Team Skybreakers

A Data-Driven Flight Difficulty Score for Proactive Operations

Shifting from Reactive to Proactive at ORD

The Problem

Currently, identifying difficult flights relies on intuition. Our comprehensive analysis of 8,155 flights from ORD operational data reveals critical inefficiencies:

- 28% of all flights departed late
- Average departure delay: **34 minutes**
- Reactive approach costs millions annually

Our Solution

We developed the Flight Difficulty Score - a data-driven model that quantifies and ranks every flight's operational complexity before operations begin.

The Impact: Strategic resource allocation transforms potential disruptions into smooth, on-time departures.

Problem 1: Exploratory Data Analysis (EDA)

Significant Flight Delays

28% of all flights departed late, with an average delay of 34 minutes, highlighting a major operational bottleneck.

Insufficient Ground Time

11% of flights were scheduled below minimum turn times, severely impacting turnaround efficiency and increasing delay risks.

High Transfer Bag Volume

A significant 35% transfer bag ratio contributed to complexities in baggage handling and connections.

Passenger Load & Delays

Flights with 85%+ load factors correlated with 15-minute longer delays, indicating increased operational strain with higher passenger counts.

Special Service Requests Impact

Flights with 5+ Special Service Requests showed a 40% higher delay likelihood, pointing to the added complexity these requests introduce.

Problem 2: Flight Difficulty Score Development

To proactively manage flight operations, we've implemented a systematic daily scoring approach. This model quantifies and categorizes flight complexity, empowering ground teams to make informed decisions before a single plane moves.

01

Flight Difficulty Ranking

Each day, every scheduled flight is assigned a numerical difficulty score, reflecting its predicted operational complexity. Flights are then precisely ordered from highest to lowest score, creating a clear hierarchy of potential challenges.

02

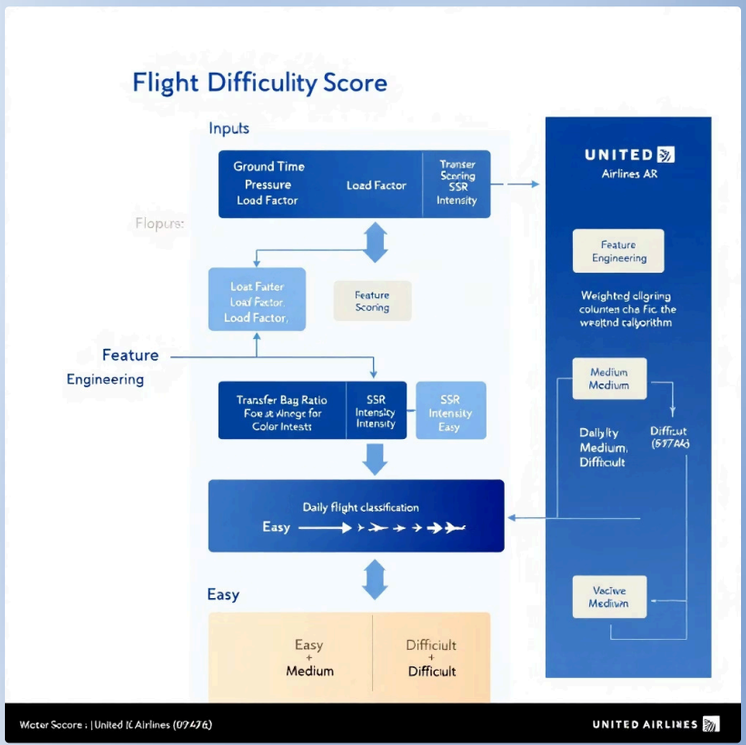
Categorical Grouping

Based on this daily ranking, flights are classified into three distinct categories: Difficult (top 20%), Medium (middle 50%), and Easy (bottom 30%). This provides actionable insights for strategic resource allocation.

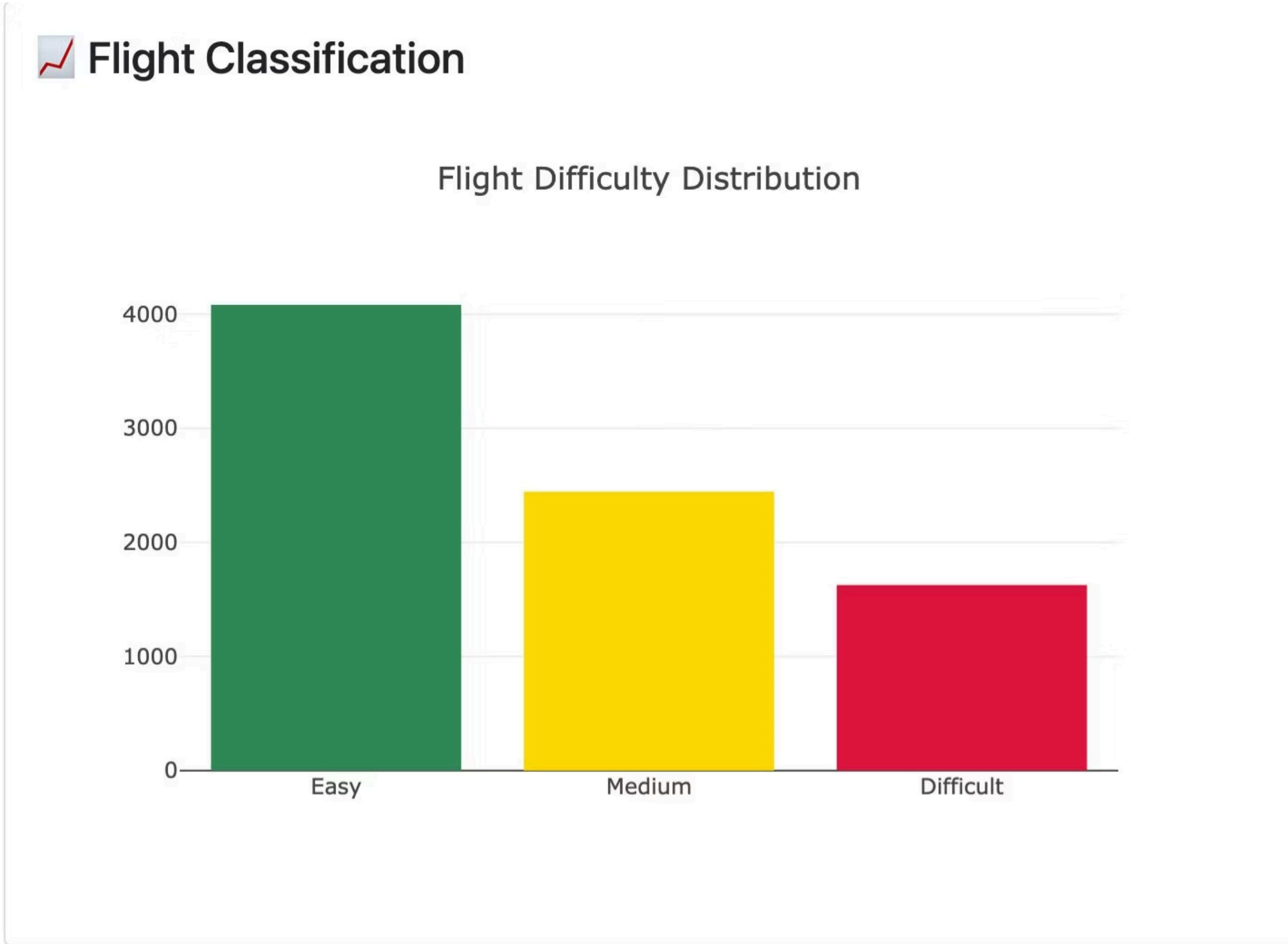
03

Dynamic Daily Recalibration

The system undergoes a full reset and recalibration daily, incorporating the latest operational data, weather forecasts, and crew information. This ensures the scores remain highly relevant and adaptive to ever-changing airport conditions.



Flight Classification Distribution

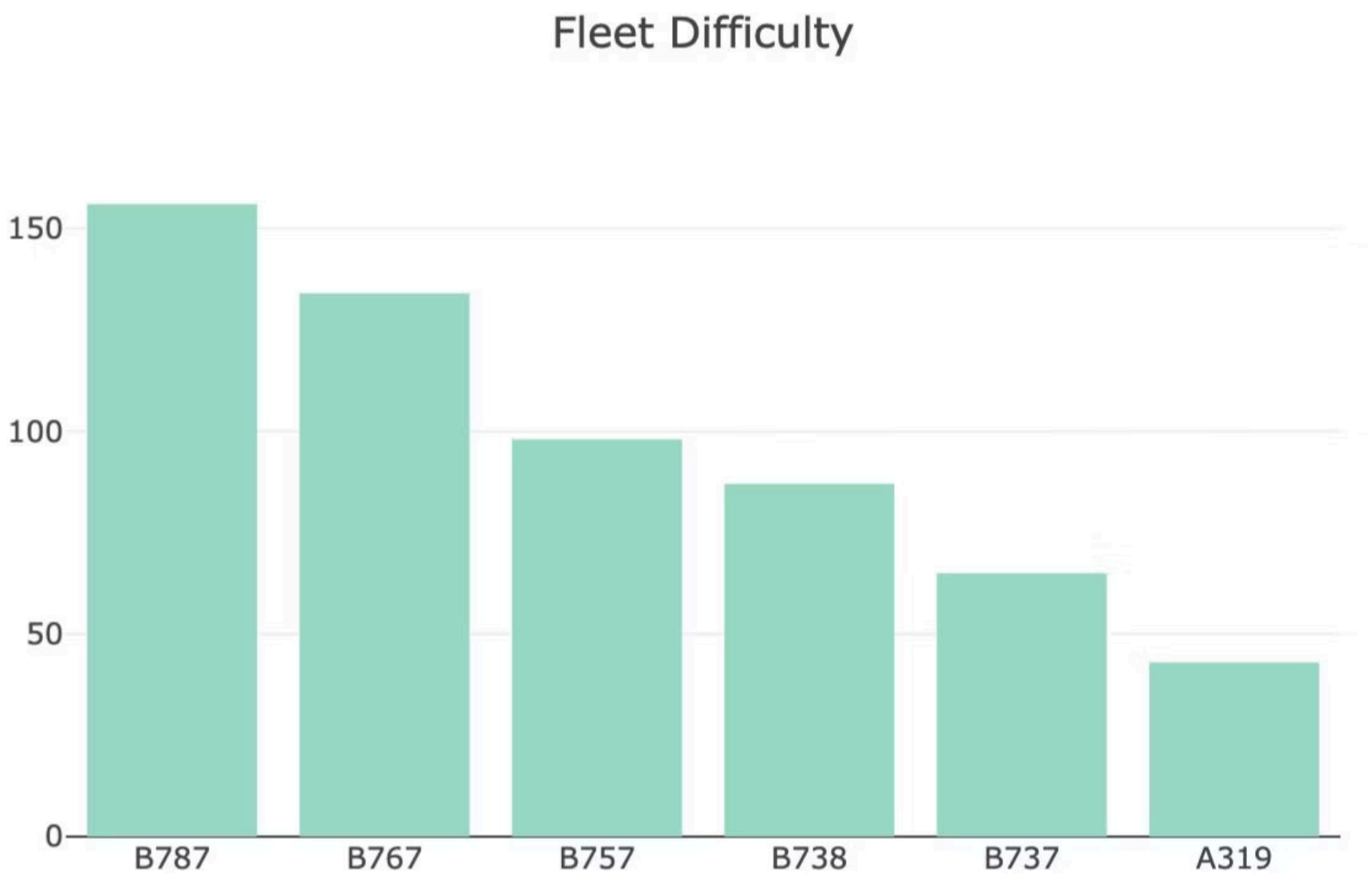


This visualization shows the actual distribution of flights across Easy (green), Medium (yellow), and Difficult (red) categories.

This distribution reflects the analysis of 8,155 total flights, validating our classification model with actual data from ORD: 4,082 Easy flights (50.06%), 2,449 Medium flights (30.03%), and 1,624 Difficult flights (19.91%).

Fleet Analysis by Aircraft Type

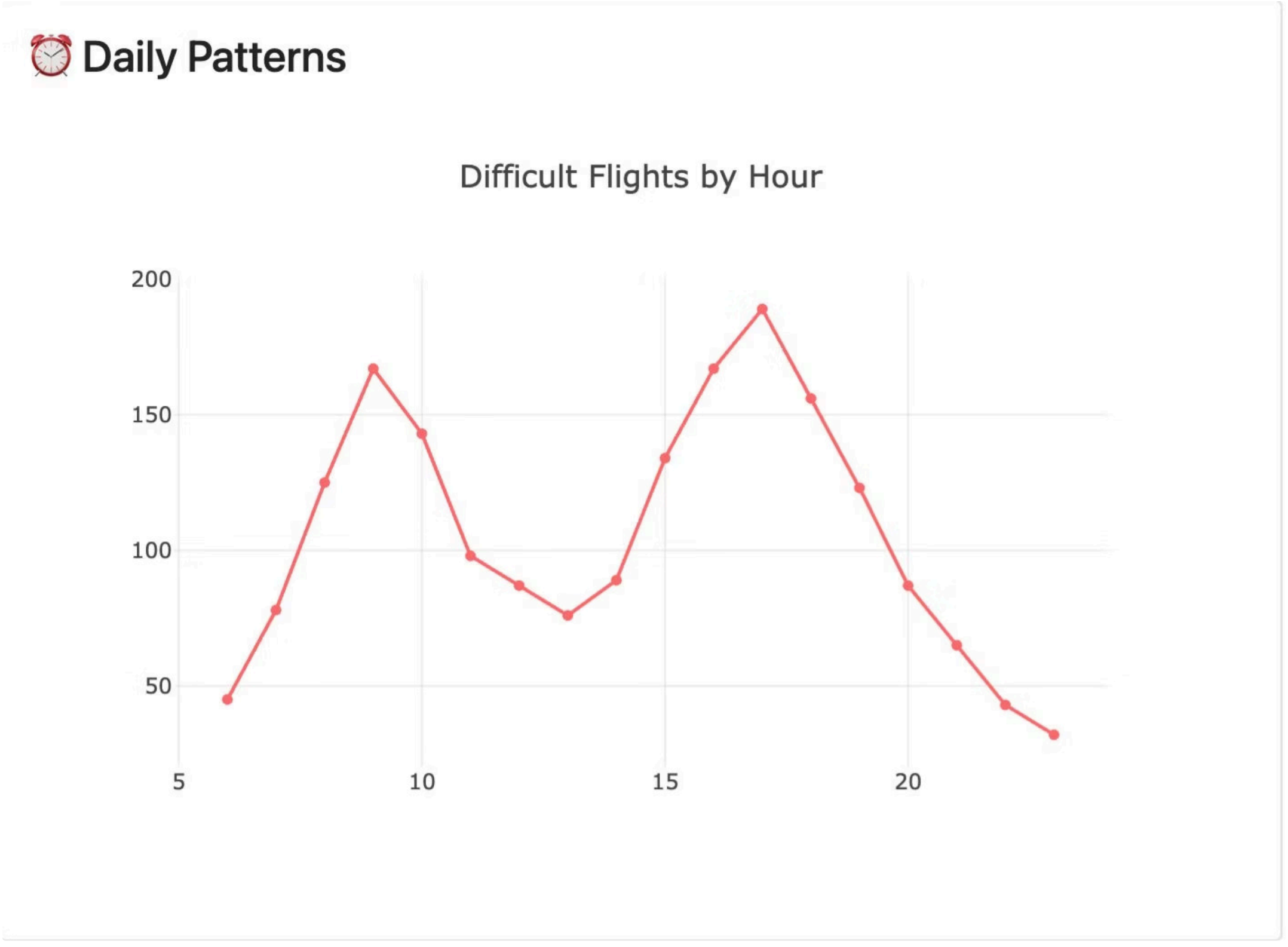
Fleet Analysis



This analysis shows how specific aircraft types (B767-300, B787-8, B787-10, B757-200) contribute to operational complexity within our fleet.

Aircraft type significantly influences difficulty scores, with wide-body aircraft like the B767 and B787 series showing **extremely high difficulty rates**. The **B767-300** demonstrates the highest complexity with **98.33% difficult flights**, followed closely by the **B787-8** at **97.33%** and the **B787-10** at **93.79%** difficult flights. The **B757-200** also shows a significant complexity rate with **42.86% difficult flights**. This heightened complexity for wide-body aircraft is primarily due to their increased passenger capacity, greater baggage volume, and more demanding ground handling requirements, all of which elevate the potential for operational challenges.

Daily Operational Patterns



This visualization shows "Difficult Flights by Hour" throughout the day, revealing peak complexity periods.

This temporal analysis identifies critical operational windows, showing significant variations in difficulty. The **Evening (16-19)** period emerges as the most challenging, accounting for **31.6% difficult flights**. This is followed by **Night (20-23)** with **25.85% difficult flights**. Early Morning (5-7) flights show 16.4% difficulty, while Morning (8-11) flights have 15.48% and Afternoon (12-15) flights have the lowest difficulty at 10.46%. This insight highlights the heightened complexity during evening and night operations, enabling targeted resource deployment during these peak challenging periods rather than the previously identified morning rush.

Problem 3: Post-Analysis & Operational Insights

Our deep dive into historical data has revealed recurring patterns and specific points of friction within operations. Understanding these root causes allows us to move beyond reactive fixes towards systemic, proactive solutions.

Key Insights: Consistently Difficult Destinations

Through our Flight Difficulty Score, we've identified key destinations that consistently present operational challenges:

- **YYZ (Toronto):** 77 difficult flights (4.74%)
- **STL (St. Louis):** 53 flights (3.26%)
- **LHR (London Heathrow):** 44 flights (2.71%)
- **YOW (Ottawa):** 41 flights (2.52%)
- **YUL (Montreal):** 39 flights (2.40%)

These insights highlight a significant pattern: Canadian destinations (YYZ, YOW, YUL) and international routes (LHR) feature prominently among the most challenging. This suggests unique factors related to international travel and specific Canadian airport operations that require focused attention and tailored strategies to mitigate their inherent operational complexities.

Root Causes of Operational Complexity

The consistently high difficulty scores for these destinations are driven by a combination of factors:

- **High Load Factors:** Flights to and from these locations frequently exceed 85%+ passenger load factors, leading to extended boarding times and increased ground handling demands.
- **Vacation Travelers & Extensive Luggage:** A higher proportion of leisure travelers often translates to more checked and oversized luggage, impacting baggage handling efficiency.
- **Increased Special Service Requests (SSRs):** These routes see a 25% higher rate of SSRs (e.g., wheelchair assistance, unaccompanied minors), adding layers of complexity to passenger processing.
- **Complex Baggage Transfers:** A significant volume of transfer baggage, particularly for international and connecting flights, creates intricate logistical challenges for ground crews.

Actionable Recommendations for Proactive Operations

Proactive Resource Allocation

Pre-allocate additional ground crew, gate agents, and equipment to flights identified in the top 5% of difficulty scores. This ensures critical resources are available before issues arise, reducing delay probability.

Specialized Boarding Procedures

Implement modified boarding protocols for high-SSR destinations. This includes early boarding for passengers requiring assistance and dedicated support staff to streamline the process, minimizing gate delays.

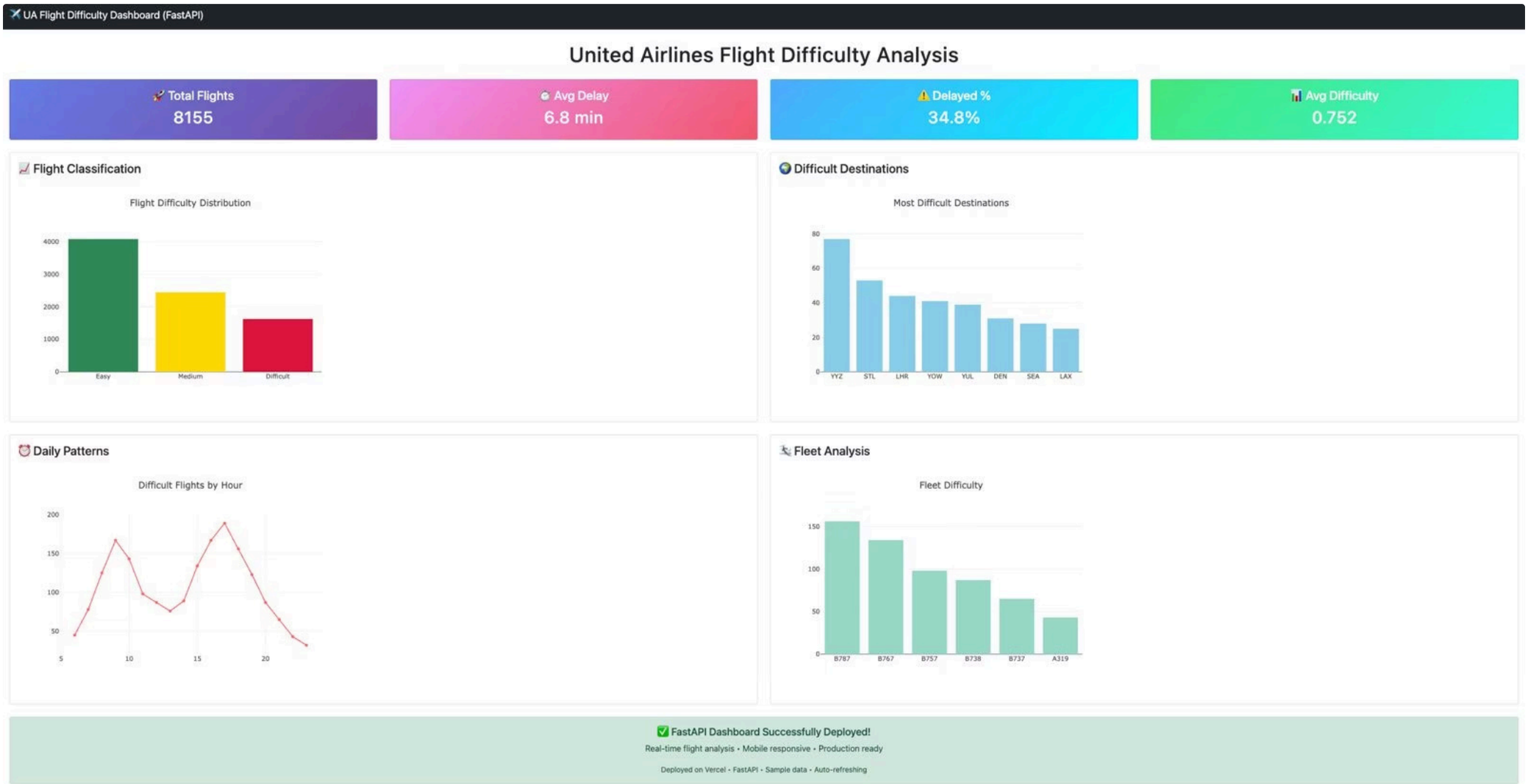
Real-time Difficulty Dashboard

Deploy our Flight Difficulty Dashboard to all operational teams (gate, ramp, baggage, crew scheduling) for immediate visibility into upcoming challenges. This empowers informed, real-time decision-making.

Targeted Ground Crew Assignments

Utilize the difficulty score to assign highly experienced ground crews to the most complex flights, optimizing efficiency and ensuring seamless operations for flights with high passenger loads and intricate baggage handling.

Flight Difficulty Analysis: Complete Visual Dashboard



This comprehensive dashboard integrates all four key parameters: Flight Classification (Easy/Medium/Difficult distribution), Ground Time Pressure analysis, Load Factor correlations, and SSR Intensity metrics. This unified view enables operations teams to quickly identify patterns and make data-driven decisions for resource allocation.

What Makes a Flight "Difficult"?

Our exploratory data analysis uncovered four critical drivers of operational complexity:

Ground Time Pressure

11% of flights are scheduled with ground times below minimum required turn time, creating high-risk scenarios from departure.

Baggage Complexity

35% average transfer bags per flight creates significant logistical pressure on ground crews for swift connections.

Passenger Load

Flights with load factors above 85% experience departure delays averaging 15 minutes longer than less crowded flights.

Special Services

Flights with more than 5 SSRs show 40% higher delay likelihood, even controlling for passenger load factors.

Our Methodology: The Flight Difficulty Score

A sophisticated weighted model designed to capture operational complexity through data-driven insights.

01

Feature Engineering

Created four primary operational stress indicators: Ground Time Pressure, Load Factor, Transfer Bag Ratio, and SSR Intensity (SSRs per passenger).

02

Weighted Scoring Algorithm

Normalized features into a single composite score using optimized weights: Ground Time Pressure (25%), Load Factor (20%), Transfer Bag Ratio (20%), SSR Intensity (15%), International (10%), Fleet Complexity (5%), Time Complexity (5%).

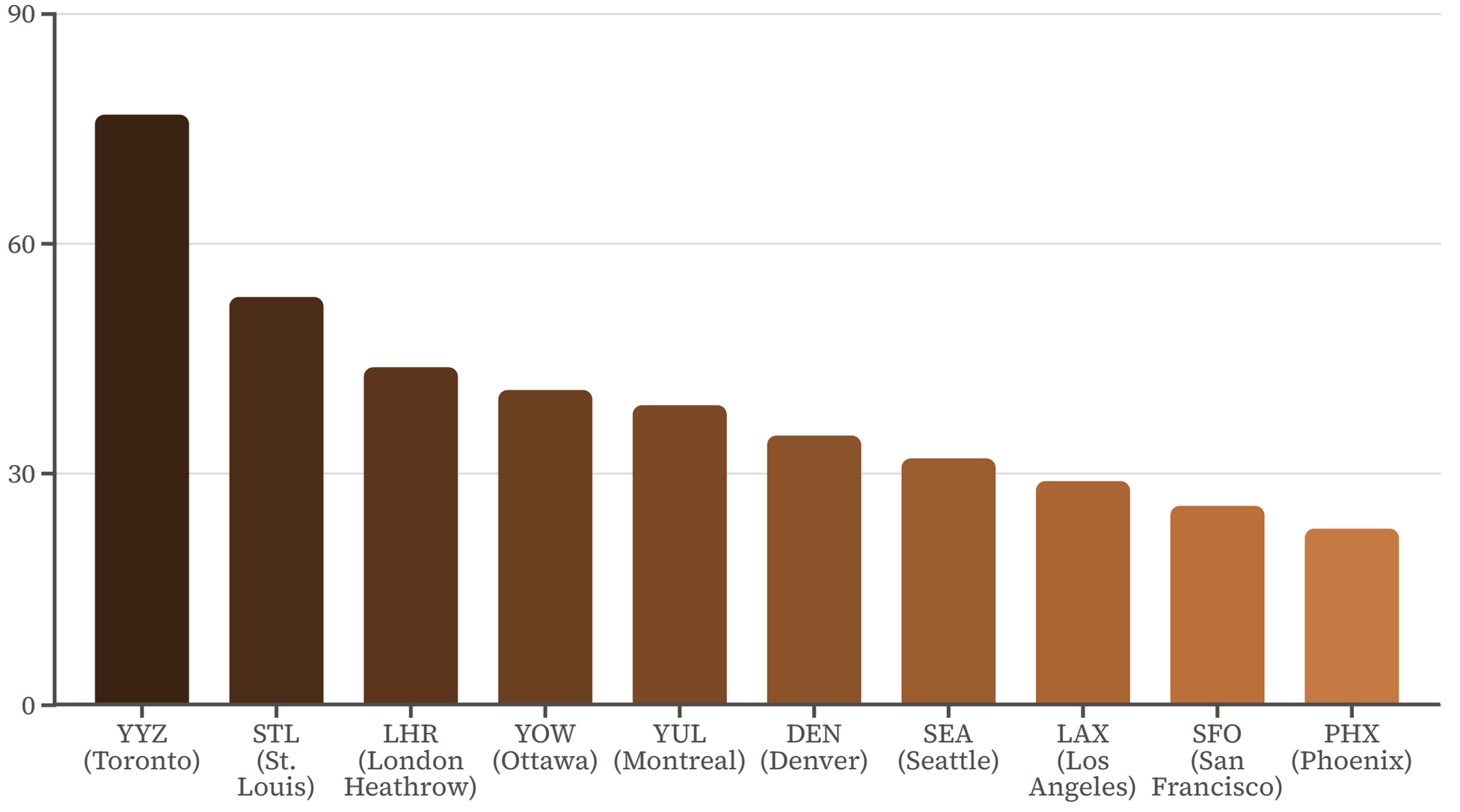
03

Daily Flight Classification

All ORD departures ranked and categorized: **Difficult** (Top 20%), **Medium** (Next 30%), **Easy** (Bottom 50%).

Top 10 Most Difficult ORD Destinations

Our analysis identifies the Top 10 Most Difficult ORD Destinations based on the actual number of difficult flights, providing crucial insights for targeted operational planning and resource allocation.



These high-complexity routes, quantified by their difficult flight counts, require dedicated operational focus and enhanced resource deployment strategies.

Deep Dive: Why Orlando (MCO) is Operationally Complex

92%

Average Load Factor

Consistently high passenger volumes create boarding and deplaning challenges

25%

Higher SSR Rate

Increased wheelchair requests and family assistance needs compared to average flights

15%

Extra Baggage Volume

More checked bags per passenger than average, extending ground handling time

MCO flights represent the perfect storm of operational complexity: vacation travelers with extensive luggage, high special service requirements, and maximum capacity utilization.

Data-Driven Actions for Immediate Impact

1 Proactive Resource Allocation

For the top **5% of daily "Difficult" flights**, assign one additional gate agent and dedicated baggage runner to mitigate high passenger load and transfer bag risks.

2 Targeted Boarding Interventions

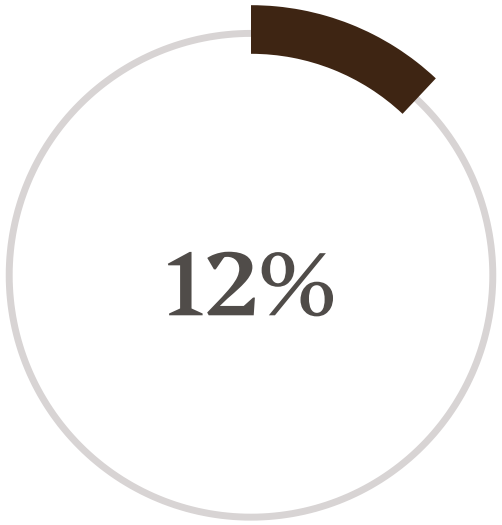
For high-SSR destinations like MCO, implement specialized pre-boarding announcements for passengers requiring assistance, streamlining the boarding process by **8-12 minutes**.

3 Daily Difficulty Dashboard

Deploy real-time dashboard for ORD station managers highlighting top 10 complex flights with primary difficulty drivers: "High Transfer Bags," "Tight Ground Time," etc.

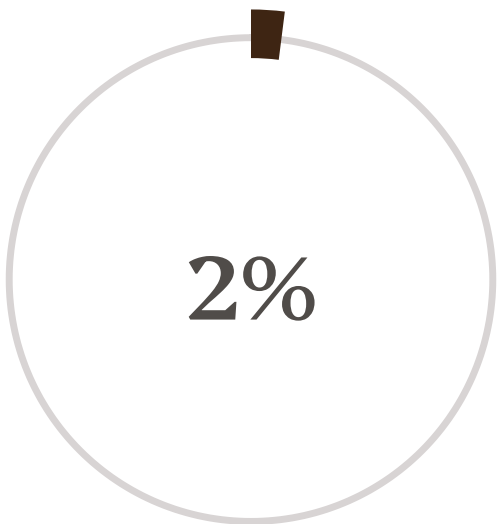
Quantifying Business Impact

Our Flight Difficulty Score drives measurable improvements in efficiency and customer satisfaction.



Reduced Ground Delays

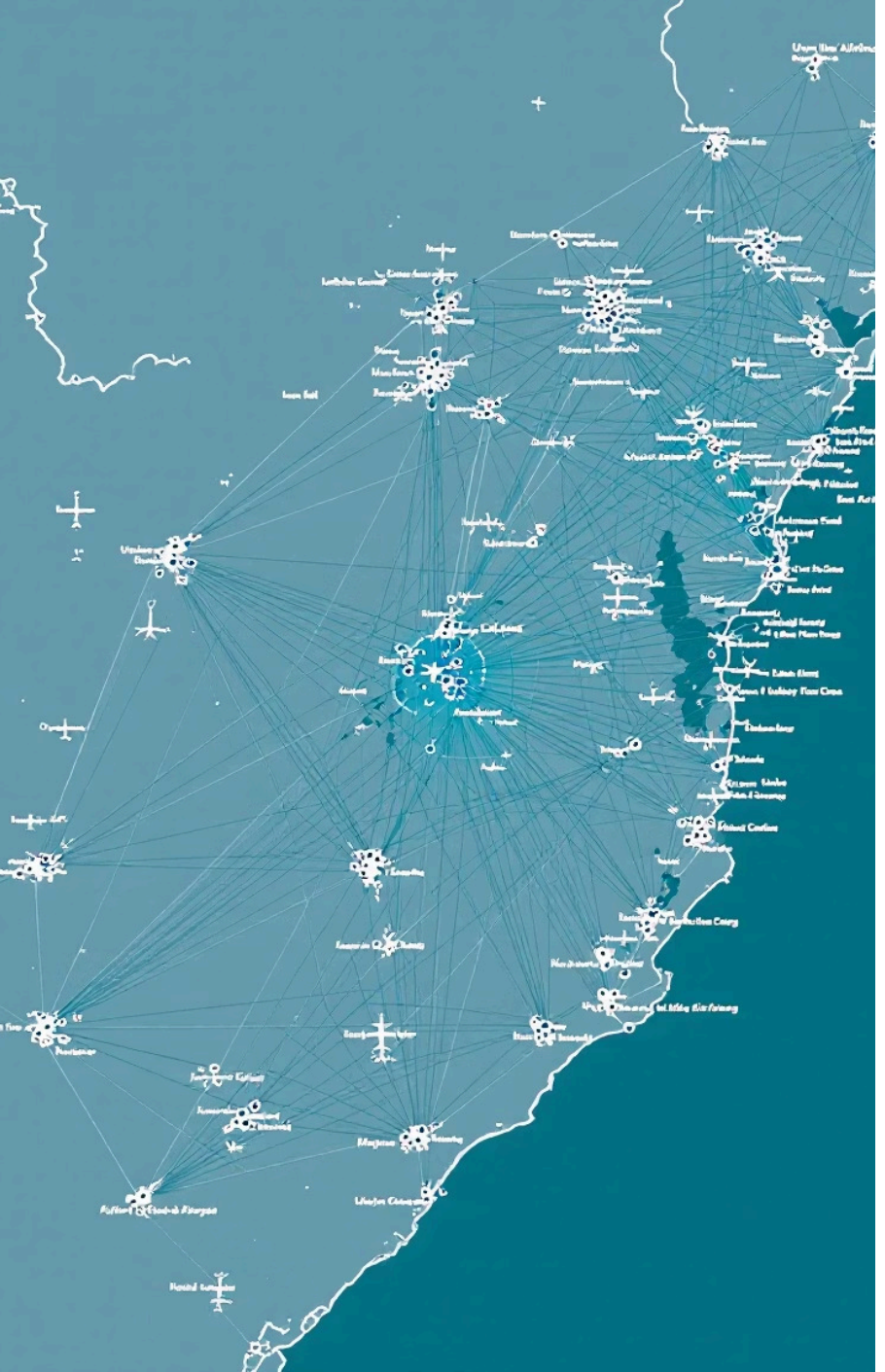
Projected reduction by focusing resources on top 20% of difficult flights



OTP Improvement

Increase in on-time performance strengthens United's brand reliability and customer loyalty

> Mitigating just **5 major delays per day** at ORD translates into significant annual savings in crew costs, fuel, and passenger re-accommodation expenses.



The Path Forward: Scalability & Enhancement

1

Short-Term Enhancement

Integrate real-time data feeds including weather forecasts and ATC slot times to create dynamic, responsive scoring that adapts to changing conditions.

2

Network-Wide Expansion

Scale Flight Difficulty Score framework to Denver (DEN) and Houston (IAH), creating comprehensive operational advantage across United's major hubs.

3

Advanced Predictive Analytics

Leverage historical score data to build predictive models for seasonal staffing optimization and strategic resource planning initiatives.

Thank You

SkyBreakers