Alaskan Bush Pilot Safety

Inferences on contributing factors to accidents and fatal injuries

Bush Pilots of DSI

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Background

- Our client: Alaska Airmen's Association:
  - A nonprofit established in 1951 to promote general aviation, enhance safety, and support initiatives that benefit pilots
  - Analyze NTSB data concerning aviation incidents/accidents involving single engine aircraft in Alaska
- The Airmen's Association aims to understand the predominant factors contributing to aviation incidents involving single-engine aircraft in Alaska, particularly those leading to fatalities
- With this information - the association can further develop targeted safety initiatives to aid in their mission to advocate for access and safety infrastructure across the state

https://alaskaairmen.org/about/

Alaskan Bush Pilots

- Operate throughout the vast and rugged Alaskan landscapes
- Most often fly single engine light aircraft
- Navigate varying weather conditions and unconventional rough landing terrain
- Usually the only feasible line of delivery and transportation to isolated communities
- Crucial to search and rescue operations

Problem Statement

- Can significant contributing factors to serious aviation accidents involving Alaskan Bush Pilots be inferred?

Data Source

- NTSB (National Transportation Safety Board) Aviation Investigation database

Features of Interest

- Information about an event that would be known about a flight before or while it was occurring such as:
- Location (on flight route)
- Details on aircraft itself
- Weather

Omitted from Initial Inference

- Details of an observation that could only be known post-event, such as:
- Probable cause
- Level of damage to aircraft
- Number of injuries

Key Definitions

Term	Definition
Highest Injury Level	Scale for worst injury that occurred as a result of an event with values “None Reported”, “Minor”, “Serious” and “Fatality”
Fatality	Injury resulting in death during the event or within 30 days after
Serious Accident/Event	An event resulting in at least one fatality
IMC / VMC	Relates to weather condition (Visual / Instrument Meteorological Conditions) where VMC is ideal, IMC indicates poor weather
Aircraft Family	A grouping of similar aircraft make/models whose variations are often just a result of a different years’ variation

https://www.govinfo.gov/content/pkg/CFR-2011-title49-vol7/pdf/CFR-2011-title49-vol7-sec830-2.pdf

Cleaning & Feature Engineering

Cleaning

- Non-linear process
  - During EDA and even after evaluating results, additional opportunities to clean/engineer were discovered

- Notable cleaning tasks:
  - Aircraft family grouping using extensive RegEx
  - Replacing nulls with ‘unknown’ where appropriate
  - Eliminating upper/lower case discrepancies

Feature Engineering

Term	Definition
Created refined target variable	The target variable was engineered such that events with a fatality were the “positive” case 1, otherwise 0
Created “Occurred Near Airport”	Binary value representing whether the event occurred at or within 3 miles of an airport
Bundled skewed categorical values	Categorical values such as make/model/purpose of flight with a disproportionate values (some very common values and many uncommon) were bundled to reduce class imbalance. Less common entries were grouped as “uncommon”

EDA

EDA Process

Step I

Exploring

Step 2

Organizing

Step 3

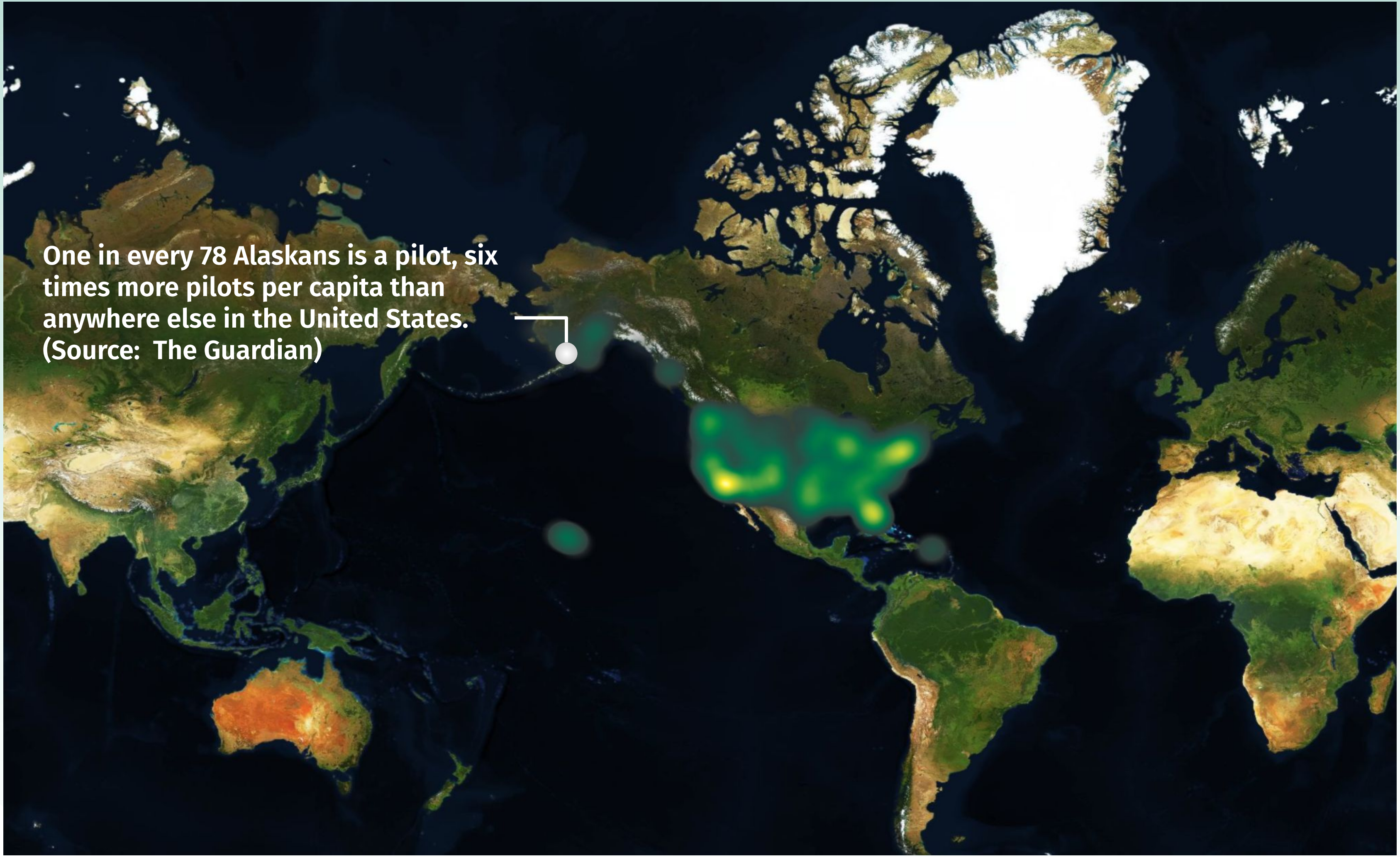
Picking Features
to Explore

Step 4

Graphing and Viz

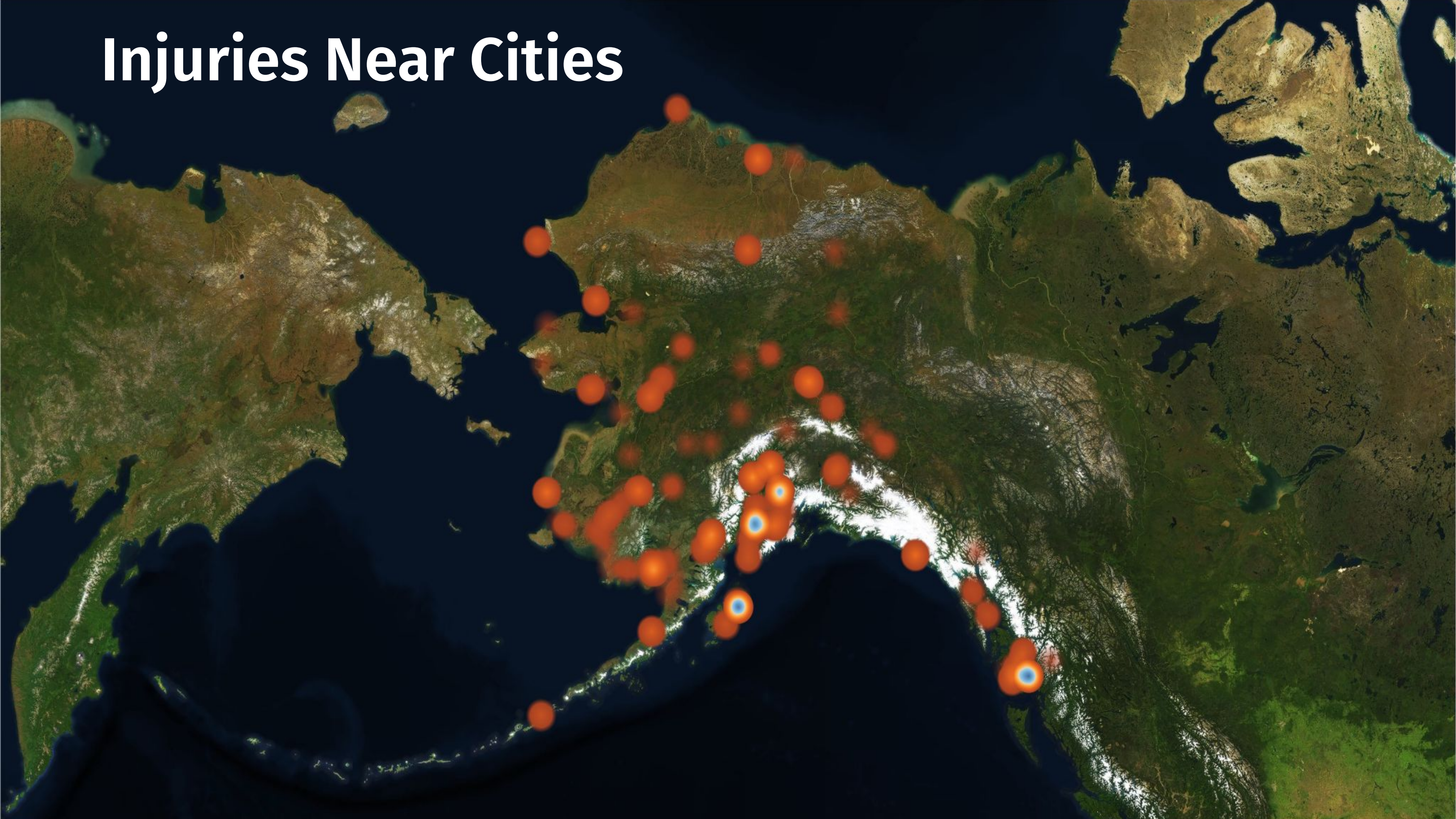
Step 5

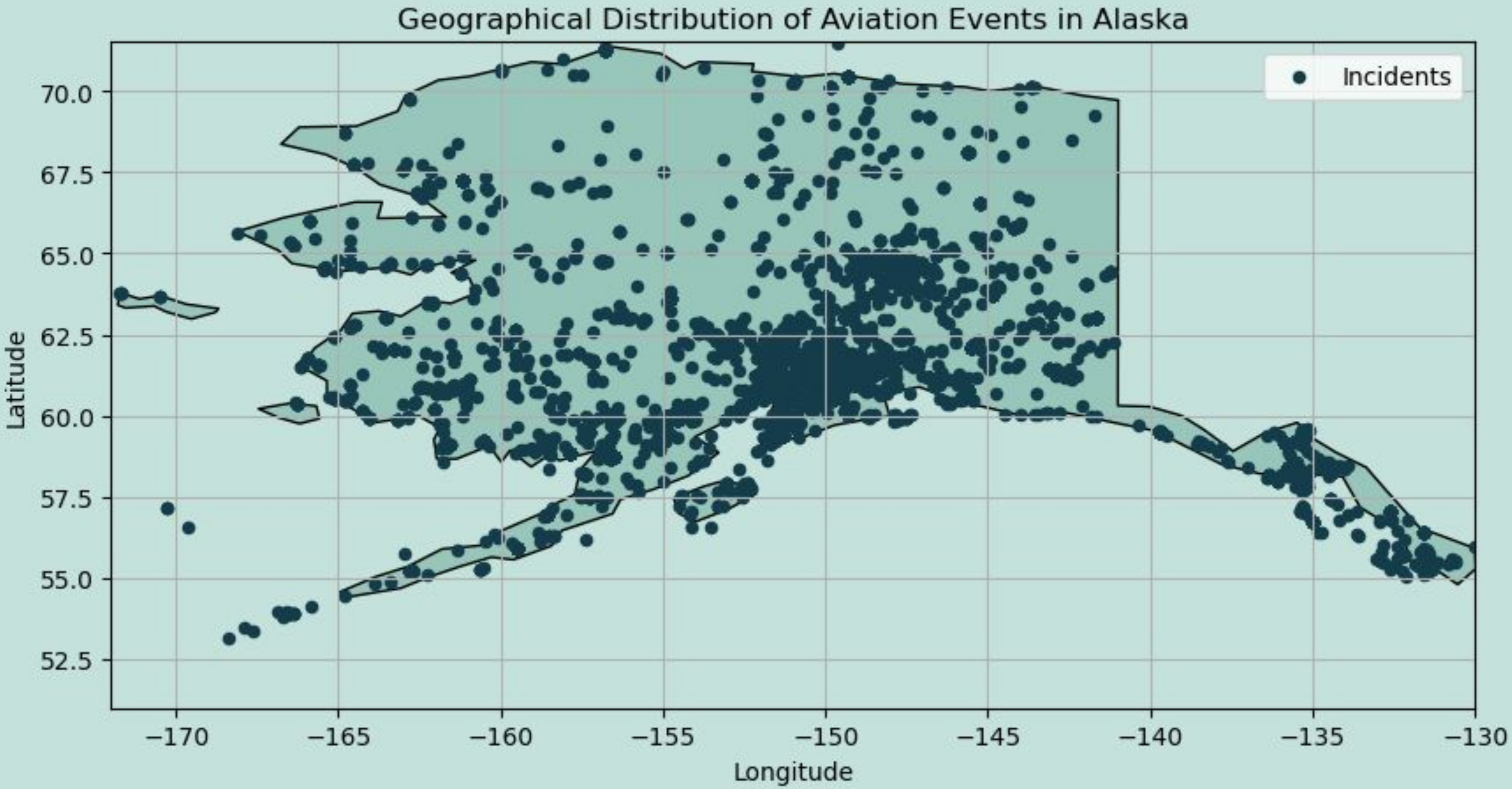
Hypothesis

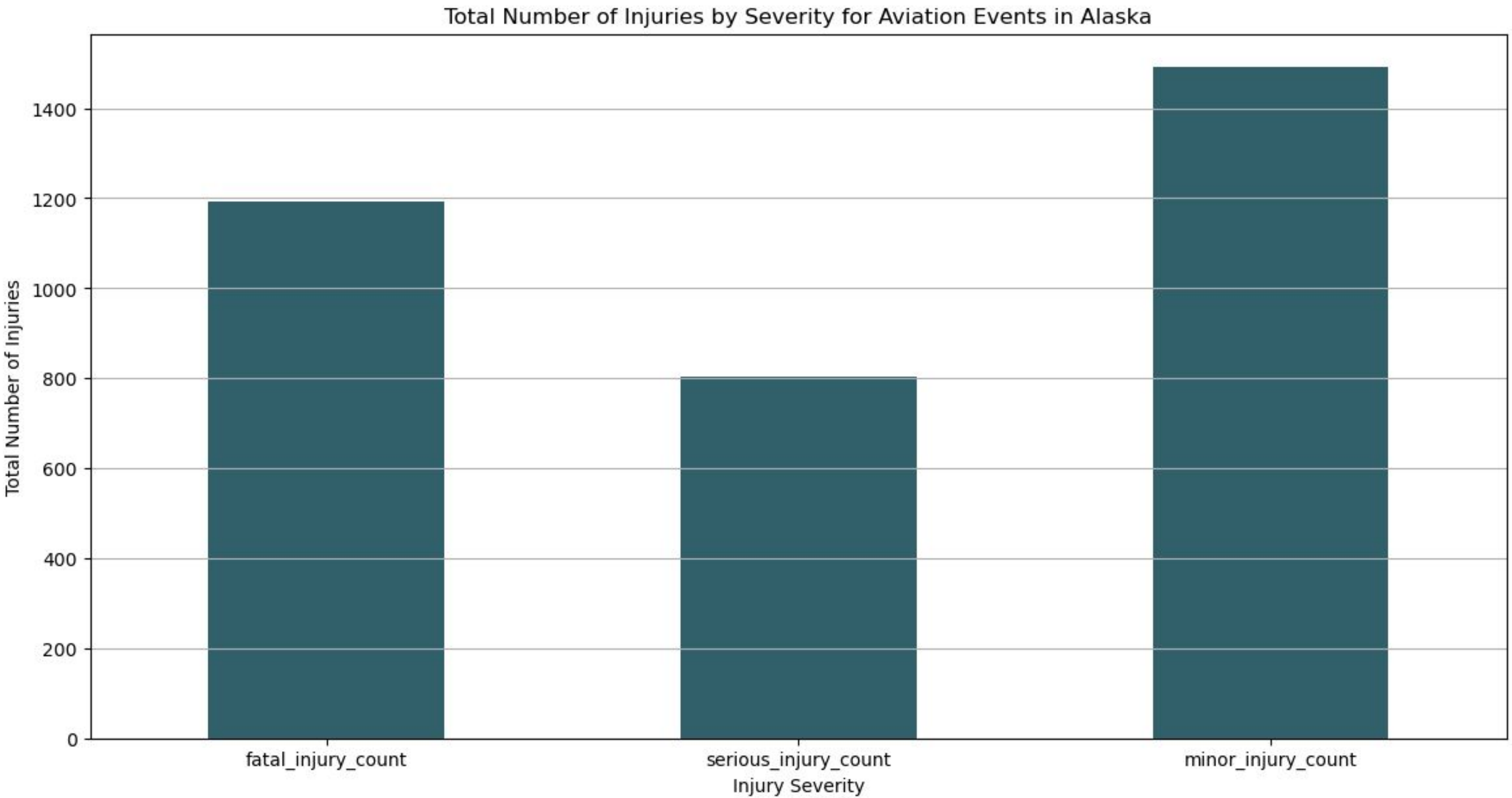


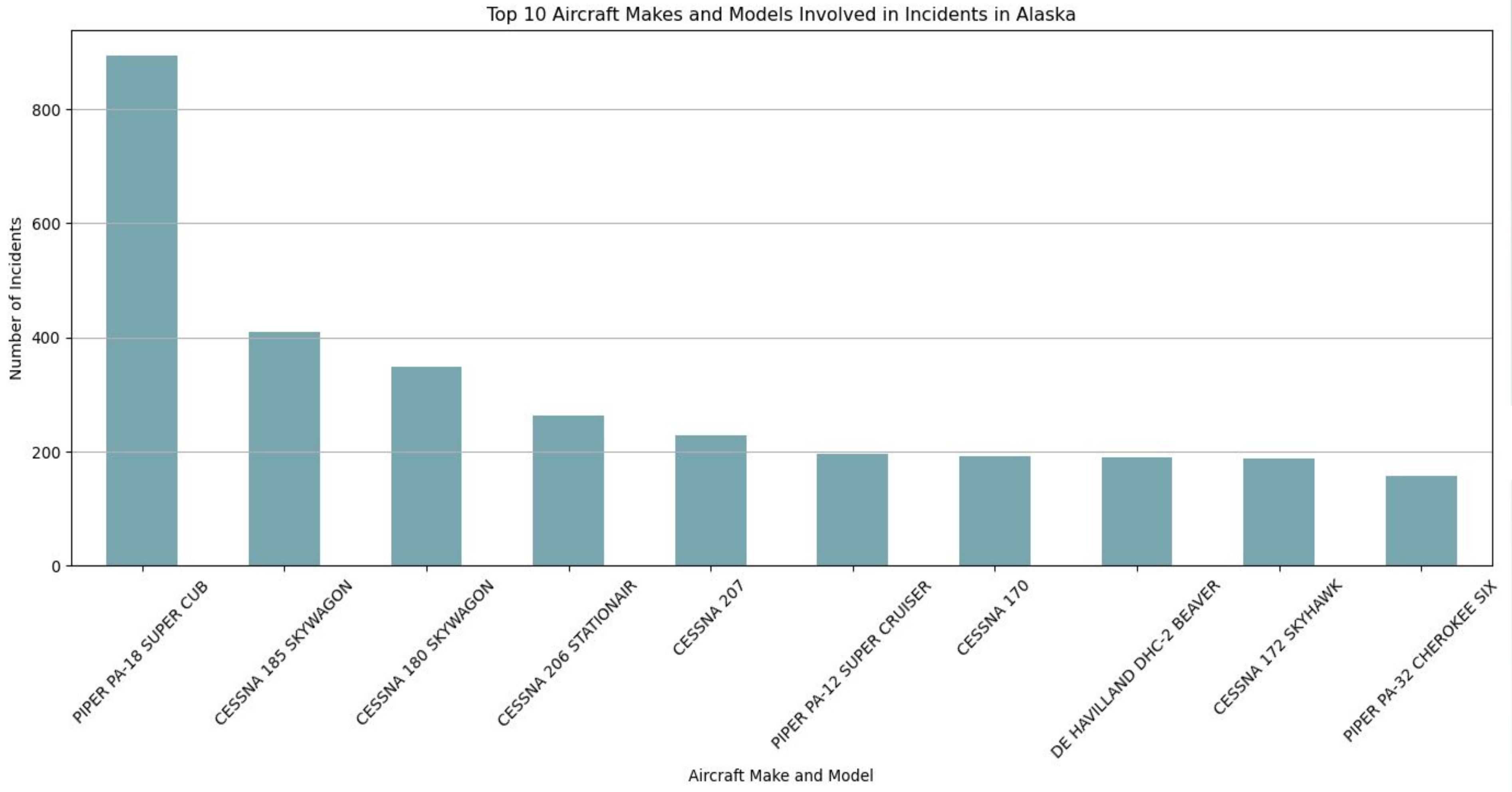
One in every 78 Alaskans is a pilot, six times more pilots per capita than anywhere else in the United States. (Source: The Guardian)

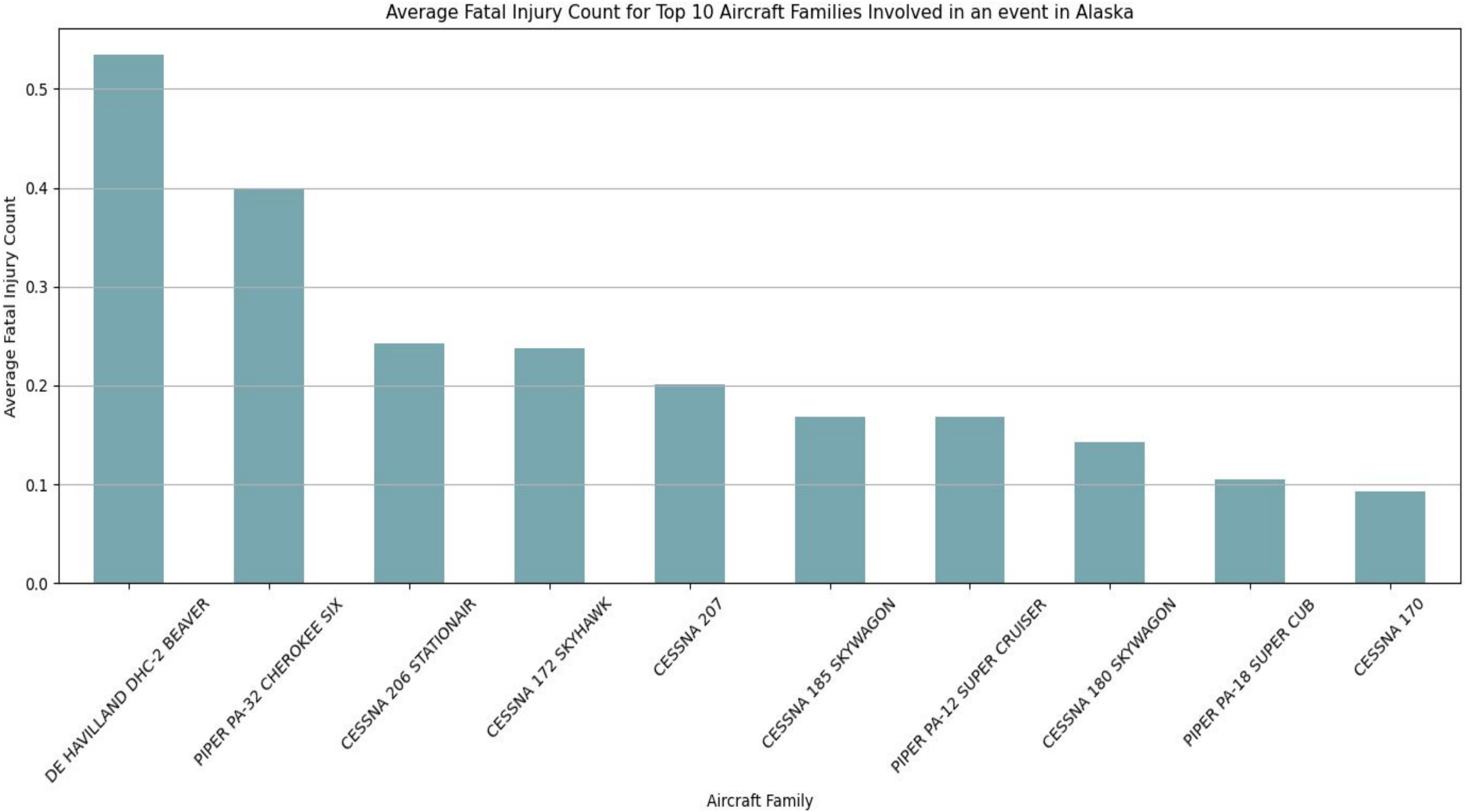
Injuries Near Cities

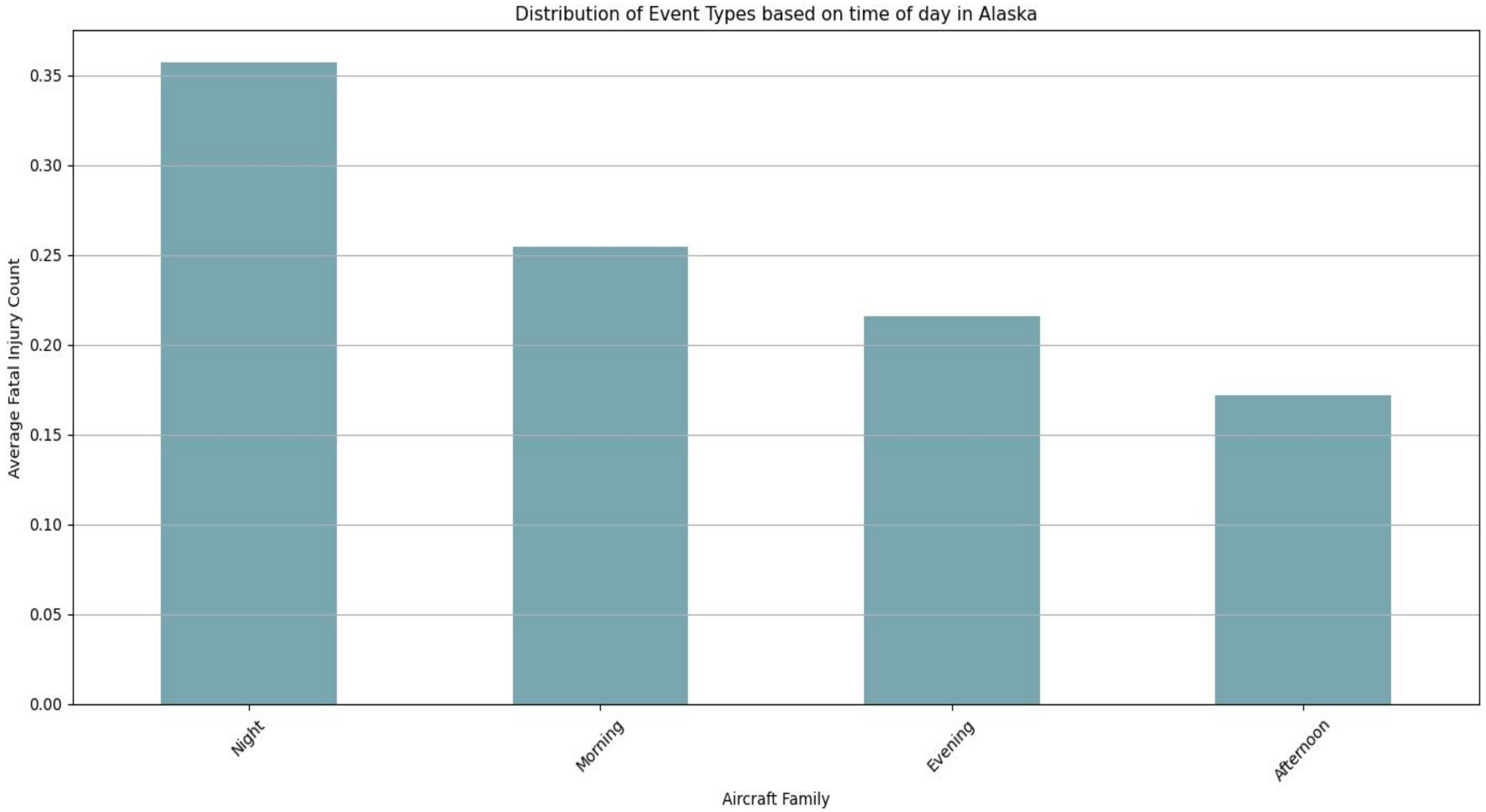



Geographical Distribution of Aviation Events in Alaska
● Incidents
Latitude
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
Longitude
−170
−165
−160
−155
−150
−145
−140
−135
−130


Total Number of Injuries by Severity for Aviation Events in Alaska
Total Number of Injuries
0
200
400
600
800
1000
1200
1400
fatal_injury_count
serious_injury_count
minor_injury_count
Injury Severity


Top 10 Aircraft Makes and Models Involved in Incidents in Alaska
Number of Incidents
0
200
400
600
800
PIPER PA-18 SUPER CUB
CESSNA 185 SKYWAGON
CESSNA 180 SKYWAGON
CESSNA 206 STATIONAIR
CESSNA 207
PIPER PA-12 SUPER CRUISER
CESSNA 170
DE HAVILLAND DHC-2 BEAVER
CESSNA 172 SKYHAWK
PIPER PA-32 CHEROKEE SIX
Aircraft Make and Model


Average Fatal Injury Count for Top 10 Aircraft Families Involved in an event in Alaska
Average Fatal Injury Count
0.0
0.1
0.2
0.3
0.4
0.5
DE HAVILLAND DHC-2 BEAVER
PIPER PA-32 CHEROKEE SIX
CESSNA 206 STATIONAIR
CESSNA 172 SKYHAWK
CESSNA 207
CESSNA 185 SKYWAGON
PIPER PA-12 SUPER CRUISER
CESSNA 180 SKYWAGON
PIPER PA-18 SUPER CUB
CESSNA 170
Aircraft Family


Distribution of Event Types based on time of day in Alaska
Average Fatal Injury Count
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Night
Morning
Evening
Afternoon
Aircraft Family

Hypothesis

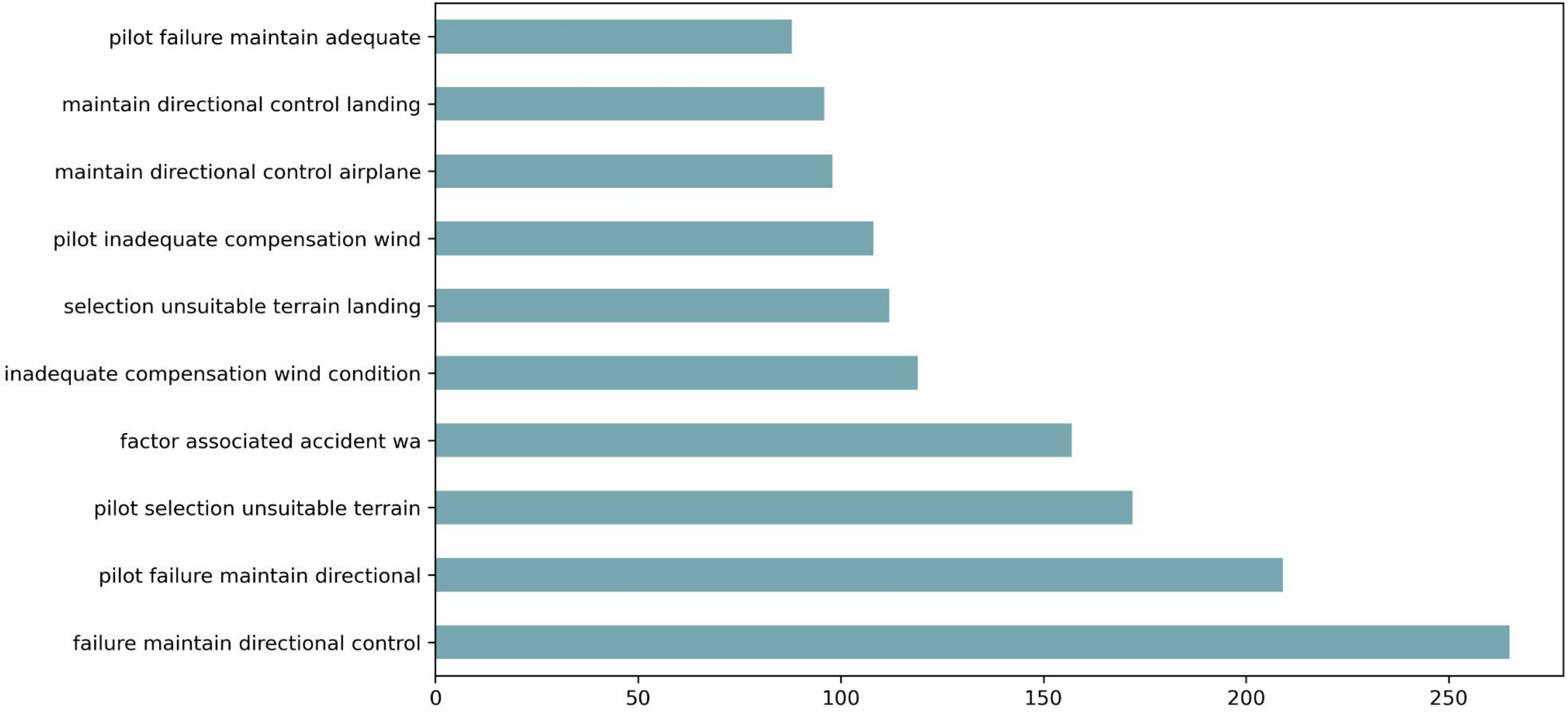
Alternative Hypothesis (H1): Weather, proximity to an airport/city, and aircraft type do have a correlation with average fatal injuries.

Null Hypothesis (H0): Weather, proximity to an airport/city, and aircraft type do not have a correlation with average fatal injuries.

Probable Cause vs Highest Injury

Features	Importance
landing	0.016870
flight	0.015610
pilot	0.014021
stall	0.013133
terrain	0.012580
instrument	0.011043
airspeed	0.010541
failure	0.010201
resulted	0.010013
condition	0.009662

Probable Cause vs Highest Injury



Make vs Highest Injury

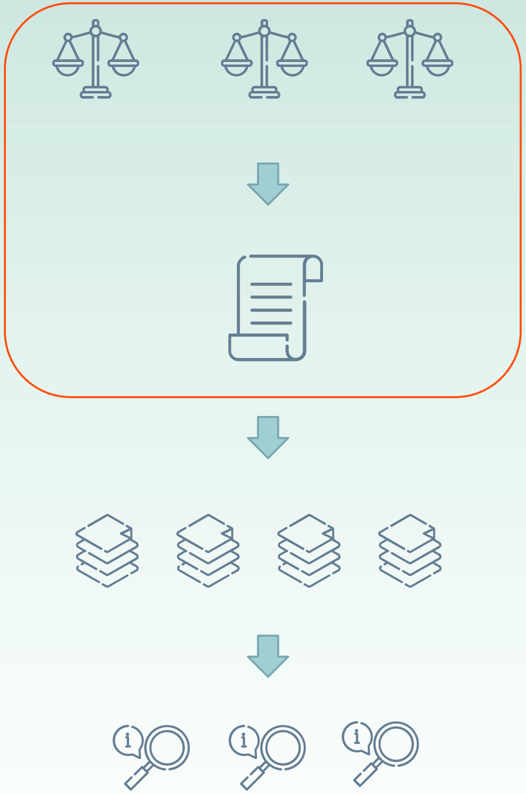
Features	Importance
bell	0.025789
beech	0.023573
eurocopter	0.022799
waspair	0.021527
havilland	0.018677
helicopters	0.014903
hughes	0.013350
taylorcraft	0.012381
piper	0.011554
colburn	0.010332

Modeling Process

Modeling Process

Step 1 - statsmodels GLMs

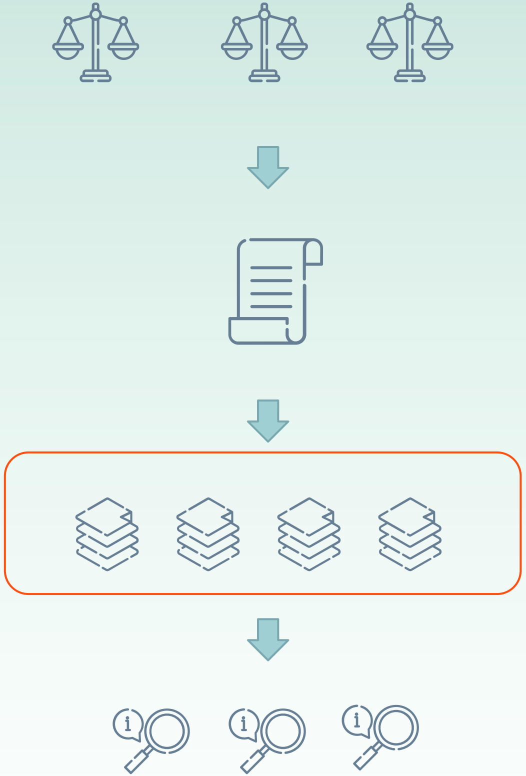
- First needed to determine where to start with predictor variables
- Extracted sources of statistical significance through use of Generalized Linear Models, specifically Binomial
- Using accuracy as a chief metric, GLM models eventually slightly outperformed baseline, which in turn provided p-values
- Expedited this process with a new class that included methods that performed preprocessing, train-test splitting, fitting, and storage of summary results in one method



Modeling Process

Step 2 - Sci-Kit Learn Logistic Regressions

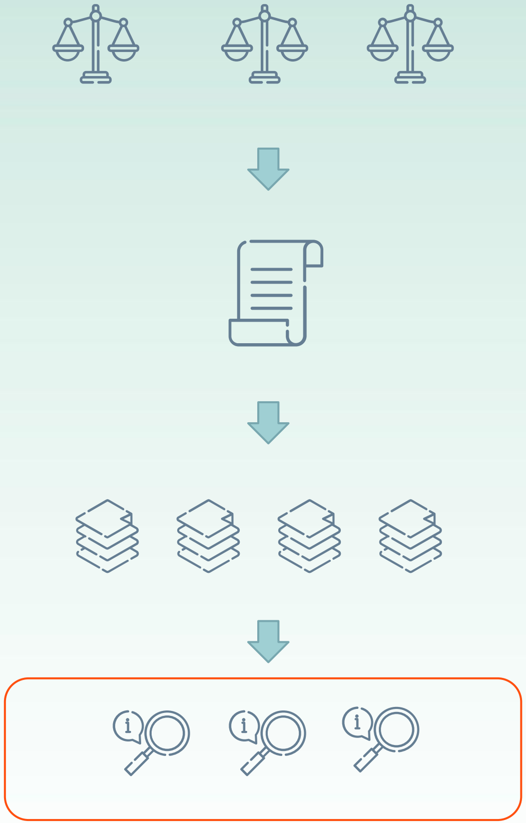
- With p-values, we set up logistic regression models each focused on very small subsets of significant features
- Variations of the same logistic regression model with different reference categorical values were run in order to generate easier to understand inferences
- These product coefficients, which now gave us magnitude and direction (the overall effect in terms of odds) of features like time of day

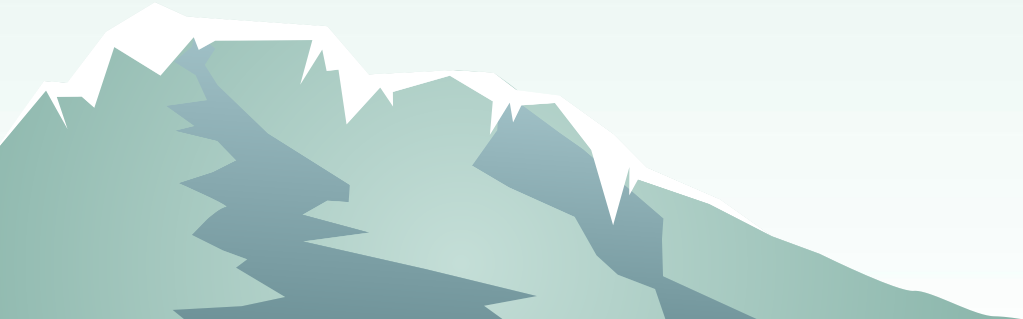


Modeling Process

Step 3 - Inferences

- With statistical significance, coefficients with magnitude and direction in hand, we could make inferences in terms of which factors were likely to contribute to a more serious accident





Results

Coefficients

Feature	p_value	Coefficient	Coefficient Reference
weather_condition_VMC	0	0.562	IMC
occurred_near_airport	0.000001	1.111	0
event_time_of_day_Night	0.0001	1.090	Morning

Conclusion

Key Insights/Recommendations

Weather Conditions/Visibility

Flying in VMC conditions leads to a 44% decrease in odds of fatal injury compared to flying in IMC conditions

Proximity to Airport

Accidents at or within 3 miles of an airport increased likelihood of fatal injury by 11%

Time of Day

Flying at night leads to a 9% increase in fatal injury compared to flying in the morning

THANKS!

QUESTIONS?

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