ElectriFly

Team 2 - FDR Presentation

Friday, April 5, 2024

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Final Design Review Agenda

How Might We Statement

Empowering stronger flight decisions through analytics & ML

HMW Statement

How might we **analyze flight, battery, and weather data** for pilots and researchers to optimize plane operations and enable the users to make decisions based on **climate conditions, battery state of charge (SOC), and SOH**?

Project Objectives

3 Core Project Objectives

1

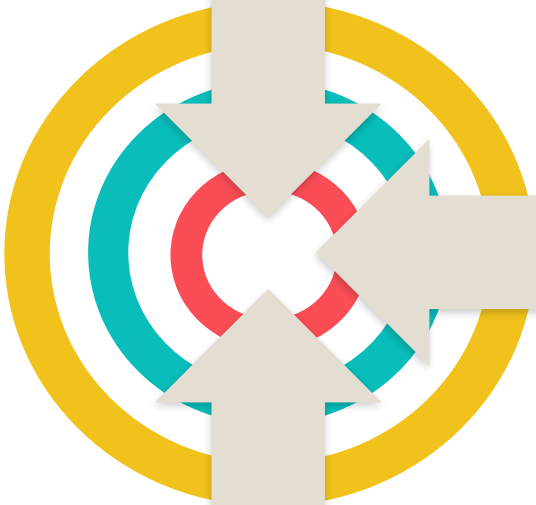
Data Pipeline

Clean, transform, label

2

Data Visualization UI

Generate graphs



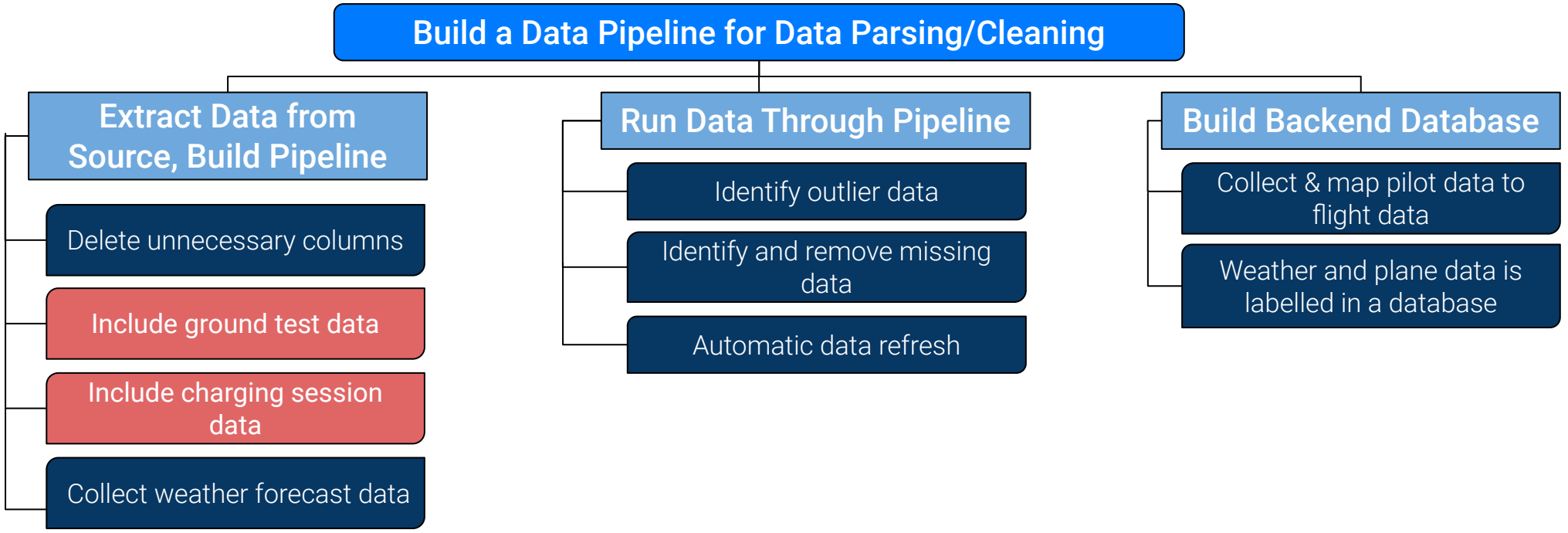
3

Prescription of Optimal Operations for Electric Planes

Recommend operations for optimal utilization of plane

Data Pipeline Requirements

Must-Have Functional Requirements



Success Criteria

KPI

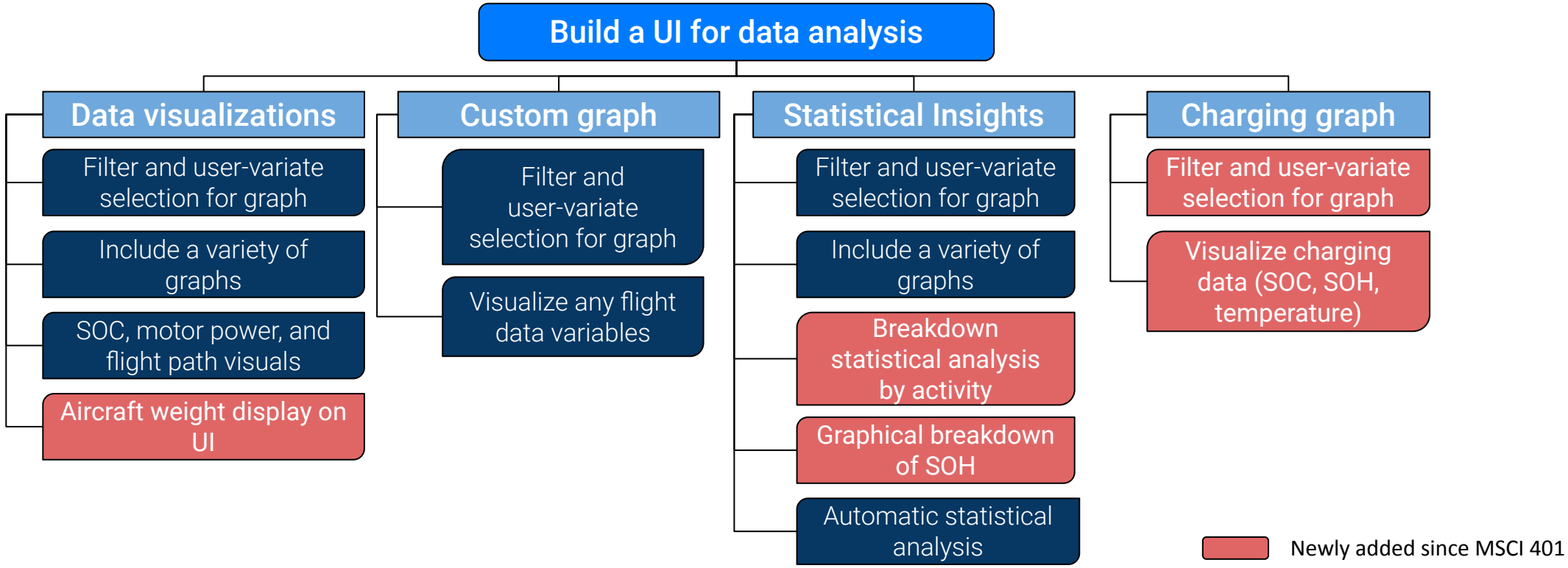
Better metrics compared to previous data parsing (faster and automated process)

Verification

Calculations, historical analysis, and qualitative user experience, pilot program

Data Visualization Requirements

Must-Have Functional Requirements



Success Criteria

KPI

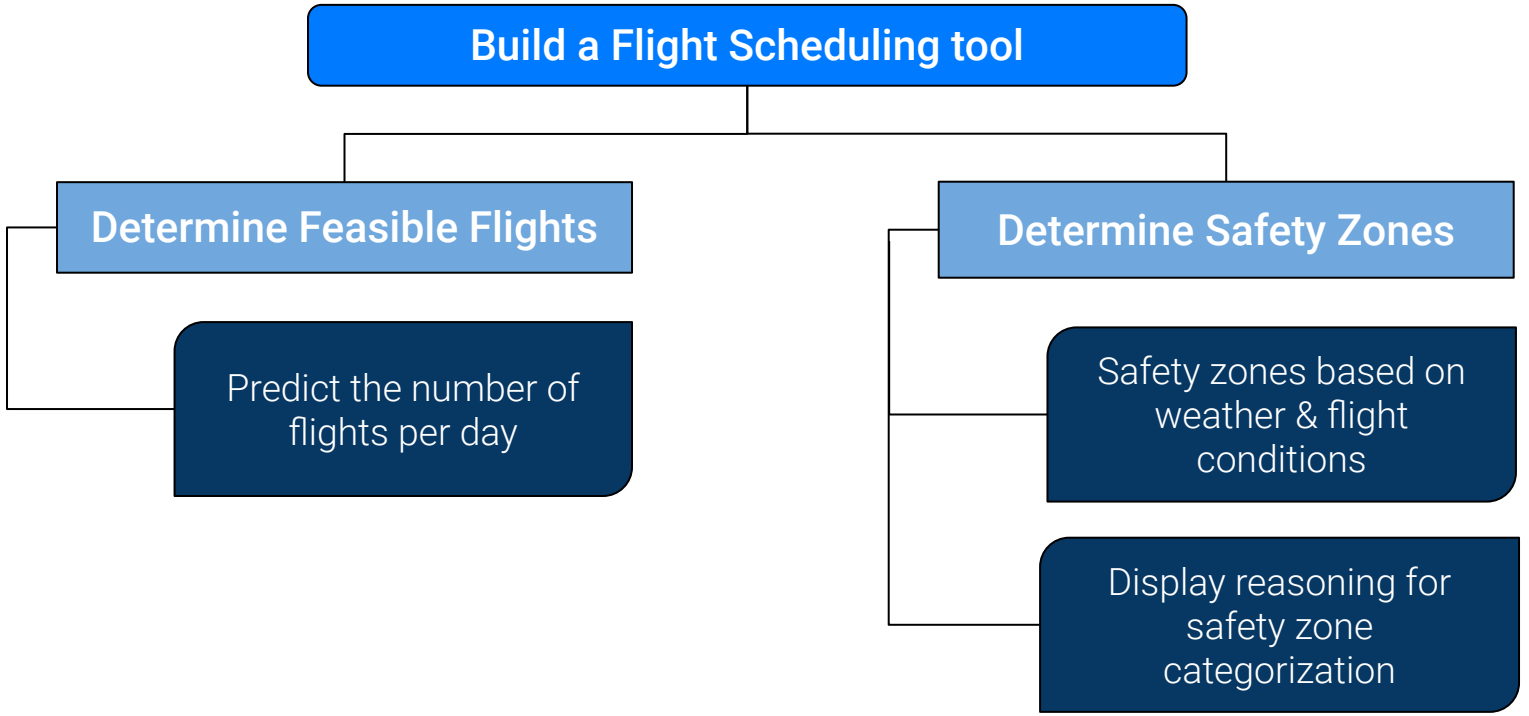
Better metrics compared to previous manual analysis, and qualitative user experience (heuristic evaluation and pilot program)

Verification

Calculations, historical analysis, and qualitative user experience (heuristic evaluation and pilot program)

Flight Scheduling Requirements

Must-Have Functional Requirements



Success Criteria

KPI

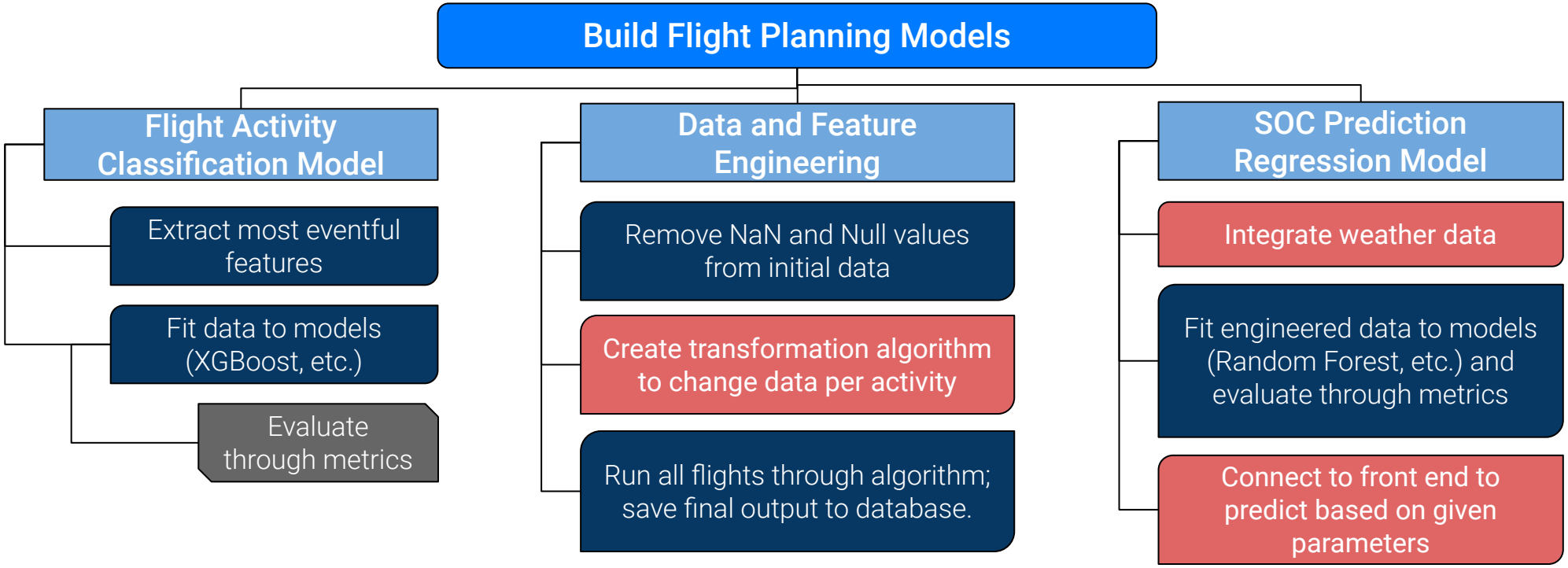
Better metrics compared to human decision given data

Verification

Calculations, historical analysis, and qualitative user experience (heuristic evaluation and pilot program)

Flight Exercise Planning Requirements

Must-Have Functional Requirements



Success Criteria

KPI

Better metrics compared to human decision given data

Verification

Calculations and qualitative user experience (heuristic evaluation and pilot program)

Verification & Validation

Machine Learning Model

Verification

	Linear Regression	Ridge Regression	Random Forest	XGBoost
Mean Squared Error (MSE)	3.83	6.44	1.6	2.02
Coefficient of Determination	0.66	0.66	0.91	0.89
K-fold cross validation score	0.64	0.63	0.85	0.88

Validation

Gabriel, Pilot

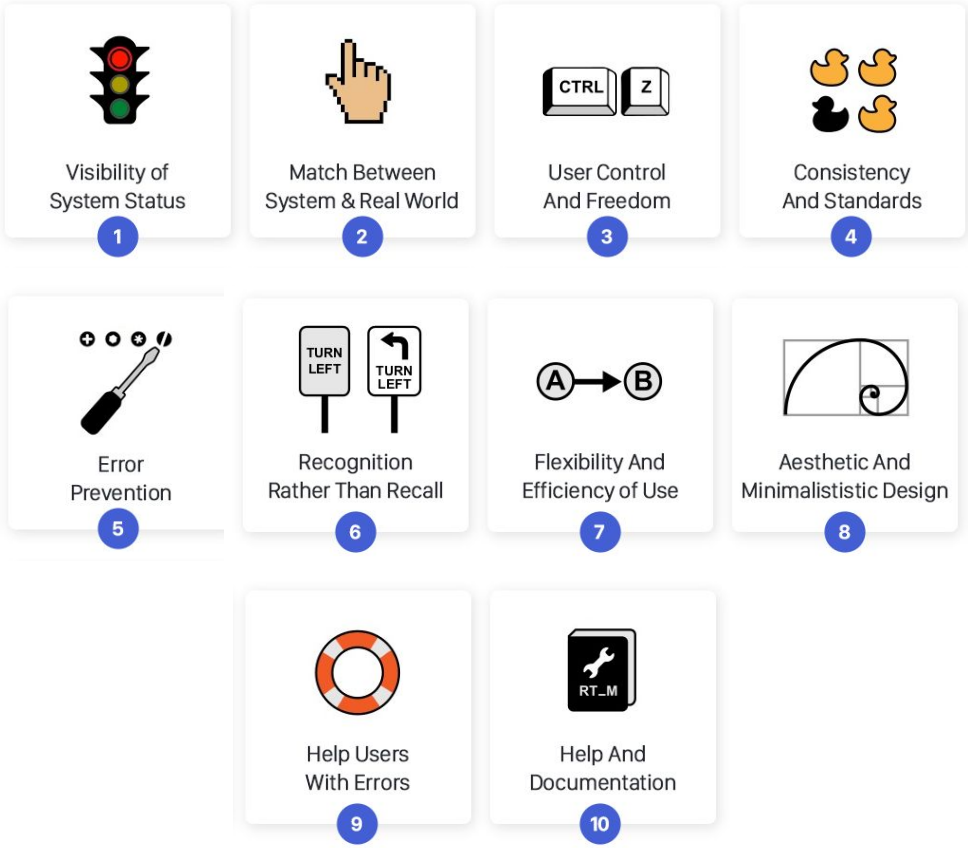
I'm impressed with how accurately your model labels flight exercises

1.5 Week **Pilot Program**

Verification & Validation

UI Verification with Heuristic Evaluations

Nielsen's 10 Usability Heuristics



49 Potential Improvements

Team Heuristic Evaluation Results

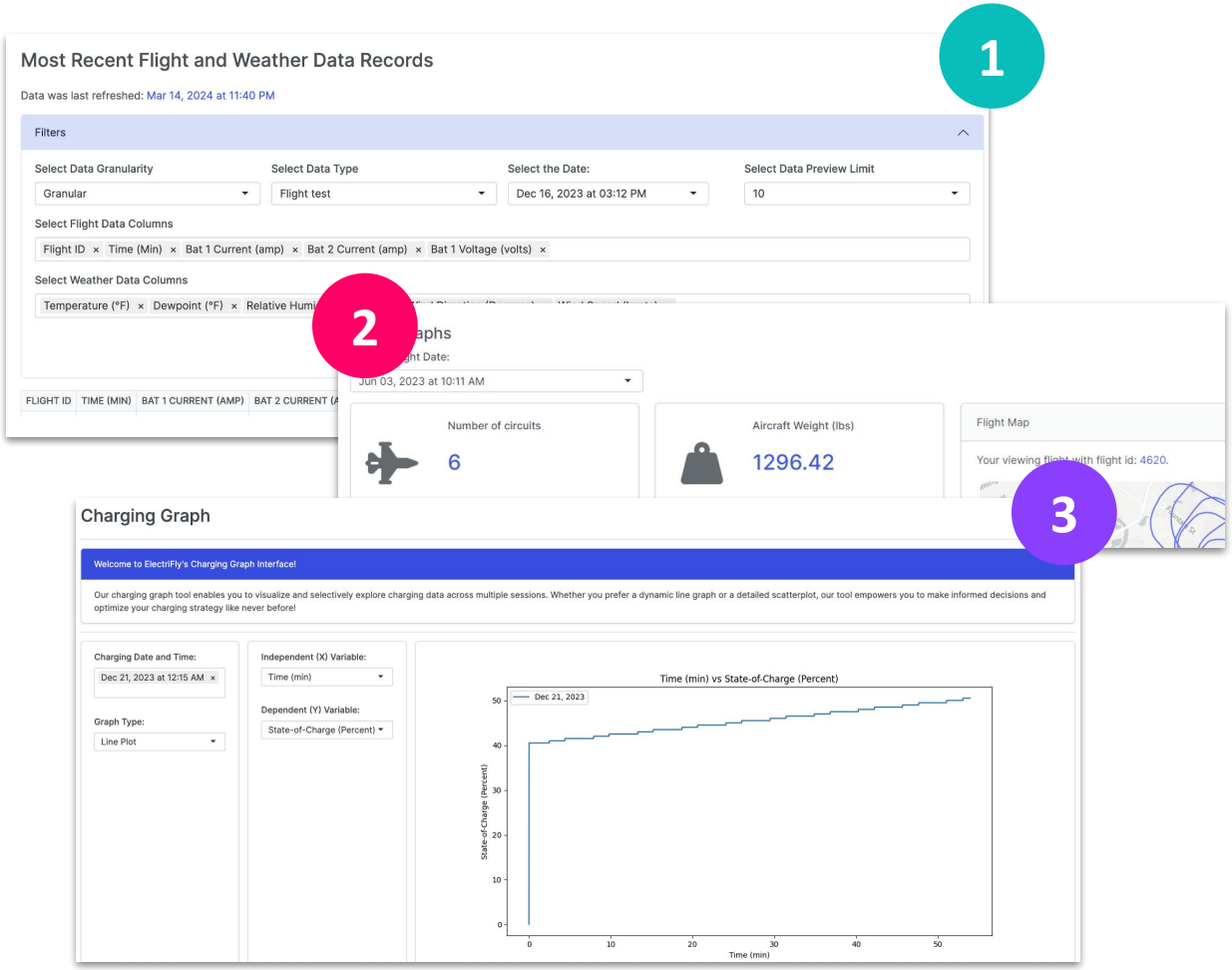
↑ PM Priority · UI Page · Severity Rating · PM Priority

Done	PM Priority	Heuristic	Description of Problem	Severity Rating	Potential Solution	UI Page
☑	Urgent	H2-1: visibility of system status	Change the menu headers to something more meaningful	2	- Upload Data → "Data Preview" - Data Analysis - Simulation → Flight Planning - Data Analysis > Recommended Graphs → Data Visualization - Simulation > Forecasting → Flight Scheduling - Simulation > Flight Operations Modeling → Flight Exercise Planning	Menu Data Analysis – Recomm... Simulation – Forecasting
☑	Urgent	H2-4: consistency and standards	All graphs titles and legends are cut off	4	Fix the sizing. Make the graphs fit onto Shiny cards.	Data Analysis – Recomm... Data Analysis – Custom ...
☑	Must do	H2-2: match between system an...	Dates are all disorganized to select	2	Make the most recent at the top and less recent at the bottom	Upload Data Page Data Analysis – Recomm... Data Analysis – Custom ... Data Analysis – Statistic... Simulation – Forecasting Simulation – Flight Ops ...
☑	Must do	H2-7: flexibility and efficiency of...	Be able to edit and delete each exercise	1	For each flight activity chosen, you should be able to edit the mins selected (and potentially the exercise selected), you should be able to delete any row	Simulation – Flight Ops ...
☑	Must do	H2-4: consistency and standards	Date/time is wrong format	1	• For date: Dec 16, 2023 • For date AND time (if multiple flights): Dec 16,	Upload Data Page Data Analysis – Statistic... Simulation – Forecasting

Verification & Validation

UI Validation with Pilot Program

Tangible Feedback & Improvements



Design Validation

ElectriFly UI - System Usability Scale

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I think that I would like to use this system frequently	○	○	○	○	○
I found the system unnecessarily complex	○	○	○	○	○
I thought the system was easy to use	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this system	○	○	○	○	○
I found the various functions in this system were well integrated	○	○	○	○	○
I thought there was too much inconsistency in this system	○	○			
I would imagine that most people would learn to use this system very quickly	○	○			

System Usability Score:

79

Alternative UI Designs

Data Preview

OLD

Most Recent Flight and Weather Data Records

Select Columns to Preview

Flight Date × Flight ID × Time (Min) × Bat 1 SOC × Bat 1 SOH ×
Bat 1 Max Cell Temp × Temperature × Visibility ×

FLIGHT DATE	FLIGHT ID	TIME (MIN)	BAT 1 SOC	BAT 1 SOH	BAT 1 MAX CELL TEMP
2023-12-16	5367	0			
2023-12-16	5367	0.02	78.4	65.6	3.6
2023-12-16	5367	0.04	98	82	18
2023-12-16	5367	0.06	98	82	18
2023-12-16	5367	0.08	98	82	18
2023-12-16	5367	0.1	98	82	18
2023-12-16	5367	0.12	98	82	18
2023-12-16	5367	0.14	98	82	18
2023-12-16	5367	0.16	98	82	18
2023-12-16	5367	0.18	98	82	18

Data was last refreshed at: 2024-02-17 15:35:54

NEW

Most Recent Flight and Weather Data Records

Data was last refreshed: Mar 27, 2024 at 01:50 PM

Filters

Select Data Granularity: Granular

Select Data Type: Flight test

Select the Date: Dec 16, 2023 at 08:12 PM

Select Data Preview Limit: 10

Select Flight Data Columns

Flight ID × Time (Min) × Bat 1 Current (amp) × Bat 2 Current (amp) × Bat 1 Voltage (volts) ×

Select Weather Data Columns

Temperature (°F) × Dewpoint (°F) × Relative Humidity (Percent) × Wind Direction (Degrees) × Wind Speed (knots) ×

Apply Filters

FLIGHT ID	TIME (MIN)	BAT 1 CURRENT (AMP)	BAT 2 CURRENT (AMP)	BAT 1 VOLTAGE (VOLTS)	TEMPERATURE (°F)	DEWPOINT (°F)	RELATIVE HUMIDITY (PERCENT)	WIND DIRECTION (DEGREES)	W
5367	0.04	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.06	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.08	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.1	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.12	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.14	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.16	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.18	0	0	398.1	42.8	37.4	81.07	90	8
5367	0.2	0	0	398.1	42.8	37.4	81.07	90	8

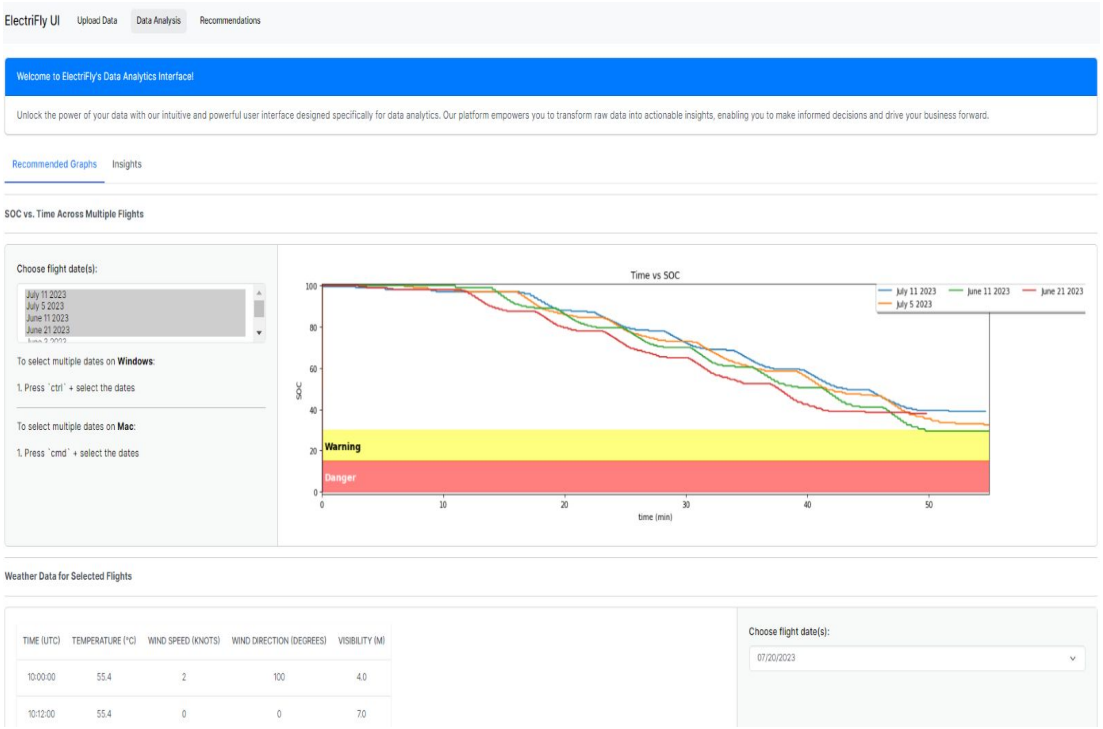
Select the Download button to download the data based on the selected granularity, data type, and date.

Download

Alternative UI Designs

Data Visualization

OLD



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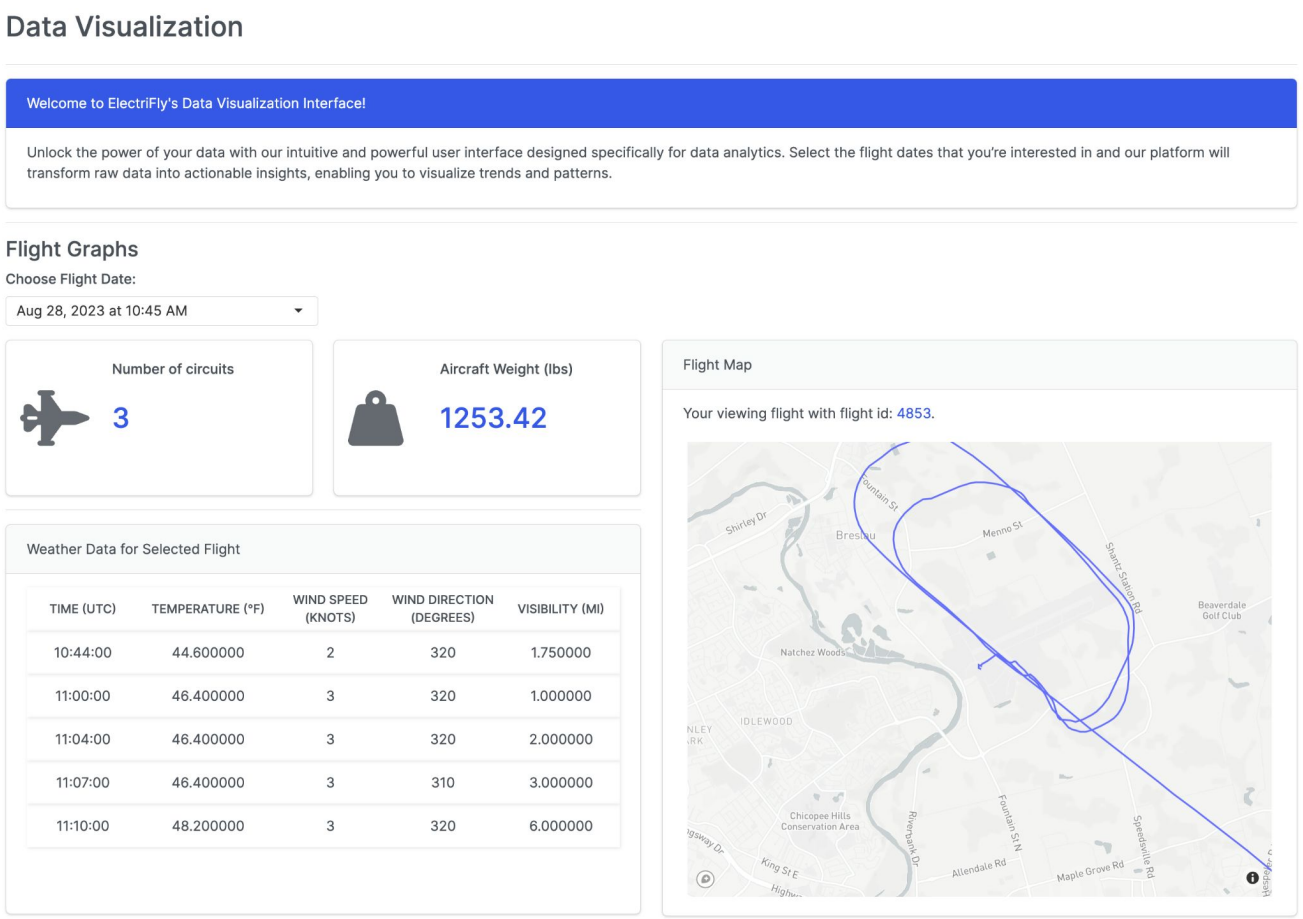

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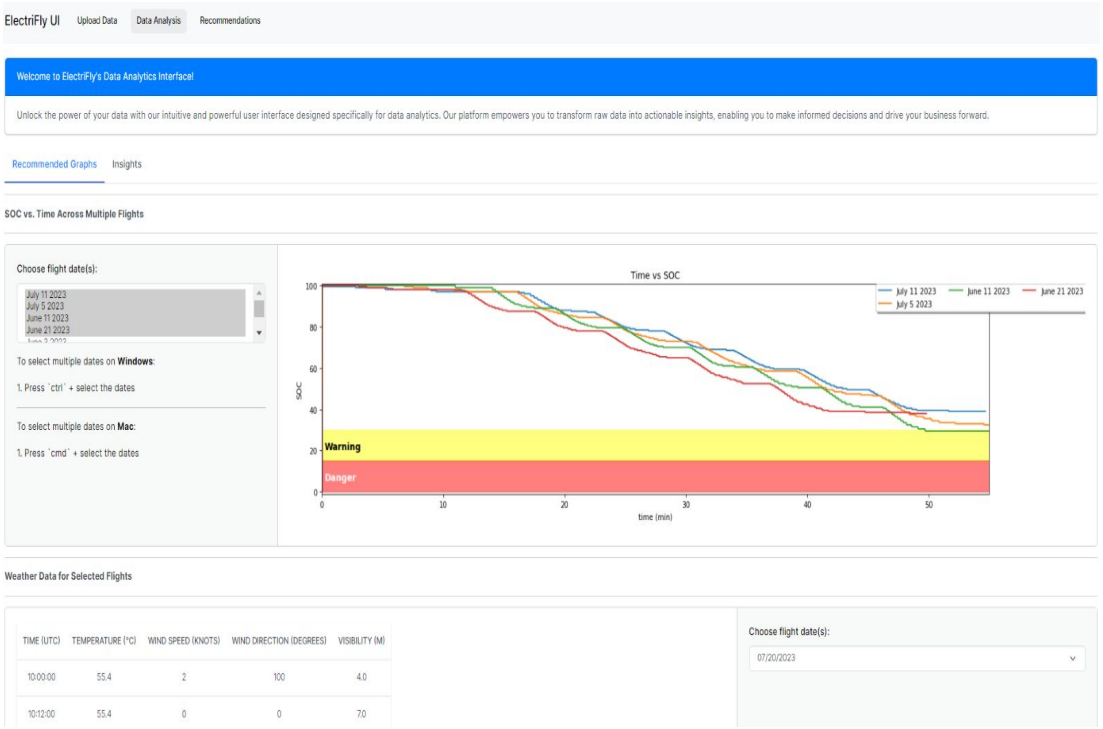
Data Visualization

OLD



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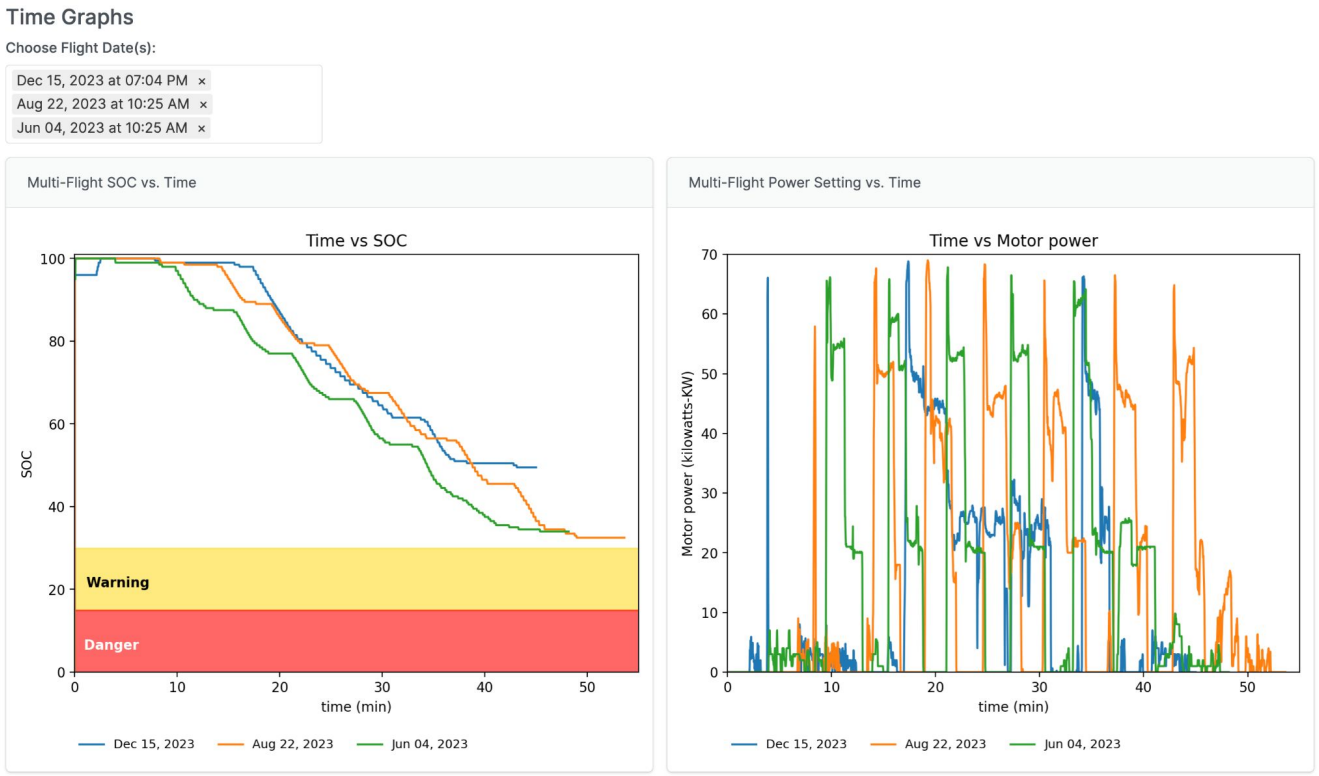
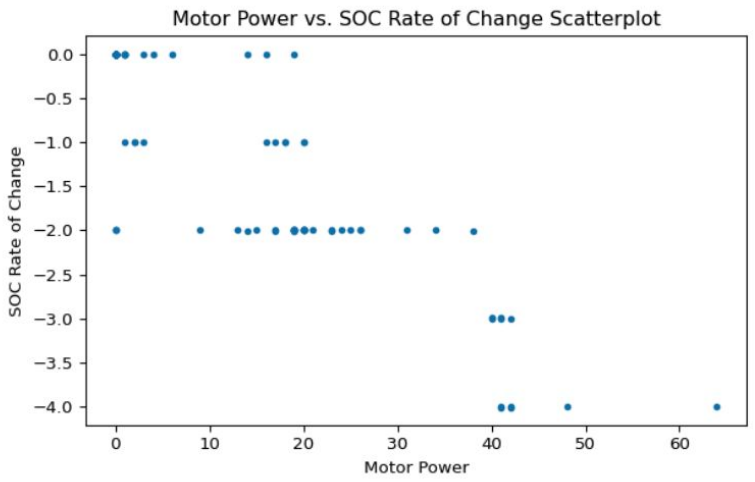
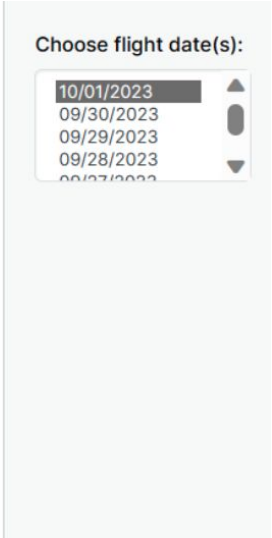


Alternative UI Designs

Statistical Insights

OLD





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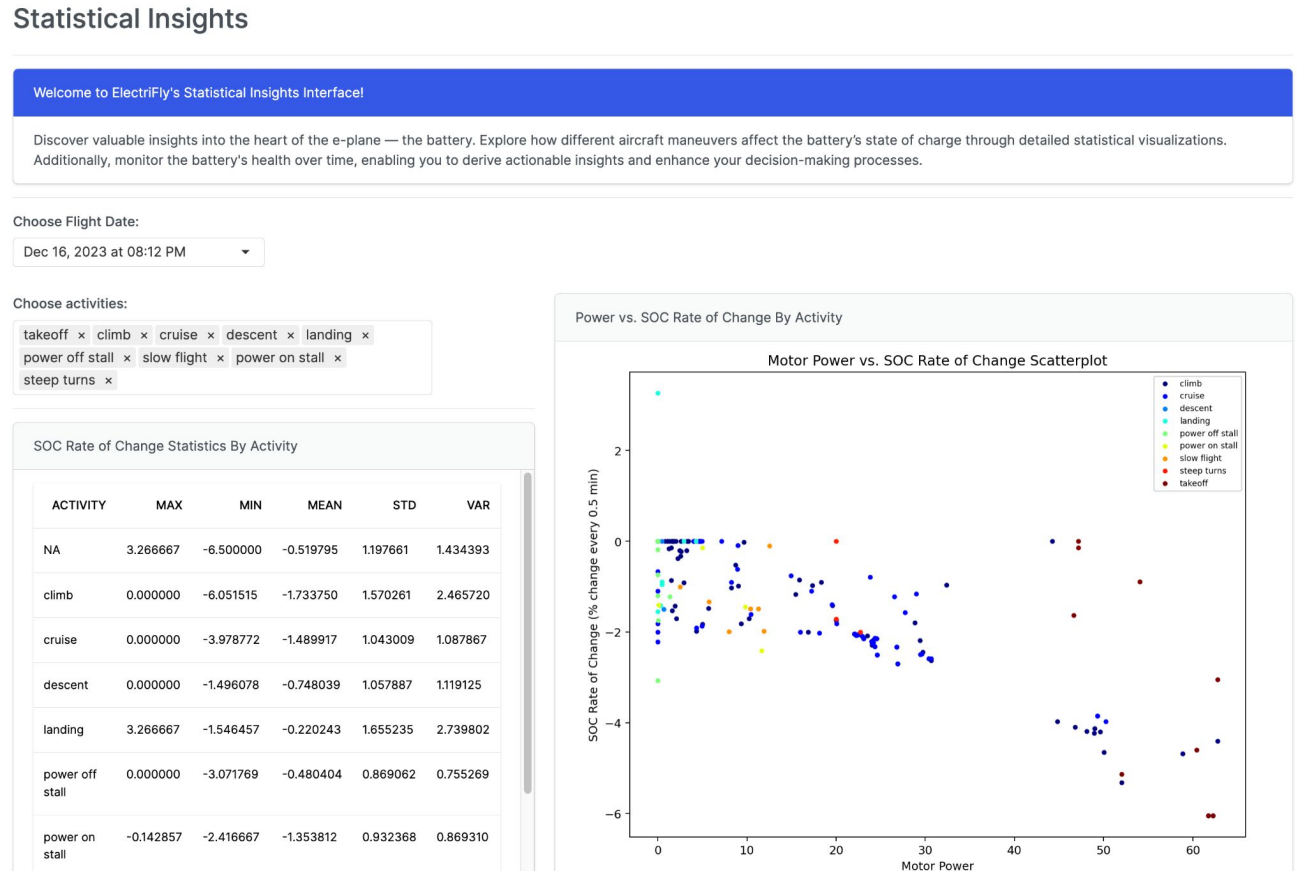
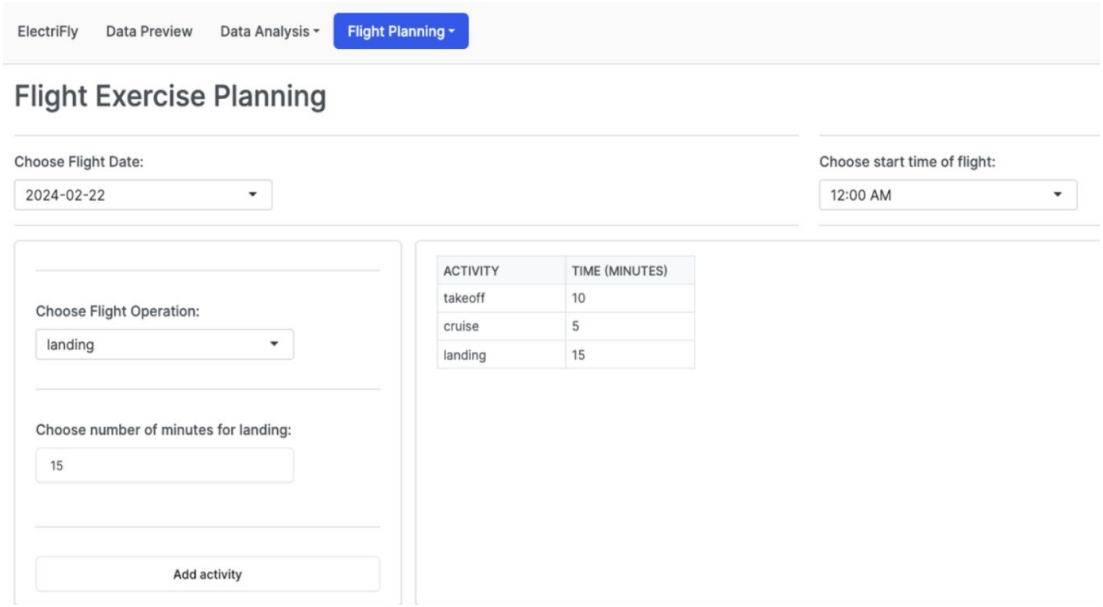


Alternative UI Designs

Flight Exercise Planning

OLD



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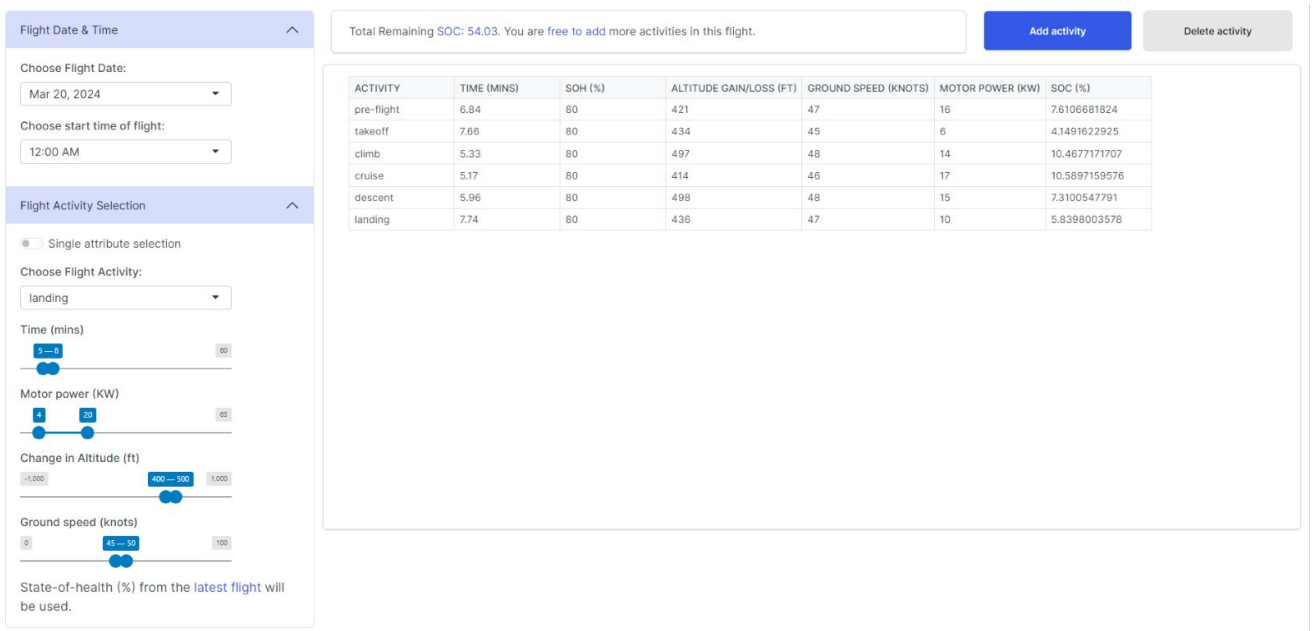
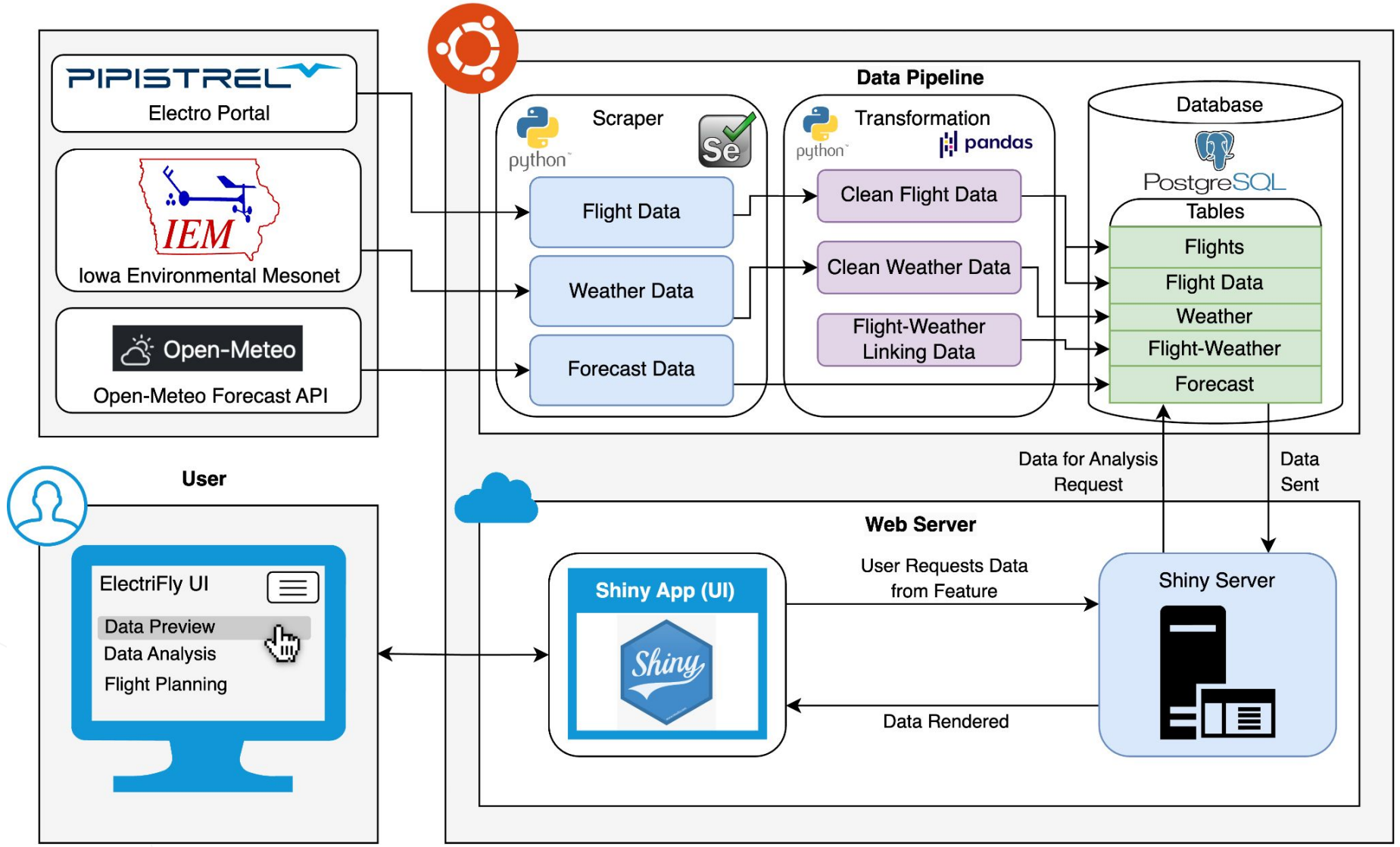


Final Design

Technology & System



Final Design

Data Pipeline

Database Schema

Flights

Flight ID	PRIMARY KEY
Date	DATE
Time (UTC)	TIME
Notes	VARCHAR(500)

FlightData_FlightID

Flight ID	FOREIGN KEY
Time(min)	DOUBLE
bat 1 current	DOUBLE
bat 2 current	DOUBLE
...	...

flight_weather

Flight ID	FOREIGN KEY
Weather ID	FOREIGN KEY

Weather

Weather ID	PRIMARY KEY
Time(min)	DOUBLE
Date	DATE
Time (UTC)	TIME
Temperature	REAL
Dewpoint	REAL
Wind Direction	SMALLINT
Wind Speed	SMALLINT
...	...

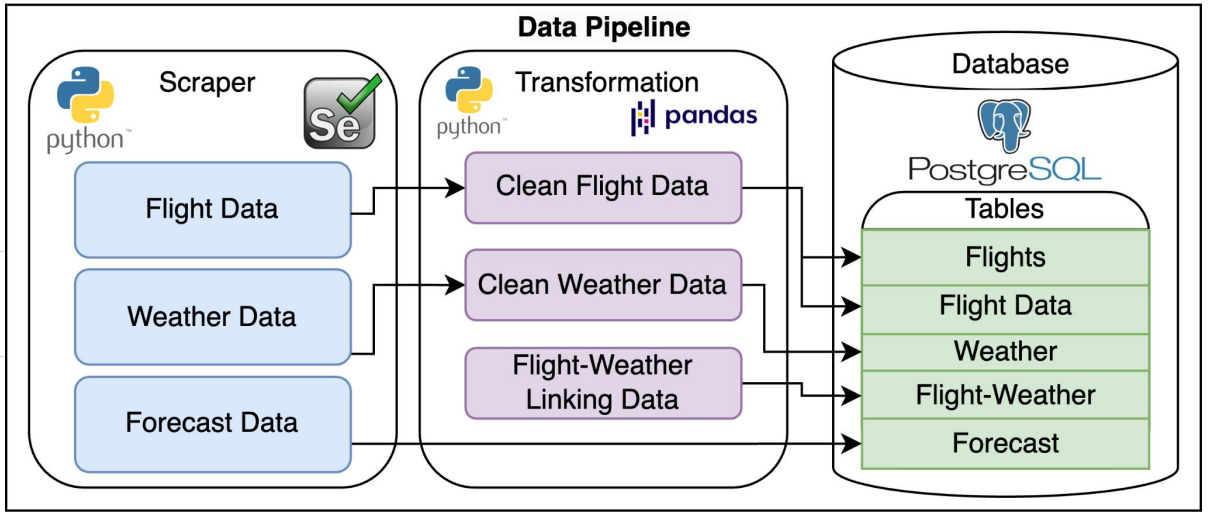
Flight Activities

Flight ID	FOREIGN KEY
Time(min)	DOUBLE
Activity	DOUBLE

Forecast

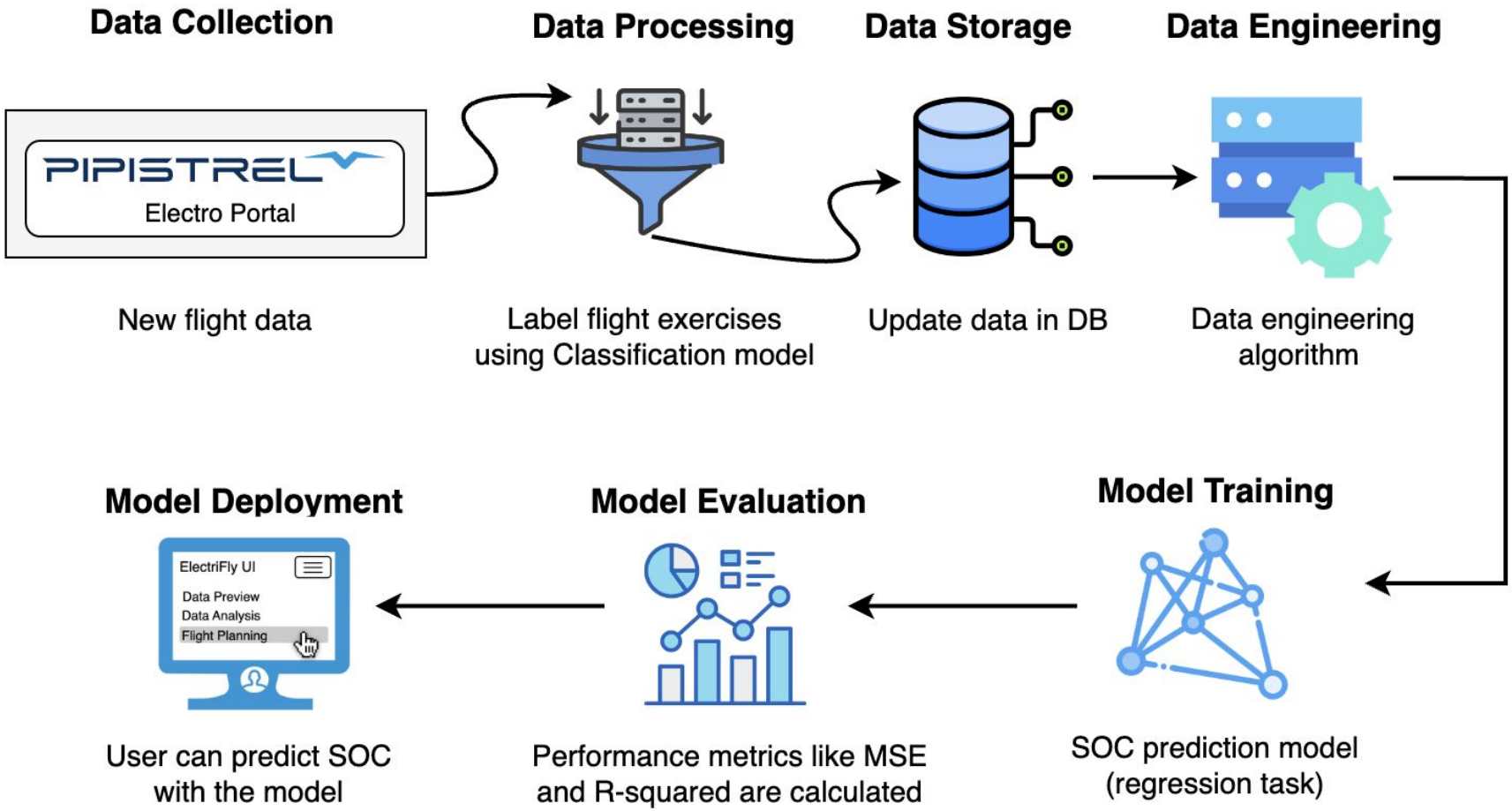
Forecast Date	DATE
Forecast TIme ET	TIME
Temperature	FLOAT
Wind Gusts	FLOAT
Visibility	FLOAT
Wind Direction	FLOAT
...	...

Data Pipeline



Final Design

ML Pipeline



Feasibility Assessment

Solution Feasibility

Verified and Validated Feasibility

Most features determined to be feasible with the workflows of our users

High Adoption Intentions

75% of pilot program participants plan to use our solution in the future

Integration with Existing Interfaces

Pipistrel - Cloud User Interface

- We utilize the Pipistrel UI data
- We enhanced its graphing capabilities
- Ongoing discussions to integrate our application with Pipistrel UI

Wingman - Flight Scheduling

- We provide scheduling decisions that integrate weather data
- WWFC utilizes Wingman to schedule flights
- Not integrated with Wingman, flight decisions at discretion of Flight Centre

Design Impacts

Key Impacts Of Our Design

Safety and Regulations

Impacts: Pilots and passengers

Warning and danger zones for SOC in visualizations

Technological Sustainability

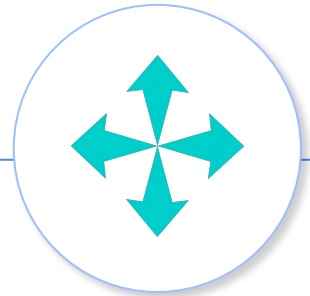
Impacts: Stakeholders

Data is able to be re-uploaded to UI in event of server crash

Social and Economic Impact

Impacts: Researchers

Increase understanding of electric plane usage in Canadian weather



Propagating Impacts

Impacts: WWFC, Pilot trainees

Addresses the pilot shortage and improves utilization rates

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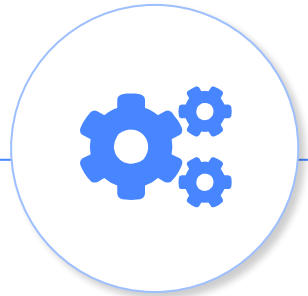

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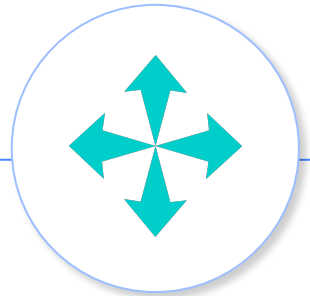

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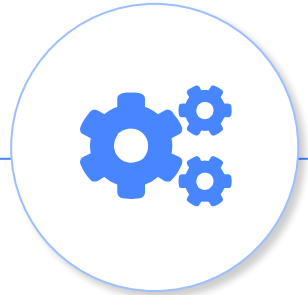

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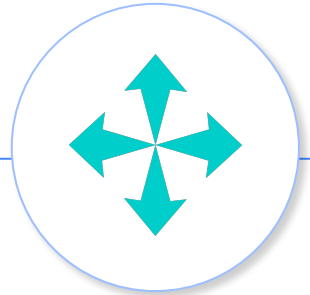

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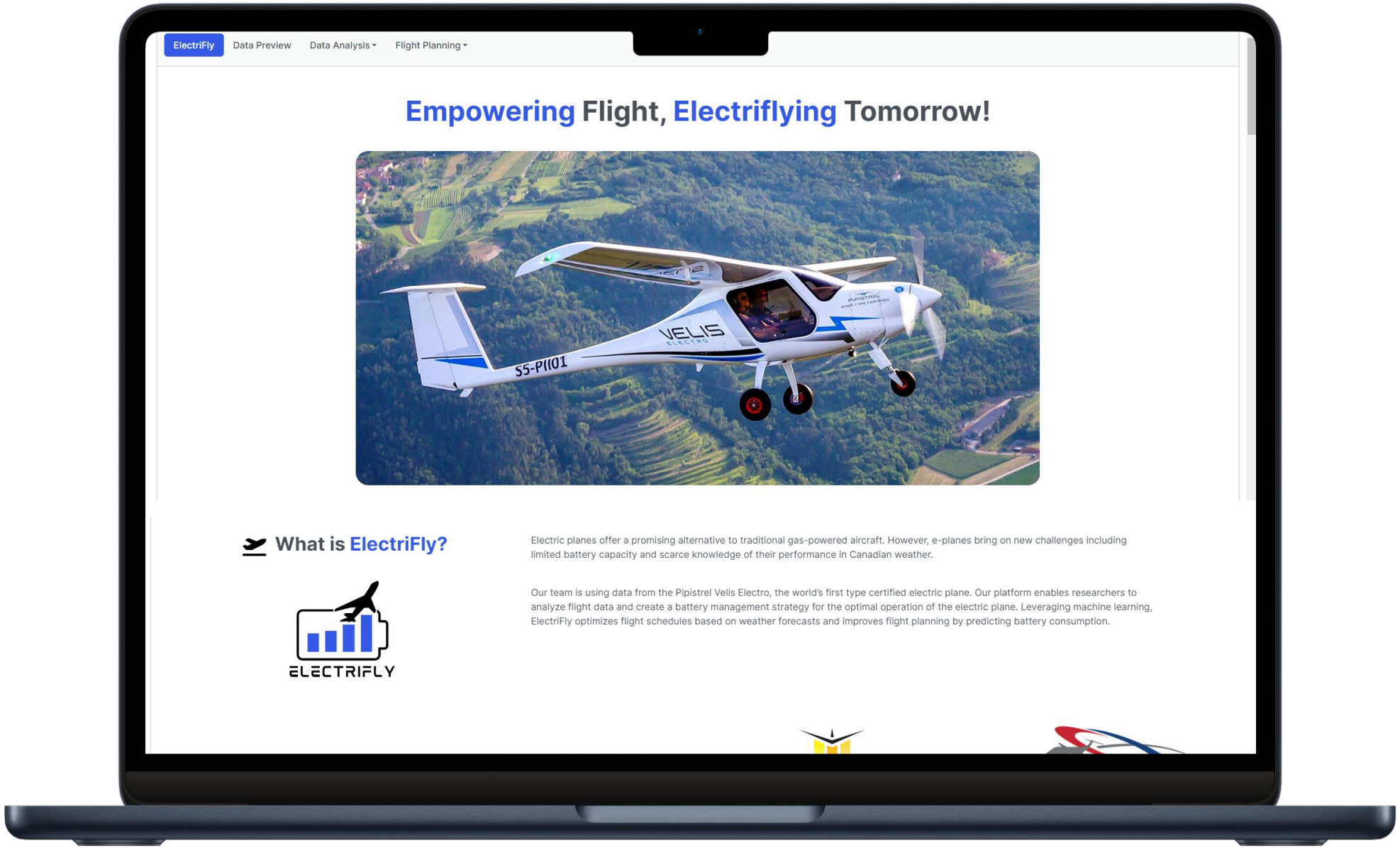
Risks and Mitigation

Component	Risk	Mitigation
Data Pipeline 	Web scraping may fail if changes occur to source data format	Communicate to stakeholders and provided user manual
User Interface 	Faulty sensors could lead to inaccurate data collection	Stakeholder communication and cleaned inconsistent data
ML Prediction 	Inadequate predictions could lead to unintended outcomes	System monitored and improved upon with pilot feedback

ElectriFly Demo



Questions?