Statistics 506- Problem Set #4

Garrett Pinkston

Link to GitHub

github: https://github.com/garrettpinkston2015/Computational-Methods

Problem 1 - Tidyverse

Install and load the package nycflights13.

```
library(nycflights13)
nycflights13::planes
```

```
# A tibble: 3,322 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~
 7 N107US   1999 Fixed wing multi~ AIRBUS INDU~ A320~       2   182    NA Turbo~
 8 N108UW   1999 Fixed wing multi~ AIRBUS INDU~ A320~       2   182    NA Turbo~
 9 N109UW   1999 Fixed wing multi~ AIRBUS INDU~ A320~       2   182    NA Turbo~
10 N110UW   1999 Fixed wing multi~ AIRBUS INDU~ A320~       2   182    NA Turbo~
# i 3,312 more rows
```

a) Generate a table (which can just be a nicely printed tibble) reporting the mean and median departure delay per airport. Generate a second table (which again can be a nicely printed tibble) reporting the mean and median arrival delay per airport. Exclude any destination with under 10 flights. Do this exclusion through code, not manually.

Additionally,

- Order both tables in descending mean delay.
- Both tables should use the airport names not the airport codes.
- Both tables should print all rows.

```
library(dplyr)
```

```


Attaching package: 'dplyr'


The following objects are masked from 'package:stats':

    filter, lag


The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
options(tibble.print_max = Inf)


depStats <- flights %>%
  group_by(dest) %>%
  filter(n() >= 10) %>%
  summarize(
    mean_dep_delay = mean(dep_delay, na.rm = TRUE),
    median_dep_delay = median(dep_delay, na.rm = TRUE)
  ) %>%
  ungroup() %>%
  left_join(airports, by = c("dest" = "faa")) %>%
  select(name, mean_dep_delay, median_dep_delay) %>%
  arrange(desc(mean_dep_delay))

print(depStats)
```

```
# A tibble: 102 x 3
    name                                   mean_dep_delay median_dep_delay
    <chr>                                           <dbl>            <dbl>
  1 "Columbia Metropolitan"                         35.6              14
  2 "Tulsa Intl"                                    34.9               8
  3 "Will Rogers World"                             30.6              10
```

```
 4 "Birmingham Intl"                               29.7               1
 5 "Mc Ghee Tyson"                                 28.5               0
 6 "Jackson Hole Airport"                          26.5              13.5
 7 "Des Moines Intl"                               26.2              -1
 8 "Richmond Intl"                                 23.6              -1
 9 "Albany Intl"                                   23.6               1
10 "Dane Co Rgnl Truax Fld"                        23.6              -1
11 "Cherry Capital Airport"                        22.1              -3
12 "Theodore Francis Green State"                  21.8               0
13 "Charlottesville-Albemarle"                     21.4              -2.5
14 "South Bend Rgnl"                               21.1              14
15 "Manchester Regional Airport"                   21.0               0
16 "Akron Canton Regional Airport"                 20.8               0
17 "San Antonio Intl"                              20.7               1
18 "Kansas City Intl"                              20.3              -1
19 "Eppley Afld"                                   20.2              -1
20 "Gerald R Ford Intl"                            19.5              -1
21 "Cincinnati Northern Kentucky Intl"             19.5              -2
22 "Bangor Intl"                                   19.5              -2
23 "Wilmington Intl"                               19.4              -3
24 "Piedmont Triad"                                19.4              -1
25 "Greenville-Spartanburg International"          19.3              -1
26 "General Mitchell Intl"                         18.8               0
27 "Sacramento Intl"                               18.7               2
28 "Chicago Midway Intl"                           18.6               2
29 "Savannah Hilton Head Intl"                     18.3              -1
30 "Bradley Intl"                                  17.7              -1
31 "Montrose Regional Airport"                     17.6               3
32 "Norfolk Intl"                                  17.6              -2
33 "James M Cox Dayton Intl"                       17.5              -2
34 "Yeager"                                        17                -4
35 "Washington Dulles Intl"                        17.0              -2
36 "Jacksonville Intl"                             16.5              -1
37 "Portland Intl Jetport"                         16.5              -2
38 "Louisville International Airport"              16.4              -2
39 "Baltimore Washington Intl"                     16.4              -2
40 "Portland Intl"                                 16.3               1
41 "Greater Rochester Intl"                        16.2              -2
42 "Lambert St Louis Intl"                         16.0              -1
43 "Nashville Intl"                                16.0              -1
44 "Myrtle Beach Intl"                             15.8              -1
45 "Memphis Intl"                                  15.7              -1
46 "Eagle Co Rgnl"                                 15.5              -1
```

```
47 "Denver Intl"                                    15.2               1
48 "Charleston Afb Intl"                            14.7              -2
49 "Syracuse Hancock Intl"                          14.4              -2
50 "William P Hobby"                                14.3               0
51 "Louis Armstrong New Orleans Intl"               14.2              -2
52 "Indianapolis Intl"                              14.0              -2
53 "Albuquerque International Sunport"              13.7               0
54 "Pittsburgh Intl"                                13.7              -2
55 "Burlington Intl"                                13.6              -2
56 "Chicago Ohare Intl"                             13.6              -2
57 "Bob Hope"                                       13.5              -1
58 "Buffalo Niagara Intl"                           13.4              -2
59 "Cleveland Hopkins Intl"                         13.4              -2
60 "Metropolitan Oakland Intl"                      13.3               0
61 "Minneapolis St Paul Intl"                       13.3              -2
62 "Austin Bergstrom Intl"                          13.0              -1
63 "Palm Beach Intl"                                13.0               0
64 "San Francisco Intl"                             12.9               0
65 "Fort Lauderdale Hollywood Intl"                 12.7              -1
66 "Hartsfield Jackson Atlanta Intl"                12.5              -2
67 "Raleigh Durham Intl"                            12.4              -2
68  <NA>                                            12.4              -1
69 "Yampa Valley"                                   12.3               6.5
70 "Port Columbus Intl"                             12.2              -3
71 "Tampa Intl"                                     12.1              -1
72 "Philadelphia Intl"                              12.0              -3
73 "Detroit Metro Wayne Co"                         11.8              -3
74 "Gallatin Field"                                 11.5               0
75 "Orlando Intl"                                   11.3              -1
76 "Long Beach"                                     11.2              -1
77 "San Diego Intl"                                 11.1               0
78 "George Bush Intercontinental"                   10.8               0
79 "Seattle Tacoma Intl"                            10.7              -1
80 "Phoenix Sky Harbor Intl"                        10.4              -1
81 "Ronald Reagan Washington Natl"                  10.3              -3
82  <NA>                                            10.1              -1
83 "Norman Y Mineta San Jose Intl"                  10.1              -1
84  <NA>                                             9.81             -1
85 "Mc Carran Intl"                                  9.42             -1
86 "Los Angeles Intl"                                9.40             -1
87 "Honolulu Intl"                                   9.29             -1
88 "Charlotte Douglas Intl"                          9.22             -3
89 "Salt Lake City Intl"                             9.03             -1
```

```
 90 "Miami Intl"                                     8.88             -2
 91 "General Edward Lawrence Logan Intl"             8.73             -3
 92 "Dallas Fort Worth Intl"                         8.68             -3
 93 "Southwest Florida Intl"                         8.28             -2
 94 "Asheville Regional Airport"                     8.19             -3
 95 "John Wayne Arpt Orange Co"                      7.76             -1
 96 "Sarasota Bradenton Intl"                        7.26             -3
 97 "Martha\\\\'s Vineyard"                          7.05             -2
 98 "NW Arkansas Regional"                           6.46             -5
 99 "Nantucket Mem"                                  6.46             -3
100  <NA>                                            4.61             -2
101 "Key West Intl"                                  3.65              0
102 "Palm Springs Intl"                             -2.94             -4
```

```r
arrivalStats <- flights %>%
  group_by(dest) %>%
  filter(n() >= 10) %>%
  summarize(
    mean_arr_delay = mean(arr_delay, na.rm = TRUE),
    median_arr_delay = median(arr_delay, na.rm = TRUE)
  ) %>%
  ungroup() %>%
  left_join(airports, by = c("dest" = "faa")) %>%
  select(name, mean_arr_delay, median_arr_delay) %>%
  arrange(desc(mean_arr_delay))

print(arrivalStats)
```

```
# A tibble: 102 x 3
    name                                   mean_arr_delay median_arr_delay
    <chr>                                           <dbl>            <dbl>
  1 "Columbia Metropolitan"                       41.8                28
  2 "Tulsa Intl"                                  33.7                14
  3 "Will Rogers World"                           30.6                16
  4 "Jackson Hole Airport"                        28.1                15
  5 "Mc Ghee Tyson"                               24.1                 2
  6 "Dane Co Rgnl Truax Fld"                      20.2                 1
  7 "Richmond Intl"                               20.1                 1
  8 "Akron Canton Regional Airport"               19.7                 3
  9 "Des Moines Intl"                             19.0                 0
 10 "Gerald R Ford Intl"                          18.2                 1
 11 "Birmingham Intl"                             16.9                -2
```

```
12 "Theodore Francis Green State"                16.2                 1
13 "Greenville-Spartanburg International"        15.9                -0.5
14 "Cincinnati Northern Kentucky Intl"           15.4                -3
15 "Savannah Hilton Head Intl"                   15.1                -1
16 "Manchester Regional Airport"                 14.8                -3
17 "Eppley Afld"                                 14.7                -2
18 "Yeager"                                      14.7                -1.5
19 "Kansas City Intl"                            14.5                 0
20 "Albany Intl"                                 14.4                -4
21 "General Mitchell Intl"                       14.2                 0
22 "Piedmont Triad"                              14.1                -2
23 "Washington Dulles Intl"                      13.9                -3
24 "Cherry Capital Airport"                      13.0               -10
25 "James M Cox Dayton Intl"                     12.7                -3
26 "Louisville International Airport"            12.7                -2
27 "Chicago Midway Intl"                         12.4                -1
28 "Sacramento Intl"                             12.1                 4
29 "Jacksonville Intl"                           11.8                -2
30 "Nashville Intl"                              11.8                -2
31 "Portland Intl Jetport"                       11.7                -4
32 "Greater Rochester Intl"                      11.6                -5
33 "Hartsfield Jackson Atlanta Intl"             11.3                -1
34 "Lambert St Louis Intl"                       11.1                -3
35 "Norfolk Intl"                                10.9                -4
36 "Baltimore Washington Intl"                   10.7                -5
37 "Memphis Intl"                                10.6                -2.5
38 "Port Columbus Intl"                          10.6                -3
39 "Charleston Afb Intl"                         10.6                -4
40 "Philadelphia Intl"                           10.1                -3
41 "Raleigh Durham Intl"                         10.1                -3
42 "Indianapolis Intl"                            9.94               -3
43 "Charlottesville-Albemarle"                    9.5                -5
44 "Cleveland Hopkins Intl"                       9.18               -5
45 "Ronald Reagan Washington Natl"                9.07               -2
46 "Burlington Intl"                              8.95               -4
47 "Buffalo Niagara Intl"                         8.95               -5
48 "Syracuse Hancock Intl"                        8.90               -5
49 "Denver Intl"                                  8.61               -2
50 "Palm Beach Intl"                              8.56               -3
51  <NA>                                          8.25               -1
52 "Bob Hope"                                     8.18               -3
53 "Fort Lauderdale Hollywood Intl"               8.08               -3
54 "Bangor Intl"                                  8.03               -9
```

```
55 "Asheville Regional Airport"                   8.00               -1
56  <NA>                                          7.87                0
57 "Pittsburgh Intl"                              7.68               -5
58 "Gallatin Field"                               7.6                -2
59 "NW Arkansas Regional"                         7.47               -2
60 "Tampa Intl"                                   7.41               -4
61 "Charlotte Douglas Intl"                       7.36               -3
62 "Minneapolis St Paul Intl"                     7.27               -5
63 "William P Hobby"                              7.18               -4
64 "Bradley Intl"                                 7.05              -10
65 "San Antonio Intl"                             6.95               -9
66 "South Bend Rgnl"                              6.5                -3.5
67 "Louis Armstrong New Orleans Intl"             6.49               -6
68 "Key West Intl"                                6.35                7
69 "Eagle Co Rgnl"                                6.30               -4
70 "Austin Bergstrom Intl"                        6.02               -5
71 "Chicago Ohare Intl"                           5.88               -8
72 "Orlando Intl"                                 5.45               -5
73 "Detroit Metro Wayne Co"                       5.43               -7
74 "Portland Intl"                                5.14               -5
75 "Nantucket Mem"                                4.85               -3
76 "Wilmington Intl"                              4.64               -7
77 "Myrtle Beach Intl"                            4.60              -13
78 "Albuquerque International Sunport"            4.38               -5.5
79 "George Bush Intercontinental"                 4.24               -5
80 "Norman Y Mineta San Jose Intl"                3.45               -7
81 "Southwest Florida Intl"                       3.24               -5
82 "San Diego Intl"                               3.14               -5
83 "Sarasota Bradenton Intl"                      3.08               -5
84 "Metropolitan Oakland Intl"                    3.08               -9
85 "General Edward Lawrence Logan Intl"           2.91               -9
86 "San Francisco Intl"                           2.67               -8
87  <NA>                                          2.52               -6
88 "Yampa Valley"                                 2.14                2
89 "Phoenix Sky Harbor Intl"                      2.10               -6
90 "Montrose Regional Airport"                    1.79              -10.5
91 "Los Angeles Intl"                             0.547              -7
92 "Dallas Fort Worth Intl"                       0.322              -9
93 "Miami Intl"                                   0.299              -9
94 "Mc Carran Intl"                               0.258              -8
95 "Salt Lake City Intl"                          0.176              -8
96 "Long Beach"                                  -0.0620             -10
97 "Martha\\\\'s Vineyard"                       -0.286              -11
```

```
 98 "Seattle Tacoma Intl"                                   -1.10             -11  
 99 "Honolulu Intl"                                         -1.37              -7  
100  <NA>                                                   -3.84              -9  
101 "John Wayne Arpt Orange Co"                             -7.87             -11  
102 "Palm Springs Intl"                                    -12.7              -13.5
```

b) How many flights did the aircraft model with the fastest average speed take? Produce a tibble with 1 row, and entires for the model, average speed (in MPH) and number of flights.

```r
flights_planes <- flights %>%
  left_join(planes, by = "tailnum")

flights_speeds <- flights_planes %>%
  filter(!is.na(air_time), !is.na(distance), !is.na(model)) %>%
  mutate(speed_mph = distance / (air_time / 60))

model_speeds <- flights_speeds %>%
  group_by(model) %>%
  summarize(
    avg_speed_mph = mean(speed_mph, na.rm = TRUE),
    num_flights = n()
  ) %>%
  ungroup()


fastest_model <- model_speeds %>%
  filter(avg_speed_mph == max(avg_speed_mph)) %>%
  slice(1)

print(fastest_model)
```

```
# A tibble: 1 x 3
  model   avg_speed_mph num_flights
  <chr>           <dbl>       <int>
1 777-222          483.           4
```

Problem 2 - get_temp()

Load the Chicago NNMAPS data we used in the visualization lectures. Write a function get_temp() that allows a user to request the average temperature for a given month. The arguments should be:

- month: Month, either a numeric 1-12 or a string.
- year: A numeric year.
- data: The data set to obtain data from.
- celsius: Logically indicating whther the results should be in celsius. Default FALSE.
- average_fn: A function with which to compute the mean. Default is mean.
- The output should be a numeric vector of length 1. The code inside the function should, as with the rest of this problem, use the tidyverse. Be sure to sanitize the input.

Prove your code works by evaluating the following. Your code should produce the result, or a reasonable error message.

```
nnmaps <- read.csv("/Users/garrettpinkston/Desktop/Michigan/STAT506/Data/chicago-nmmaps.csv")
```

```
library(dplyr)
library(stringr)

get_temp <- function(month, year, data, celsius = FALSE, average_fn = mean) {
  if (!is.numeric(year) || length(year) != 1 || ((year > 2000) || (year < 1997))) {
    stop("Year must be provided as a single numeric value between 1997 and 2000.")
  }

  if (is.numeric(month)) {
    if (month < 1 || month > 12) {
      stop("Month must be a number between 1 and 12.")
    }
    month_type <- "numeric"
  } else if (is.character(month)) {
    month <- str_sub(str_to_lower(month), 1, 3)
    month_type <- "string"
  } else {
    stop("Month must be either a numeric (1-12) or a string (e.g., 'Jan', 'February').")
  }

  if (month_type == "numeric") {
    result <- data %>%
      filter(year == !!year, month_numeric == !!month) %>%
      summarize(avg_temp = average_fn(temp, na.rm = TRUE))
  } else {
    result <- data %>%
      filter(year == !!year, str_sub(str_to_lower(.$month), 1, 3) == !!month) %>%
      summarize(avg_temp = average_fn(temp))
  }
  if (nrow(result) == 0) {
    stop("No matching data for the specified month and year.")
  }

  avg_temp <- result$avg_temp
  if (celsius) {
    avg_temp <- (avg_temp - 32) * (5/9)
  }

  return(avg_temp)
}
```

```
get_temp("Apr", 1999, data = nnmaps)
```

```
[1] 49.8
```

```
get_temp("Apr", 1999, data = nnmaps, celsius = TRUE)
```

```
[1] 9.888889
```

```
get_temp(10, 1998, data = nnmaps, average_fn = median)
```

```
[1] 55
```

```
get_temp(13, 1998, data = nnmaps)
```

```
Error in get_temp(13, 1998, data = nnmaps): Month must be a number between 1 and 12.
```

```
get_temp(2, 2005, data = nnmaps)
```

```
Error in get_temp(2, 2005, data = nnmaps): Year must be provided as a single numeric value b
```

```
get_temp("November", 1999, data =nnmaps, celsius = TRUE,
         average_fn = function(x) {
           x %>% sort -> x
           x[2:(length(x) - 1)] %>% mean %>% return
         })
```

```
[1] 7.301587
```

Problem 3 - Visualization

- Is there a change in the sales price in USD over time?

```
art <- read.csv("/Users/garrettpinkston/Desktop/Michigan/STAT506/Data/df_for_ml_improved_new_
```

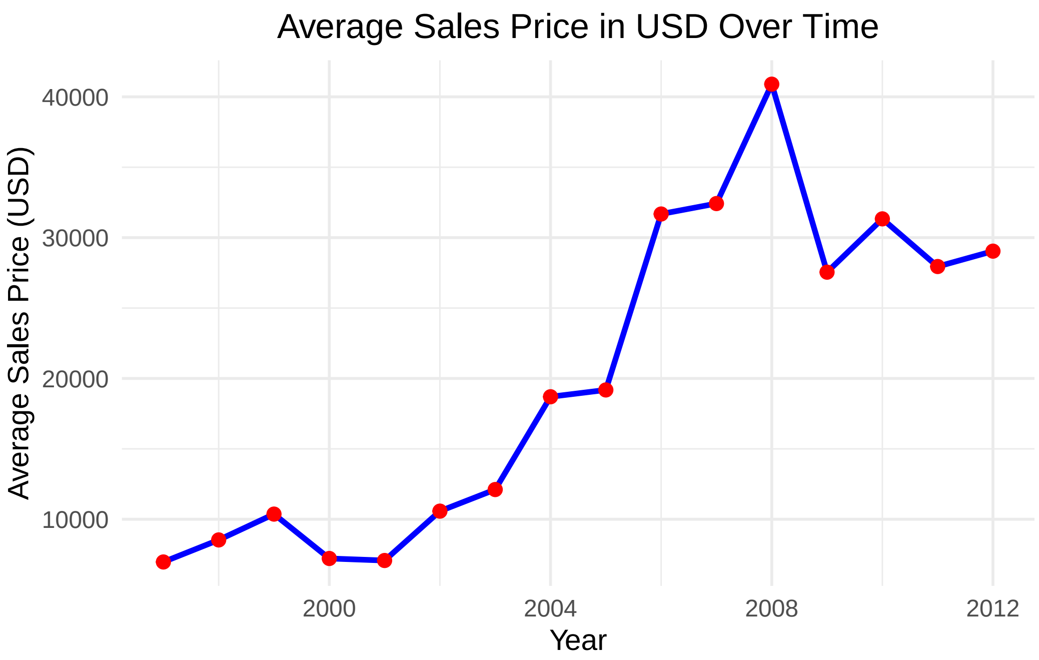
```
library(ggplot2)

class (art)
```

```
[1] "data.frame"
```

```
art %>%
  group_by(year) %>%
  summarize(avg_sales_price = mean(price_usd, na.rm = TRUE)) %>%
  ggplot(aes(x = year, y = avg_sales_price)) +
  geom_line(color = "blue", size = 1) +
  geom_point(color = "red", size = 2) +
  labs(title = "Average Sales Price in USD Over Time",
       x = "Year",
       y = "Average Sales Price (USD)") +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5))
```

```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```



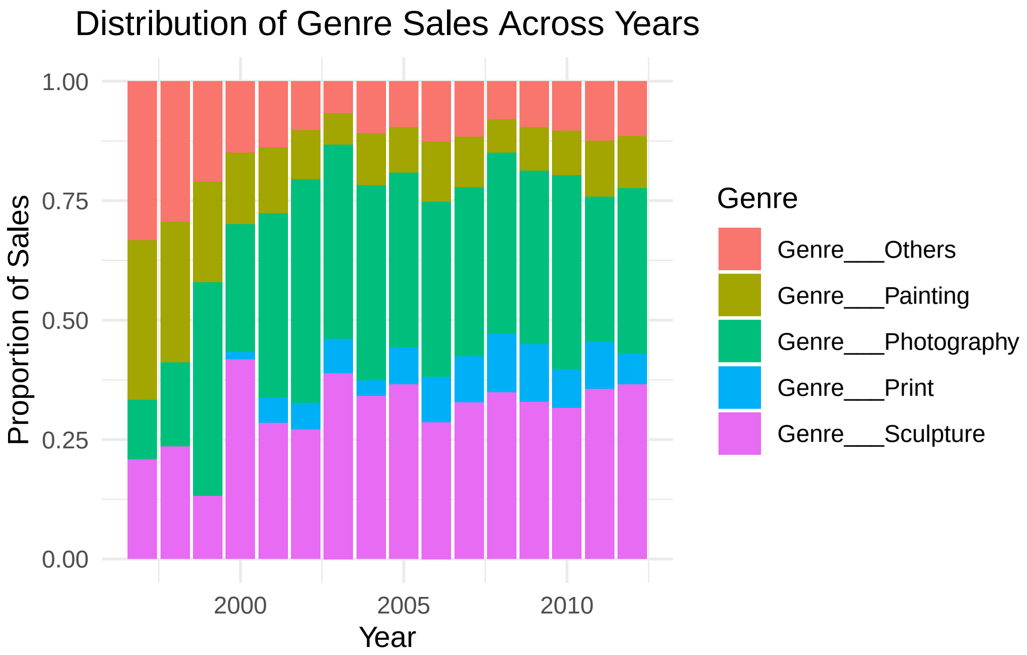
- Does the distribution of genre of sales across years appear to change?

```r
library(tidyr)

df_long <- art %>%
  pivot_longer(cols = starts_with("Genre___"),
               names_to = "genre",
               values_to = "count") %>%
  filter(count == 1)

df_long %>%
  group_by(year, genre) %>%
  summarize(count = n()) %>%
  group_by(year) %>%
  mutate(proportion = count / sum(count)) %>%
  ggplot(aes(x = year, y = proportion, fill = genre)) +
  geom_bar(stat = "identity", position = "fill") +
  labs(title = "Distribution of Genre Sales Across Years",
       x = "Year",
       y = "Proportion of Sales",
       fill = "Genre") +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5))
```

```
`summarise()` has grouped output by 'year'. You can override using the
`.groups` argument.
```

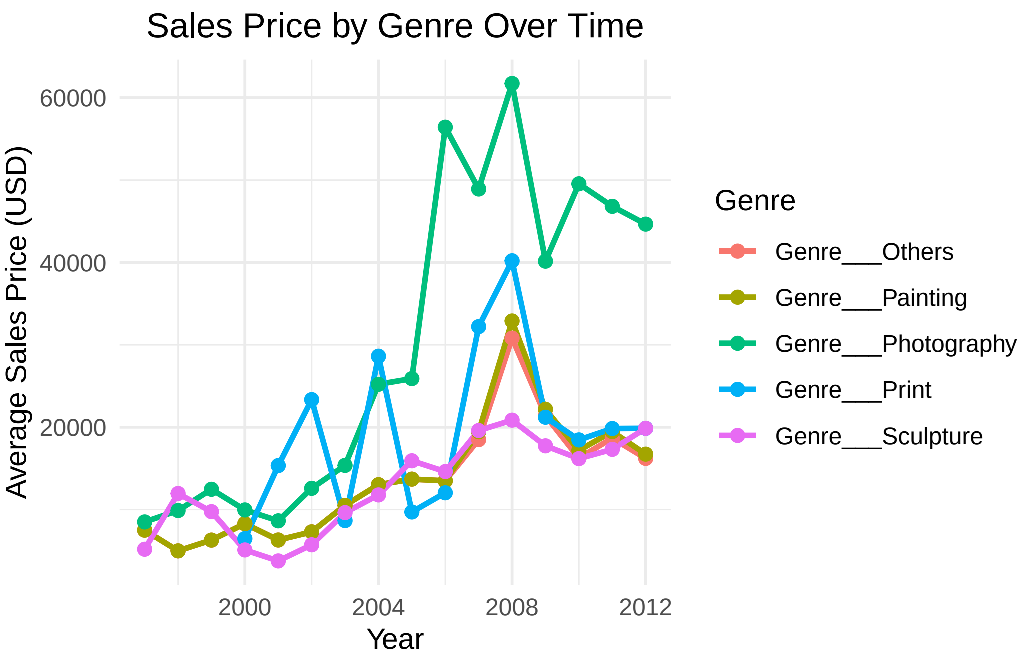


- How does the genre affect the change in sales price over time?

```
df_long <- art %>%
  pivot_longer(cols = starts_with("Genre___"),
               names_to = "genre",
               values_to = "count") %>%
  filter(count == 1)

df_long %>%
  group_by(year, genre) %>%
  summarize(avg_sales_price = mean(price_usd, na.rm = TRUE)) %>%
  ggplot(aes(x = year, y = avg_sales_price, color = genre)) +
  geom_line(size = 1) +
  geom_point(size = 2) +
  labs(title = "Sales Price by Genre Over Time",
       x = "Year",
       y = "Average Sales Price (USD)",
       color = "Genre") +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5))
```

```
`summarise()` has grouped output by 'year'. You can override using the
`.groups` argument.
```


Sales Price by Genre Over Time
Average Sales Price (USD)
Year
Genre
Genre___Others
Genre___Painting
Genre___Photography
Genre___Print
Genre___Sculpture