Final Project Proposal STAT167

Group Name: Statistically Speaking
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Installation & Packages

```
library(nycflights13)
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

Introduction

The primary goal of this research is to explore factors influencing flight delays from New City airports in 2013.

Problem Statement and Motivation

Understanding factors that contribute to flight delays is critical for informing Federal Aviation Administration (FAA) policies and guiding airlines and airports in improving operational efficiency, enhancing weather preparedness, and reducing delays through controllable factors. By analyzing weather conditions, airline differences, holiday effects, fleet age, and airport specific challenges, this research can provide data-driven insights to optimize air travel and ensure compliance with aviation regulations in heavily congested areas like New York City.

Main Research Question

What are the key correlations between flight delays from NYC airports?

Sub-questions:

The following questions will guide the analysis:

1. How do weather conditions affect flight delays?
    a. Are specific weather variables (e.g., precipitation, wind speed, humidity) correlated with departure and arrival delays?
2. How do differences between airlines influence flight delays?
    a. Do certain airlines experience more delays than other, if so, what operational or fleet-related factors contribute to these differences?
    b. How do metrics like cancelation rates and plane speed vary across airlines, and what impact do these metrics have on delays?
3. Are delays more frequent during major holidays?
    a. Are there differences during peak travel periods (e.g., Thanksgiving, Christsmas, New Year's Day)
4. Does the age of the plane affect flight delays?
    a. Do older planes experience more delays compared to newer ones?
    b. Are there specific plane models or manufactures associated with better on-time performance?
5. How do environmental factors like humidity, visibility, and wind affect flight delays?
    a. Are these effects observed across all airports?
6. What impact does precipitation have on specific airports and weather-related delays?
    a. Do airports in regions with higher average precipitation experience more delays?

Datasets

1. Flights dataset: All flights that departed from NYC in 2013

```
1 head(flights)
```

```
# A tibble: 6 x 19
   year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
  <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
1  2013     1     1      517            515         2      830            819
2  2013     1     1      533            529         4      850            830
3  2013     1     1      542            540         2      923            850
```

```
4  2013     1     1      544            545        -1     1004           1022
5  2013     1     1      554            600        -6      812            837
6  2013     1     1      554            558        -4      740            728
# i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
#   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
#   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```
dim(flights)
```

```
[1] 336776     19
```

```
names(flights)
```

```
 [1] "year"           "month"          "day"            "dep_time"
 [5] "sched_dep_time" "dep_delay"      "arr_time"       "sched_arr_time"
 [9] "arr_delay"      "carrier"        "flight"         "tailnum"
[13] "origin"         "dest"           "air_time"       "distance"
[17] "hour"           "minute"         "time_hour"
```

```
str(flights)
```

```
tibble [336,776 x 19] (S3: tbl_df/tbl/data.frame)
 $ year          : int [1:336776] 2013 2013 2013 2013 2013 2013 2013 2013 2013 2013 ...
 $ month         : int [1:336776] 1 1 1 1 1 1 1 1 1 1 ...
 $ day           : int [1:336776] 1 1 1 1 1 1 1 1 1 1 ...
 $ dep_time      : int [1:336776] 517 533 542 544 554 554 555 557 557 558 ...
 $ sched_dep_time: int [1:336776] 515 529 540 545 600 558 600 600 600 600 ...
 $ dep_delay     : num [1:336776] 2 4 2 -1 -6 -4 -5 -3 -3 -2 ...
 $ arr_time      : int [1:336776] 830 850 923 1004 812 740 913 709 838 753 ...
 $ sched_arr_time: int [1:336776] 819 830 850 1022 837 728 854 723 846 745 ...
 $ arr_delay     : num [1:336776] 11 20 33 -18 -25 12 19 -14 -8 8 ...
 $ carrier       : chr [1:336776] "UA" "UA" "AA" "B6" ...
 $ flight        : int [1:336776] 1545 1714 1141 725 461 1696 507 5708 79 301 ...
 $ tailnum       : chr [1:336776] "N14228" "N24211" "N619AA" "N804JB" ...
 $ origin        : chr [1:336776] "EWR" "LGA" "JFK" "JFK" ...
 $ dest          : chr [1:336776] "IAH" "IAH" "MIA" "BQN" ...
 $ air_time      : num [1:336776] 227 227 160 183 116 150 158 53 140 138 ...
 $ distance      : num [1:336776] 1400 1416 1089 1576 762 ...
 $ hour          : num [1:336776] 5 5 5 5 6 5 6 6 6 6 ...
 $ minute        : num [1:336776] 15 29 40 45 0 58 0 0 0 0 ...
 $ time_hour     : POSIXct[1:336776], format: "2013-01-01 05:00:00" "2013-01-01 05:00:00" ...
```

```
glimpse(flights)
```

```
Rows: 336,776
Columns: 19
$ year           <int> 2013, 2013, 2013, 2013, 2013, 2013, 2013, 2013, 2013, 2~
$ month          <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1~
$ day            <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1~
$ dep_time       <int> 517, 533, 542, 544, 554, 554, 555, 557, 557, 558, 558, ~
$ sched_dep_time <int> 515, 529, 540, 545, 600, 558, 600, 600, 600, 600, 600, ~
$ dep_delay      <dbl> 2, 4, 2, -1, -6, -4, -5, -3, -3, -2, -2, -2, -2, -2, -1~
$ arr_time       <int> 830, 850, 923, 1004, 812, 740, 913, 709, 838, 753, 849,~
$ sched_arr_time <int> 819, 830, 850, 1022, 837, 728, 854, 723, 846, 745, 851,~
$ arr_delay      <dbl> 11, 20, 33, -18, -25, 12, 19, -14, -8, 8, -2, -3, 7, -1~
$ carrier        <chr> "UA", "UA", "AA", "B6", "DL", "UA", "B6", "EV", "B6", "~
$ flight         <int> 1545, 1714, 1141, 725, 461, 1696, 507, 5708, 79, 301, 4~
$ tailnum        <chr> "N14228", "N24211", "N619AA", "N804JB", "N668DN", "N394~
$ origin         <chr> "EWR", "LGA", "JFK", "JFK", "LGA", "EWR", "EWR", "LGA",~
$ dest           <chr> "IAH", "IAH", "MIA", "BQN", "ATL", "ORD", "FLL", "IAD",~
$ air_time       <dbl> 227, 227, 160, 183, 116, 150, 158, 53, 140, 138, 149, 1~
$ distance       <dbl> 1400, 1416, 1089, 1576, 762, 719, 1065, 229, 944, 733, ~
$ hour           <dbl> 5, 5, 5, 5, 6, 5, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 6, 6, 6~
$ minute         <dbl> 15, 29, 40, 45, 0, 58, 0, 0, 0, 0, 0, 0, 0, 0, 0, 59, 0~
$ time_hour      <dttm> 2013-01-01 05:00:00, 2013-01-01 05:00:00, 2013-01-01 0~
```

Variables:

- flights (year, month, day, dep_time, arr_time, sched_dep_time, sched_arr_time, dep_delay, arr_delay, carrier, origin, dest, air_time, distance, time_hour)
  - year, month, day : date of departure
  - dep_time, arr_time : actual departure and arrival times in HHMM
  - sched_dep_time, sched_arr_time : scheduled departure and arrival times in HHMM
  - dep_delay, arr_delay : departure and arrival delays in minutes
  - carrier : two letter carrier abbreviation of the carrier
  - origin, dest : origin and destination
  - air_time : amount of time spent in air in minutes
  - distance : distance between airport in miles
  - time_hour : scheduled date and hour of the flight as POSIXct date

2. Airlines dataset: Translation between two letter carrier codes and names

```
1 head(airlines)
```

```
# A tibble: 6 x 2
  carrier name
  <chr>   <chr>
1 9E      Endeavor Air Inc.
2 AA      American Airlines Inc.
```

```
3 AS      Alaska Airlines Inc.
4 B6      JetBlue Airways
5 DL      Delta Air Lines Inc.
6 EV      ExpressJet Airlines Inc.
```

```
dim(airlines)
```

```
[1] 16  2
```

```
names(airlines)
```

```
[1] "carrier" "name"
```

```
str(airlines)
```

```
tibble [16 x 2] (S3: tbl_df/tbl/data.frame)
 $ carrier: chr [1:16] "9E" "AA" "AS" "B6" ...
 $ name   : chr [1:16] "Endeavor Air Inc." "American Airlines Inc." "Alaska Airlines Inc." "JetBlue A
```

```
glimpse(airlines)
```

```
Rows: 16
Columns: 2
$ carrier <chr> "9E", "AA", "AS", "B6", "DL", "EV", "F9", "FL", "HA", "MQ", "O~
$ name    <chr> "Endeavor Air Inc.", "American Airlines Inc.", "Alaska Airline~
```

Variables:

- airlines (carrier, name)
  - carrier : two-letter abbreviation of the airlines
  - name : full name of the airlines

3. Airports dataset: Airport names and locations

```
head(airports)
```

```
# A tibble: 6 x 8
  faa   name                            lat   lon   alt    tz dst   tzone
  <chr> <chr>                         <dbl> <dbl> <dbl> <dbl> <chr> <chr>
1 04G   Lansdowne Airport              41.1 -80.6  1044    -5 A     America/Ne~
2 06A   Moton Field Municipal Airport  32.5 -85.7   264    -6 A     America/Ch~
3 06C   Schaumburg Regional            42.0 -88.1   801    -6 A     America/Ch~
4 06N   Randall Airport                41.4 -74.4   523    -5 A     America/Ne~
5 09J   Jekyll Island Airport          31.1 -81.4    11    -5 A     America/Ne~
6 0A9   Elizabethton Municipal Airport 36.4 -82.2  1593    -5 A     America/Ne~
```

```r
dim(airports)
```

```
[1] 1458    8
```

```r
names(airports)
```

```
[1] "faa"   "name"  "lat"   "lon"   "alt"   "tz"    "dst"   "tzone"
```

```r
str(airports)
```

```
tibble [1,458 x 8] (S3: tbl_df/tbl/data.frame)
 $ faa  : chr [1:1458] "04G" "06A" "06C" "06N" ...
 $ name : chr [1:1458] "Lansdowne Airport" "Moton Field Municipal Airport" "Schaumburg Regional" "Ran
 $ lat  : num [1:1458] 41.1 32.5 42 41.4 31.1 ...
 $ lon  : num [1:1458] -80.6 -85.7 -88.1 -74.4 -81.4 ...
 $ alt  : num [1:1458] 1044 264 801 523 11 ...
 $ tz   : num [1:1458] -5 -6 -6 -5 -5 -5 -5 -5 -5 -8 ...
 $ dst  : chr [1:1458] "A" "A" "A" "A" ...
 $ tzone: chr [1:1458] "America/New_York" "America/Chicago" "America/Chicago" "America/New_York" ...
 - attr(*, "spec")=
  .. cols(
  ..   id = col_double(),
  ..   name = col_character(),
  ..   city = col_character(),
  ..   country = col_character(),
  ..   faa = col_character(),
  ..   icao = col_character(),
  ..   lat = col_double(),
  ..   lon = col_double(),
  ..   alt = col_double(),
  ..   tz = col_double(),
  ..   dst = col_character(),
  ..   tzone = col_character()
  .. )
```

```r
glimpse(airports)
```

```
Rows: 1,458
Columns: 8
$ faa   <chr> "04G", "06A", "06C", "06N", "09J", "0A9", "0G6", "0G7", "0P2", "~
$ name  <chr> "Lansdowne Airport", "Moton Field Municipal Airport", "Schaumbur~
$ lat   <dbl> 41.13047, 32.46057, 41.98934, 41.43191, 31.07447, 36.37122, 41.4~
$ lon   <dbl> -80.61958, -85.68003, -88.10124, -74.39156, -81.42778, -82.17342~
$ alt   <dbl> 1044, 264, 801, 523, 11, 1593, 730, 492, 1000, 108, 409, 875, 10~
$ tz    <dbl> -5, -6, -6, -5, -5, -5, -5, -5, -5, -8, -5, -6, -5, -5, -5, -5, ~
$ dst   <chr> "A", "A", "A", "A", "A", "A", "A", "A", "U", "A", "A", "U", "A",~
$ tzone <chr> "America/New_York", "America/Chicago", "America/Chicago", "Ameri~
```

Variables:

- airports (faa, name, lat, lon)
  - faa : FAA airport code
  - name : usual name of the airport
  - lat, lon : location of airport

4. Planes dataset: Construction information about each plane

```
head(planes)
```

```
# A tibble: 6 x 9
  tailnum  year type               manufacturer model engines seats speed engine
  <chr>   <int> <chr>              <chr>        <chr>   <int> <int> <int> <chr>
1 N10156   2004 Fixed wing multi ~ EMBRAER      EMB-~       2    55    NA Turbo~
2 N102UW   1998 Fixed wing multi ~ AIRBUS INDU~ A320~       2   182    NA Turbo~
3 N103US   1999 Fixed wing multi ~ AIRBUS INDU~ A320~       2   182    NA Turbo~
4 N104UW   1999 Fixed wing multi ~ AIRBUS INDU~ A320~       2   182    NA Turbo~
5 N10575   2002 Fixed wing multi ~ EMBRAER      EMB-~       2    55    NA Turbo~
6 N105UW   1999 Fixed wing multi ~ AIRBUS INDU~ A320~       2   182    NA Turbo~
```

```
dim(planes)
```

```
[1] 3322    9
```

```
names(planes)
```

```
[1] "tailnum"      "year"         "type"         "manufacturer" "model"
[6] "engines"      "seats"        "speed"        "engine"
```

```
str(planes)
```

```
tibble [3,322 x 9] (S3: tbl_df/tbl/data.frame)
 $ tailnum     : chr [1:3322] "N10156" "N102UW" "N103US" "N104UW" ...
 $ year        : int [1:3322] 2004 1998 1999 1999 2002 1999 1999 1999 1999 1999 ...
 $ type        : chr [1:3322] "Fixed wing multi engine" "Fixed wing multi engine" "Fixed wing multi e
 $ manufacturer: chr [1:3322] "EMBRAER" "AIRBUS INDUSTRIE" "AIRBUS INDUSTRIE" "AIRBUS INDUSTRIE" ...
 $ model       : chr [1:3322] "EMB-145XR" "A320-214" "A320-214" "A320-214" ...
 $ engines     : int [1:3322] 2 2 2 2 2 2 2 2 2 2 ...
 $ seats       : int [1:3322] 55 182 182 182 55 182 182 182 182 182 ...
 $ speed       : int [1:3322] NA NA NA NA NA NA NA NA NA NA ...
 $ engine      : chr [1:3322] "Turbo-fan" "Turbo-fan" "Turbo-fan" "Turbo-fan" ...
```

```r
glimpse(planes)
```

```
Rows: 3,322
Columns: 9
$ tailnum      <chr> "N10156", "N102UW", "N103US", "N104UW", "N10575", "N105UW~
$ year         <int> 2004, 1998, 1999, 1999, 2002, 1999, 1999, 1999, 1999, 199~
$ type         <chr> "Fixed wing multi engine", "Fixed wing multi engine", "Fi~
$ manufacturer <chr> "EMBRAER", "AIRBUS INDUSTRIE", "AIRBUS INDUSTRIE", "AIRBU~
$ model        <chr> "EMB-145XR", "A320-214", "A320-214", "A320-214", "EMB-145~
$ engines      <int> 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ~
$ seats        <int> 55, 182, 182, 182, 55, 182, 182, 182, 182, 182, 55, 55, 5~
$ speed        <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, N~
$ engine       <chr> "Turbo-fan", "Turbo-fan", "Turbo-fan", "Turbo-fan", "Turb~
```

Variables:

- planes (year, type, manufacturer, model, engines, seats, speed, engine)
  - year : year manufactured
  - type : type of plane
  - manufacturer, model : manufacturer and model
  - engines, seats : number of engines and seats
  - speed : average cruising speed in mph
  - engine : type in engine

5. Weather dataset: Hourly meterological data for each airport

```r
head(weather)
```

```
# A tibble: 6 x 15
  origin  year month   day  hour  temp  dewp humid wind_dir wind_speed wind_gust
  <chr>  <int> <int> <int> <int> <dbl> <dbl> <dbl>    <dbl>      <dbl>     <dbl>
1 EWR     2013     1     1     1  39.0  26.1  59.4      270      10.4         NA
2 EWR     2013     1     1     2  39.0  27.0  61.6      250       8.06        NA
3 EWR     2013     1     1     3  39.0  28.0  64.4      240      11.5         NA
4 EWR     2013     1     1     4  39.9  28.0  62.2      250      12.7         NA
5 EWR     2013     1     1     5  39.0  28.0  64.4      260      12.7         NA
6 EWR     2013     1     1     6  37.9  28.0  67.2      240      11.5         NA
# i 4 more variables: precip <dbl>, pressure <dbl>, visib <dbl>,
#   time_hour <dttm>
```

```r
dim(weather)
```

```
[1] 26115    15
```

```r
names(weather)
```

```
 [1] "origin"     "year"       "month"      "day"        "hour"
 [6] "temp"       "dewp"       "humid"      "wind_dir"   "wind_speed"
[11] "wind_gust"  "precip"     "pressure"   "visib"      "time_hour"
```

```r
str(weather)
```

```
tibble [26,115 x 15] (S3: tbl_df/tbl/data.frame)
 $ origin    : chr [1:26115] "EWR" "EWR" "EWR" "EWR" ...
 $ year      : int [1:26115] 2013 2013 2013 2013 2013 2013 2013 2013 2013 2013 ...
 $ month     : int [1:26115] 1 1 1 1 1 1 1 1 1 1 ...
 $ day       : int [1:26115] 1 1 1 1 1 1 1 1 1 1 ...
 $ hour      : int [1:26115] 1 2 3 4 5 6 7 8 9 10 ...
 $ temp      : num [1:26115] 39 39 39 39.9 39 ...
 $ dewp      : num [1:26115] 26.1 27 28 28 28 ...
 $ humid     : num [1:26115] 59.4 61.6 64.4 62.2 64.4 ...
 $ wind_dir  : num [1:26115] 270 250 240 250 260 240 240 250 260 260 ...
 $ wind_speed: num [1:26115] 10.36 8.06 11.51 12.66 12.66 ...
 $ wind_gust : num [1:26115] NA NA NA NA NA NA NA NA NA NA ...
 $ precip    : num [1:26115] 0 0 0 0 0 0 0 0 0 0 ...
 $ pressure  : num [1:26115] 1012 1012 1012 1012 1012 ...
 $ visib     : num [1:26115] 10 10 10 10 10 10 10 10 10 10 ...
 $ time_hour : POSIXct[1:26115], format: "2013-01-01 01:00:00" "2013-01-01 02:00:00" ...
```

```r
glimpse(weather)
```

```
Rows: 26,115
Columns: 15
$ origin     <chr> "EWR", "EWR", "EWR", "EWR", "EWR", "EWR", "EWR", "EWR", "EW~
$ year       <int> 2013, 2013, 2013, 2013, 2013, 2013, 2013, 2013, 2013, 2013,~
$ month      <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,~
$ day        <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,~
$ hour       <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, ~
$ temp       <dbl> 39.02, 39.02, 39.02, 39.92, 39.02, 37.94, 39.02, 39.92, 39.~
$ dewp       <dbl> 26.06, 26.96, 28.04, 28.04, 28.04, 28.04, 28.04, 28.04, 28.~
$ humid      <dbl> 59.37, 61.63, 64.43, 62.21, 64.43, 67.21, 64.43, 62.21, 62.~
$ wind_dir   <dbl> 270, 250, 240, 250, 260, 240, 240, 250, 260, 260, 260, 330,~
$ wind_speed <dbl> 10.35702, 8.05546, 11.50780, 12.65858, 12.65858, 11.50780, ~
$ wind_gust  <dbl> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, 20.~
$ precip     <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,~
$ pressure   <dbl> 1012.0, 1012.3, 1012.5, 1012.2, 1011.9, 1012.4, 1012.2, 101~
$ visib      <dbl> 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10,~
$ time_hour  <dttm> 2013-01-01 01:00:00, 2013-01-01 02:00:00, 2013-01-01 03:00~
```

Variables:

- weather (origin, year, month, day, hour, temp, dewp, humid, wind_dir, wind_speed, wind_gust, precip, pressure, visib, time_hour)
  - origin : weather station
  - year, month, day, hour : time of recording
  - temp, dewp : temperature and dew point in Fahrenheit
  - humid : relative humidity
  - wind_dir, wind_speed, wind_gust : wind direction in degrees, wind speed and gust in mph
  - precip : precipitation in inches
  - pressure : sea level pressure in millibars
  - visib : visibility in miles
  - time_hour : date and hour of the recording as POSIXct date

We can join the data tables by combining them through similar attributes, such as combining flights : time_hour with weather : time_hour.

EDA:

Summary Statistics & Check for Missing Values:

```
summary(flights)
```

```
      year          month             day           dep_time    sched_dep_time
 Min.   :2013   Min.   : 1.000   Min.   : 1.00   Min.   :   1   Min.   : 106
 1st Qu.:2013   1st Qu.: 4.000   1st Qu.: 8.00   1st Qu.: 907   1st Qu.: 906
 Median :2013   Median : 7.000   Median :16.00   Median :1401   Median :1359
 Mean   :2013   Mean   : 6.549   Mean   :15.71   Mean   :1349   Mean   :1344
 3rd Qu.:2013   3rd Qu.:10.000   3rd Qu.:23.00   3rd Qu.:1744   3rd Qu.:1729
 Max.   :2013   Max.   :12.000   Max.   :31.00   Max.   :2400   Max.   :2359
                                                 NA's   :8255
   dep_delay          arr_time    sched_arr_time   arr_delay
 Min.   : -43.00   Min.   :   1   Min.   :   1   Min.   : -86.000
 1st Qu.:  -5.00   1st Qu.:1104   1st Qu.:1124   1st Qu.: -17.000
 Median :  -2.00   Median :1535   Median :1556   Median :  -5.000
 Mean   :  12.64   Mean   :1502   Mean   :1536   Mean   :   6.895
 3rd Qu.:  11.00   3rd Qu.:1940   3rd Qu.:1945   3rd Qu.:  14.000
 Max.   :1301.00   Max.   :2400   Max.   :2359   Max.   :1272.000
 NA's   :8255      NA's   :8713                  NA's   :9430
   carrier             flight       tailnum             origin
 Length:336776      Min.   :   1   Length:336776      Length:336776
 Class :character   1st Qu.: 553   Class :character   Class :character
 Mode  :character   Median :1496   Mode  :character   Mode  :character
                    Mean   :1972
                    3rd Qu.:3465
                    Max.   :8500
```

```
    dest              air_time        distance         hour
Length:336776      Min.   : 20.0   Min.   :  17   Min.   : 1.00
Class :character   1st Qu.: 82.0   1st Qu.: 502   1st Qu.: 9.00
Mode  :character   Median :129.0   Median : 872   Median :13.00
                   Mean   :150.7   Mean   :1040   Mean   :13.18
                   3rd Qu.:192.0   3rd Qu.:1389   3rd Qu.:17.00
                   Max.   :695.0   Max.   :4983   Max.   :23.00
                   NA's   :9430
    minute        time_hour
Min.   : 0.00   Min.   :2013-01-01 05:00:00.00
1st Qu.: 8.00   1st Qu.:2013-04-04 13:00:00.00
Median :29.00   Median :2013-07-03 10:00:00.00
Mean   :26.23   Mean   :2013-07-03 05:22:54.64
3rd Qu.:44.00   3rd Qu.:2013-10-01 07:00:00.00
Max.   :59.00   Max.   :2013-12-31 23:00:00.00
```

```
1 colSums(is.na(flights))
```

```
          year          month            day       dep_time sched_dep_time
             0              0              0           8255              0
     dep_delay       arr_time sched_arr_time      arr_delay        carrier
          8255           8713              0           9430              0
        flight        tailnum         origin           dest       air_time
             0           2512              0              0           9430
      distance           hour         minute      time_hour
             0              0              0              0
```

```
1 summary(airlines)
```

```
   carrier             name
Length:16          Length:16
Class :character   Class :character
Mode  :character   Mode  :character
```

```
1 colSums(is.na(airlines))
```

```
carrier    name
      0       0
```

```
1 summary(airports)
```

```
    faa                name               lat             lon
Length:1458        Length:1458        Min.   :19.72   Min.   :-176.65
```

```
Class :character   Class :character   1st Qu.:34.26   1st Qu.:-119.19
Mode  :character   Mode  :character   Median :40.09   Median : -94.66
                                      Mean   :41.65   Mean   :-103.39
                                      3rd Qu.:45.07   3rd Qu.: -82.52
                                      Max.   :72.27   Max.   : 174.11
      alt               tz             dst              tzone
Min.   : -54.00   Min.   :-10.000   Length:1458        Length:1458
1st Qu.:  70.25   1st Qu.: -8.000   Class :character   Class :character
Median : 473.00   Median : -6.000   Mode  :character   Mode  :character
Mean   :1001.42   Mean   : -6.519
3rd Qu.:1062.50   3rd Qu.: -5.000
Max.   :9078.00   Max.   :  8.000
```

```
colSums(is.na(airports))
```

```
 faa  name   lat   lon   alt    tz   dst tzone
   0     0     0     0     0     0     0     3
```

```
summary(planes)
```

```
  tailnum              year         type           manufacturer
Length:3322        Min.   :1956   Length:3322        Length:3322
Class :character   1st Qu.:1997   Class :character   Class :character
Mode  :character   Median :2001   Mode  :character   Mode  :character
                   Mean   :2000
                   3rd Qu.:2005
                   Max.   :2013
                   NA's   :70
   model              engines          seats           speed
Length:3322        Min.   :1.000   Min.   :  2.0   Min.   : 90.0
Class :character   1st Qu.:2.000   1st Qu.:140.0   1st Qu.:107.5
Mode  :character   Median :2.000   Median :149.0   Median :162.0
                   Mean   :1.995   Mean   :154.3   Mean   :236.8
                   3rd Qu.:2.000   3rd Qu.:182.0   3rd Qu.:432.0
                   Max.   :4.000   Max.   :450.0   Max.   :432.0
                                                   NA's   :3299
   engine
Length:3322
Class :character
Mode  :character
```

```
colSums(is.na(planes))
```

```
    tailnum         year         type manufacturer        model      engines
          0           70            0            0            0            0
      seats        speed       engine
          0         3299            0
```

```
summary(weather)
```

```
   origin               year          month             day
Length:26115       Min.   :2013   Min.   : 1.000   Min.   : 1.00
Class :character   1st Qu.:2013   1st Qu.: 4.000   1st Qu.: 8.00
Mode  :character   Median :2013   Median : 7.000   Median :16.00
                   Mean   :2013   Mean   : 6.504   Mean   :15.68
                   3rd Qu.:2013   3rd Qu.: 9.000   3rd Qu.:23.00
                   Max.   :2013   Max.   :12.000   Max.   :31.00

     hour            temp            dewp            humid
Min.   : 0.00   Min.   : 10.94   Min.   :-9.94   Min.   : 12.74
1st Qu.: 6.00   1st Qu.: 39.92   1st Qu.:26.06   1st Qu.: 47.05
Median :11.00   Median : 55.40   Median :42.08   Median : 61.79
Mean   :11.49   Mean   : 55.26   Mean   :41.44   Mean   : 62.53
3rd Qu.:17.00   3rd Qu.: 69.98   3rd Qu.:57.92   3rd Qu.: 78.79
Max.   :23.00   Max.   :100.04   Max.   :78.08   Max.   :100.00
                NA's   :1        NA's   :1       NA's   :1
   wind_dir       wind_speed        wind_gust         precip
Min.   :  0.0   Min.   :   0.000   Min.   :16.11   Min.   :0.000000
1st Qu.:120.0   1st Qu.:   6.905   1st Qu.:20.71   1st Qu.:0.000000
Median :220.0   Median :  10.357   Median :24.17   Median :0.000000
Mean   :199.8   Mean   :  10.518   Mean   :25.49   Mean   :0.004469
3rd Qu.:290.0   3rd Qu.:  13.809   3rd Qu.:28.77   3rd Qu.:0.000000
Max.   :360.0   Max.   :1048.361   Max.   :66.75   Max.   :1.210000
NA's   :460     NA's   :4          NA's   :20778
   pressure          visib          time_hour
Min.   : 983.8   Min.   : 0.000   Min.   :2013-01-01 01:00:00.0
1st Qu.:1012.9   1st Qu.:10.000   1st Qu.:2013-04-01 21:30:00.0
Median :1017.6   Median :10.000   Median :2013-07-01 14:00:00.0
Mean   :1017.9   Mean   : 9.255   Mean   :2013-07-01 18:26:37.7
3rd Qu.:1023.0   3rd Qu.:10.000   3rd Qu.:2013-09-30 13:00:00.0
Max.   :1042.1   Max.   :10.000   Max.   :2013-12-30 18:00:00.0
NA's   :2729
```

```
colSums(is.na(weather))
```

```
   origin       year      month        day       hour       temp       dewp
        0          0          0          0          0          1          1
```

```
    humid   wind_dir wind_speed  wind_gust     precip   pressure       visib
        1        460          4      20778          0       2729           0
time_hour
        0
```

Planes Dataset EDA

```
dim(planes)
```

```
[1] 3322    9
```

```
colnames(planes)
```

```
[1] "tailnum"      "year"         "type"         "manufacturer" "model"
[6] "engines"      "seats"        "speed"        "engine"
```

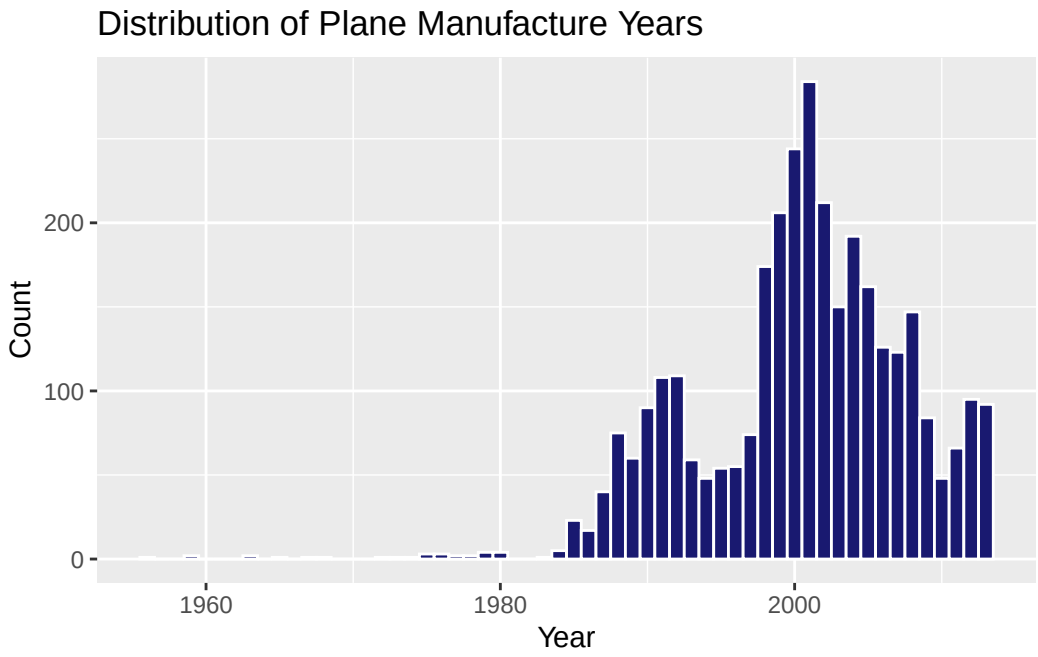
```
planes %>%
  count(manufacturer, sort = TRUE) %>%
  top_n(10) %>%
  ggplot(aes(x = reorder(manufacturer, n), y = n)) +
  geom_col(fill = "darkgreen") +
  coord_flip() +
  labs(title = "Top 10 Plane Manufacturers", x = "Manufacturer", y = "Number of Planes")
```

```
Selecting by n
```

The visualization above shows the top 10 plane manufacturers present in the data-set. Boeing has the largest amount of planes with approximately 1750 planes, and Airbus has the second most with approximately 400 planes.

```
ggplot(planes, aes(x = year)) +
  geom_histogram(binwidth = 1, fill = "midnightblue", color = "white") +
  labs(title = "Distribution of Plane Manufacture Years", x = "Year", y = "Count")
```

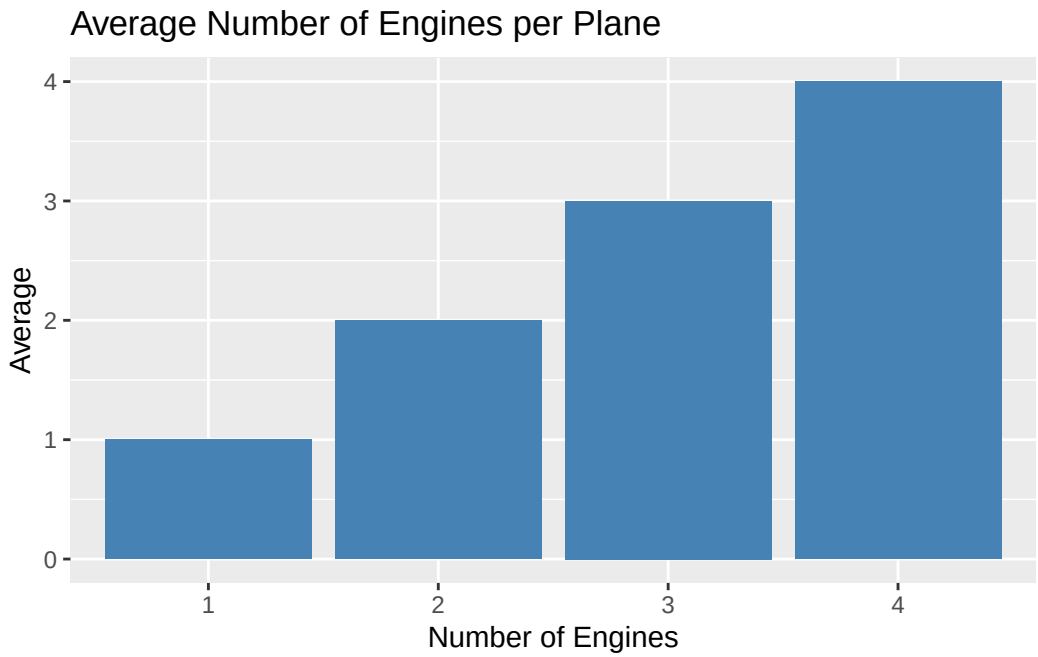
```
Warning: Removed 70 rows containing non-finite outside the scale range
(`stat_bin()`).
```



This histogram shows the distribution of plane manufacture years, with the majority of planes built between the mid-1990s and early 2000s. There is a notable peak around the year 2000, indicating a surge in plane production during that period.

```
avg_engines <- planes %>%
  group_by(engines) %>%
  summarise(avg = mean(engines, na.rm = TRUE))

# Create the bar plot
ggplot(avg_engines, aes(x = factor(engines), y = avg)) +
  geom_bar(stat = "identity", fill = "steelblue") +
  labs(title = "Average Number of Engines per Plane", x = "Number of Engines", y = "Average")
```



Analysis Approach Plan:

Assumptions: All variables are independent

The process of analysis will involve data cleaning after forming our question, basic exploration of the data, comparison of certain datasets with other datasets, visualization of the data, and an interpretation of the data/results. Cleaning of the data will deal with tasks like handling empty cells/columns and NA values. When it comes to exploratory data analysis, we plan on using tools such as histograms and boxplots to gain an understanding of the data and identify patterns and relationships. The statistical analysis that we plan on performing with the data will most likely involve making comparisons between groups to compare airlines, times, and other metrics to make our overall claim. For example, we might be comparing trends in time performance by weeks or month between different airlines to gain a better understanding of how differences in airlines affect delays. In terms of data visualization, we will most likely be using line graphs for trends over time when it comes to comparing flight time under different variables and heatmaps/scatterplots for flight delays to help communicate our findings. Finally, interpretation of the data will involve us answering the proposed question by summarizing our statistics/findings as well as through the presentation of graphical evidence.

Alternative Strategies & Back Up Plan:

As a backup idea, we are planning on seeing if there is any correlation between the amount of delays present in the different airports. Our data deals with the airports EWR, JFK, and LGA which are all different airports within New York City. Our first question is to figure out if the JFK airport has a different amount of delays compared to LGA or EWR if there is a higher amount of precipitation in

the JFK area. Although all the airports are in New York, within the different areas of the city, there can be different amounts of precipitation and rainfall that occur. Our second question is to decide whether the different airports have different models of planes and if the difference affects the amounts of delays. For example if a plane is older or a different configuration, does that lead to more delays due to cleaning or maintenance? And lastly, our third question is whether the three different airports have different airlines coming in and out and if these differing airlines affect the amount of delays present on a given day. For example, if Delta services one airport and not another, does that increase or decrease the amount of total delays for an airport. These questions can be further investigated if our first set of questions are not approved or if we need more content to explore within our project. These sets of backup questions will further explore the flight data we have.