

Project Plan - 2025 Summer AI Research Institute
Institute Dates: May 27 - Aug 1, 2025
Submission Link: <https://bit.ly/submit-projectplan2025>

Proposed Project	
Project Name	AI-Driven Flight Delay Prediction Model for Climate-Resilient Airspace Management

Faculty Lead	
MUST attend weekly IN-PERSON meetings with your team for a minimum of one hour.	
Faculty Name	Dr Kofi Nyarko
Faculty Email	kofi.nyarko@morgan.edu
Department	Electrical and Computer Engineering
Funding Needed	[X] YES, I am requesting summer salary (MAX Limit: 1/3 summer salary) [] NO, I do not need summer funding
Research Lab	[X] I do not have a physical lab space.
	Name
	Location

Graduate Student/Postdoc Mentor	
MUST be ON CAMPUS EVERY DAY and available to work 40 hours per week (9:30am-5pm)	
Student Name	Abiola Olayinka Ajala
Student Email	Abaja7@morgan.edu
Level	[X] Doctoral (As of Spring 2025) [] Masters (As of Spring 2025)
Major	Electrical and Computer Engineering
Department	Electrical and Computer Engineering

Experience	<i>How long has the graduate student worked on the proposed research project with you, the faculty mentor?</i> [X] 1 semester [] 2 semesters [] 1 full academic year or more [] None yet; This summer will be their first time working on this project.
	<i>Has the graduate student/postdoc collaborated with you on a prior project related or similar to the proposed one? Please describe the techniques used and the outcomes.</i>

Project Summary	
Overview	Briefly describe the project’s primary objectives and goals. This project researches the use of machine learning and artificial intelligence to predict weather-induced flight delays and improve climate resilience in airspace management. Using historical flight data, real-time weather reports, and air traffic information, students will develop AI-driven predictive models (Random Forest, XGBoost, and LSTMs) to estimate potential disruptions. The project will also include a literature review on AI applications in aviation, feature engineering for improved model accuracy, and a visualization dashboard for real-time delay forecasting.
Research Focus	Describe the AI/ML and/or tools to be used and their applications in the project. This project will leverage a range of artificial intelligence and machine learning techniques to develop a robust predictive model for flight delays. The primary tools and methods include Random Forest and XGBoost for structured, tabular data, and Long Short-Term Memory (LSTM) networks for capturing temporal dependencies in time-series data. These models will be evaluated for accuracy, interpretability, and real-time applicability. To enhance model transparency and support decision-making, the project will incorporate Explainable AI (XAI) methods such as SHAP (SHapley Additive Explanations) and LIME (Local Interpretable Model-agnostic Explanations). Programming and data analysis will be conducted using Python, with libraries such as Pandas, Scikit-learn, TensorFlow, and Matplotlib, and final

results will be visualized using tools like Streamlit or Plotly Dash to build an interactive dashboard.

Deliverable(s)

What will the undergraduate student build/develop, analyze or contribute to?

For the purpose of this research the undergraduate students will contribute to the development of an AI powered flight delay prediction system. Their deliverables will include:

1. A literature review report summarizing existing AI/ML approaches in aviation delay forecasting.
2. A cleaned and preprocessed dataset combining historical flight, weather, and air traffic data.
3. Multiple predictive models (Random Forest, XGBoost, and LSTM) built, trained, and evaluated for forecasting weather-induced flight delays.
4. An Explainable AI analysis using SHAP/LIME to interpret model outputs and identify key delay factors.
5. A functional, interactive dashboard (via Streamlit or Plotly Dash) that visualizes real-time predictions and insights for end users.
6. A final research paper and presentation summarizing methodology, results, and recommendations.

Outcome(s)

What does success look like for the undergraduate student in this research project? How will you assess student progress and achievements?

Success for the undergraduate student in this research project means developing a solid understanding of machine learning techniques, gaining hands-on experience in applying AI tools to real-world datasets, and contributing to a meaningful, data-driven solution for climate resilience in aviation. By the end of the project, students should be able to build, evaluate, and explain predictive models and communicate their findings clearly through visualizations and written reports.

The duties of the undergraduate researcher in the proposed project will be to:

Desired Outcome	Evaluation
Demonstrate understanding of AI/ML concepts and aviation data challenges	Faculty /Mentors will assess the students weekly check-ins, participation in discussions, and a short written summary of key concepts of this research.
Successfully preprocess and analyze aviation and weather datasets	Faculty /Mentors will assess the students ability to submit of cleaned datasets and EDA report
Build and evaluate machine learning models	Faculty /Mentors will assess the students ability based on the Model performance metrics (RMSE, MAE, accuracy), and comparison reports
Interpret model outputs using explainable AI techniques	Faculty /Mentors will assess the students ability based on the SHAP/LIME analysis visuals and feature importance summary
Develop a functional and user-friendly dashboard for prediction visualization	Faculty /Mentors will assess the students ability based on the working dashboard demonstration and user feedback.

Effectively communicate research findings, including Publication	Faculty/Mentor will assess the undergraduate student ability on the quality of final paper and poster, literature review on AI/ML applications in aviation and climate resilience. Give clarity of oral presentation, and ability to answer questions

Skills & Preparation

Required Skills	What should students already know before starting? List specific programming languages, AI/ML concepts, or tools.
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Participants must have a basic understanding of:

1. Python Programming:
 - i. Familiarity with Python syntax, variables, loops, and functions.
 - ii. Experience with data handling libraries such as Pandas and NumPy.
2. Fundamentals of Machine Learning:
 - i. Basic knowledge of supervised learning algorithms (e.g., decision trees, linear regression).
 - ii. Understanding of model evaluation metrics such as accuracy, precision, recall, RMSE, etc.
3. Data Visualization:
 - i. The ability to create plots using tools like Matplotlib or Seaborn to analyze and interpret data trends.
4. Working with CSV and Tabular Data:
 - i. Comfort with loading, cleaning, and exploring datasets in Jupyter Notebooks or other IDEs.
5. Version Control (optional but encouraged):
 - i. Familiarity with Git and GitHub for collaboration and code tracking.

Pre-Projects	List any recommended readings, coding exercises, or prerequisite skills students should develop before the first day.
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Participants should complete the following before the first day:

1. Complete a Python Basics Tutorial

- i. Recommended: W3Schools Python Tutorial or [Python for Everybody \(Coursera\)](#)
- ii. Focus on variables, data types, loops, functions, and file handling.

2. Review Introductory Machine Learning Concepts

- i. Watch: Google's Machine Learning Crash Course
- ii. Learn about classification, regression, overfitting, and evaluation metrics.

3. Practice with Pandas and NumPy

- i. Recommended Exercise: Kaggle's Python and Pandas Micro-Courses

4. Explore Data Visualization Basics

- i. Practice creating charts with Matplotlib or Seaborn.
- ii. Resource: [Data Visualization with Python – IBM \(Coursera\)](#)

5. Set up Your Python Environment

I. Install Anaconda or set up a virtual environment with Jupyter Notebooks, Pandas, Matplotlib, and Scikit-learn.

Supplies, Software, & Equipment

Enter an itemized list of supplies, software, and equipment (include links to where each can be acquired) needed for the undergraduate student to be successful.

Item	Link
Laptop or Desktop Computer (with internet access)	Provided by student or CEAMLS
Python software (via Anaconda)	https://www.anaconda.com/products/distribution

distribution)	
Jupyter Notebook	Included with Anaconda or install via: https://jupyter.org
Pandas, NumPy, Scikit-learn, Matplotlib	Install via Anaconda or pip: https://scikit-learn.org/stable/install.html
TensorFlow or PyTorch (for LSTM models)	https://www.tensorflow.org/install https://pytorch.org/
Streamlit or Plotly Dash (for dashboard)	https://streamlit.io/ https://dash.plotly.com/
Git & GitHub (for version control)	https://git-scm.com/ https://github.com/
Data Sources: FAA, BTS, NOAA, OpenSky	https://www.faa.gov/data_research/aviation_data_statistics

Weekly Research Activity Schedule

Outline key activities to be completed across 10 weeks

Week	Dates	Activity
1	5/27 - 5/31	Mandatory Virtual Bootcamp/Orientation for undergraduate participants and mentors and Faculty. -Intro to project goals, tools, AI/ML concepts, and team expectations. Install Python/Anaconda, GitHub setup, and basic tutorials.
2	6/2 - 6/6	Literature Review + Dataset Exploration Review 10 + papers on AI in aviation and climate resilience. Begin collecting datasets from FAA, NOAA, BTS, OpenSky
3	6/9 - 6/13	Data Cleaning & Preprocessing + Exploratory Data Analysis (EDA) -Merge and clean datasets, conduct basic statistics, and visualize trends Pandas/Matplotlib.
4	6/16 - 6/20	Feature Engineering + Baseline Model (Logistic Regression/Decision Tree) - Test simple models and prepare for ML comparisons.
5	6/23 - 6/27	Mandatory Mid-Summer Presentations (6/27) Advanced Modeling: Random Forest & XGBoost Train and tune models. Evaluate using RMSE, MAE, accuracy.
6	6/30 - 7/4	Deep Learning Model – LSTM for Time Series Forecasting -Introduce temporal modeling and compare with previous results.
7	7/7 - 7/11	Explainable AI (XAI) – SHAP & LIME Implementation Interpret feature importance and explain model predictions visually.
8	7/14 - 7/18	Dashboard Development (Streamlit or Plotly Dash)

		Create an interactive dashboard showing real-time predictions and insights.
9	7/21 - 7/25	Final Report Writing + Presentation Drafting Compile all results, visualizations, and findings into a research paper and presentation slides.
10	7/28 - 8/1	Mandatory End of Summer Research Symposium (7/31) Present final work, submit deliverables (dashboard, paper, slides), and reflect on learning outcomes.

Part 2: Graduate Student Project Video (Due April 1, 2025)

Your graduate student mentor must create a video explaining the project to undergraduate students. The video should include the project overview, the graduate mentor's research history, undergraduate learning objectives, expected outcomes, a detailed weekly research schedule, and a call to action encouraging students to vote on the project. Additionally, **it must feature an AI or ML tutorial** demonstrating relevant techniques, including their implementation and practical applications. **The mentor should remain on camera with the PowerPoint visible throughout the presentation.** The completed video must be submitted via Google Form by **noon on April 1st, 2025.**

 **Use the following PowerPoint template for the video:**
 [CEAMLS SAIRI ProjectPlan Template](#)

Video Requirements:

- ☒ **Project Overview** – Clearly explain the objectives and relevance to AI.
- ☒ **Research History** – Describe prior work and techniques used.
- ☒ **Learning Objectives** – Outline what undergraduates will gain from the project.
- ☒ **AI/ML Tutorial** – Include a hands-on demo, code walkthrough, and explanation of real-world applications.
- ☒ **Project Deliverables** – Describe expected outcomes for students.
- ☒ **Weekly Research Schedule** – Provide an overview of project milestones.
- ☒ **Engaging Presentation** – Keep the video clear, structured, and well-paced.

Presentation Tips:

- **Clarity and Engagement:**
 - Keep the content clear and engaging by avoiding jargon. Use visuals in the PowerPoint to illustrate complex ideas (diagrams, flowcharts).
 - Stay on camera throughout to maintain a personal connection.
- **Pacing:**
 - Keep the video concise (10-15 minutes). Break content into sections to make it easier for students to follow.
- **Call to Action:**

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- Clearly explain the next steps, including where to submit their votes and any important deadlines.