# CAP5768_Assignment2_Corbin_Adam

September 27, 2019

# 1 CAP 5768 - Data Science - Adam Corbin - Fall 2019

## 1.1 Assignment 2: Exploratory data analysis

### 1.1.1 Goals

- To increase familiarity with the Python "data science stack" (NumPy, Pandas, Matplotlib).
- To explore (manipulate, summarize, and visualize) datasets.
- To improve the ability to write Python code to answer questions and test hypotheses based on the contents of those datasets.

### 1.1.2 Instructions

- This assignment is structured in three parts, using a different dataset for each part.
- For each part, there will be some Python code to be written and questions to be answered.
- At the end, you should export your notebook to PDF format; it will "automagically" become your report.
- Submit the report (PDF), notebook (.ipynb file), and (optionally) link to the "live" version of your solution on Google Colaboratory via Canvas.
- The total number of points is 154 (plus up to 85 bonus points), distributed as follows: Part 1 (58+ pts), Part 2 (28+ pts), Part 3 (43+ pts), and Conclusions (25 pts).

### 1.1.3 Important

- It is OK to attempt the bonus points, but please **do not overdo it!**
- Remember: this is an exercise in performing exploratory data analysis; expanding (and practicing) your knowledge of Python, Jupyter notebooks, Numpy, Pandas, and Matplotlib; and writing code to test hypotheses and answer questions based on the available data (and associated summary statistics).
- This is not (yet) the time to do sophisticated statistical analysis, train ML models, etc.
- You must **organize your data files in the proper folders** for the code to work.

---

## 1.2 Part 1: The MovieLens 1M dataset

This is a dataset of movie ratings data collected from users of MovieLens in the late 1990s and early 2000s. The data provide movie ratings, movie metadata, and demographic data about the users. Such data is often of interest in the development of recommendation systems based on machine learning algorithms.

The MovieLens 1M dataset contains ~1 million ratings collected from ~6,000 users on ~4,000 movies. It's spread across three tables: *ratings*, *user information*, and *movie information*. After extracting the data from the ZIP file (available on Canvas), we can load each table into a pandas DataFrame object using the Python code below.

See: https://grouplens.org/datasets/movielens/ for additional information.

[125]:
```
# Imports
import numpy as np
import pandas as pd
from pandas import DataFrame, Series

%matplotlib inline
import matplotlib.pyplot as plt
import seaborn as sns

from scipy.stats import pearsonr
from sklearn import preprocessing
```

Before running the cell below, make sure that you have downloaded the movielens.zip file from Canvas, unzipped it, and placed its contents under the 'data' folder.

movielens_path.png

[126]:
```
import pandas as pd

# Make display smaller
pd.options.display.max_rows = 10

unames = ['user_id', 'gender', 'age', 'occupation', 'zip']
users = pd.read_table('data/movielens/users.dat', sep='::',
                      header=None, names=unames, engine='python')

rnames = ['user_id', 'movie_id', 'rating', 'timestamp']
ratings = pd.read_table('data/movielens/ratings.dat', sep='::',
                        header=None, names=rnames, engine='python')

mnames = ['movie_id', 'title', 'genres']
movies = pd.read_table('data/movielens/movies.dat', sep='::',
                       header=None, names=mnames, engine='python')
```

## 2 Your turn! (24 points, i.e., 6 pts each)

Write Python code to answer the following questions (make sure the messages displayed by your code are complete and descriptive enough): 1. How many users are stored in the *users* table and what information is stored for each user? 2. How many movies are stored in the *movies* table and what information is stored for each movie? 3. How many ratings are stored in the *ratings* table and what information is stored for each rating? 4. How are users, the movies each user has rated, and the rating related?

*Note*: ages and occupations are coded as integers indicating *groups* described in the dataset's README file.

[128]:

```
print("#1")
print("user count",len(users.index))
print("Columns: ", ", ".join(users.columns.to_list()))
```

```
#1
user count 6040
Columns:  user_id, gender, age, occupation, zip
```

[129]:

```
print("#2")
print("movies count",len(movies.index))
print("Columns: ", ", ".join(movies.columns.to_list()))
```

```
#2
movies count 3883
Columns:  movie_id, title, genres
```

[130]:

```
print("#3")
print("ratings count",len(ratings.index))
print("Columns: ", ", ".join(ratings.columns.to_list()))
```

```
#3
ratings count 1000209
Columns:  user_id, movie_id, rating, timestamp
```

[131]:

```
print("#4")
print("How to relate Ratings to Movies and Users for 3 users and 2 movie␣
 ↪ratings for each")
user_1 = users[users["user_id"] == 1]
user_2 = users[users["user_id"] == 4]
user_3 = users[users["user_id"] == 19]

user_set = [user_1, user_2, user_3]

for user in user_set:
    print("User:", user["user_id"].values[0])

    # grab 3 ratings per user
    user_ratings = ratings[ratings["user_id"] == user["user_id"].values[0]][0:3]
    print("\t","Rating","\t", "Title")
    for index, rating in user_ratings.iterrows():
        movie = movies[movies["movie_id"] == rating["movie_id"]]
        print("\t",rating["rating"],"\t\t",movie["title"].values[0],"\t")
    print("---------------")
    print("\n\n")
```

```
#4
How to relate Ratings to Movies and Users for 3 users and 2 movie ratings for
each
User: 1
         Rating          Title
         5               One Flew Over the Cuckoo's Nest (1975)
         3               James and the Giant Peach (1996)
         3               My Fair Lady (1964)
---------------



User: 4
         Rating          Title
         5               Hustler, The (1961)
         3               Star Wars: Episode VI - Return of the Jedi (1983)
         4               Fistful of Dollars, A (1964)
---------------



User: 19
         Rating          Title
         4               Who Framed Roger Rabbit? (1988)
         4               For Your Eyes Only (1981)
         3               Animal House (1978)
---------------
```

## 3 Your turn! (24 points, i.e., 6 pts each)

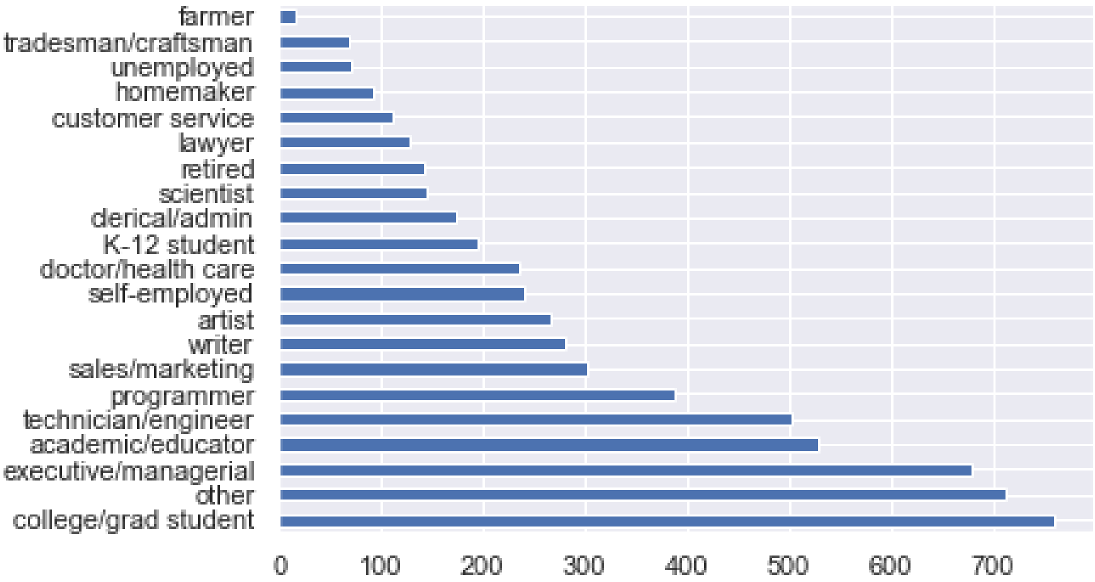
Write Python code to answer the following questions (make sure the messages displayed by your code are complete and descriptive enough): 5. What is the occupation that maps to most of the users? Plot a histogram of the occupation counts and report the size of the largest bin. 6. What percentage of users are 50 years old or older? Plot a pie chart showing all percentages (per age group) and report the requested value. 7. Which movie received the highest number of ratings (and how were such ratings distributed)? 8. What is the average rating for all movies/users?

### 3.1 Solution

[132]:
```
print("#5")

occupation_dict = {0:  "other",
        1:  "academic/educator",
        2:  "artist",
          3:  "clerical/admin",
          4:  "college/grad student",
          5:  "customer service",
          6:  "doctor/health care",
          7:  "executive/managerial",
          8:  "farmer",
          9:  "homemaker",
         10:  "K-12 student",
         11:  "lawyer",
         12:  "programmer",
         13:  "retired",
         14:  "sales/marketing",
         15:  "scientist",
         16:  "self-employed",
         17:  "technician/engineer",
         18:  "tradesman/craftsman",
         19:  "unemployed",
         20:  "writer"
}
cleanup_occupation = {"occupation" : occupation_dict}
most_index = users["occupation"].value_counts().index.tolist()[0]
print("Most occupation: ", occupation_dict[most_index])
updated_users = users.copy()
updated_users.replace(cleanup_occupation, inplace=True)
updated_users["occupation"].value_counts().plot.barh()
```

```
#5
Most occupation:  college/grad student
```

[132]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x20807debd48>
```



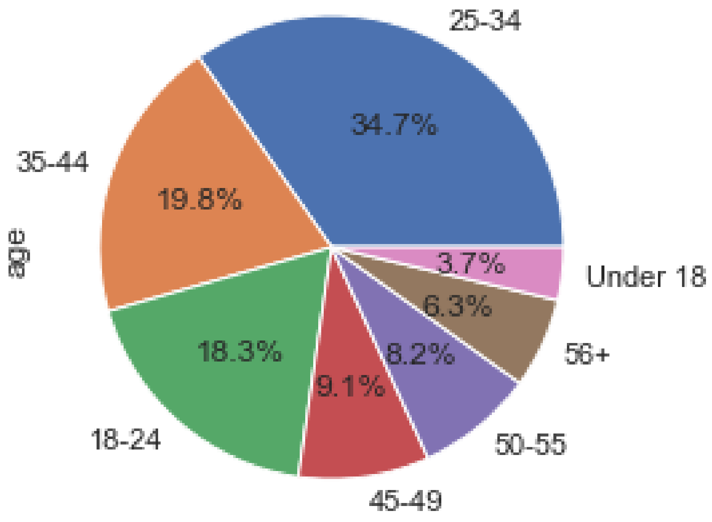
[203]:

```
print("#6")
users_50_plus = users[users["age"] >= 50]
percent = round(len(users_50_plus) / len(users) * 100, 2)
print("Users 50 years or older: ", percent,"%")

age_dict = {1:  "Under 18",
18:  "18-24",
25:  "25-34",
35:  "35-44",
45:  "45-49",
50:  "50-55",
56:  "56+"}
clean_age = {"age": age_dict}

updated_age_users = users.copy()
updated_age_users.replace(clean_age,inplace=True)
updated_age_users["age"].value_counts().plot(kind="pie",autopct='%1.1f%%')
```

```
#6
Users 50 years or older:  14.5 %
```

[203]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x2089d379f48>
```



[ ]:

```
```

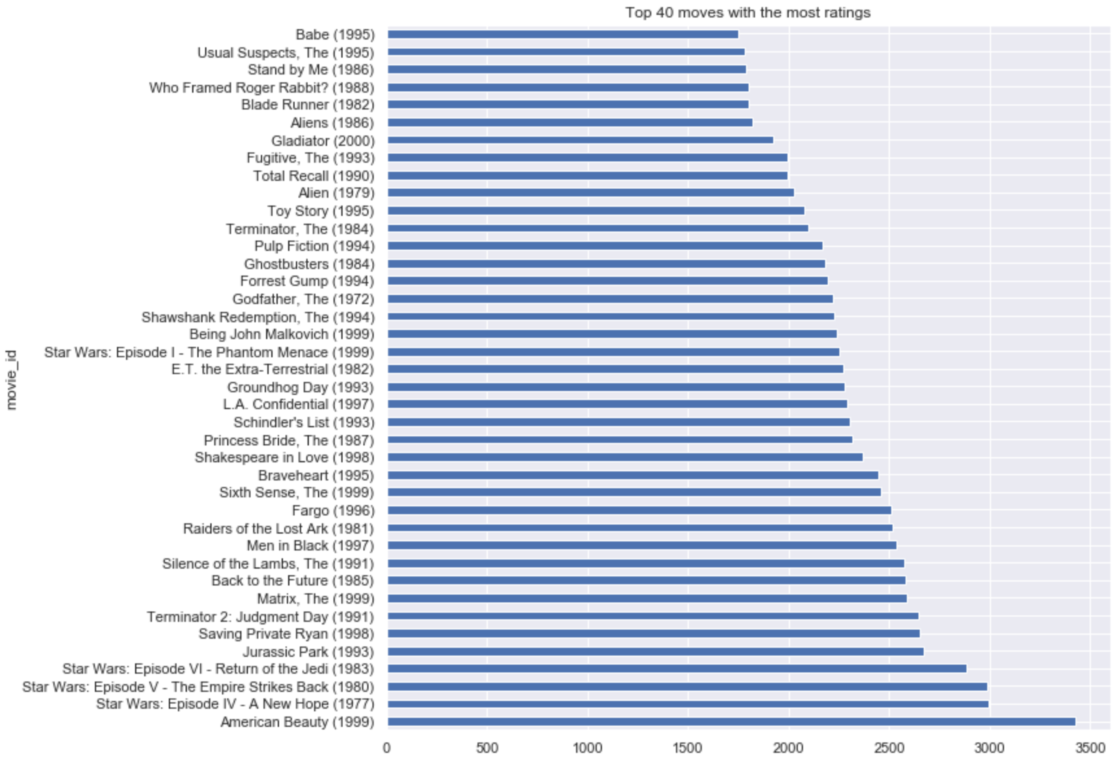
[211]:

```
print("#7")
movie_titles_dict = dict(zip(movies["movie_id"],movies["title"]))
update_movie_id = {"movie_id": movie_titles_dict}
updated_ratings = ratings.copy()
updated_ratings.replace(update_movie_id,inplace=True)

query = updated_ratings.groupby('movie_id', as_index=False).size().
 ↪sort_values(ascending=False)
move_title = query.keys()[0]
print("Most rated movie: ", movie_title) #,"Rating",␣
 ↪round(num_1_movie_rating,3))
query.head(n=40).plot.barh(figsize=(10,10), title="Top 40 moves with the most␣
 ↪ratings")
```

```
#7
Most rated movie:  2789    American Beauty (1999)
Name: title, dtype: object
```

[211]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x208a771fb88>
```



[135]:
```
print("#8")
print("Average rating of all movies", round(ratings["rating"].mean(),3))
```

```
#8
Average rating of all movies 3.582
```

---

We will use the Python code below to merge all three tables into a unified data frame.

[136]:
```
data = pd.merge(pd.merge(ratings, users), movies)
data
```

[136]:
```
         user_id  movie_id  rating  timestamp gender  age  occupation    zip  \
0              1      1193       5  978300760      F    1          10  48067
1              2      1193       5  978298413      M   56          16  70072
2             12      1193       4  978220179      M   25          12  32793
3             15      1193       4  978199279      M   25           7  22903
4             17      1193       5  978158471      M   50           1  95350
...          ...       ...     ...        ...    ...  ...         ...    ...
1000204     5949      2198       5  958846401      M   18          17  47901
1000205     5675      2703       3  976029116      M   35          14  30030
1000206     5780      2845       1  958153068      M   18          17  92886
1000207     5851      3607       5  957756608      F   18          20  55410
1000208     5938      2909       4  957273353      M   25           1  35401
```

```
                                             title                 genres
0             One Flew Over the Cuckoo's Nest (1975)                  Drama
1             One Flew Over the Cuckoo's Nest (1975)                  Drama
2             One Flew Over the Cuckoo's Nest (1975)                  Drama
3             One Flew Over the Cuckoo's Nest (1975)                  Drama
4             One Flew Over the Cuckoo's Nest (1975)                  Drama
...                                              ...                    ...
1000204                           Modulations (1998)            Documentary
1000205                        Broken Vessels (1998)                  Drama
1000206                            White Boys (1999)                  Drama
1000207                      One Little Indian (1973)  Comedy|Drama|Western
1000208  Five Wives, Three Secretaries and Me (1998)            Documentary

[1000209 rows x 10 columns]
```

The Python code below will show the top 10 films among female viewers (and, for comparison's sake, the ratings for those movies by male viewers) in decreasing order (highest rated movie on top).

[137]:

```
# Build pivot table

mean_ratings = data.pivot_table('rating', index='title',
                                columns='gender', aggfunc='mean')

# Group ratings by title
ratings_by_title = data.groupby('title').size()

# Select only movies with 250 ratings or more
active_titles = ratings_by_title.index[ratings_by_title >= 250]

# Select rows on the index
mean_ratings = mean_ratings.loc[active_titles]

# Fix naming inconsistency
mean_ratings = mean_ratings.rename(index={'Seven Samurai (The Magnificent␣
 ↪Seven) (Shichinin no samurai) (1954)':
                           'Seven Samurai (Shichinin no samurai) (1954)'})

top_female_ratings = mean_ratings.sort_values(by='F', ascending=False)
top_female_ratings[:10]
```

[137]:

```
gender                                                   F         M
title
Close Shave, A (1995)                             4.644444  4.473795
Wrong Trousers, The (1993)                        4.588235  4.478261
Sunset Blvd. (a.k.a. Sunset Boulevard) (1950)     4.572650  4.464589
Wallace & Gromit: The Best of Aardman Animation...  4.563107  4.385075
Schindler's List (1993)                           4.562602  4.491415
```

```
Shawshank Redemption, The (1994)                     4.539075  4.560625
Grand Day Out, A (1992)                              4.537879  4.293255
To Kill a Mockingbird (1962)                         4.536667  4.372611
Creature Comforts (1990)                             4.513889  4.272277
Usual Suspects, The (1995)                           4.513317  4.518248
```

# 4 Your turn! (10 points, i.e., 5 pts each)

Modify the Python code to: 9. Display the top 10 favorite movies among male viewers, selecting only movies with 250 ratings or more. 10. Display the top 10 favorite movies among young viewers (17 years old or younger), selecting only movies with 300 ratings or more.

## 4.1 Solution

[138]:

```
print("#9")
top_male_ratings = mean_ratings.sort_values(by='M', ascending=False)
top_male_ratings[:10]
```

```
#9
```

[138]:

```
gender                                              F         M
title
Godfather, The (1972)                        4.314700  4.583333
Seven Samurai (Shichinin no samurai) (1954)  4.481132  4.576628
Shawshank Redemption, The (1994)             4.539075  4.560625
Raiders of the Lost Ark (1981)               4.332168  4.520597
Usual Suspects, The (1995)                   4.513317  4.518248
Star Wars: Episode IV - A New Hope (1977)    4.302937  4.495307
Schindler's List (1993)                      4.562602  4.491415
Wrong Trousers, The (1993)                   4.588235  4.478261
Close Shave, A (1995)                        4.644444  4.473795
Rear Window (1954)                           4.484536  4.472991
```

[188]:

```
print("#10")

# Steps Filter make sure movies have at least 300 movie ratings
# Then look at ratings from people 17 and younger

filtered_min_300_ratings = data.groupby("title").filter(lambda x: len(x) > 300)
young_filtered_min_300_ratings =␣
 ↪filtered_min_300_ratings[filtered_min_300_ratings["age"] == 1]

top_young = young_filtered_min_300_ratings.pivot_table(
    'rating', index='title', aggfunc='mean')
sorted_top_young = top_young.sort_values(by='rating', ascending=False)
# We are displaying 16 rows becuase some movies have the save rating value␣
 ↪which means they are tied for a top movie
```

```
pd.options.display.max_rows = 16
sorted_top_young.head(n=16)
```

#10

[188]:

```
                                        rating
title
Metropolis (1926)                     4.888889
GoodFellas (1990)                     4.840000
Third Man, The (1949)                 4.818182
Double Indemnity (1944)               4.777778
Piano, The (1993)                     4.750000
Fried Green Tomatoes (1991)           4.750000
Raging Bull (1980)                    4.714286
Roman Holiday (1953)                  4.687500
Citizen Kane (1941)                   4.680000
Charade (1963)                        4.666667
From Here to Eternity (1953)          4.666667
Manchurian Candidate, The (1962)      4.666667
Notorious (1946)                      4.666667
Real Genius (1985)                    4.666667
Apostle, The (1997)                   4.666667
Bridge on the River Kwai, The (1957)  4.636364
```

[ ]:

```
pd.reset_option('display.max_rows')
```

## 5 BONUS! (up to 20 points)

Write Python code to display the most divisive movies (selecting only movies with 250 ratings or more), i.e.: - The top 10 movies with the greatest rating difference so that we can see which ones were preferred by women. - The top 10 movies with the greatest rating difference in the opposite direction (sign) so that we can see which ones were preferred by men.

Hint/Convention: `mean_ratings['diff'] = mean_ratings['M'] - mean_ratings['F']`

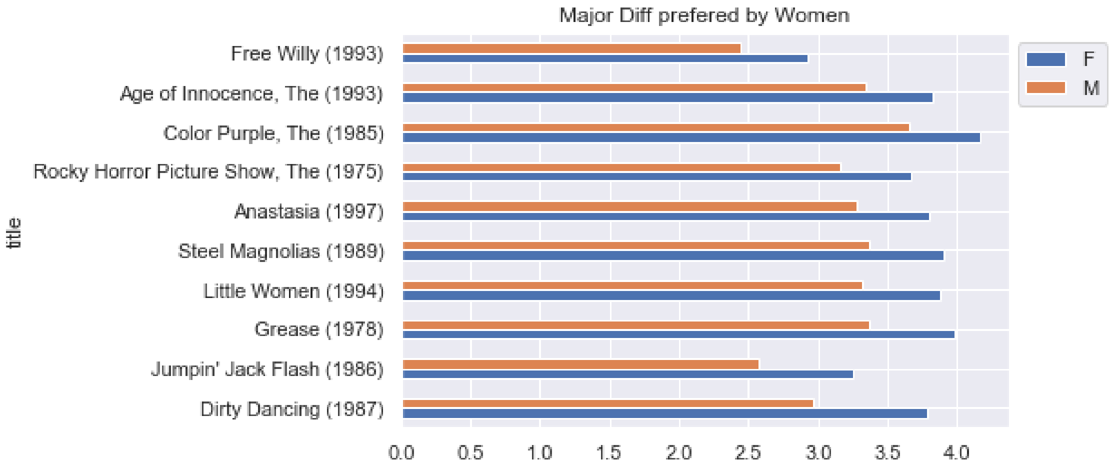
### 5.1 Solution

[140]:

```
print("Bonus 1\n-------------")

mean_ratings['diff'] = mean_ratings['M'] - mean_ratings['F']
top_10_diff = mean_ratings.sort_values(by='diff', ascending=True)[0:10]

print(top_10_diff)

top_10_diff[["F","M"]].plot.barh(title="Major Diff prefered by Women").
 ↪legend(bbox_to_anchor=(1, 1))
```

```
Bonus 1
-------------
gender                                      F         M      diff
title
Dirty Dancing (1987)                 3.790378  2.959596 -0.830782
Jumpin' Jack Flash (1986)            3.254717  2.578358 -0.676359
Grease (1978)                        3.975265  3.367041 -0.608224
Little Women (1994)                  3.870588  3.321739 -0.548849
Steel Magnolias (1989)               3.901734  3.365957 -0.535777
Anastasia (1997)                     3.800000  3.281609 -0.518391
Rocky Horror Picture Show, The (1975) 3.673016  3.160131 -0.512885
Color Purple, The (1985)             4.158192  3.659341 -0.498851
Age of Innocence, The (1993)         3.827068  3.339506 -0.487561
Free Willy (1993)                    2.921348  2.438776 -0.482573
```

[140]:
```
<matplotlib.legend.Legend at 0x20823d6bd48>
```

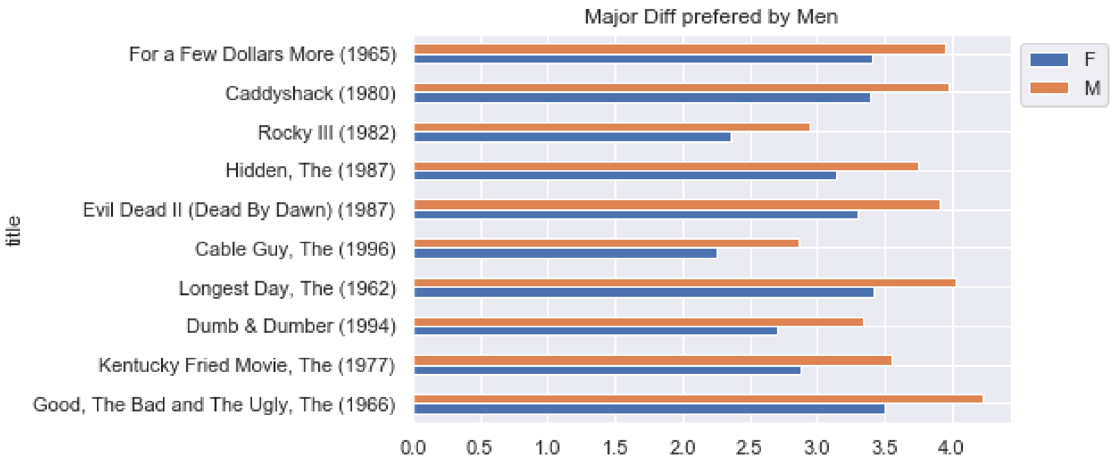


[141]:
```
print("Bonus 2\n-------------")

top_10_diff = mean_ratings.sort_values(by='diff', ascending=False)[0:10]

print(top_10_diff)

top_10_diff[["F","M"]].plot.barh(title="Major Diff prefered by Men").
 ↪legend(bbox_to_anchor=(1, 1))
```

```
Bonus 2
-------------
gender                                      F         M      diff
title
Good, The Bad and The Ugly, The (1966)  3.494949  4.221300  0.726351
```

```
Kentucky Fried Movie, The (1977)        2.878788  3.555147  0.676359
Dumb & Dumber (1994)                    2.697987  3.336595  0.638608
Longest Day, The (1962)                 3.411765  4.031447  0.619682
Cable Guy, The (1996)                   2.250000  2.863787  0.613787
Evil Dead II (Dead By Dawn) (1987)      3.297297  3.909283  0.611985
Hidden, The (1987)                      3.137931  3.745098  0.607167
Rocky III (1982)                        2.361702  2.943503  0.581801
Caddyshack (1980)                       3.396135  3.969737  0.573602
For a Few Dollars More (1965)           3.409091  3.953795  0.544704
```

[141]:
```
<matplotlib.legend.Legend at 0x2084ecaf448>
```



## 6 BONUS! (up to 10 points)

Write Python code to display the top 10 movies (with 250 ratings or more) that elicited the most disagreement among viewers, independent of gender identification.

Hint: Disagreement can be measured by the *variance* or *standard deviation* of the ratings.

### 6.1 Solution

[142]:
```
min_250_ratings_all = data.groupby("title").filter(lambda x: len(x) > 250)
std_data = min_250_ratings_all.pivot_table('rating', index='title',␣
 ↪aggfunc='std')
print("Standard Deviation table")
std_data.sort_values(by='rating', ascending=False)[0:10]
```

```
Standard Deviation table
```

[142]:

```
                                      rating
title
Dumb & Dumber (1994)                1.321333
Blair Witch Project, The (1999)     1.316368
Natural Born Killers (1994)         1.307198
Tank Girl (1995)                    1.277695
Rocky Horror Picture Show, The (1975)  1.260177
Eyes Wide Shut (1999)               1.259624
Evita (1996)                        1.253631
Billy Madison (1995)                1.249970
Fear and Loathing in Las Vegas (1998)  1.246408
Bicentennial Man (1999)             1.245533
```

[143]:

```
var_data = min_250_ratings_all.pivot_table('rating', index='title',␣
 ↪aggfunc='var')
print("Variance")
var_data.sort_values(by='rating', ascending=False)[0:10]
```

```
Variance
```

[143]:

```
                                      rating
title
Dumb & Dumber (1994)                1.745921
Blair Witch Project, The (1999)     1.732824
Natural Born Killers (1994)         1.708766
Tank Girl (1995)                    1.632506
Rocky Horror Picture Show, The (1975)  1.588047
Eyes Wide Shut (1999)               1.586651
Evita (1996)                        1.571591
Billy Madison (1995)                1.562425
Fear and Loathing in Las Vegas (1998)  1.553533
Bicentennial Man (1999)             1.551351
```

# 7 BONUS! (up to 10 points)

Write Python code to answer the question: What is the most popular movie genre? Plot a histogram of the genre counts and report the size of the largest bin.

Hint: use the original **movies** data frame, *before* the merge!

## 7.1 Solution

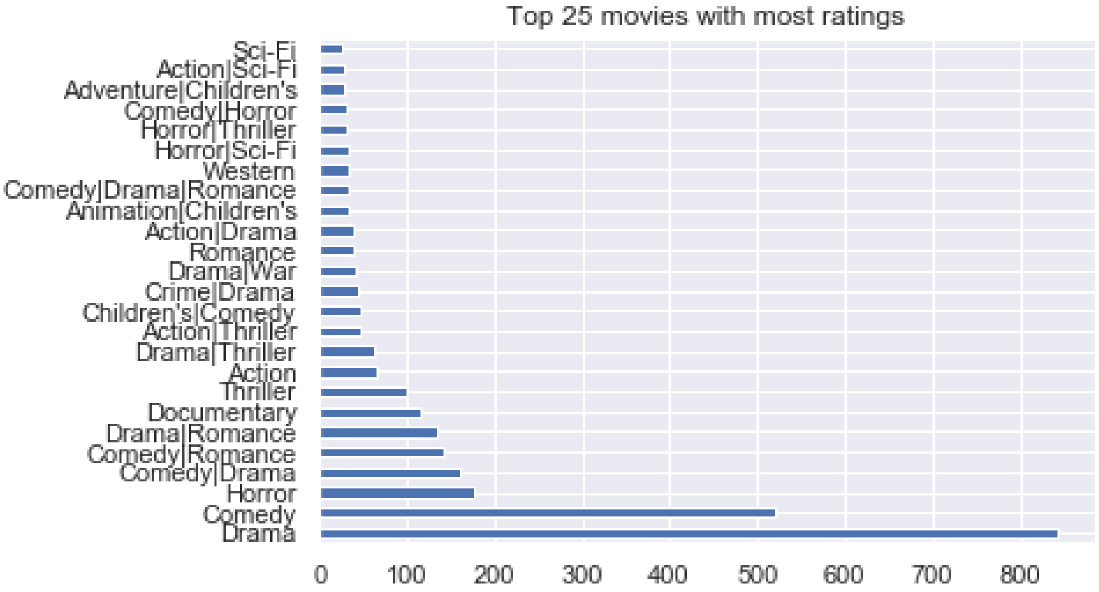
[144]:

```
## Enhacement go back and use origional data frame and string manapulation on␣
 ↪genera column

mean_ratings = data.pivot_table('rating', index='genres', aggfunc='mean')

top = mean_ratings.sort_values(by='rating', ascending=False)[0:1]
```

```
print("The top geners is\n",top,"\n")


largest_genere = movies["genres"].value_counts().head(n=1)
print("Largest genere count: ", largest_genere)
movies["genres"].value_counts().head(n=25).plot.barh(title="Top 25 movies with␣
 ↪most ratings")
```

```
The top geners is
                              rating
genres
Animation|Comedy|Thriller  4.473837

Largest genere count:  Drama    843
Name: genres, dtype: int64
```

[144]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2084ecdb8c8>
```



---

## 7.2 Part 2: Titanic

In this part we'll use the dataset of passengers on the *Titanic*, available through the Seaborn library. See https://www.kaggle.com/c/titanic/data for codebook and additional information.

[145]:
```
titanic = sns.load_dataset('titanic')
```

[146]:
```
titanic.head()
```

```
[146]:    survived  pclass     sex   age  sibsp  parch     fare embarked  class  \
       0         0       3    male  22.0      1      0   7.2500        S  Third
       1         1       1  female  38.0      1      0  71.2833        C  First
       2         1       3  female  26.0      0      0   7.9250        S  Third
       3         1       1  female  35.0      1      0  53.1000        S  First
       4         0       3    male  35.0      0      0   8.0500        S  Third

            who  adult_male deck  embark_town alive  alone
       0    man        True  NaN  Southampton    no  False
       1  woman       False    C    Cherbourg   yes  False
       2  woman       False  NaN  Southampton   yes   True
       3  woman       False    C  Southampton   yes  False
       4    man        True  NaN  Southampton    no   True
```

### 7.3 Questions 11-14 (16 points total, i.e. 4 pts each)

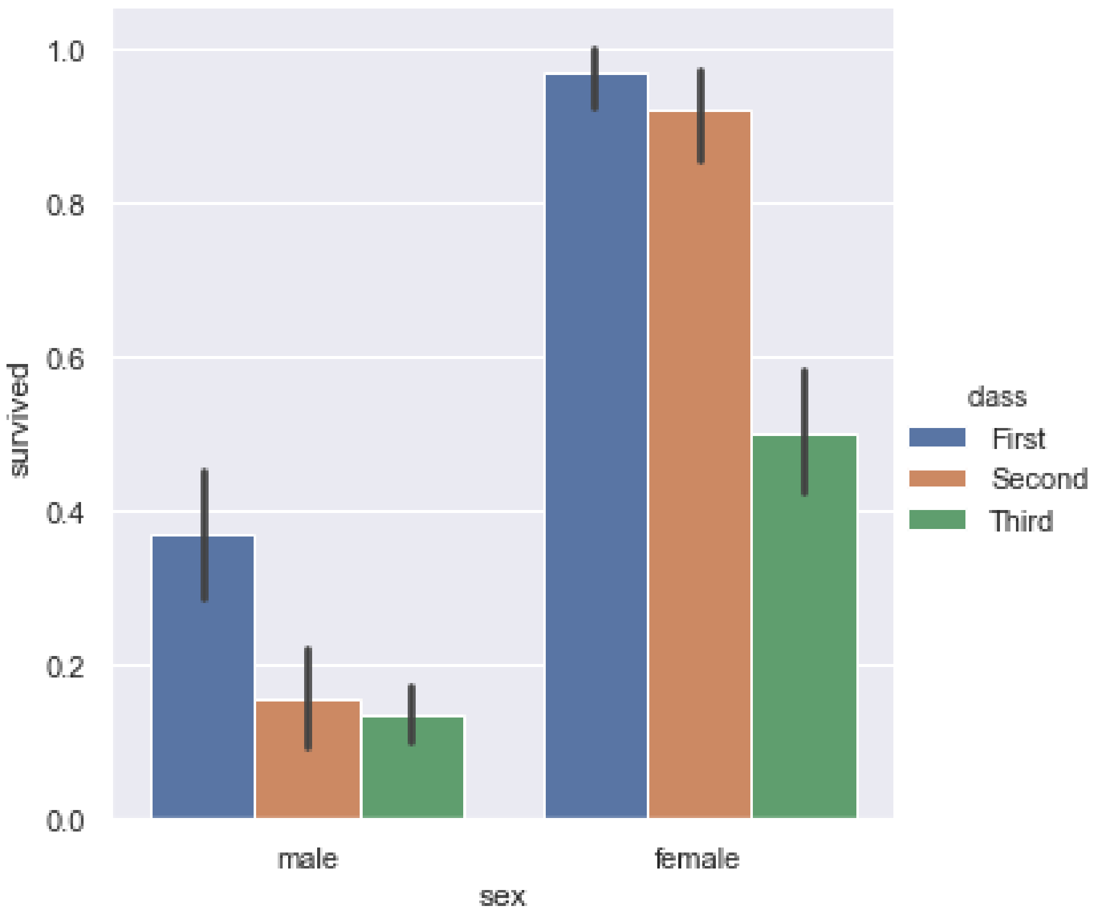
Look at the Python code below and answer the following questions (expressing the amounts in absolute terms):

11. How many female passengers did not survive (regardless of their class)?
12. How many first class female passengers did not survive?
13. How many male passengers did not survive (regardless of their class)?
14. How many third class male passengers did not survive?

```
[147]: titanic.pivot_table('survived', index='sex', columns='class', margins=True)
```

```
[147]: class      First    Second     Third       All
       sex
       female  0.968085  0.921053  0.500000  0.742038
       male    0.368852  0.157407  0.135447  0.188908
       All     0.629630  0.472826  0.242363  0.383838
```

```
[148]: sns.catplot(x="sex", y="survived", hue="class", kind="bar", data=titanic);
```



### 7.4 Solution

[149]:

```
print("Total people on the titanic:", len(titanic))
print("Problem\tAbs Cnt\tTotal%")

size_titanic = len(titanic)

size_female_didnt_survive = len(
    titanic[(titanic["survived"] == 1) & (titanic["sex"] == "female")])
print("#11", size_female_didnt_survive, round(
    size_female_didnt_survive/size_titanic * 100, 2), sep="\t")

size_female_first_class_didnt_survive = len(titanic[(titanic["survived"] == 0)␣
 ↪& (
    titanic["sex"] == "female") & (titanic["class"] == "First")])
print("#12", size_female_first_class_didnt_survive, round(
    size_female_first_class_didnt_survive/size_titanic * 100, 2), sep="\t")
```

```
size_male_didnt_survive = len(
    titanic[(titanic["survived"] == 0) & (titanic["sex"] == "male")])
print("#13", size_male_didnt_survive, round(
    size_male_didnt_survive/size_titanic * 100, 2), sep="\t")

size_third_class_male_didnt_survive = len(titanic[(titanic["survived"] == 0) & (
    titanic["sex"] == "male") & (titanic["class"] == "Third")])
print("#14", size_third_class_male_didnt_survive, round(
    size_third_class_male_didnt_survive/size_titanic * 100, 2), sep="\t")
```

```
Total people on the titanic: 891
Problem Abs Cnt Total%
#11     233     26.15
#12     3       0.34
#13     468     52.53
#14     300     33.67
```

### 7.5 Your turn! (12 points, i.e., 4 pts each)

Write Python code to answer the following questions (make sure the messages displayed by your code are complete and descriptive enough):

15. How many passengers (absolute number) were there per deck/class?

(**Hint**: The plot below shows how decks and classes were related and provides a visual estimate.) 16. How many passengers (absolute number) in Deck A survived? 17. How many passengers (absolute number) in Deck E survived and what was the breakdown (in Deck E) per class?

example_categorical_plot_titanic.png

### 7.6 Solution

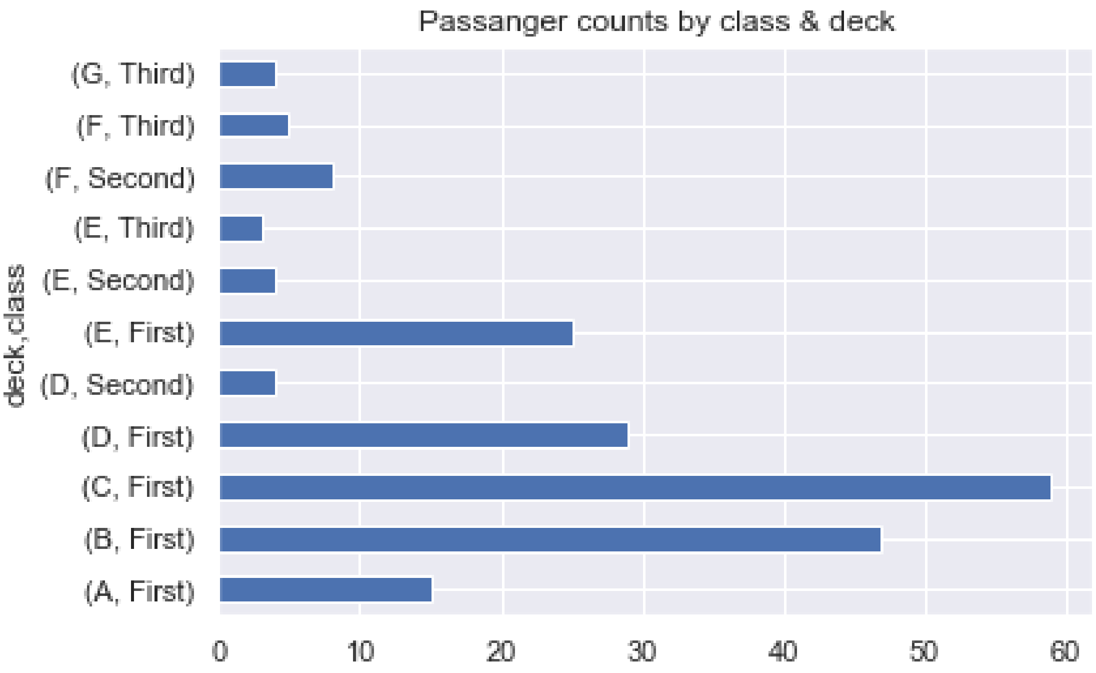
[150]:

```
print("#15 - passangers separated by deck and class")
pd.set_option('display.max_rows', 25)
print(titanic.pivot_table(index=["deck","class"], values=[], aggfunc=len))
titanic.pivot_table(index=["deck","class"], values=[], aggfunc=len).plot.
 ↪barh(title="Passanger counts by class & deck")
```

```
#15 - passangers separated by deck and class
deck  class
A     First     15
B     First     47
C     First     59
D     First     29
      Second     4
E     First     25
```

```
        Second      4
        Third       3
F       Second      8
        Third       5
G       Third       4
dtype: int64
```

[150]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2084ed20148>
```



[151]:
```
print("#16 - Survived on Deck A separated by classes")
survived = titanic[titanic["survived"] == 1]
survived_on_deck_a = survived[survived["deck"] == "A"]

table = survived_on_deck_a.pivot_table(index=["deck","class"], values=[],␣
 ↪aggfunc=len)
table
```

```
#16 - Survived on Deck A separated by classes
```

[151]:
```
deck  class
A     First    7
dtype: int64
```

[152]:
```
print("#17 - Survived on Deck E separated by classes")
survived_on_deck_e = survived[survived["deck"] == "E"]
```

```
table = survived_on_deck_e.pivot_table(index=["deck","class"], values=[],␣
 ↪aggfunc=len)
table
```

```
#17 - Survived on Deck E separated by classes
```

[152]:
```
deck  class
E     First     18
      Second     3
      Third      3
dtype: int64
```

## 8 BONUS! (up to 20 points)

Write Python code to answer the following questions (using percentage values): - How many women traveling alone did not survive? - How many men 35 years old or younger did not survive? - What was the average fare per class?

### 8.1 Solution

[153]:
```
def get_percentage(numerator):
    return round(len(numerator)/len(titanic) * 100,2)
```

[154]:
```
didnt_survive = titanic[titanic["survived"] == 0]
women_didnt_survive = didnt_survive[didnt_survive["sex"] == "female"]
alone_women_didnt_survive = women_didnt_survive[women_didnt_survive["alone"] ==␣
 ↪True]
print("% women alone who didnt survive␣
 ↪",get_percentage(alone_women_didnt_survive),"%", sep="")
```

```
% women alone who didnt survive 3.03%
```

[155]:
```
men_didnt_survive = didnt_survive[didnt_survive["sex"] == "male" ]
over_35_men_didnt_survive = men_didnt_survive[men_didnt_survive["age"] >= 35]
print("% men over 35 didnt survive␣
 ↪",get_percentage(over_35_men_didnt_survive),"%", sep="")
younger_than_35_men_didnt_survive = men_didnt_survive[men_didnt_survive["age"]␣
 ↪< 35]
print("% men younger than 35 didnt survive␣
 ↪",get_percentage(younger_than_35_men_didnt_survive),"%", sep="")
```

```
% men over 35 didnt survive 14.03%
% men younger than 35 didnt survive 26.37%
```

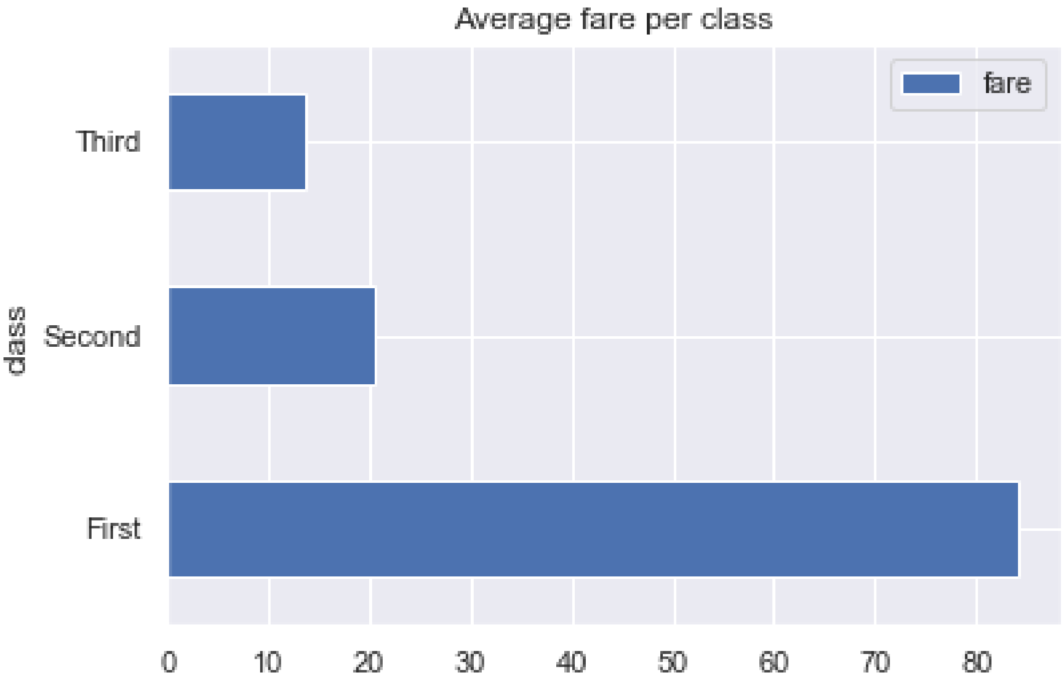
[156]:

```
#Average fair
print("Average fair")
table = titanic.pivot_table(values="fare", index="class", aggfunc="mean")
print(table)
table.plot.barh(title="Average fare per class")
```

```
Average fair
              fare
class
First   84.154687
Second  20.662183
Third   13.675550
```

[156]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x20866d81048>
```



## 8.2 Part 3: US Baby Names 1880–2018

The United States Social Security Administration (SSA) has made available data on the frequency of baby names from 1880 through the present. These plain text data files, one per year, contain the total number of births for each sex/name combination. The raw archive of these files can be obtained from http://www.ssa.gov/oact/babynames/limits.html.

After downloading the 'National data' file *names.zip* and unzipping it, you will have a directory containing a series of files like *yob1880.txt* through *yob2018.txt*. We need to do some data wrangling to load this dataset (see code below).

For your convenience, I have made the *names.zip* file available on Canvas. Before running the cell below, make sure that you have downloaded it, unzipped it, and placed its contents under the 'data' folder.

names_path.png

[157]:

```
years = range(1880, 2019)

pieces = []
columns = ['name', 'sex', 'births']

for year in years:
    path = 'data/names/yob%d.txt' % year
    frame = pd.read_csv(path, names=columns)

    frame['year'] = year
    pieces.append(frame)

# Concatenate everything into a single DataFrame
names = pd.concat(pieces, ignore_index=True)
```

[158]:

```
names
```

[158]:

```
               name sex  births  year
0              Mary   F    7065  1880
1              Anna   F    2604  1880
2              Emma   F    2003  1880
3         Elizabeth   F    1939  1880
4            Minnie   F    1746  1880
...             ...  ..     ...   ...
1957041      Zylas   M       5  2018
1957042      Zyran   M       5  2018
1957043      Zyrie   M       5  2018
1957044      Zyron   M       5  2018
1957045      Zzyzx   M       5  2018

[1957046 rows x 4 columns]
```

### 8.3 Your turn! (25 points)

Write Python code to compute the number of baby boys and baby girls born each year and display the two line plots over time.

Hint: Start by aggregating the data at the year and sex level using `groupby` or `pivot_table`.

Your plot should look like this:

birth_vs_year.png

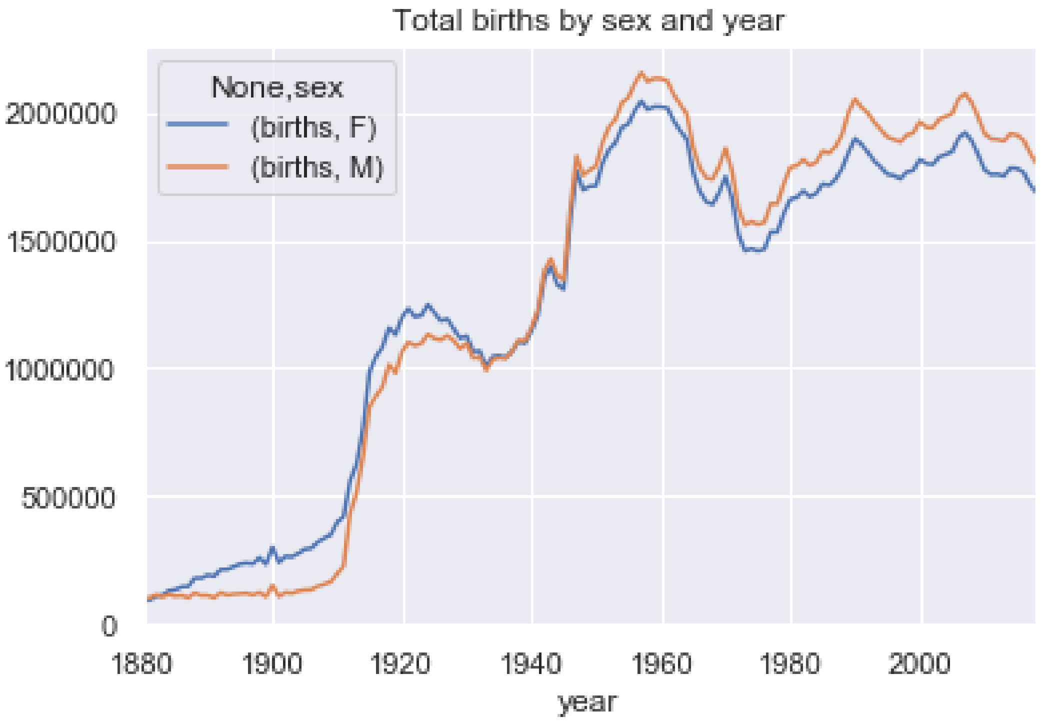
## 8.4 Solution

[159]:

```
sns.set()
names_pivot = names.pivot_table( index="year", columns="sex", aggfunc=sum)
names_pivot.plot(title="Total births by sex and year")
```

[159]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x208a13be5c8>
```



---

## 8.5 Analyzing Naming Trends

Suppose we're interested in analyzing the Top 1000 most popular baby names per year.

We will do so by following these steps: 1. Insert a column *prop* with the fraction of babies given each name relative to the total number of births. A prop value of 0.02 would indicate that 2 out of every 100 babies were given a particular name in a given year. 2. Group the data by year and sex, then add the new column to each group. 3. Extract a subset of the data (the top 1,000 names for each sex/year combination). This is yet another group operation. 4. Split the Top 1,000 names into the boy and girl portions. 5. Build a pivot table of the total number of births by year and name.

Finally, we will plot the absolute number of babies named 'John', 'Noah', 'Madison', or 'Lorraine' over time.

[160]:
```
def add_prop(group):
    group['prop'] = group.births / group.births.sum()
    return group
names = names.groupby(['year', 'sex']).apply(add_prop)
```

[161]:
```
names
```

[161]:
```
                  name sex  births  year      prop
0                 Mary   F    7065  1880  0.077642
1                 Anna   F    2604  1880  0.028617
2                 Emma   F    2003  1880  0.022012
3            Elizabeth   F    1939  1880  0.021309
4               Minnie   F    1746  1880  0.019188
...                ...  ..     ...   ...       ...
1957041         Zylas   M       5  2018  0.000003
1957042         Zyran   M       5  2018  0.000003
1957043         Zyrie   M       5  2018  0.000003
1957044         Zyron   M       5  2018  0.000003
1957045         Zzyzx   M       5  2018  0.000003

[1957046 rows x 5 columns]
```

[162]:
```
# Sanity check (all percentages should add up to 1, i.e., 100%)
names.groupby(['year', 'sex']).prop.sum()
```

[162]:
```
year  sex
1880  F      1.0
      M      1.0
1881  F      1.0
      M      1.0
1882  F      1.0
            ...
2016  M      1.0
2017  F      1.0
      M      1.0
2018  F      1.0
      M      1.0
Name: prop, Length: 278, dtype: float64
```

[163]:
```
def get_top1000(group):
    return group.sort_values(by='births', ascending=False)[:1000]
grouped = names.groupby(['year', 'sex'])
top1000 = grouped.apply(get_top1000)
# Drop the group index, not needed
top1000.reset_index(inplace=True, drop=True)
```

[164]:
```
top1000
```

[164]:
```
                 name sex  births  year      prop
0                Mary   F    7065  1880  0.077642
```

```
1            Anna   F    2604  1880  0.028617
2            Emma   F    2003  1880  0.022012
3       Elizabeth   F    1939  1880  0.021309
4          Minnie   F    1746  1880  0.019188
...           ...  ..     ...   ...       ...
277872     Korbyn   M     207  2018  0.000115
277873    Randall   M     207  2018  0.000115
277874     Benton   M     206  2018  0.000114
277875    Coleman   M     206  2018  0.000114
277876     Markus   M     206  2018  0.000114

[277877 rows x 5 columns]
```

[165]:
```
boys = top1000[top1000.sex == 'M']
girls = top1000[top1000.sex == 'F']
```

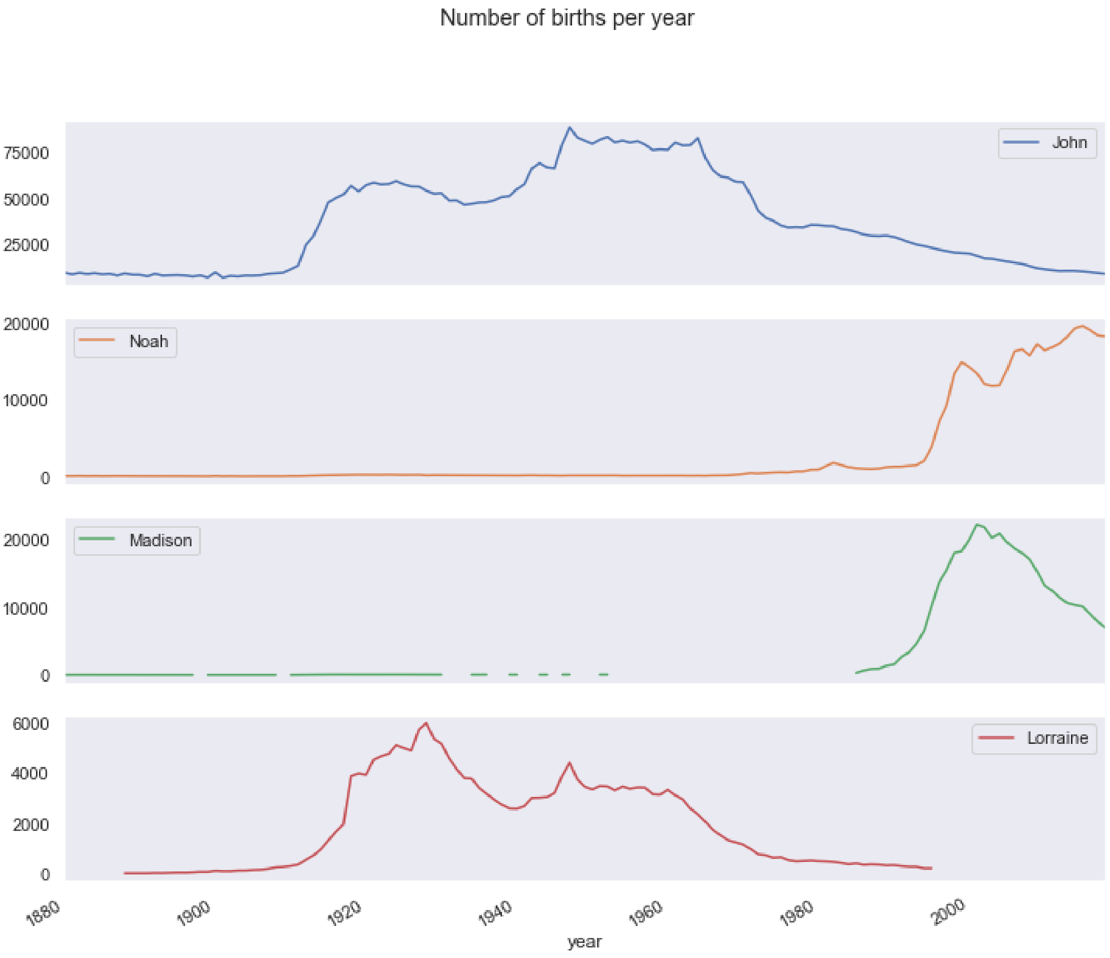
[166]:
```
total_births = top1000.pivot_table('births', index='year',
                                   columns='name',
                                   aggfunc=sum)
```

[167]:
```
total_births.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 139 entries, 1880 to 2018
Columns: 7174 entries, Aaden to Zyaire
dtypes: float64(7174)
memory usage: 7.6 MB
```

[168]:
```
subset = total_births[['John', 'Noah', 'Madison', 'Lorraine']]
subset.plot(subplots=True, figsize=(12, 10), grid=False,
            title="Number of births per year")
```

[168]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x00000208400E1448>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x000002084020FCC8>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x00000208401E0F48>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x0000020841AC2BC8>],
      dtype=object)
```



## 9 BONUS! (up to 25 points)

Write Python code to test the hypothesis:

H1: There has been an increase in naming diversity over time.

Hint: Compute a metric that consists of the number of distinct names, taken in order of popularity from highest to lowest, in the top 50% of births, and plot that metric over time.

Your plot should look like this:

naming_diversity.png

### 9.1 Solution

[169]:

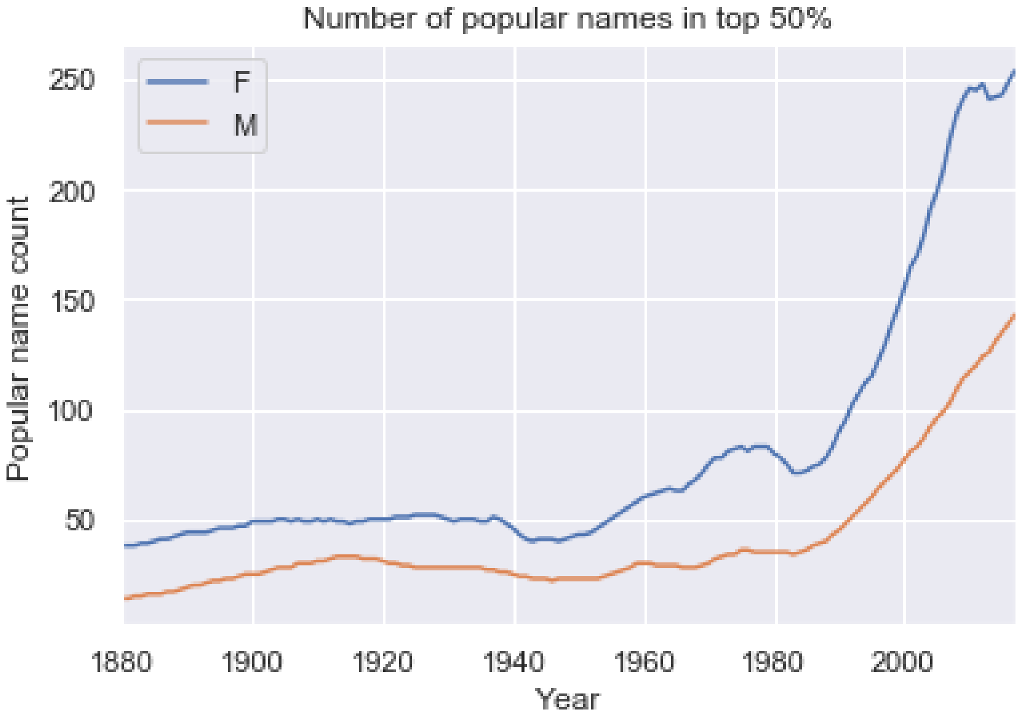
```
def get_top_50_percent(group):
    # Loop over calculating the sum of the prop, when we hit .5 then return
    group = group.sort_values(by="prop", ascending=False)
    for i in range(0,len(group)):
        if group["prop"][:i].sum() >= .5:
            return group[:i]

# Loop over year, filter on sex, sort by prop, capture size
male_top_50_count = []
female_top_50_count = []
years = []

for year in range(1880,2018):
    years.append(year)
    selected_year = names[names["year"] == year]

    male_selected_year = selected_year[selected_year["sex"] == "M"]
    male_top_50 = get_top_50_percent(male_selected_year)
    male_top_50_count.append(len(male_top_50))

    female_selected_year = selected_year[selected_year["sex"] == "F"]
    female_top_50 = get_top_50_percent(female_selected_year)
    female_top_50_count.append(len(female_top_50))
```

[170]:

```
percent_data = {"F" : female_top_50_count, "M": male_top_50_count}
df = pd.DataFrame(percent_data, index = years)
df.plot.line(title="Number of popular names in top 50%")
plt.xlabel("Year")
plt.ylabel("Popular name count")
```

[170]:

```
Text(0, 0.5, 'Popular name count')
```



### 9.2 Boy names that became girl names (and vice versa)

Next, let's look at baby names that were more popular with one sex earlier in the sample but have switched to the opposite sex over the years. One example is the name Lesley or Leslie (or other possible, less common, spelling variations).

We will do so by following these steps: 1. Go back to the top1000 DataFrame and compute a list of names occurring in the dataset starting with "lesl". 2. Filter down to just those names and sum births grouped by name to see the relative frequencies. 3. Aggregate by sex and year and normalize within year. 4. Plot the breakdown by sex over time.

[171]:
```
all_names = pd.Series(top1000.name.unique())
lesley_like = all_names[all_names.str.lower().str.contains('lesl')]
lesley_like
```

[171]:
```
632      Leslie
2294     Lesley
4264     Leslee
4732      Lesli
6108      Lesly
dtype: object
```

[172]:
```
filtered = top1000[top1000.name.isin(lesley_like)]
filtered.groupby('name').births.sum()
```

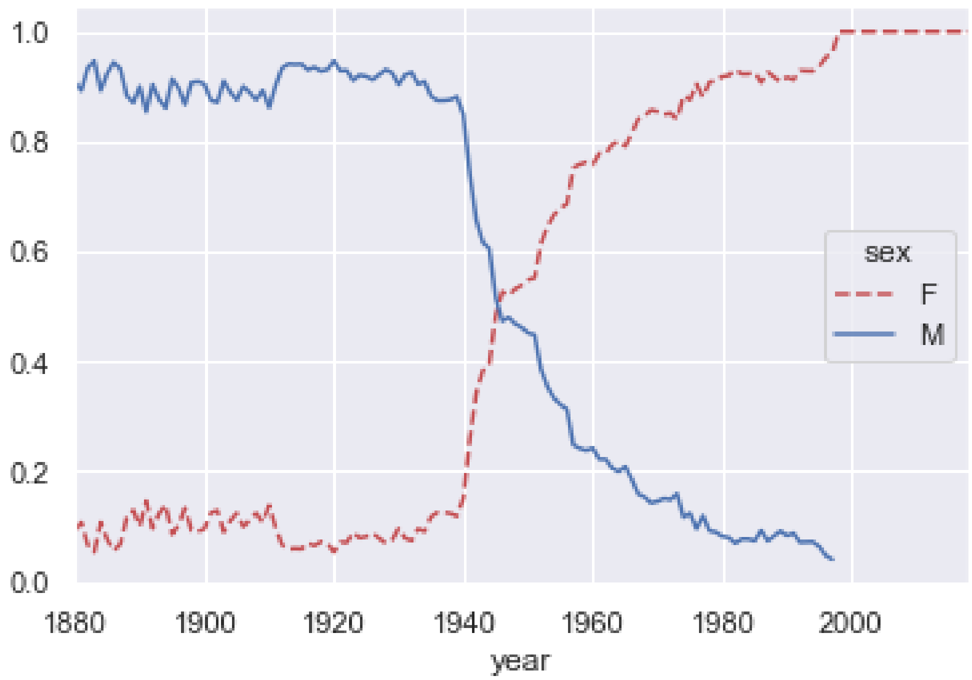
[172]:
```
name
Leslee       993
Lesley     35033
Lesli        929
Leslie    378168
Lesly      11433
Name: births, dtype: int64
```

[173]:
```
table = filtered.pivot_table('births', index='year',
                             columns='sex', aggfunc='sum')
table = table.div(table.sum(1), axis=0)
```

[174]:
```
fig = plt.figure()
table.plot(style={'M': 'b-', 'F': 'r--'})
```

[174]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2086731a0c8>
```

```
<Figure size 432x288 with 0 Axes>
```



---

Now it's time for you to come up with a different hypotheses, which we will call H2. **Be creative!**

Example: The name 'Reese' has been more prevalent among baby girls than baby boys since 2000.

### 9.3 Your turn! (28 points)

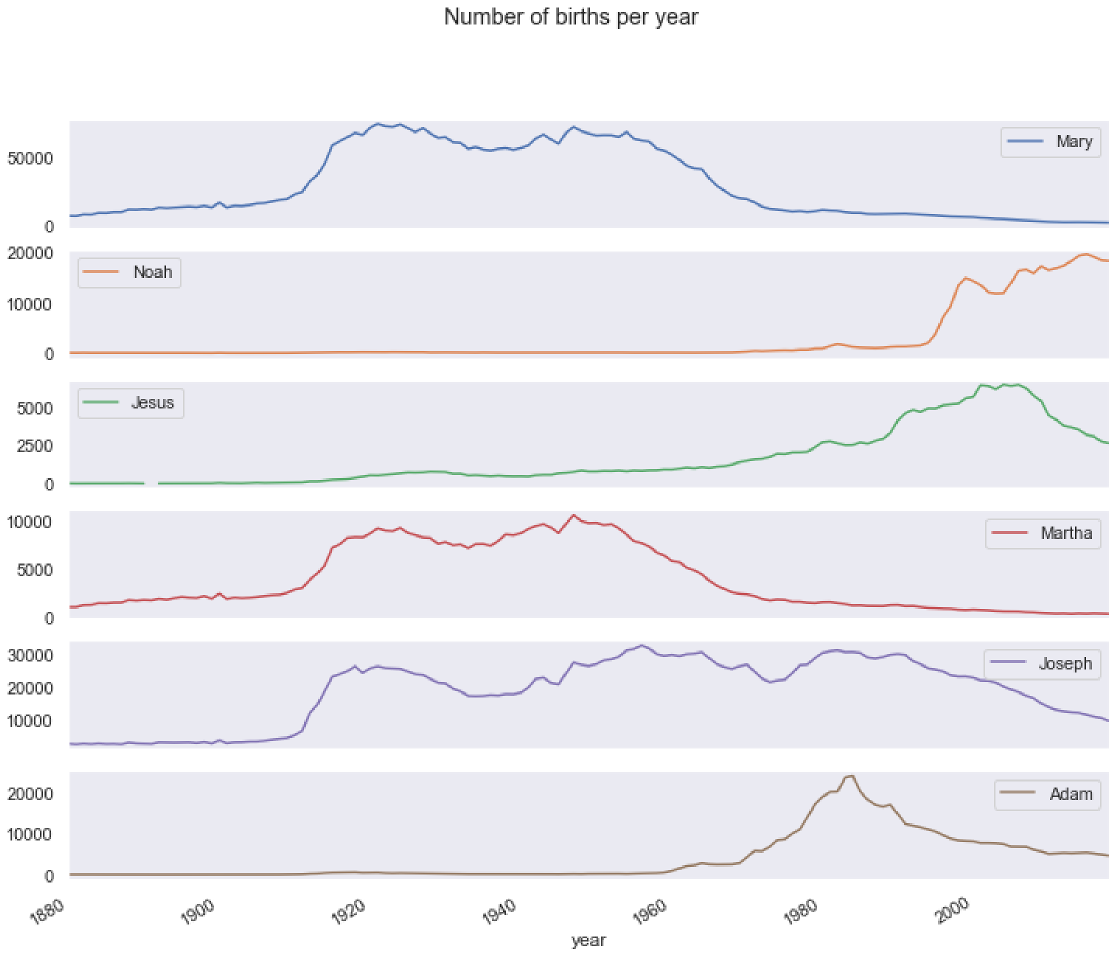
Write Python code to test hypothesis H2 (and some text to explain whether it was confirmed or not).

### 9.4 Solution

H2: Biblical names such as [“Mary”, “Noah”, “Jesus”, “Martha”,“Joseph”,"Adam] are becoming less popular over time

[175]:
```
subset = total_births[["Mary", "Noah", "Jesus", "Martha", "Joseph", "Adam"]]
subset.plot(subplots=True, figsize=(12, 10), grid=False,
            title="Number of births per year")
```

[175]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x000002084ECCB6C8>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x000002084ECAF748>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x000002084ED01DC8>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x0000020850E15748>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x0000020850DCAFC8>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x0000020852953948>],
      dtype=object)
```



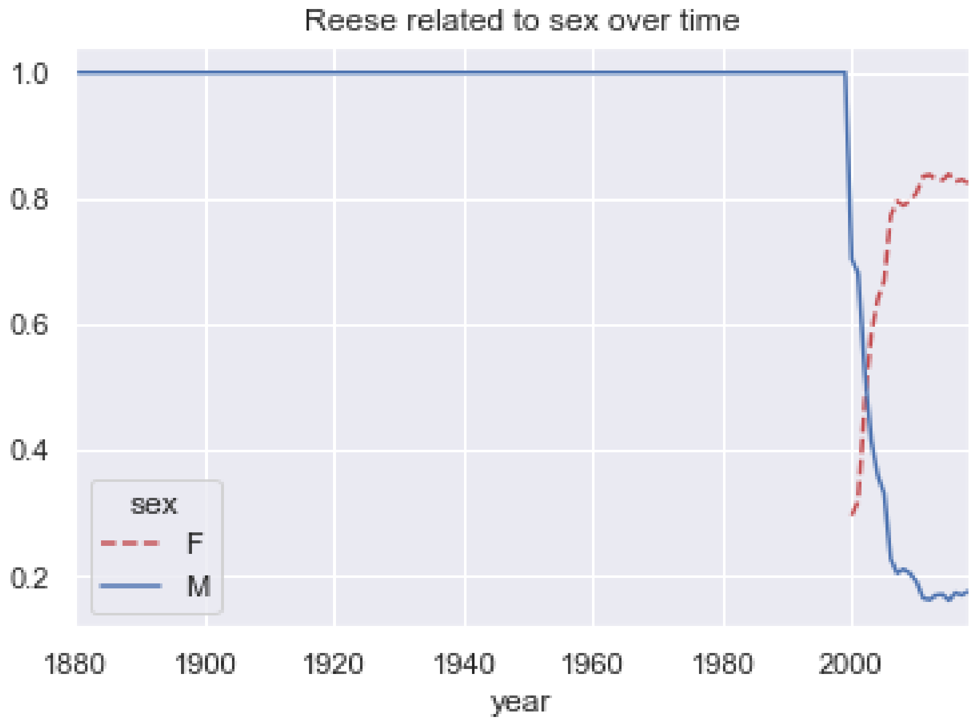
H2: From the small subset selected we see some trend in 5 of the 6 names going downward. If we stated this was the only list of biblical names then I would say this is confirmed.

H3: The name 'Reese' has been more prevalent among baby girls than baby boys since 2000.

[176]:
```
reese_like = all_names[all_names.str.lower() == 'reese']
filtered = top1000[top1000.name.isin(reese_like)]
filtered.groupby('name').births.sum()
table = filtered.pivot_table('births', index='year',
                             columns='sex', aggfunc='sum')
table = table.div(table.sum(1), axis=0)
fig = plt.figure()
table.plot(style={'M': 'b-', 'F': 'r--'},title = "Reese related to sex over␣
 ↪time")
```

[176]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x20852a8e3c8>
```

```
<Figure size 432x288 with 0 Axes>
```



H3: Based on the previous plot there was a strong shift between male and female for Reese around 2000 where female overtook the majority percentage. H3 is confirmed.

### 9.5 Conclusions (25 points)

Write your conclusions and make sure to address the issues below: - What have you learned from this assignment? - Which parts were the most fun, time-consuming, enlightening, tedious? - What would you do if you had an additional week to work on this?

### 9.6 Solution

1. I have a much better understanding of groupby and pivot tables. I think it will take some more practice with those methods to master them but I am getting more comfortable. I also started using the plot method right off of the Pandas DataFrames like df.plot.barh() or df.plot.line() and found that to be easier to set up than the matplotlib. I think under the covers it does use matplotlib anyways.
2. On #10 I got tripped up on trying to filter the age first before the # of ratings. That messed me up but in the Slack group Christian pointed that out which was very helpful. Also on #10 I displayed more than 10 row because of some movies have the same rating value which means they would be tied for a top number slow. I found that near the end of the assignments tend to go a little quicker which maybe is a good thing :). The titanic dataset is really fun to mess with. Probably because of how many different ways you can slice and filter the data.
3. I felt that maybe on the baby names dataset we could have done some more analysis so I would want to dive in there more. Maybe come up some more hypothesis to test. Also I would like to compare the rating average vs the # of ratings on a bar chart with some alpha to see how they might relate