

PROJECT REPORT

Developing A Flight Delay Prediction Model

Using Machine Learning

Submitted By

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TABLE OF CONTENTS

1 INTRODUCTION	4
1.1 PROJECT OVERVIEW	4
1.2 PURPOSE	4
2 LITERATURE SURVEY	5
2.1 EXISTING PROBLEM	5
2.2 REFERENCES	5
2.3 PROBLEM STATEMENT DEFINITION	5
3 IDEATION AND PROPOSED SOLUTION	6
3.1 EMPATHY MAP CANVAS	6
3.2 IDEATION & BRAINSTORMING	6
3.3 PROPOSED SOLUTION	10
3.4 PROBLEM SOLUTION FIT	11
4 REQUIREMENT ANALYSIS	13
4.1 FUNCTIONAL REQUIREMENTS	13
4.2 NON FUNCTIONAL REQUIREMENTS	14
5 PROJECT DESIGN	16
5.1 DATA FLOW DIAGRAM	16
5.2 SOLUTION & TECHNICAL ARCHITECTURE	17
6 PROJECT PLANNING AND SCHEDULING	17
6.1 SPRINT PLANNING AND ESTIMATION	17
6.2 SPRINT DELIVERY SCHEDULE	18
7 CODING & SOLUTIONING	21

8 TESTING	24
8.1 TEST CASES	24
8.2 USER ACCEPTANCE TESTING	24
8.2.1 DEFECT ANALYSIS	25
8.2.2 TEST CASE ANALYSIS	25
9 RESULTS	26
9.1 PERFORMANCE METRICS	26
10 ADVANTAGES & DISADVANTAGES	28
ADVANTAGES	28
DISADVANTAGES	28
11 CONCLUSION	32
12 FUTURE SCOPE	33
APPENDIX	36
SOURCE CODE	31
DEMO VIDEO	34

CHAPTER-1

INTRODUCTION

1.1 PROJECT OVERVIEW

Over the last twenty years, air travel has been increasingly preferred among travelers, mainly because of its speed and in some cases comfort. This has led to phenomenal growth in air traffic and on the ground. An increase in air traffic growth has also resulted in massive levels of aircraft delays on the ground and in the air. These delays are responsible for large economic and environmental losses. The main objective of the model is to predict flight delays accurately in order to optimize flight operations and minimize delays.

Using a machine learning model, we can predict flight arrival delays. The input to our algorithm is rows of feature vectors like departure date, departure delay, distance between the two airports, scheduled arrival time etc. We then use a decision tree classifier to predict if the flight arrival will be delayed or not. A flight is considered to be delayed when the difference between scheduled and actual arrival times is greater than 15 minutes. Furthermore, we compare decision tree classifiers with logistic regression and a simple neural network for various figures of merit.

1.2 PURPOSE

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.

CHAPTER - 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

Flight scheduling, is one of the challenging issue in the Modern world, which is faced with many uncertain conditions. One of such conditions is delay, which comes from various factors and inflicts considerable cost on airlines, operators, and travelers. So, we are implemented flight delay prediction through some proposed approaches based on machine learning algorithms.

2.2 REFERENCES

- [1] <https://doi.org/10.24200/sci.2017.20020> (Khaksar, H., & Sheikholeslami, A. (2017)).
- [2] <https://doi.org/10.1177/0361198120930014> (Esmaeilzadeh, E., & Mokhtarimousavi, S. (2020)).
- [3] <https://doi.org/10.5121/ijdkp.2018.8301>(M. Al-Tabbakh, S., M. Mohamed, H., & H. El, Z. (2018)).
- [4]<https://doi.org/10.3390/su12072749>(Ye, B., Liu, B., Tian, Y., & Wan, L. (2020)).
- [5]<https://doi.org/10.1016/j.tre.2019.03.013>(Yu, B., Guo, Z., Asian, S., Wang, H., & Chen, G. (2019)).
- [6]<https://doi.org/10.5772/9385> (Oladipupo, T. (2010)).
- [7] <https://doi.org/10.1186/s40537-020-00355-0>(Nibareke, T.,& Laassiri, J. (2020)).

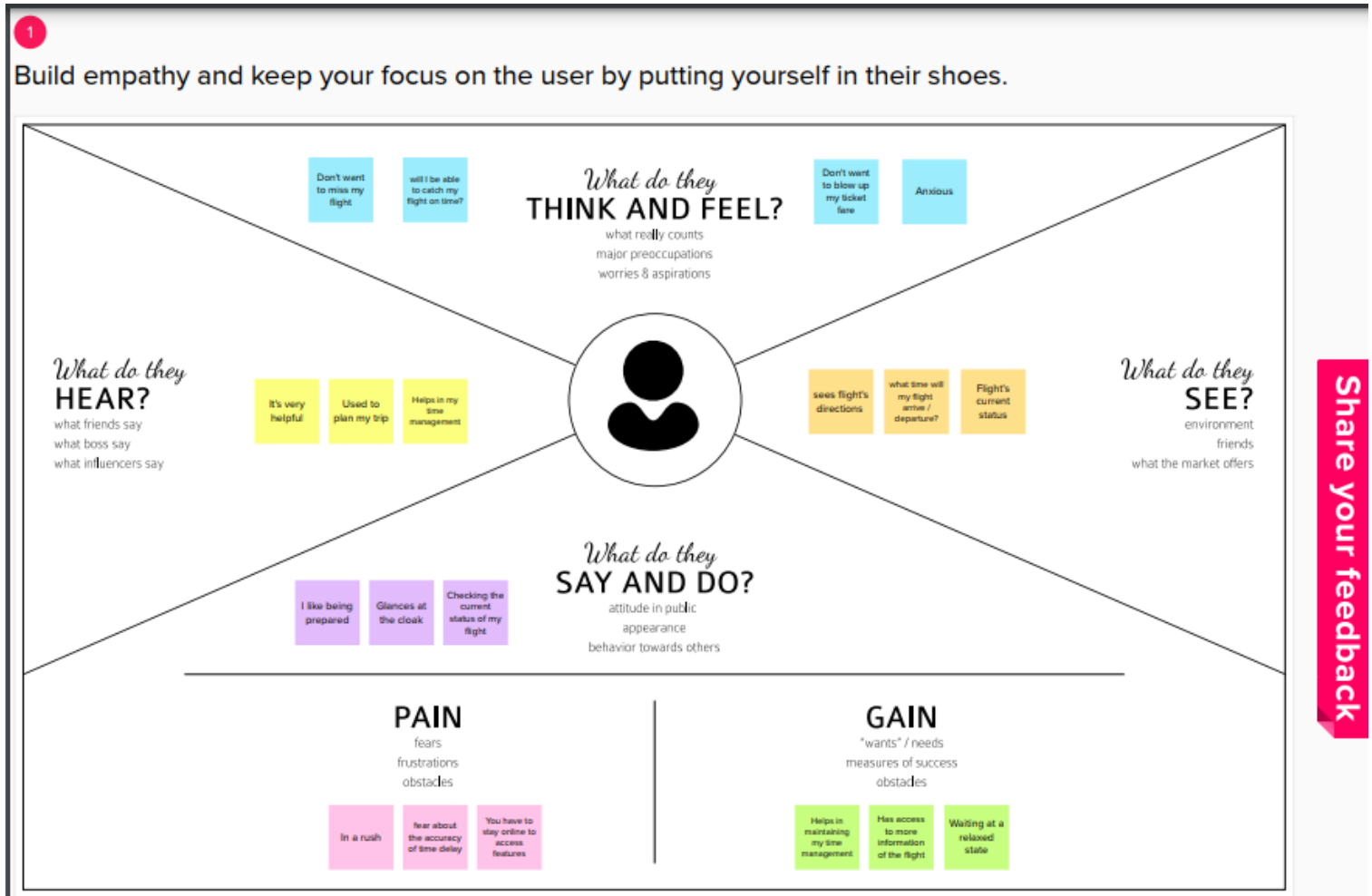
2.3 PROBLEM STATEMENT DEFINITION

Throughout the year 2015, there has been over 5,4 million domestic flights within the US. All of their metadata are recorded and saved in the Department of Transportation's (DOT) Bureau of Transportation Statistics. Flight delays cause significant financial and other losses to airlines, airports, and passengers. Their prediction is crucial during the decision-making process for all players of American aviation industry. Therefore, predicting the likelihood of delay based on flights' features bridges an important information asymmetry between airlines and passengers.

CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



3.2 IDEATION & BRAINSTORMING

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

Step-1: Team Gathering, Collaboration and Select the Problem Statement

Conducting a brainstorm

Executing a brainstorm isn't unique; holding a productive brainstorm is. Great brainstorms are ones that set the stage for fresh and generative thinking through simple guidelines and an open and collaborative environment. Use this when you're just kicking-off a new project and want to hit the ground running with big ideas that will move your team forward.

- 🕒 15 minutes to prepare
- 🕒 30-60 minutes to collaborate
- 👤 3-8 people recommended

Created in partnership with  Meta  Meta



Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

🕒 15 minutes

- A Choose your best "How Might We" Questions**
Create 5 HMW statements before the activity to propose them to the team.
- B Set the stage for creativity and inclusivity**
Go over the brainstorming rules and keep them in front of your team while brainstorming to encourage collaboration, optimism, and creativity.
 1. **Encourage wild ideas** (If none of the ideas sound a bit ridiculous, then you are filtering yourself too much.)
 2. **Defer judgement** (This can be as direct as harsh words or as subtle as a condescending tone or talking over one another.)
 3. **Build on the ideas of others** ("I want to build on that idea" or the use of "yes, and...")
 4. **Stay focused on the topic at hand**
 5. **Have one conversation at a time**
 6. **Be visual** (Draw and/or upload to show ideas, whenever possible.)
 7. **Go for quantity**
- C Interested in learning more?**
Check out the Meta Think Kit website for additional tools and resources to help your team collaborate, innovate and move ideas forward with confidence.

[Open the website](#) →

QUESTION

How might we... [insert problem statement here]?

QUESTION

How might we... [insert problem statement here]?

QUESTION

How might we... [insert problem statement here]?

QUESTION

How might we... [insert problem statement here]?

QUESTION

How might we... [insert problem statement here]?

Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm solo

Have each participant begin in the "solo brainstorm space" by silently brainstorming ideas and placing them into the template. This "silent-storming" avoids group-think and creates an inclusive environment for introverts and extroverts alike. Set a time limit. Encourage people to go for quantity.

🕒 10 minutes

priyadharshinii

Flight plan	Flight schedule	Airport schedule
connective weather		

roshinibanu

Surface weather	visibility	season
coiling		

rajclinton

Airline status	Frequency	Aircraft model
Aircraft occupancy	region	

sakthivel

operational conditions	cancellation	new delay
Time of day	city	

GROUPING IDEAS:

Brainstorm as a group

Have everyone move their ideas into the "group sharing space" within the template and have the team silently read through them. As a team, sort and group them by thematic topics or similarities. Discuss and answer any questions that arise. Encourage "Yes, and..." and build on the ideas of other people along the way.

TIP

You can use the Voting session tool above to focus on the strongest ideas.



45 minutos

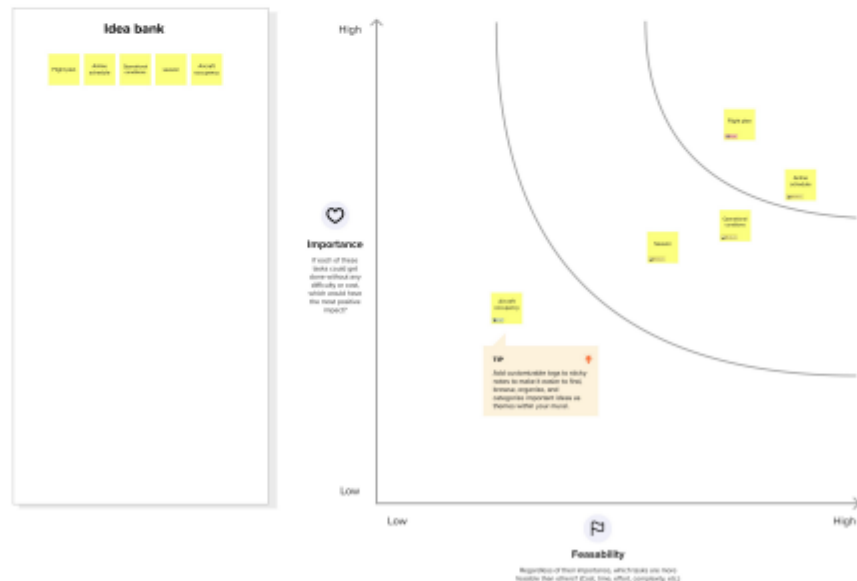


Idea prioritization

Use this framework to rank ideas based on their feasibility and impact to visually compare the merits of multiple ideas. Deliver a set of ideas that your team wants to try out, and identify which of them need to be prioritized.

Collect your ideas in one place

• **Dot down** different ideas your team is interested in trying out. These could be different solutions, or different approaches to the same solution. As a team, go through the ideas in the idea bank one by one and place them on the grid. Take the time to discuss each idea and come to a consensus on where it should go.



3.3 PROPOSED SOLUTION

S.No	Parameters	Description
1.	Problem Statement (Problem to be solved)	To find the Flight delay using its given information.
2.	Idea / Solution description	To give the result in an efficient way through the Flight current status
3.	Novelty / Uniqueness	To give accuracy in the Flight Delay prediction.
4.	Social Impact/ Customer Satisfaction	It will be very useful and convenient to foreseen the Flight timings.
5.	Business Model(Revenue Model)	It will also have a high growth in the business related areas.
6.	Scalability of the Solution	Its scalability would be in wide range.Increase the accuracy in Flight delay prediction.

3.4 PROBLEM SOLUTION FIT

Define CS, fit into CC	CUSTOMER SEGMENT CS Flight Passengers.	6. CUSTOMER CONSTRAINTS CC Network connections, available devices.	5. AVAILABLE SOLUTIONS AS From manual to digital updated accurate information and can foreseen the delay.	Explore AS, differentiate
Focus on J&P, tap into BE, understand RC	2. JOBS-TO-BE-DONE/PROBLEMS J&P To find the Flight delay using its given information by the user.	9. PROBLEM ROOT CAUSE RC Passengers can forecast the delay, if their Flight will be delay and can see the current status of flight too.	7. BEHAVIOUR BE Directly-related: fill the Flight's information . Indirectly-related: waiting for the accurate flight current status and its delay.	Focus on J&P, tap into BE, understand RC
	3. TRIGGERS R reading about a more efficient solution.	10. YOUR SOLUTION L Giving more accuracy in the Flight Delay prediction.	8. CHANNELS of BEHAVIOUR H 8.1 ONLINE Extract online info from #7 8.2 OFFLINE Extract offline channels from #7 and use them for customer development.	
	4. EMOTIONS: BEFORE / AFTER M			

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement(Epic)	Sub Requirement (Story / Sub-Task)
FR-1	HomePage	<ul style="list-style-type: none">·Flight delay prediction· Information about Flight information required for prediction· If new User , REGISTER· If Already exist, SIGN IN
FR-2	User Registration	Enters Mail ID and other personal details required for Registering
FR-3	User Login	Uses Mail ID and Password for login
FR-4	Flight Info	Flight Info Flight number,name,destination and timing should be entered for prediction

4.2 NON FUNCTIONAL REQUIREMENTS

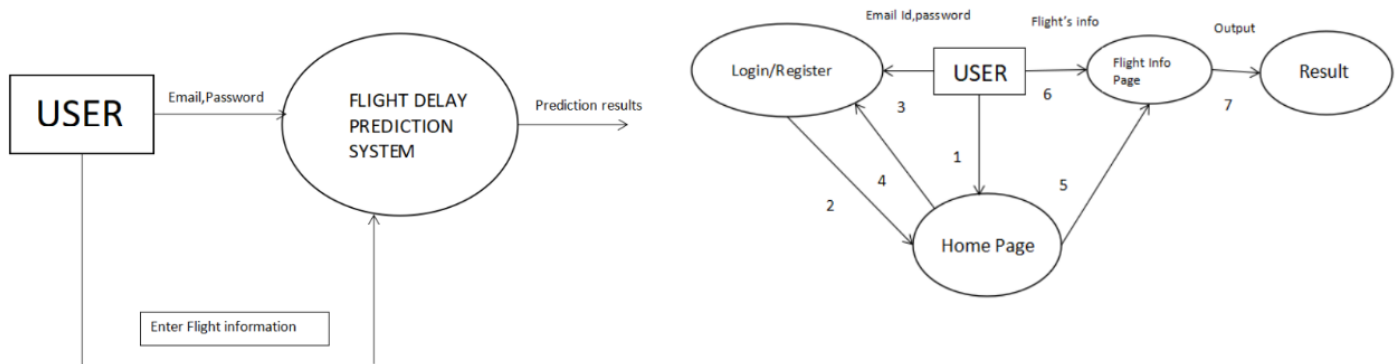
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	It describes the context of When,Where and Why. The specific activities the requirements describe should reflect the both range of goals that the system must support
NFR-2	Security	Security functionality that ensures one of many different security properties of software is being satisfied.Security requirements are derived from industry standards,applicable laws,and a history of past vulnerabilities.
NFR-3	Reliability	It is the measure of the prediction based on the Flights given information and its current status.
NFR-4	Performance	It defines the accuracy of the delay of fligh

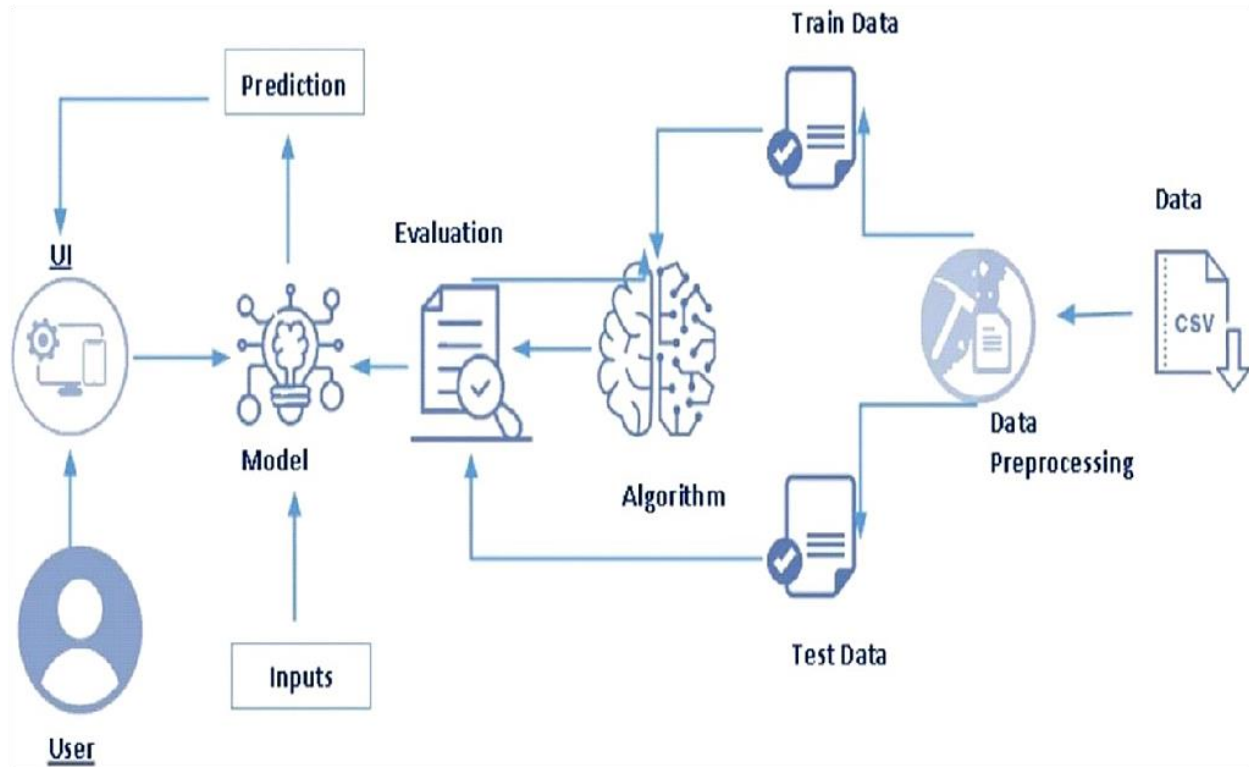
CHAPTER - 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM



5.2 SOLUTION & TECHNICAL ARCHITECTURE



CHAPTER 6

PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint 1	Data Collection	USN-1	As a user, I can collect the dataset from various resources with different flight models	10	Low	Priyadharshinii S Roshini banu L
Sprint 1	Data Pre- processing	USN-2	As a user, I can load the data set, handling the missing data, scale and split data into train and test.	10	Medium	Priyadharshinii S Roshini banu L
Sprint 2	Model Building	USN-3	As a user, I will get an application with ML model which provides high accuracy of recognized handwritten digit.	5	High	Priyadharshinii S Roshini banu L Rajclinton Sakthivel
Sprint 2	Add CNN layers	USN-4	Creating the model and adding the input, hidden, and output layer to it.	5	High	Priyadharshinii S Roshini banu L Rajclinton Sakthivel

Sprint 2	Compiling the model	USN-5	With both the training data and model it's time to configure the learning process.	2	Medium	Priyadharshinii S Roshini banu L Rajclinton Sakthivel
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Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priorit y	Team Members
Train & test the model	USN-6	As a user, let us train our model with our image Data set.	6	Medium	Roshini banu L Rajclinton Sakthivel
Save the model	USN-7	As a user,the modelis saved integratedwith an android application or web application in order to predict something.	2	Low	Priyadharshnii S
Building UI Application	USN-8	As a user I will upload the flight model image to the application by clicking a upload button.	5	High	Priyadharshinii S Sakthivel

	USN-9	As a user, I can know the details of the fundamental usage of the application.	5	Low	Rajclinton
Train the model on IBM	USN-10	As a user, I train the model on IBM and integrate flask with scoring end point.	10	High	Priyadharshinii S Roshini banu L Rajclinton Sakthivel

6.2 SPRINT DELIVERY SCHEDULE

Sprint	Total Story Points	Due	Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Released Date (Actual)
Sprint1	20	3 Days	04 Nov 2022	07 Nov 2022	20	07 Nov 2022
Sprint2	20	3 Days	07 Nov 2022	10 Nov 2022	20	10 Nov 2022
Sprint3	20	3 Days	10 Nov 2022	13 Nov 2022	20	13 Nov 2022
Sprint4	20	3 Days	13 Nov 2022	16 Nov 2022	20	16 Nov 2022

CHAPTER -7

CODING AND SOLUTION

FLIGHTDELY.HTML:

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <link rel="stylesheet" href="{{ url_for('static',filename='styles/styles.css') }}">
  <script src="{{url_for('static', filename='styles/delaypredict.js')}}"></script>
  <title>Flight Delay Prediction</title>
</head>
<body id="flight-form">
<h2 id="main-head" class="centered-head">FLIGHT DELAY PREDICTION</h2>

<form name="flightForm" action="/result" method="POST" target="_blank">
  <div id="form-content">
    <div id="block1">
      <div class="detail-container">
        <label for="fno" class="label-item">Enter the Flight Number</label>
        <br>
        <input type="number" id="fno" name="fno" class="text-input">
      </div>
      <div class="detail-container">
        <label for="month" class="label-item">Month</label>
        <br>
        <input type="number" id="month" name="month" class="text-input"
onblur="checkValid('month');" placeholder="Enter the Month Number">
        <div class="alert-text" id="month-valid">Enter a valid month between 1 to
12.</div>
      </div>
      <div class="detail-container">
        <label for="daym" class="label-item">Day of Month</label>
        <br>
        <input type="number" id="daym" name="daym" class="text-input"
onblur="checkValid('daym');">
        <div class="alert-text" id="daym-valid">Enter a valid day of month.</div>
      </div>
      <div class="detail-container">
        <label for="dayw" class="label-item">Day of Week</label>
        <br>
```

```

        <input type="number" id="dayw" name="dayw" class="text-input"
onblur="checkValid('dayw');">
        <div class="alert-text" id="dayw-valid">Enter a valid day between 1 to 7.</div>
    </div>
    <div class="detail-container">
        <label for="org" class="label-item">Origin</label>
        <br>
        <select id="org" name="org" class="select-input">
            <option value="ATL" class="option-item">ATL</option>
            <option value="SEA" class="option-item">SEA</option>
            <option value="DTW" class="option-item">DTW</option>
            <option value="MSP" class="option-item">MSP</option>
            <option value="JFK" class="option-item">JFK</option>
        </select>
    </div>
    <div class="detail-container">
        <label for="dest" class="label-item">Destination</label>
        <br>
        <select id="dest" name="dest" class="select-input" onblur="checkValid('dest');">
            <option value="ATL" class="option-item">ATL</option>
            <option value="SEA" class="option-item">SEA</option>
            <option value="DTW" class="option-item">DTW</option>
            <option value="MSP" class="option-item">MSP</option>
            <option value="JFK" class="option-item">JFK</option>
        </select>
        <div class="alert-text" id="dest-valid">Enter different Origin and
Destination.</div>
    </div>
</div>
<div id="block2">
    <div class="detail-container">
        <label for="sdt" class="label-item">Scheduled Departure Time</label>
        <br>
        <input type="number" id="sdt" name="sdt" class="text-input"
onblur="checkValid('sdt');" placeholder="Enter in the format HHMM">
        <div class="alert-text" id="sdt-valid">Enter a valid time between 500 to
2359.</div>
    </div>
    <div class="detail-container">
        <label for="sat" class="label-item">Scheduled Arrival Time</label>
        <br>
        <input type="number" id="sat" name="sat" class="text-input"
onblur="checkValid('sat');" placeholder="Enter in the format HHMM">
        <div class="alert-text" id="sat-valid">Enter a valid time between 500 to
2359.</div>
    </div>
    <div class="detail-container">

```

```

        <label for="adt" class="label-item">Actual Departure Time</label>
        <br>
        <input type="number" id="adt" name="adt" class="text-input"
onblur="checkValid('adt');" placeholder="Enter in the format HHMM">
        <div class="alert-text" id="adt-valid">Enter a valid time between 500 to
2359.</div>
    </div>
</div>
<div id="submit-button">
    <input type="submit" value="Submit" id="submit" class="button" onclick="validateForm()">
</div>
</form>
</body>
</html>

```

RESULT.HTML:

```

<!doctype html>
<html>
<head>
    <title>Flight Delay Prediction - Result</title>
    <link rel="stylesheet" href="{ url_for('static',filename='styles/result_styles.css') }">
</head>
<body>
    
    {% if prediction[0]== 0.0 %}
    <div class="pred_result" id="result_0">There is a good chance that your flight will be on
time</div>
    {% endif %}
    {% if prediction[0] == 1.0 %}
    <div class="pred_result" id="result_1">There is a possibility that your flight will be
delayed</div>
    {% endif %}
</body>
</html>

```

CHAPTER 8

TESTING

8.1 TEST CASES

Test case ID	Feature	Component	Scenario	Expected Result	Actual Result	Status
HP_TC_001	UI	Home Page	Elements in the home page	The Homepage must be displayed properly	Working as expected	PASS
BE_TC_001	Functional	Backend	Check if all the routes are working properly	All theroutes should work properly	Working as expected	PASS
RP_TC_001	UI	Result	Verify UI elements in the Result Page	The Result page must be display properly	Working as expected	PASS

8.2 USER ACCEPTANCE TESTING

8.2.1 DEFECT ANALYSIS

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	1	4	2	3	10
Duplicate	0	0	3	0	3
External	0	1	0	0	1
Fixed	1	3	2	6	12
Not Reproduced	0	0	0	0	0
Skipped	1	1	0	0	2
Won't Fix	1	0	0	0	1
Totals	4	9	7	9	29

8.2.2 TEST CASE ANALYSIS

Section	Total Cases	Not Tested	Fail	Pass
Model Evaluation	10	0	0	10
Client Application	20	0	0	20
Exception Reporting	2	0	0	2
Final Report Output	4	0	0	4

CHAPTER - 9

RESULTS

9.1 PERFORMANCE METRICS

FLIGHT DELAY PREDICTION

Enter the Flight Number
3433

Month
2

Day of Month
4

Day of Week
4

Origin
ATL

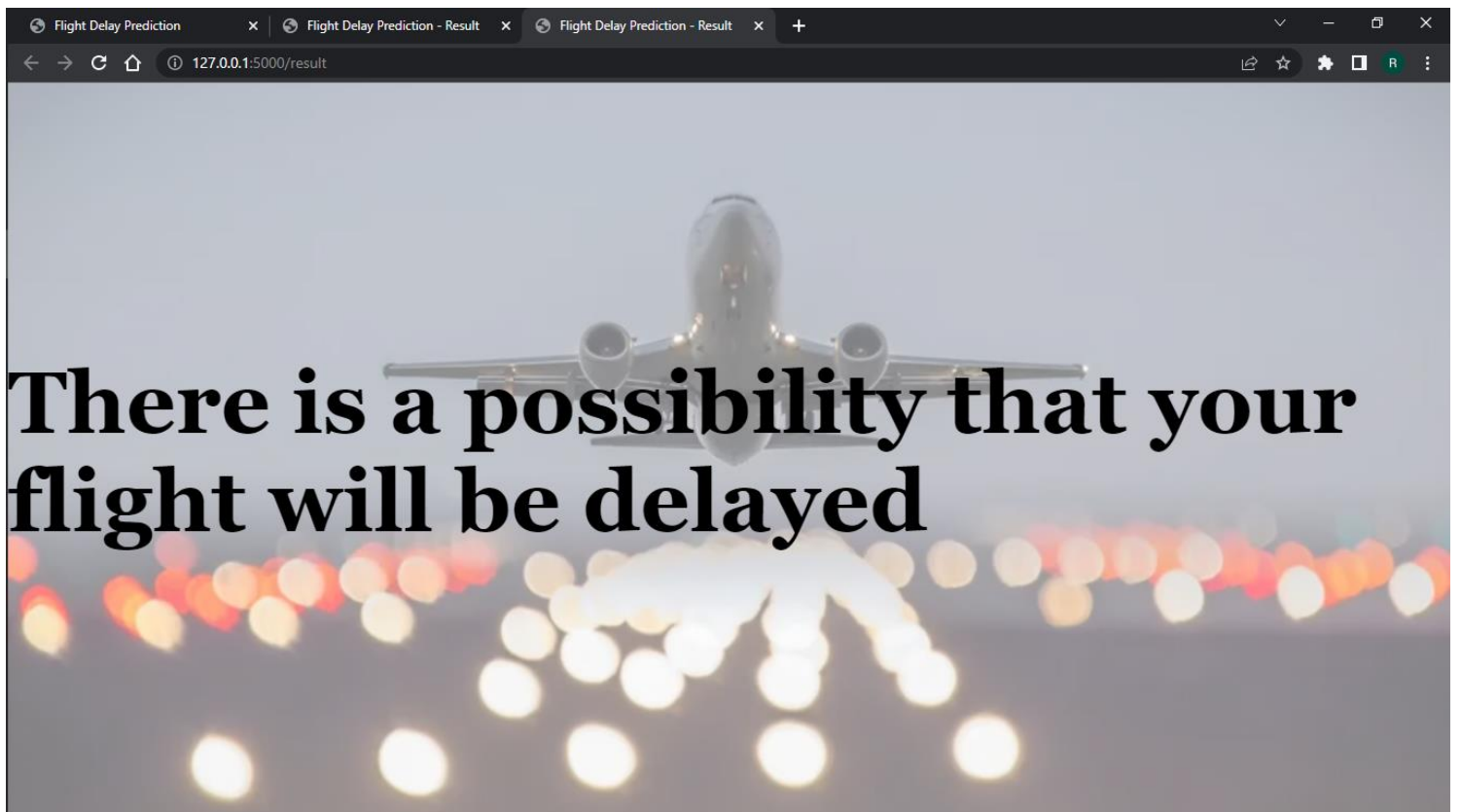
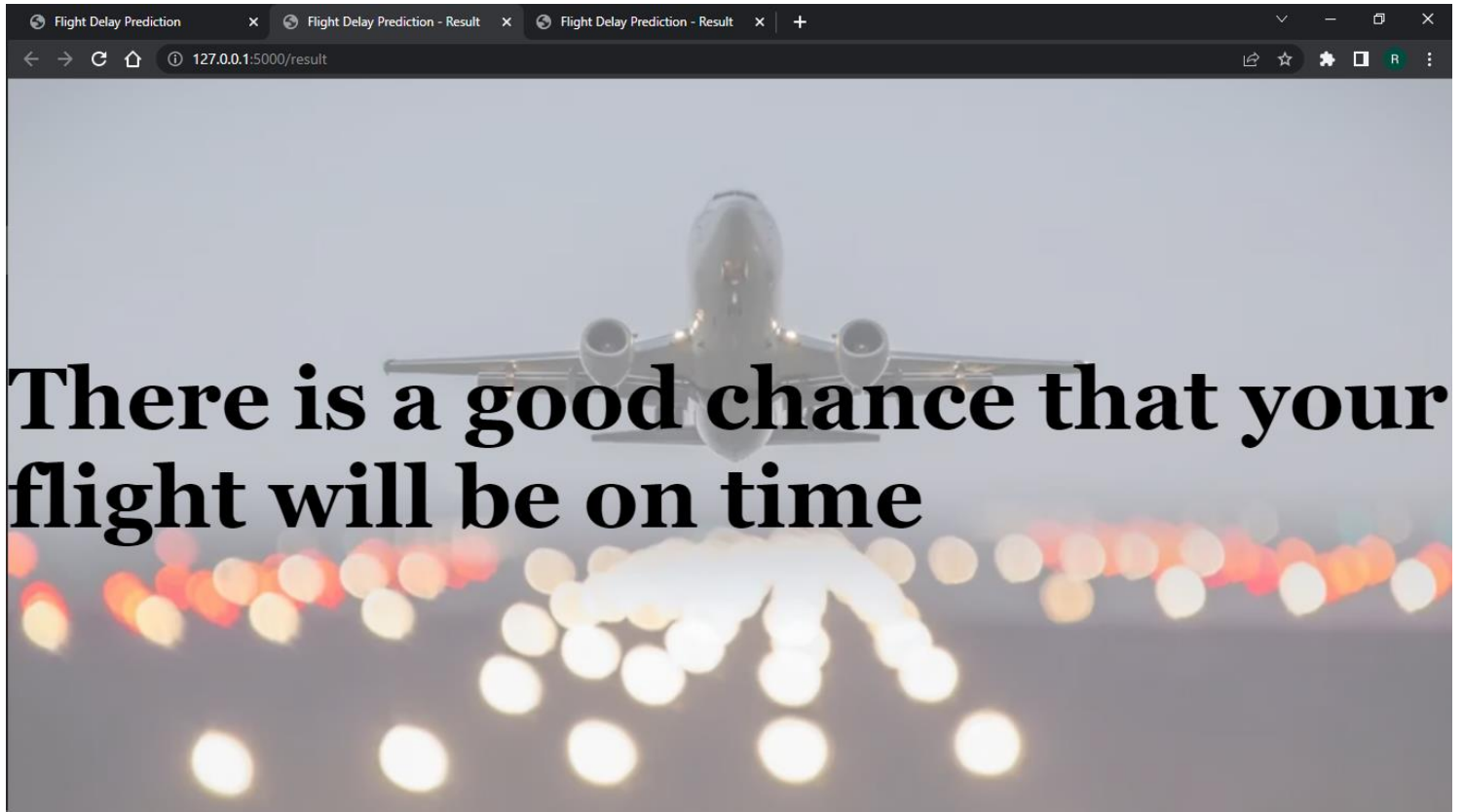
Destination
SEA

Scheduled Departure Time
600

Scheduled Arrival Time
800

Actual Departure Time
600

Submit



CHAPTER - 10

ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Reduces manual work
- More accurate than average human
- Capable of handling a lot of data
- Can be used anywhere from any device

DISADVANTAGES

- Cannot handle complex data
- All the data must be in digital format
- Requires a high performance server for faster predictions
- Prone to occasional errors

CHAPTER 11

CONCLUSION

This project demonstrated a web application that uses machine learning to recognise handwritten numbers. Flask, HTML, CSS, JavaScript, and a few other technologies were used to create this project. The model predicts the handwritten digit using a CNN network. During testing, the model achieved a 99.61% recognition rate. The proposed project is scalable and can easily handle a huge number of users. Since it is a web application, it is compatible with any device that can run a browser. This project is extremely useful in real-world scenarios such as recognizing number plates of vehicles, processing bank cheque amounts, numeric entries in forms filled up by hand (tax forms) and so on. There is so much room for improvement, which can be implemented in subsequent versions.

CHAPTER - 12

FUTURE SCOPE

This project is far from complete and there is a lot of room for improvement. Some of the improvements that can be made to this project are as follows:

- Add support to detect from digits multiple images and save the results
- Add support to detect multiple digits
- Improve model to detect digits from complex images
- Add support to different languages to help users from all over the world

This project has endless potential and can always be enhanced to become better. Implementing this concept in the real world will benefit several industries and reduce the workload on many workers, enhancing overall work efficiency.

APPENDIX

SOURCE CODE

MODEL CREATION

```
from flask import Flask, render_template, request
import pandas as pd
import joblib
import numpy as np

app = Flask(__name__)
```

```
@app.route('/')
def home():
    return render_template('Flightdelay.html')
```

```
@app.route('/result', methods = ['POST'])
def predict():
    fl_num = int(request.form.get('fno'))
    month = int(request.form.get('month'))
    dayofmonth = int(request.form.get('daym'))
    dayofweek = int(request.form.get('dayw'))
    sdeptime = request.form.get('sdt')
    adeptime = request.form.get('adt')
    arrtime = int(request.form.get('sat'))
    depdelay = int(adeptime) - int(sdeptime)
    inputs = list()
    inputs.append(fl_num)
    inputs.append(month)
    inputs.append(dayofmonth)
    inputs.append(dayofweek)
    if (depdelay < 15):
        inputs.append(0)
    else:
        inputs.append(1)
    inputs.append(arrtime)
    origin = str(request.form.get("org"))
    dest = str(request.form.get("dest"))
    if(origin=="ATL"):
        a=[1,0,0,0,0]
        inputs.extend(a)
    elif(origin=="DTW"):
        a=[0,1,0,0,0]
```

```

        inputs.extend(a)
    elif(origin=="JFK"):
        a=[0,0,1,0,0]
        inputs.extend(a)
    elif(origin=="MSP"):
        a=[0,0,0,1,0]
        inputs.extend(a)
    elif(origin=="SEA"):
        a=[0,0,0,0,1]
        inputs.extend(a)

    if(dest=="ATL"):
        b=[1,0,0,0,0]
        inputs.extend(b)
    elif(dest=="DTW"):
        b=[0,1,0,0,0]
        inputs.extend(b)
    elif(dest=="JFK"):
        b=[0,0,1,0,0]
        inputs.extend(b)
    elif(dest=="MSP"):
        b=[0,0,0,1,0]
        inputs.extend(b)
    elif(dest=="SEA"):
        b=[0,0,0,0,1]
        inputs.extend(b)

```

```

prediction = preprocessAndPredict(inputs)
#Pass prediction to prediction template
print(inputs)
return render_template('/result.html', prediction = prediction)

```

```

def preprocessAndPredict(inputs):
    test_data = np.array(inputs).reshape((1,16))

    model_file = open('model.pkl', 'rb')

    trained_model = joblib.load(model_file)

```

```

    df = pd.DataFrame(data=test_data[0:, 0:], columns=['FL_NUM', 'MONTH', 'DAY_OF_MONTH',
'DAY_OF_WEEK', 'DEP_DEL15', 'CRS_ARR_TIME', 'ORIGIN_ATL', 'ORIGIN_DTW', 'ORIGIN_JFK',
'ORIGIN_MSP', 'ORIGIN_SEA', 'DEST_ATL', 'DEST_DTW', 'DEST_JFK', 'DEST_MSP', 'DEST_SEA'])

```

```

data = df.values

```

```

result = trained_model.predict(data)

```



```
print(result)
return result
```

```
if __name__ == '__main__':
    app.run(debug=True)
```

DEMO VIDEO LINK:

https://drive.google.com/drive/folders/1D719_M82juSzpD7hpCJhrtCWKD4OUdPO?usp=share_link