# Fashion Image Classification

A Machine Learning Project with Gradio UI

Introduction to Our Project

# Classifying Fashion Items

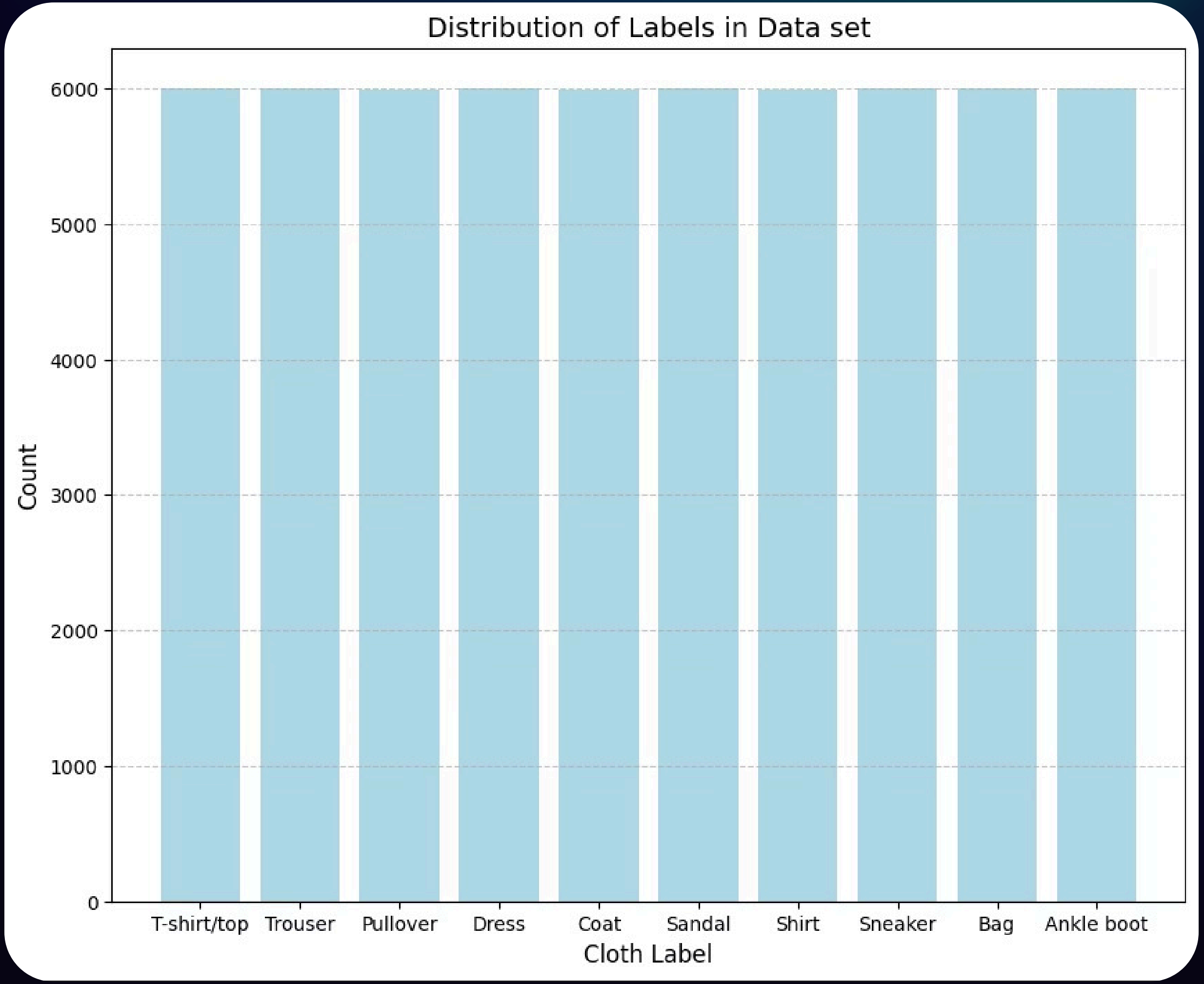
### Project Goal

Classify fashion items into 10 distinct categories, such as T-shirts, bags, and sneakers, using machine learning.

### Dataset Overview

Utilizing the Fashion-MNIST dataset, comprising 70,000 grayscale images (28x28 pixels): 60,000 for training and 10,000 for testing.

# Sample Images from the dataset:




This bar chart shows the distribution of labels in the dataset.

As we can see, the dataset is **well-balanced**, with each class (e.g., Shirt, Sneaker, Bag) having an **equal number of samples**.

A balanced dataset helps in ensuring the model doesn't get biased toward any particular class.

# Why Image Classification & XGBoost

## Why Image Classification?

Image classification is crucial for retail, inventory management, and personalized recommendations, enhancing user experience and operational efficiency.

## Why XGBoost ?

We explored XGBoost to understand the performance of tree-based models on image data and evaluate its interpretability and speed against traditional neural networks.

# Data Preprocessing Steps

### Normalization

Pixel values are scaled from 0-255 to 0-1. This standardizes input data, improving model stability and training speed.

### Flattening Images

Each 28x28 image is flattened into a 784-pixel vector, preparing it for input into tabular models like XGBoost.

### Real-World Challenges

Adapting real-world web images to the Fashion-MNIST format presents challenges due to varying backgrounds, lighting, and resolutions.

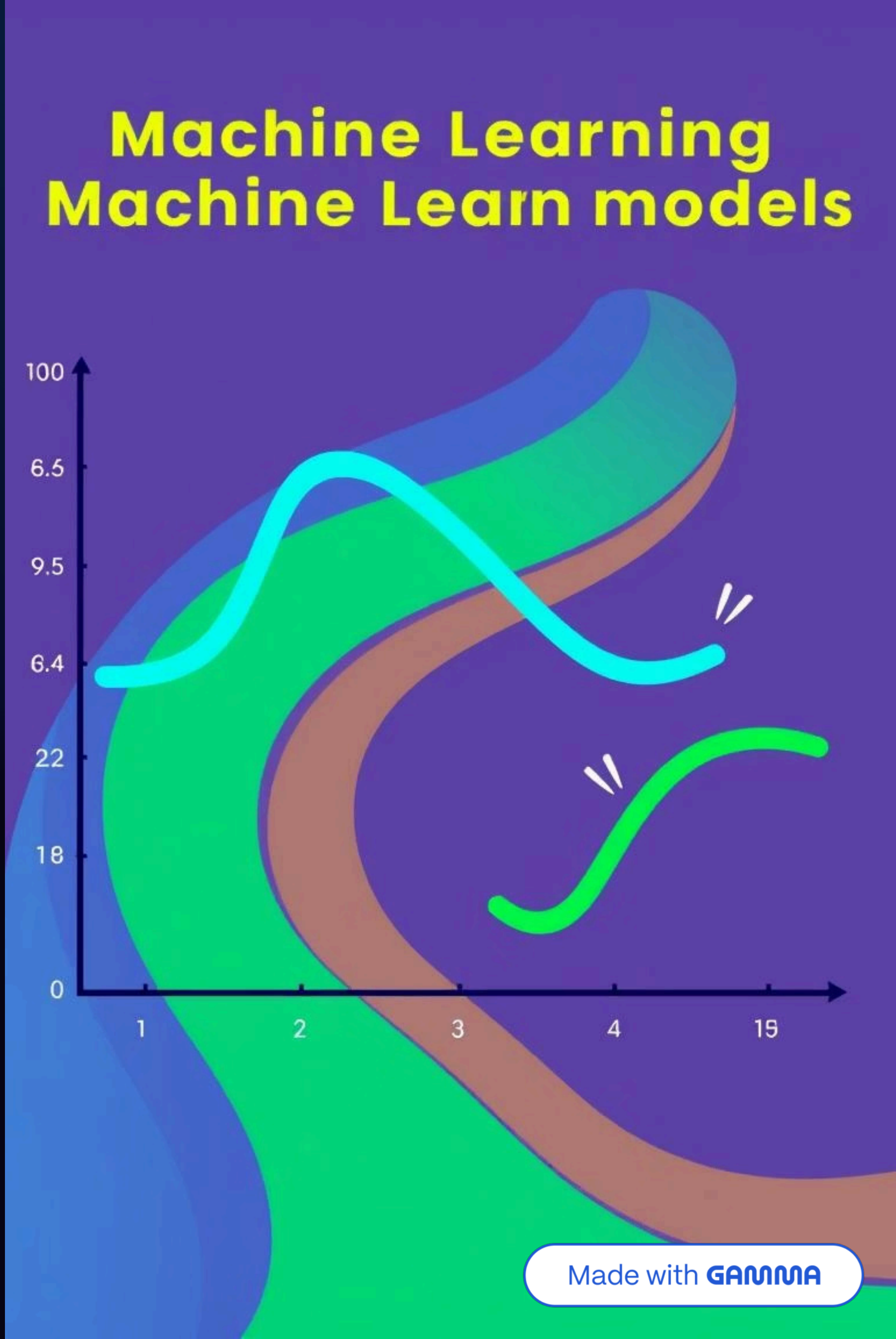
# Model Comparison & Selection

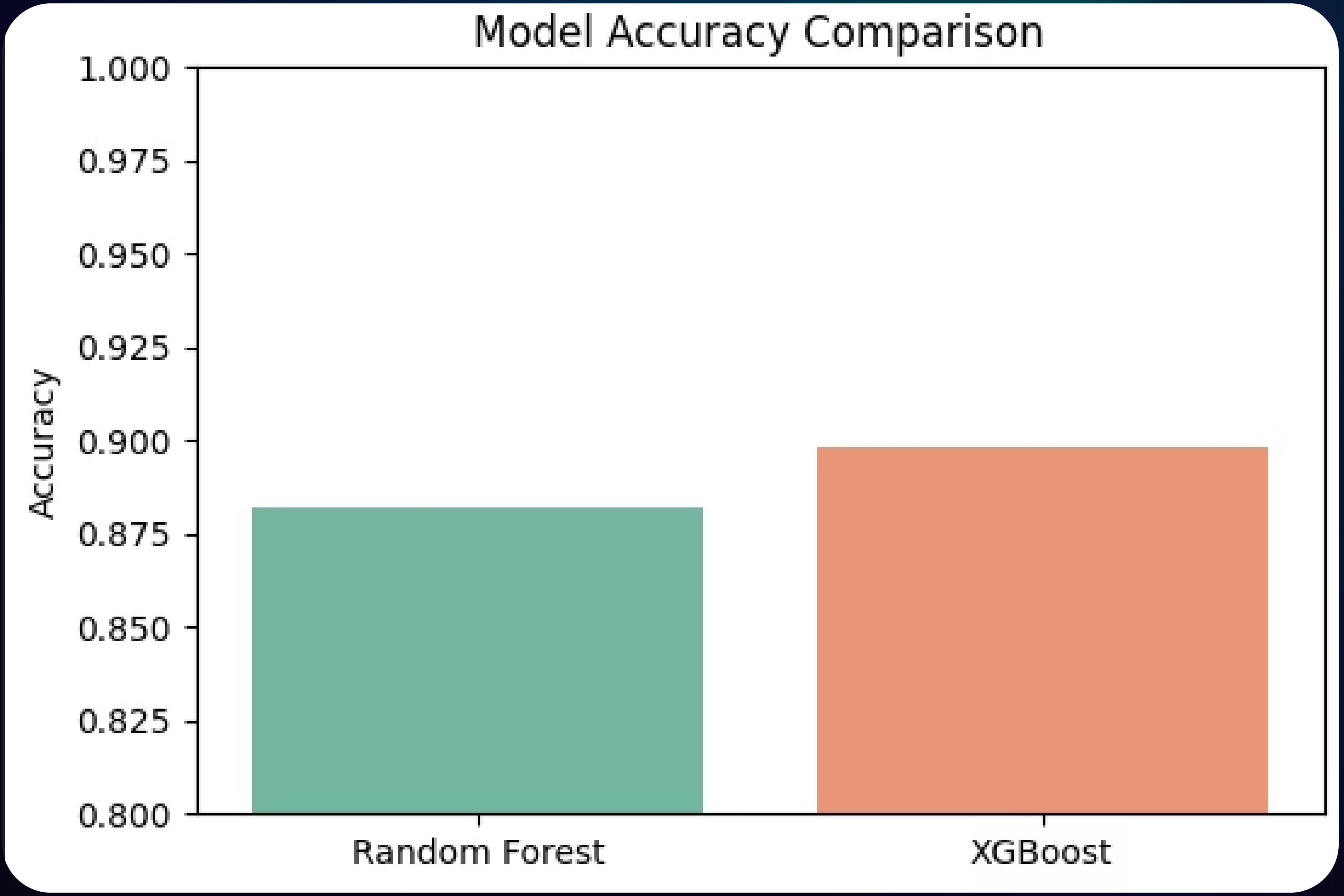
## Random Forest Classifier

A strong ensemble method, Random Forest was considered for its robustness. However, its accuracy on our Fashion-MNIST dataset did not match our higher expectations.

## XGBoost Classifier (Selected)

XGBoost, a highly efficient gradient boosting framework, demonstrated superior performance. Its higher accuracy and interpretability made it the clear choice for our image classification task.

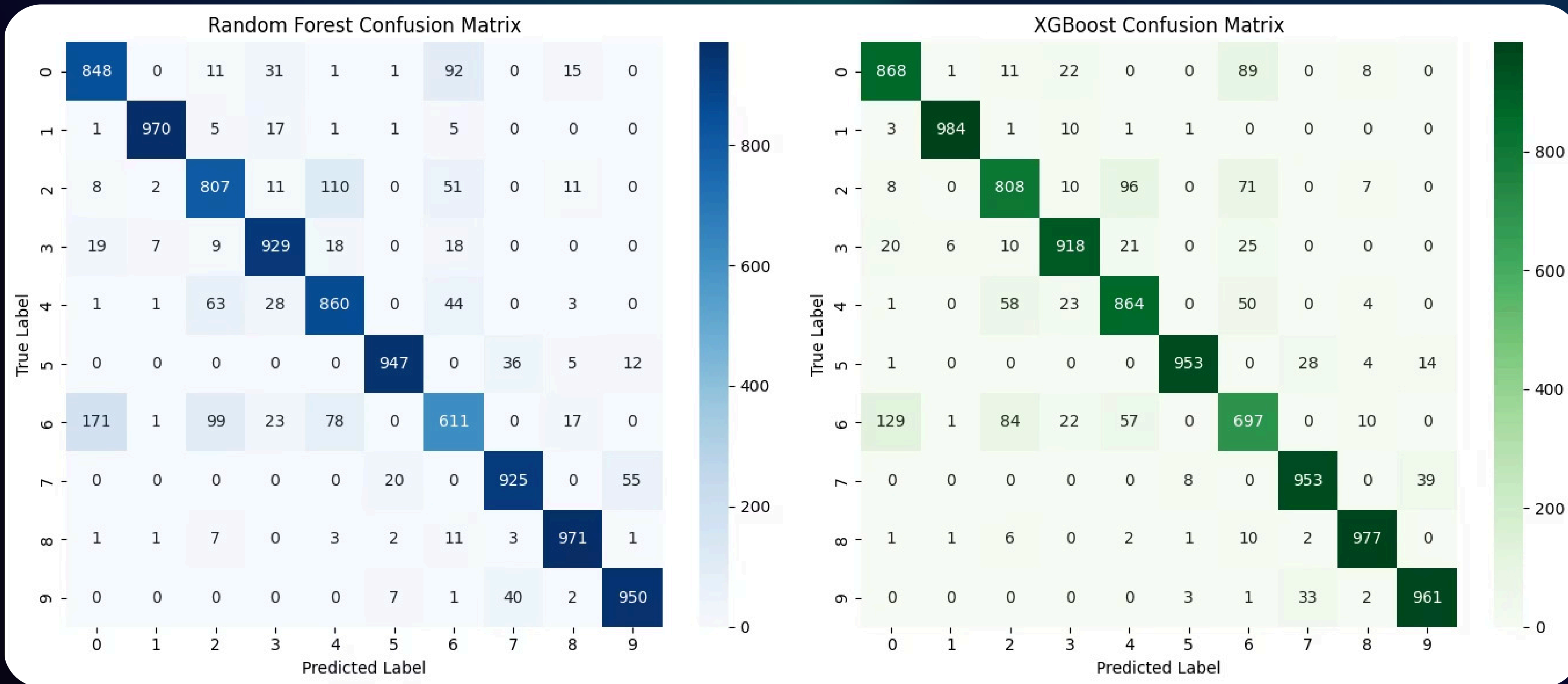





# We evaluated and compared the performance of two machine learning models:

- Random Forest: **88.19%**
- XGBoost: **89.66%**

Although Random Forest achieved higher training accuracy, **XGBoost generalized better**, showing a **higher test accuracy** with less overfitting.

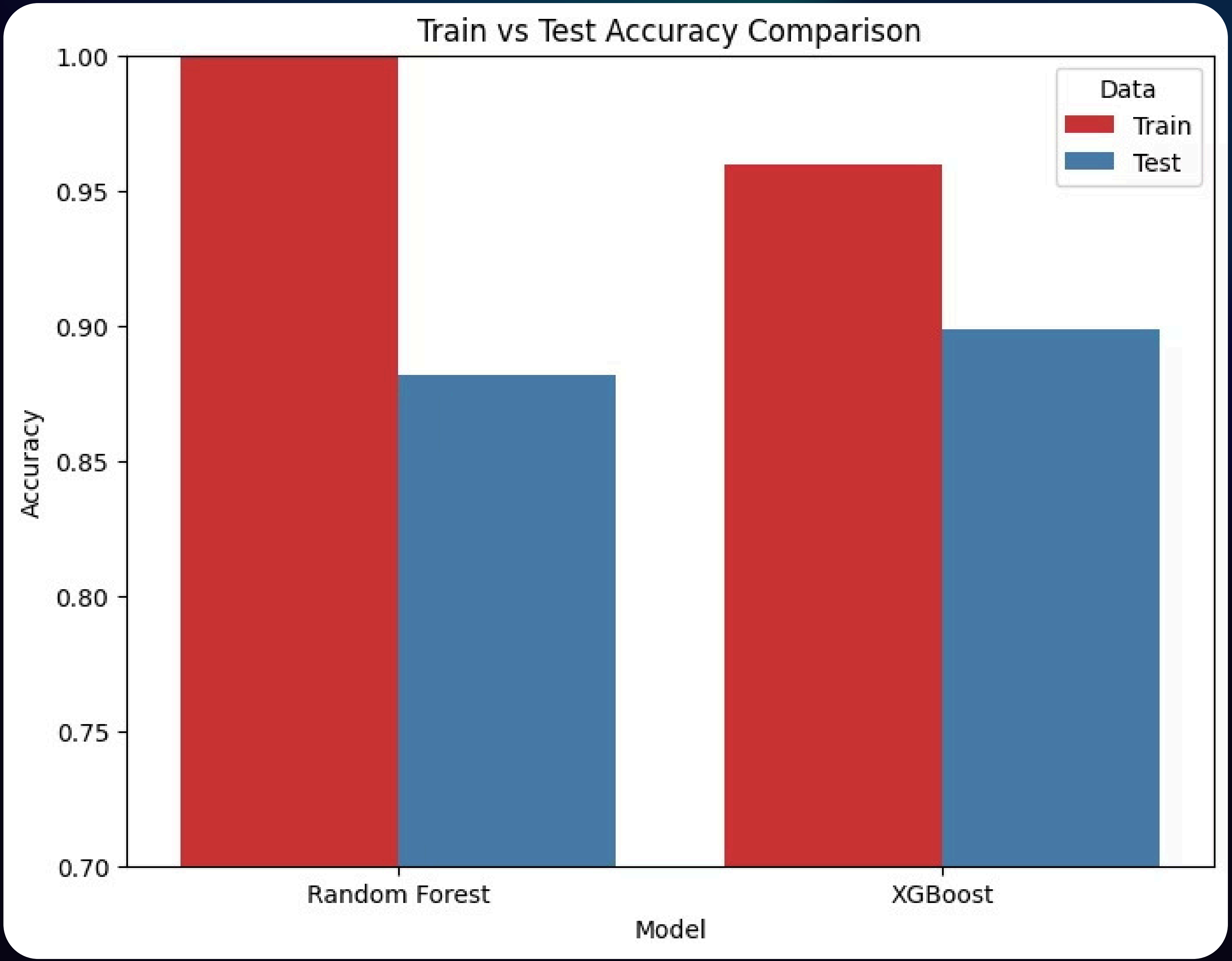



# Confusion Matrix:

> 🔹 **Random Forest:**
>
> Shows overfitting — high train accuracy, but some misclassifications on unseen data.

> 🔹 **XGBoost:**
>
> More balanced predictions, better generalization across classes.

> 📊 Confusion matrices highlight **misclassifications**, especially between similar classes like **Shirt vs Bag**.


Train vs Test Accuracy Comparison
Accuracy
1.00
0.95
0.90
0.85
0.80
0.75
0.70
Data
Train
Test
Random Forest
XGBoost
Model

# Model Selection: XGBoost Classifier

### Selected Model

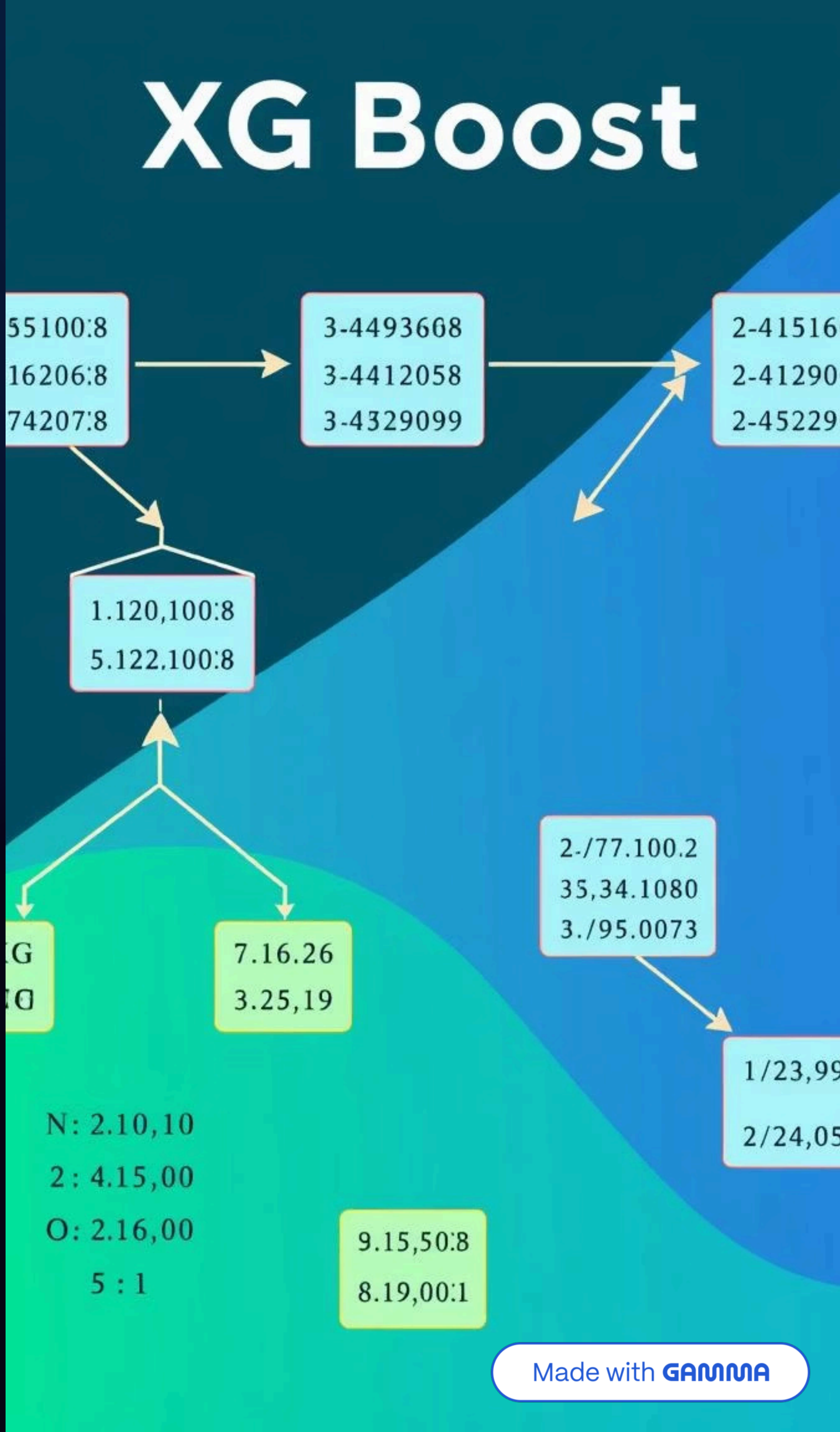
We chose the XGBoost Classifier for its strong performance and robustness in handling various data types.

### Key Parameters

- `objective="multi:softmax"` for multi-class classification.
- `num_class=10` for our ten fashion categories.

### Why XGBoost?

XGBoost offers a balance of high accuracy, efficient training speed, and strong interpretability, making it a powerful choice.



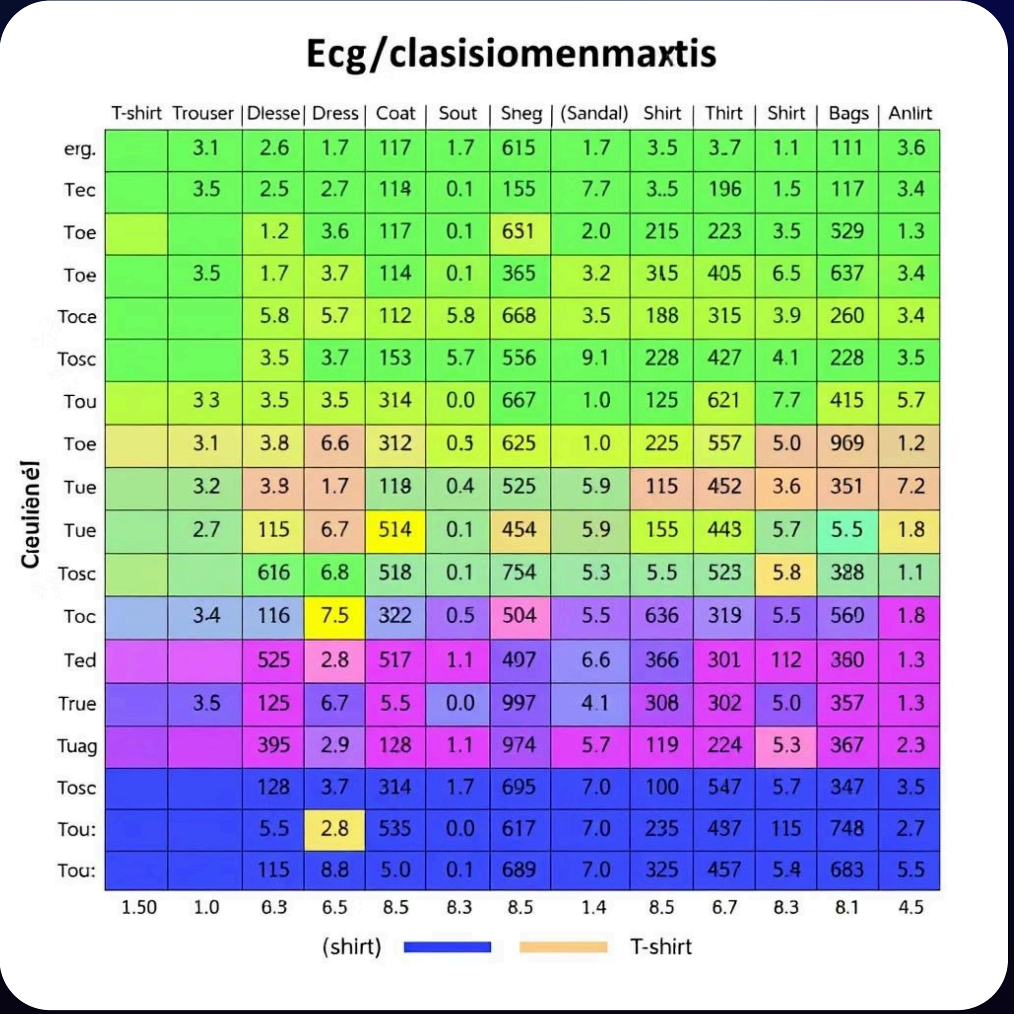
# Training & Evaluation Insights

## Performance Metrics

Our model achieved **90.2% accuracy** on the test set, indicating strong performance. The confusion matrix revealed specific areas for improvement.

## Common Misclassifications

- Shirts often confused with other tops.
- Bags sometimes misclassified as shoes or accessories due to similar outlines.



# Challenges with Web Images

Testing the model with real-world web images highlighted critical limitations.

1

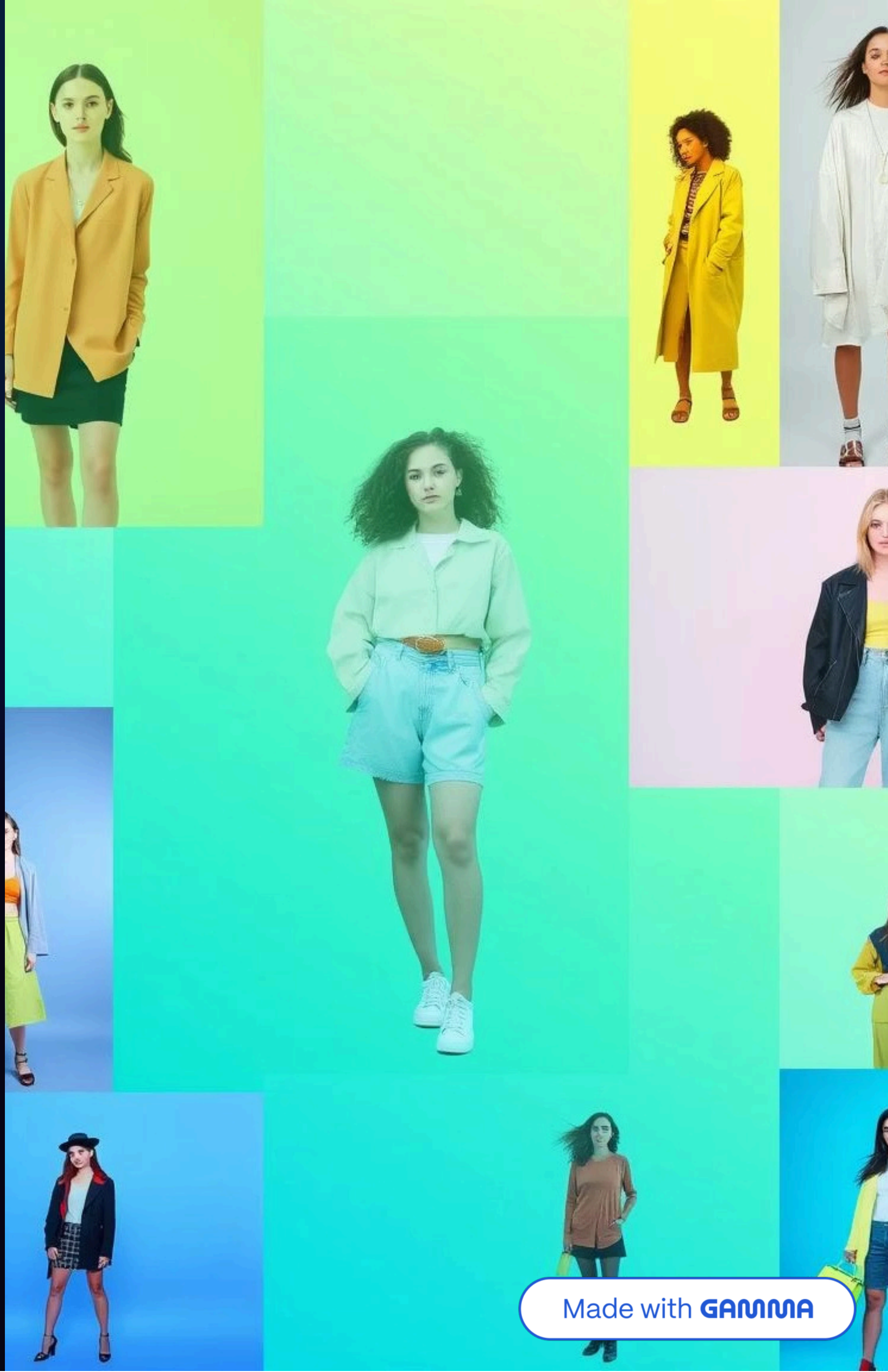
### Preprocessing

Web images required extensive preprocessing, including resizing, cropping, and converting to grayscale, to match the Fashion-MNIST format.

2

### Real-World Data Issues

Differences in backgrounds, diverse lighting conditions, and inconsistent resolutions significantly impacted model performance.

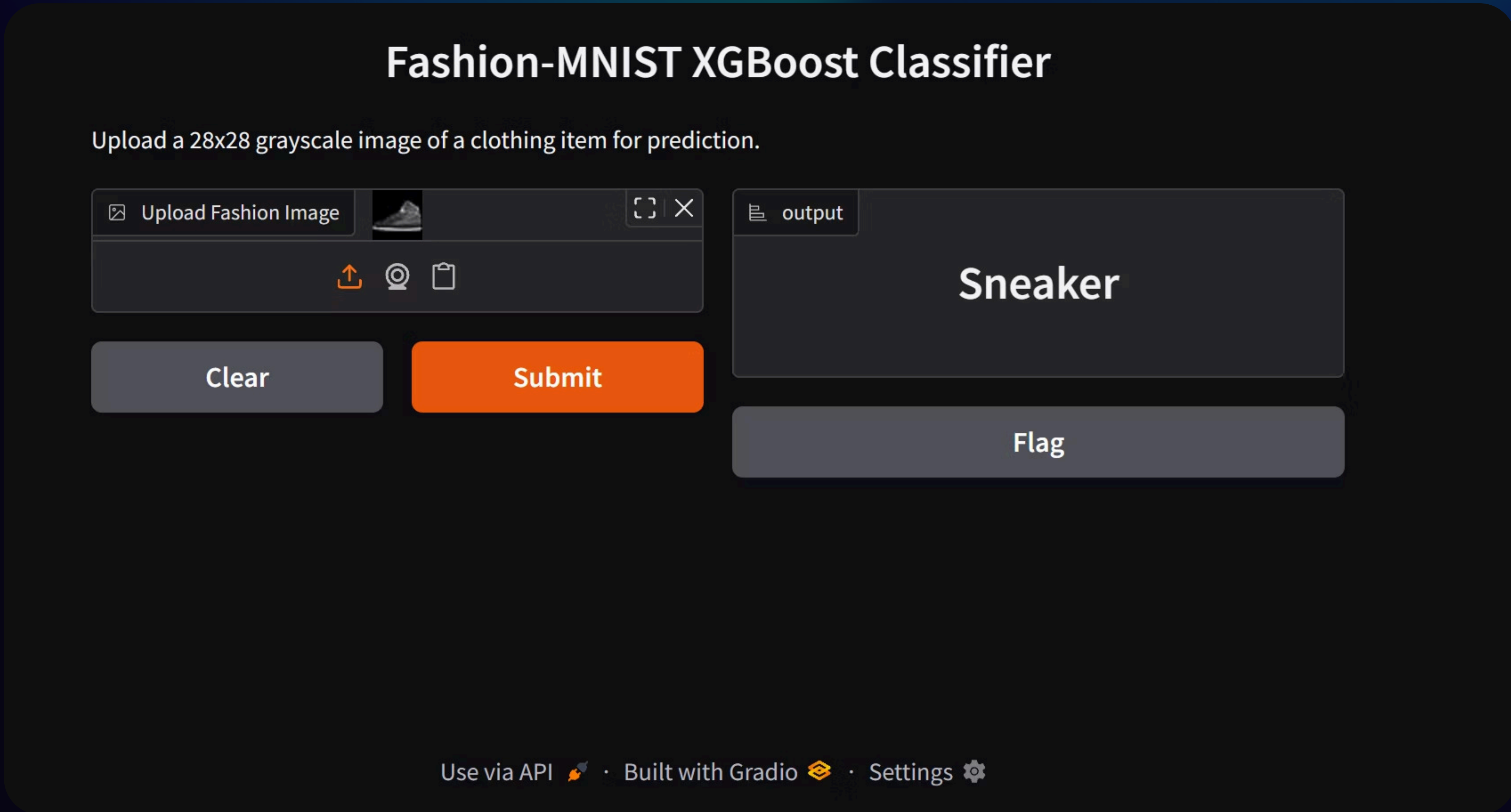


# Model Deployment with Gradio

We deployed our model using Gradio, creating an intuitive user interface for real-time predictions.

## Gradio UI

Users can **upload an image** and instantly view the model's classification. This interactive demo showcases the model's capabilities in a practical setting.


Fashion-MNIST XGBoost Classifier
Upload a 28x28 grayscale image of a clothing item for prediction.
Upload Fashion Image
output
Sneaker
Clear
Submit
Flag
Use via API · Built with Gradio · Settings

# Challenges & Learnings

Our exploration revealed critical insights into the limitations of our model and the importance of data preparation.

### Model Limitations

The XGBoost model, while robust, showed significant performance drops when applied to diverse, real-world web images not conforming to the clean Fashion-MNIST dataset.

### Preprocessing is Key

Effective preprocessing, including consistent resizing, normalization, and noise reduction, proved paramount for bridging the gap between ideal and real-world data.

# Future Work

Our next steps focus on leveraging advanced techniques and refining the user experience to further enhance the project's capabilities.

### Adopt CNN-Based Models

Explore Convolutional Neural Networks with TensorFlow for superior feature extraction and enhanced accuracy, addressing the limitations of tree-based models on pixel data.

### Enhance Data Pipeline

Implement robust data augmentation techniques and an advanced preprocessing pipeline for real-world web images, ensuring better model generalization and performance.

### Refine Gradio UI

Continuously improve the Gradio user interface for a more intuitive and seamless experience, adding features like batch processing or detailed prediction explanations.

# Conclusion

Our project showcased a practical application of machine learning for fashion image classification, revealing key insights and paving the way for future enhancements.

### Successful Classification & Deployment

We successfully built and deployed an XGBoost model, achieving **90.2% accuracy** on the Fashion-MNIST dataset, demonstrating its viability for structured image data.

### Insights into Real-World Challenges

Testing with web images highlighted critical preprocessing needs and the inherent limitations of tree-based models compared to CNNs for diverse visual data.

### Interactive User Experience

The Gradio UI provides an intuitive platform for real-time predictions, making the model accessible and interactive for users.

Try the Live Demo

Explore the Code

# Any Questions?

Feel free to reach out to us!

Email: ahmedtlotfy01@gmail.com
mohamedwalid847@gmail.com

Explore the code on GitHub: https://github.com/mooowalid/Fashion-MNIST-Classification-using-XGboost