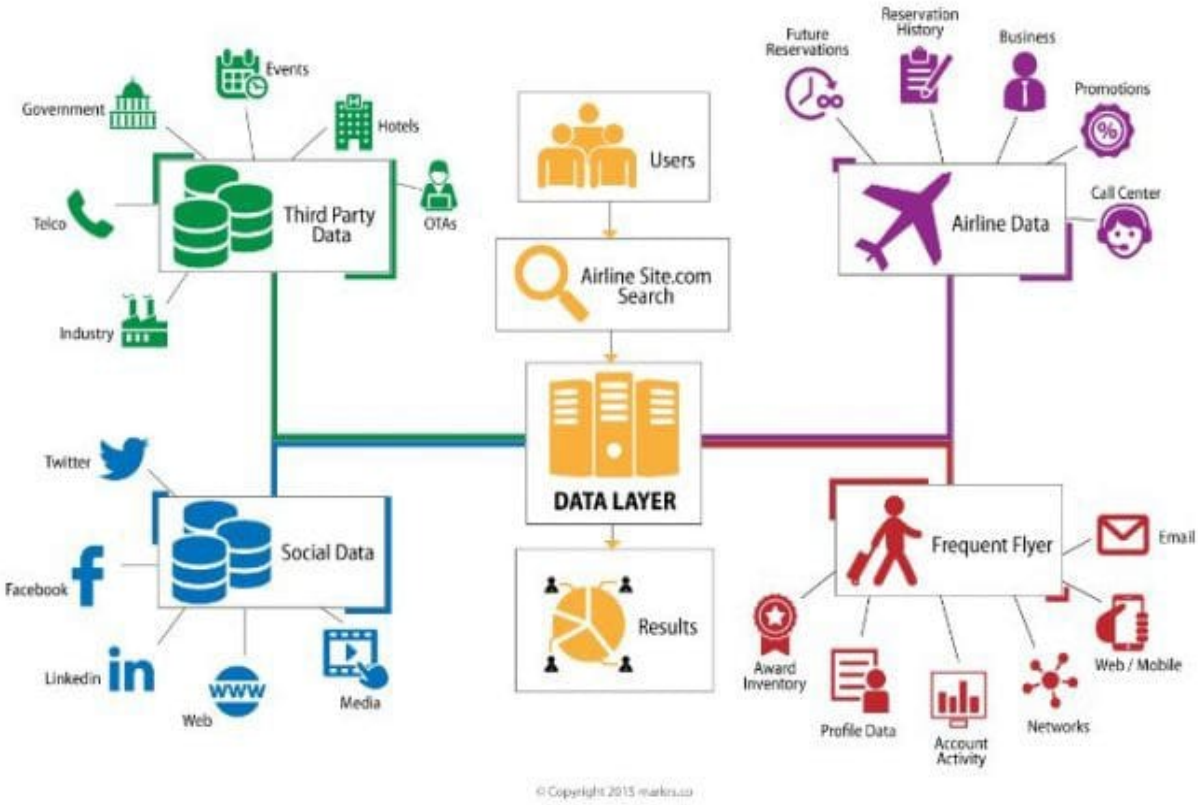


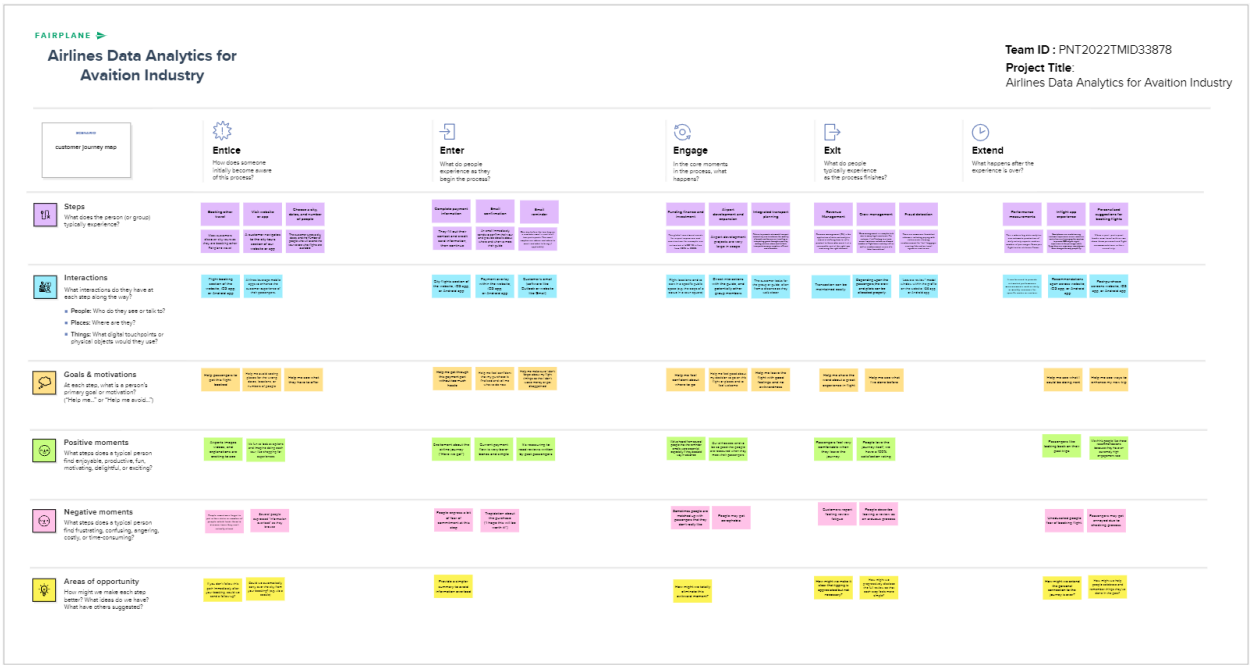
Table-1: Components & Technologies:

S.No	Components	Description	Technology
1.	User Interface	How user interacts with application. Example: Mobile App	HTML, CSS, Java Script, Excel
2.	Application Logic-1	Logic for a process in the application	IBM Watson STT service, Python
3.	Application Logic-2	Logic for a process in the application	IBM Watson Assistant
4.	Database	Data Type, Configurations	MySQL, NSQL
5.	Cloud Database	Database service on cloud	IBM DB2, IBM Cloudant
6.	File Storage	File Storage requirements	IBM Blocks Storage or other storage service or Local File system
7.	External API-1	Purpose of External API used in the application	IBM Weather API
8.	External API-1	Purpose of External API used in the application	Aadhar API
9.	Infrastructure (Server/Cloud)	Application Deployment on Local System/Cloud Local Server Configuration: Cloud Server Configuration	Local, Cloud Foundry

Table-2: Application Characteristics:

S. No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Technology of open-source framework
2.	Security Implementations	List all the security/access controls implemented, use of firewalls.	Example: SHA-256, Encryption, IAM Controls, OWASP
3.	Scalable Architecture	Justify the scalability of architecture	Cognos Used
4.	Availability	Justify the availability of application (e.g: use of load balancers, distributed servers)	AWS Used
5.	Performance	Design consideration for the performance of the application (number of requests per second, use of Cache, use of CDN's)	Dashboard,Reports, Stories

Customer Journey Map



USE STORIES

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	26 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	02 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	09 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	16 Nov 2022

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story points	Priority	Team Members
Sprint1	Data Preprocessing and Exploratory Data Analysis(EDA)	USN-1	Data cleaning is implemented to check whether, there are any null values or any outliers are found	10	Medium	Divya Dharshini R Janani C S Subhashini S Vismaya M J
		USN-2	Testing and Training the data model is implemented using Jupyter notebook	10	High	Divya Dharshini R Janani C S Subhashini S Vismaya M J
Sprint2	Working with dataset	USN-3	Working with the Dataset. Understanding the Dataset Loading the Dataset Exploring the dataset Visualize the Data.	20	Medium	Divya Dharshini R Janani C S Subhashini S Vismaya M J
Sprint3	Data Visualization	USN-4	We plan to create various graphs and charts to highlight the insights and visualizations with the given attributes	20	High	Divya Dharshini R Janani C S Subhashini S Vismaya M J

Sprint4	Dashboard	USN-5	Dashboard Showing Different Types Of Visuals	15	High	Divya Dharshini R Janani C S Subhashini S Vismaya M J
		USN-6	User can able to generate Report and Story	5	Medium	Divya Dharshini R Janani C S Subhashini S Vismaya M J

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	26 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	02 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	09 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	16 Nov 2022

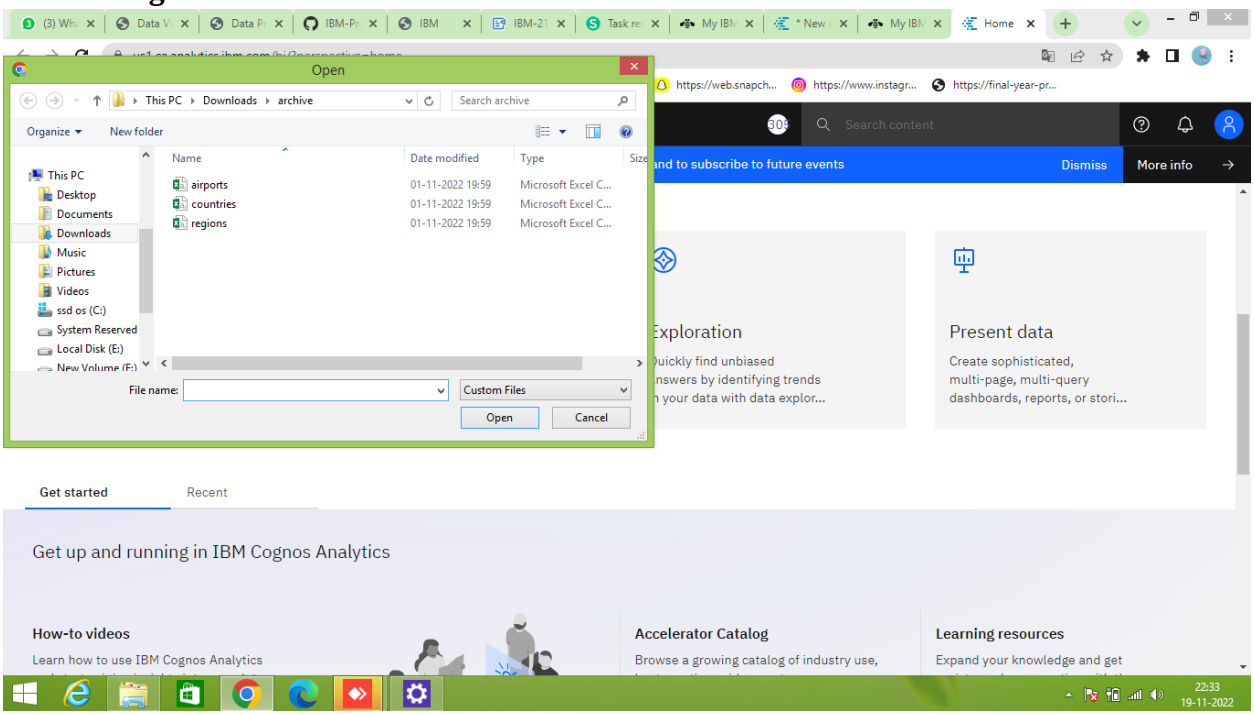
7. WORKING WITH THE DATASET & DATA VISUALIZATION

7.1 Understanding the Dataset

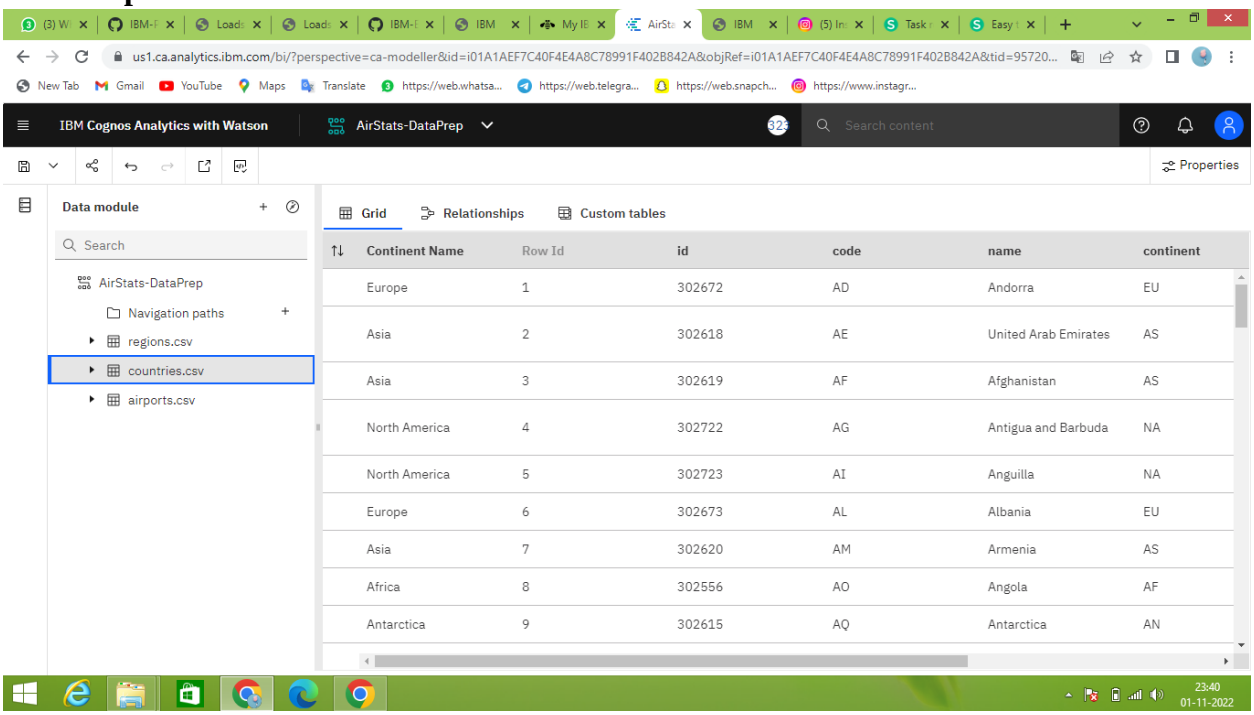
A dataset is a collection of data within a database. Typically, datasets take on a tabular format consisting of rows and columns. Each column represents a specific variable, while each row corresponds to a specific value.

Airstats-data-on-airports-around-the-world
Circum-Airport performance reports
Resource coverage-data

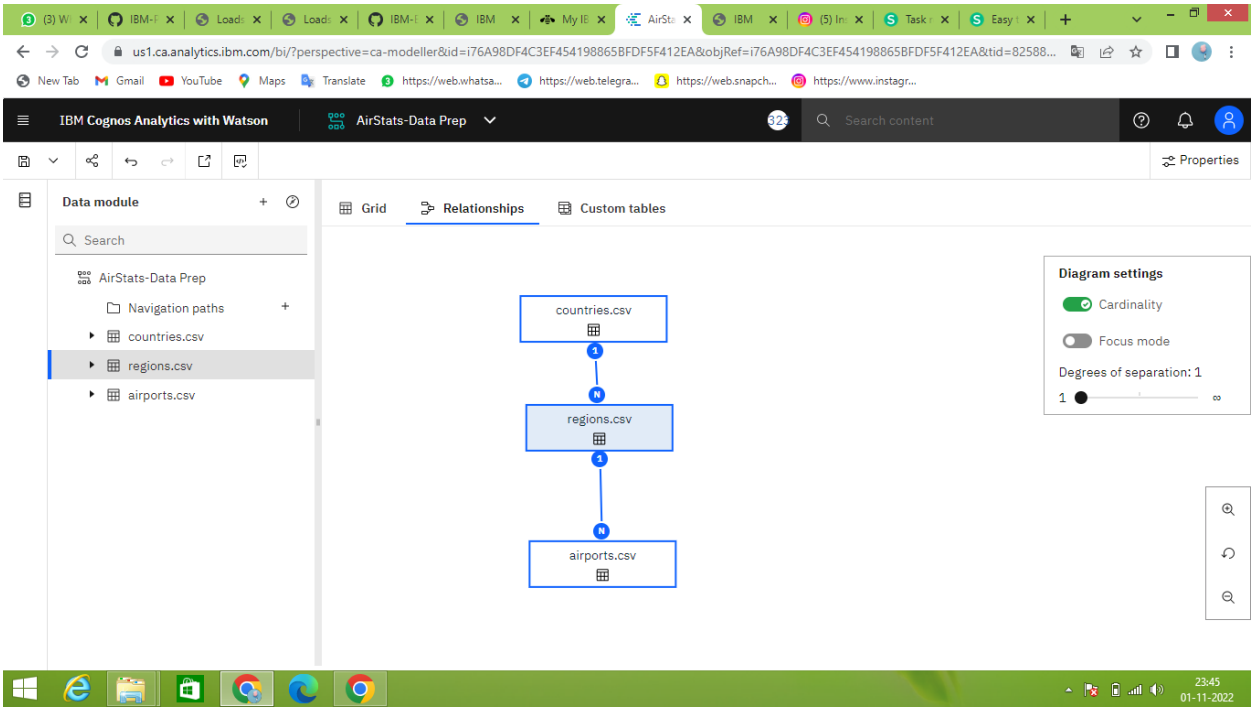
7.2 Loading the Dataset



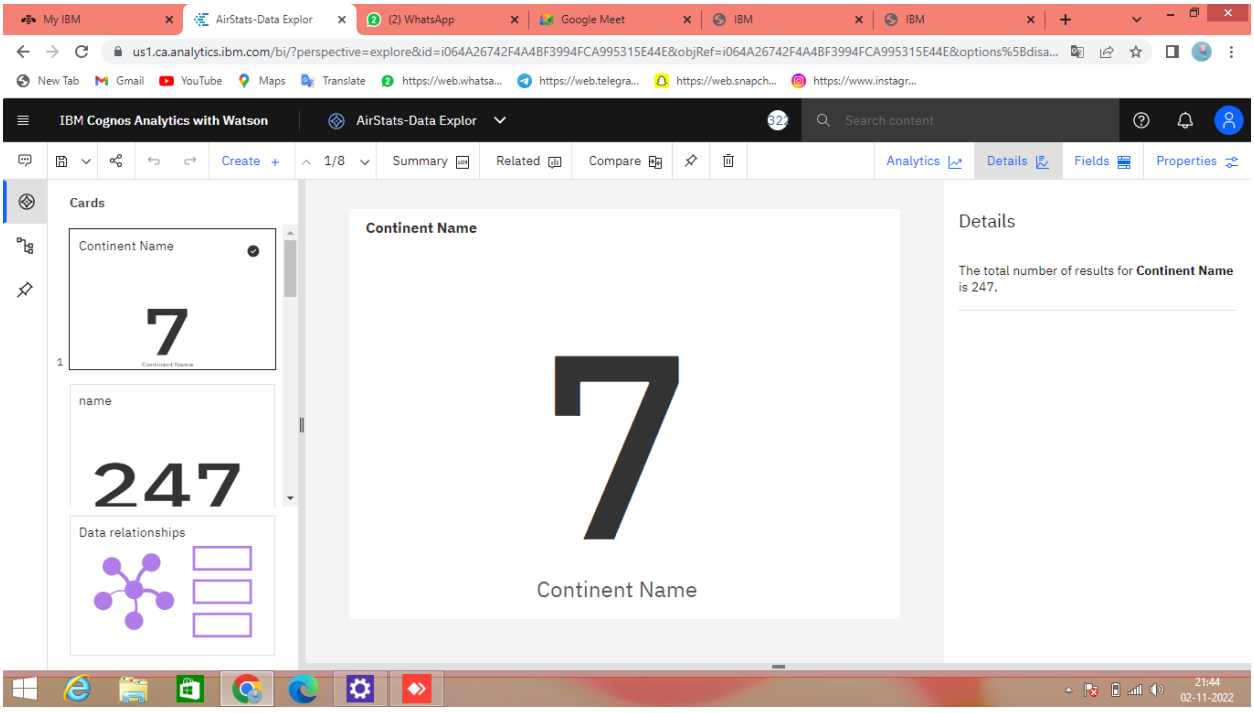
Data Preparation :

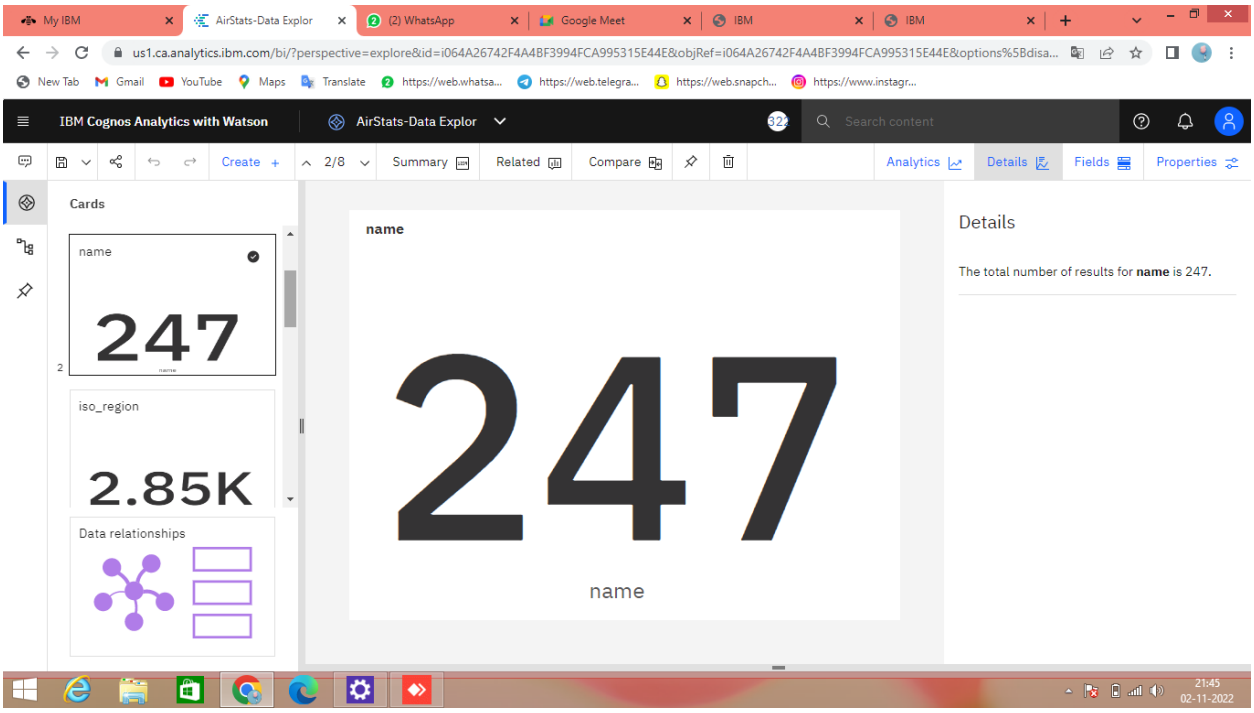


JOINING OF TABLES :



EXPLORATION OF DATA :




IBM Cognos Analytics with Watson
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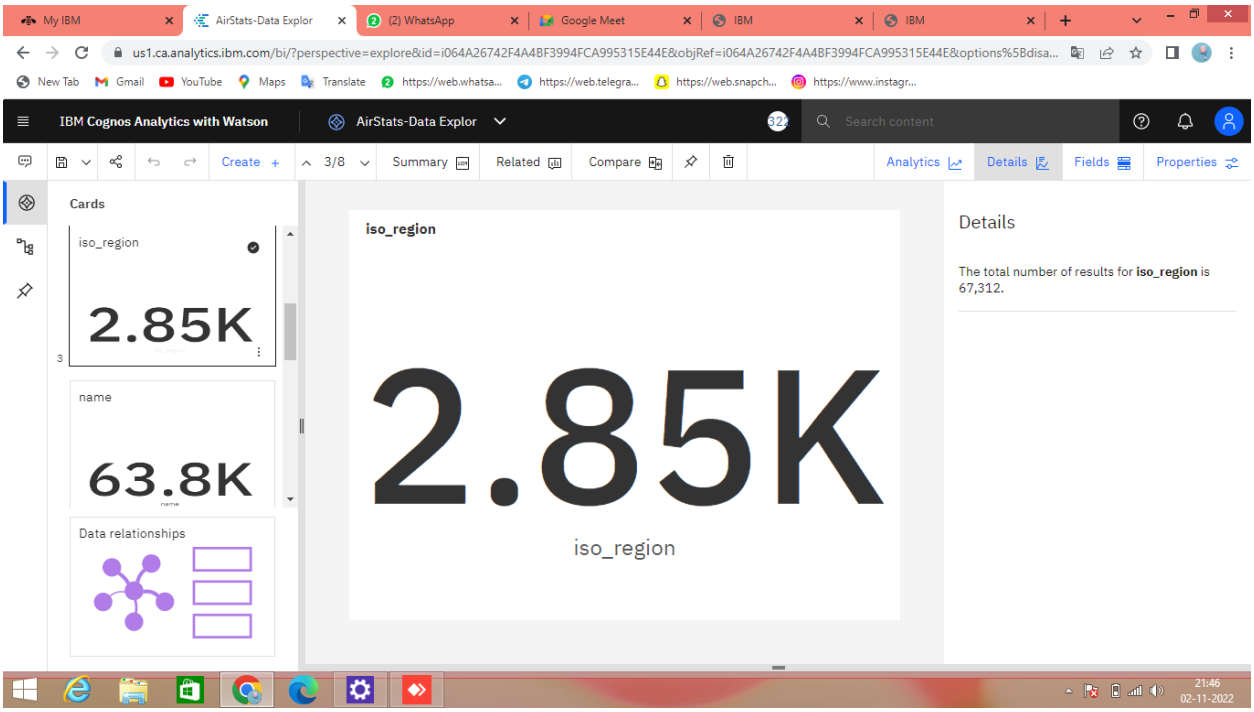
IBM Cognos Analytics with Watson
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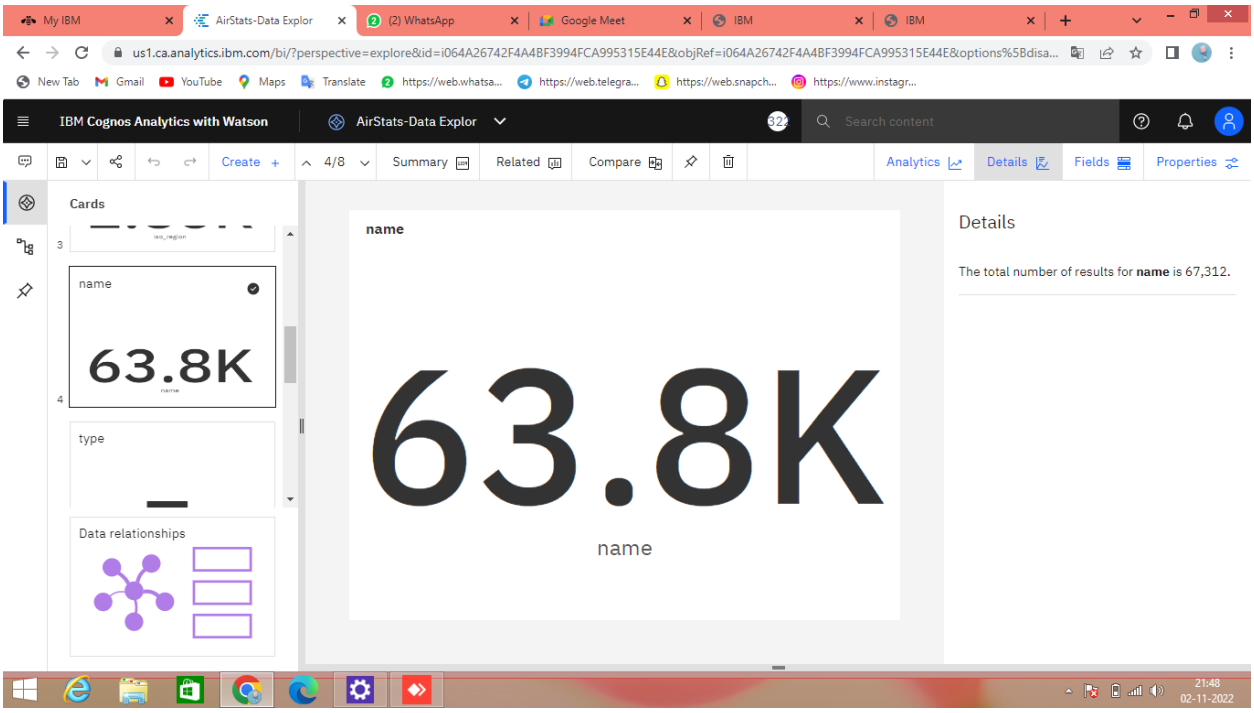
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AirStats-Data Explor
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Google Meet
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IBM
us1.ca.analytics.ibm.com/bi/?perspective=explore&id=i064A26742F4A4BF3994FCA995315E44E&objRef=i064A26742F4A4BF3994FCA995315E44E&options%5Bdisa...
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Maps
Translate
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IBM Cognos Analytics with Watson
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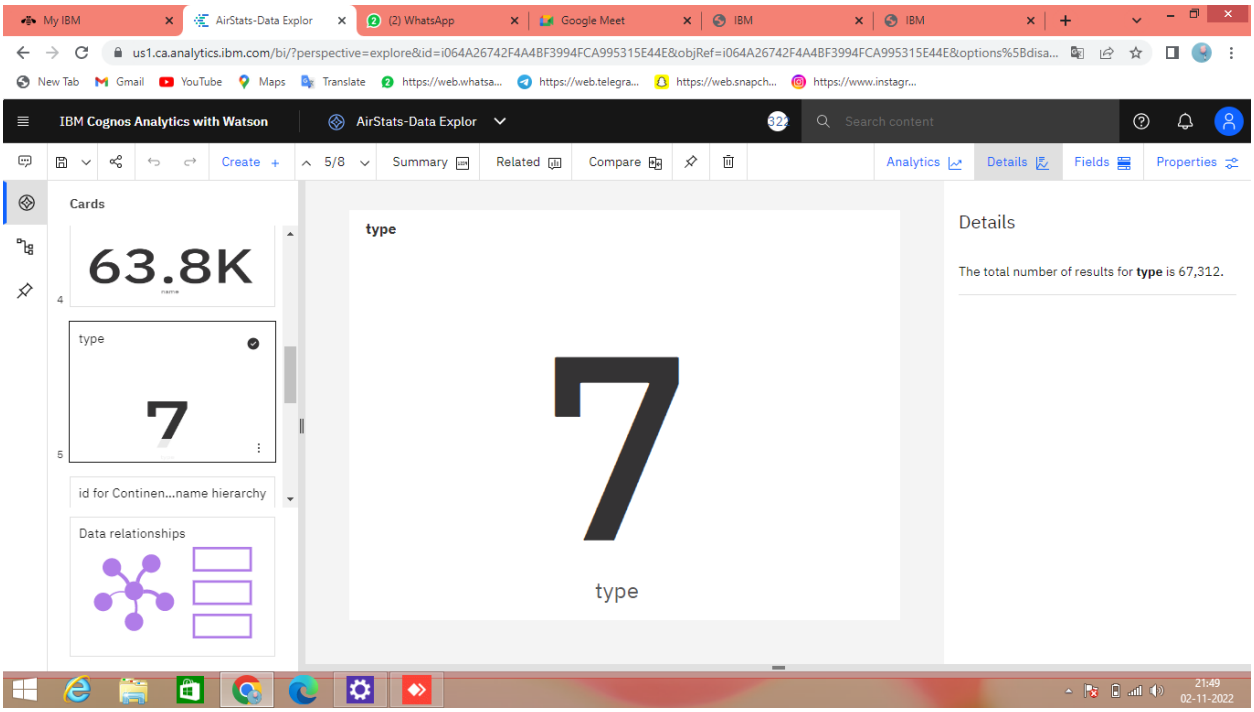
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Google Meet
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YouTube
Maps
Translate
https://web.whatsa...
https://web.telegra...
https://web.snapch...
https://www.instagr...
IBM Cognos Analytics with Watson
AirStats-Data Explor
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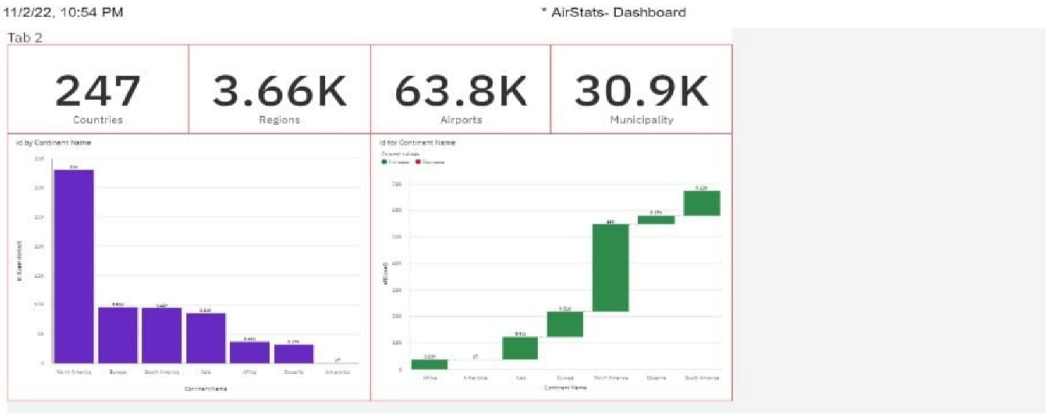
7.3 Visualization Chart & Creating a Dashboard

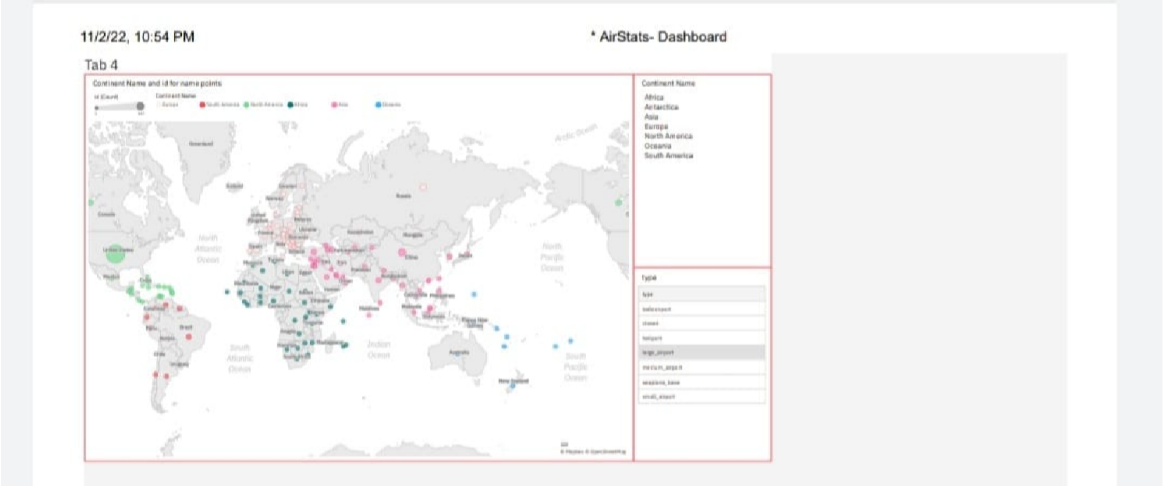
Representation Of Flight Count By Categories

No Of Flights By Countries , Regions And Airports



Continent Wise Count Of Airports Using Geo Map

Country Wise Airports With Types



Dashboard Showing Count Of Flights By Types, Countries And Continents

9. ADVANTAGES & DISADVANTAGES

1. Increase in airline revenue
2. Smart maintenance
3. Cost reduction
4. Customer satisfaction
5. Digital transform
6. Performance measurements
7. Risk management

1. Cost
2. Some Product Limitation
3. Capacity for Small Carriage
4. Enormous investment

10. CONCLUSION

Big data as a new technology paradigm for data that is generated at high velocity and high volume, and with high variety, has captured the attention of both researchers and practitioners. Davis describes big data as expansive collections of data that are updated quickly and frequently and that exhibit a huge range of different formats and content . Big data analytics is a process of examining information and patterns from huge data. The airline industry is interesting because of its importance to the global economy, international presence and fierce competitive environment. The study identified many types and sources of big data that airlines deal with on a regular basis which are related to customer data, flight data, multimedia data, documented data, competitors' data, and some other data related to the aviation industry, international reports, oil prices, political relations between states and others.

The results also demonstrated that big data presents a plenty of promising opportunities for the aviation industry. Big data provides airlines with modern insights that can invent new business models.

To provide better Airline and AirPort services and to avoid delays in Air Travel across different locations at Municipality level. The aim is to provide airports, airlines, and the travelling public with a neutral, third-party view of which airlines are delivering on their promise to get passengers from Point A to Point B on-time.

11. FUTURE SCOPE

Today, AI makes it possible to enhance customer experience with automation and self-service solutions, optimize employee workflow, and ensure higher air safety with predictive and prescriptive aircraft maintenance. It also allows airlines to make informed decisions about pricing and market positioning through the smart use of data.

No doubt, AI and big data analytics will transform the experience of customers and other engagements at airports. By 2020, numerous airlines are planning significant initiatives of artificial intelligence technology that include real-time predictive pricing offers, air travel experience to chatbots, etc.

There are many areas in the airline industry which can be tapped by big data solutions in a much better way. Marketing, crew and flight operations and aerial cargo are some of them. Big data solutions help the airlines to understand their customers individually, their preferences, their behavioural patterns and also predict the requests that might come up.

Today's travellers are more happy with the fact that their airlines know where they are, what they would like to be served on board, and what climatic conditions they will be met with on arrival at their destination.

The airline industry has been keeping a tab on this information since long but it needs big data to help them analyse it and make it useful for the customer.

12. SOURCE CODE

```
<!DOCTYPE html>
<html lang="en">

<head>
   <meta charset="UTF-8">
   <meta name="viewport" content="width=device-width, initial-scale=1.0">
   <title>Login Form</title>
   <link rel="stylesheet" href="style.css">
   <link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-
awesome/5.15.3/css/all.min.css" />
</head>

<body>
   <div class="wrapper">
      <header>Login Form</header>
      <form action="#">
         <div class="field email">
            <div class="input-area">
               <input type="text" placeholder="Email Address">
               <i class="icon fas fa-envelope"></i>
               <i class="error error-icon fas fa-exclamation-circle"></i>
```

```
            </div>
            <div class="error error-txt">Email can't be blank</div>
          </div>
          <div class="field password">
            <div class="input-area">
              <input type="password" placeholder="Password">
              <i class="icon fas fa-lock"></i>
              <i class="error error-icon fas fa-exclamation-circle"></i>
            </div>
            <div class="error error-txt">Password can't be blank</div>
          </div>
          <div class="pass-txt"><a href="#">Forgot password?</a></div>
          <input type="submit" value="Login">
        </form>
        <div class="sign-txt">Not yet member? <a href="#">Signup now</a></div>
    </div>

    <script src="script.js"></script>

</body>

</html>
```

script .js

```
const form = document.querySelector("form");
eField = form.querySelector(".email"),
    eInput = eField.querySelector("input"),
    pField = form.querySelector(".password"),
    pInput = pField.querySelector("input");

form.onsubmit = (e) => {
    e.preventDefault();

    (eInput.value == "") ? eField.classList.add("shake", "error"): checkEmail();
    (pInput.value == "") ? pField.classList.add("shake", "error"): checkPass();
```

```
    setTimeout(() => {
        eField.classList.remove("shake");
        pField.classList.remove("shake");
    }, 500);

    eInput.onkeyup = () => { checkEmail(); }
    pInput.onkeyup = () => { checkPass(); }

    function checkEmail() {
        let pattern = /^[^ ]+@[^ ]+\.[a-z]{2,3}$/;
        if (!eInput.value.match(pattern)) {
            eField.classList.add("error");
            eField.classList.remove("valid");
            let errorTxt = eField.querySelector(".error-txt");

            (eInput.value != "") ? errorTxt.innerText = "Enter a valid email address":
errorTxt.innerText = "Email can't be blank";
        } else {
            eField.classList.remove("error");
            eField.classList.add("valid");
        }
    }

    function checkPass() {
        if (pInput.value == "") {
            pField.classList.add("error");
            pField.classList.remove("valid");
        } else {
            pField.classList.remove("error");
            pField.classList.add("valid");
        }
    }

    if (!eField.classList.contains("error") && !pField.classList.contains("error")) {
        window.location.href = form.getAttribute("action");
    }
}
```

style.css

```
@import
url('https://fonts.googleapis.com/css2?family=Poppins:wght@400;500;600&display=swap');
* {
    margin: 0;
    padding: 0;
    box-sizing: border-box;
    font-family: "Poppins", sans-serif;
}

body {
    width: 100%;
    height: 100vh;
    display: flex;
    align-items: center;
    justify-content: center;
    background: #E9FF33;
}

::selection {
    color: #fff;
    background: #7ff053;
}

.wrapper {
    width: 380px;
    padding: 40px 30px 50px 30px;
    background: #fff;
    border-radius: 5px;
    text-align: center;
    box-shadow: 10px 10px 15px rgba(0, 0, 0, 0.1);
}

.wrapper header {
    font-size: 35px;
    font-weight: 600;
```

```
}

.wrapper form {
    margin: 40px 0;
}

form .field {
    width: 100%;
    margin-bottom: 20px;
}

form .field.shake {
    animation: shake 0.3s ease-in-out;
}

@keyframes shake {
    0%,
    100% {
        margin-left: 0px;
    }
    20%,
    80% {
        margin-left: -12px;
    }
    40%,
    60% {
        margin-left: 12px;
    }
}

form .field .input-area {
    height: 50px;
    width: 100%;
    position: relative;
}

form input {
```

```
    width: 100%;
    height: 100%;
    outline: none;
    padding: 0 45px;
    font-size: 18px;
    background: none;
    caret-color: #5372F0;
    border-radius: 5px;
    border: 1px solid #bfbfbf;
    border-bottom-width: 2px;
    transition: all 0.2s ease;
}

form .field input:focus,
form .field.valid input {
    border-color: #5372F0;
}

form .field.shake input,
form .field.error input {
    border-color: #3d35dc;
}

.field .input-area i {
    position: absolute;
    top: 50%;
    font-size: 18px;
    pointer-events: none;
    transform: translateY(-50%);
}

.input-area .icon {
    left: 15px;
    color: #949191;
    transition: color 0.2s ease;
}
```

```
.input-area .error-icon {
    right: 15px;
    color: #dc3545;
}

form input:focus~.icon,
form .field.valid .icon {
    color: #5372F0;
}

form .field.shake input:focus~.icon,
form .field.error input:focus~.icon {
    color: #bfbfbf;
}

form input::placeholder {
    color: #bfbfbf;
    font-size: 17px;
}

form .field .error-txt {
    color: #dc3545;
    text-align: left;
    margin-top: 5px;
}

form .field .error {
    display: none;
}

form .field.shake .error,
form .field.error .error {
    display: block;
}

form .pass-txt {
    text-align: left;
```

```
    margin-top: -10px;
}

.wrapper a {
    color: #5372F0;
    text-decoration: none;
}

.wrapper a:hover {
    text-decoration: underline;
}

form input[type="submit"] {
    height: 50px;
    margin-top: 30px;
    color: #fff;
    padding: 0;
    border: none;
    background: #5372F0;
    cursor: pointer;
    border-bottom: 2px solid rgba(0, 0, 0, 0.1);
    transition: all 0.3s ease;
}

form input[type="submit"]:hover {
    background: #2c52ed;
}
```

13. GITHUB LINK

https://github.com/IBM-EPBL/IBM-Project-21313-1659777505

14. DEMO LINK

https://youtu.be/AXLi04KgTz0