matrix_factorizations_5(NMF)

February 28, 2020

1 Matrix Factorization Visualizations - Method 5(Off-the-shelf Implementation)

[1]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd

from surprise import Dataset, Reader, NMF
from surprise.model_selection import cross_validate, KFold, GridSearchCV
```

[2]:

```
# Use SurpriseSVD

# load data
train = np.loadtxt('./data/train2.txt').astype(int)
test = np.loadtxt('./data/test2.txt').astype(int)
data = np.loadtxt('./data/data2.txt').astype(int)
train = pd.DataFrame(train)
train.columns=['User', 'Movie', 'Rating']
test = pd.DataFrame(test)
test.columns=['User', 'Movie', 'Rating']
data = pd.DataFrame(data)
data.columns=['User', 'Movie', 'Rating']

reader = Reader(rating_scale=(1, 5))
train_data = Dataset.load_from_df(data[['User', 'Movie', 'Rating']], reader)
train_data = train_data.build_full_trainset()
```

[3]:

```
# Train using NMF (non-negative matrix formation)
algo = NMF()
algo.fit(train_data)
```

[3]:

```
<surprise.prediction_algorithms.matrix_factorization.NMF at 0x25887abe188>
```

[4]:

```
# Get the U and V matrix to correct dimensions
U = algo.pu.T
V = algo.qi.T
```

[5]:

```
# mean-centering
V_mean = V.mean(axis=1)
for i in range(len(V[0])):
    V[:,i] -= V_mean
for i in range(len(U[0])):
    U[:,i] -= V_mean

# get SVD of V
A, S, B = np.linalg.svd(V)
```

[6]:

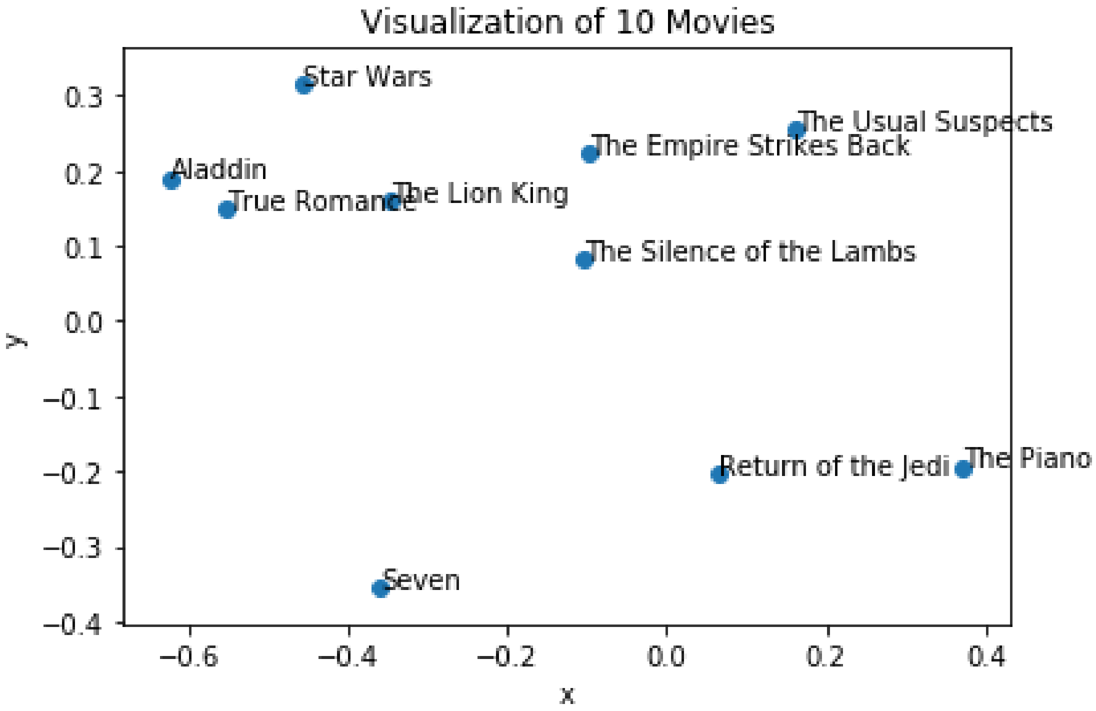
```
# project U, V into K-dimensional space
K = 2
U_tilde = np.matmul(A.T[:K], U)
V_tilde = np.matmul(A.T[:K], V)
```

[7]:

```
# load data from cleaned files
movies = pd.read_csv('data/movies.csv')
data = pd.read_csv('data/data.csv')
```

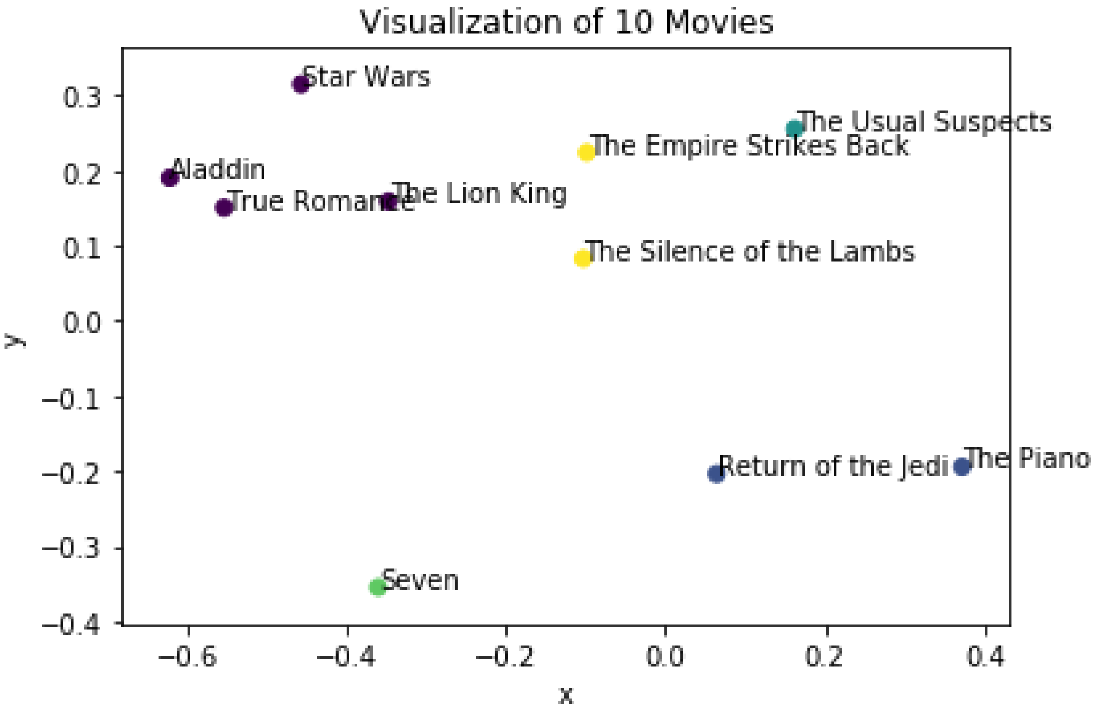
[8]:

```
# visualize any 10 movies
ids = [11, 12, 71, 95, 98, 92, 578, 181, 172, 50]

titles = ['Seven', 'The Usual Suspects', 'The Lion King', 'Aladdin', 'The␣
 ↪Silence of the Lambs', 'True Romance', 'The Piano', 'Return of the Jedi',␣
 ↪'The Empire Strikes Back', 'Star Wars']

x = [0]*10
y = [0]*10
for i in range(len(ids)):
    x[i] = V_tilde[0][ids[i]-1]
    y[i] = V_tilde[1][ids[i]-1]

fig, ax = plt.subplots()
plt.scatter(x, y)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_a.png')
```



[9]:

```
from sklearn.cluster import KMeans

X = np.column_stack((x, y))
labels = KMeans(n_clusters=5, random_state=0).fit_predict(X)

fig, ax = plt.subplots()
plt.scatter(x, y, c=labels)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_a_clusters.png')
```

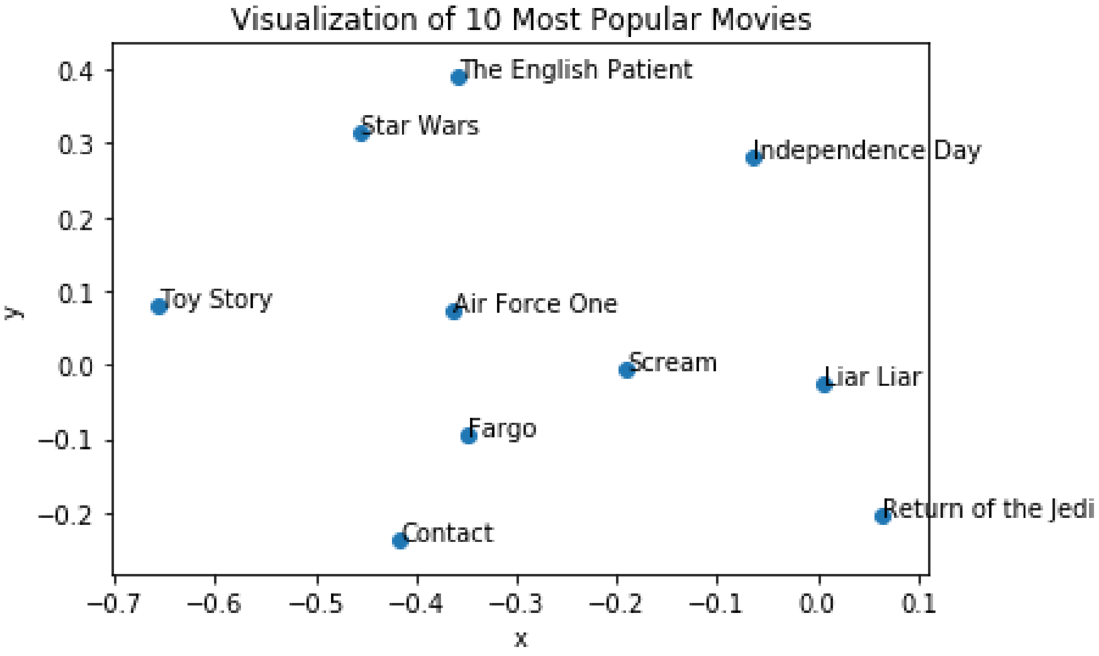


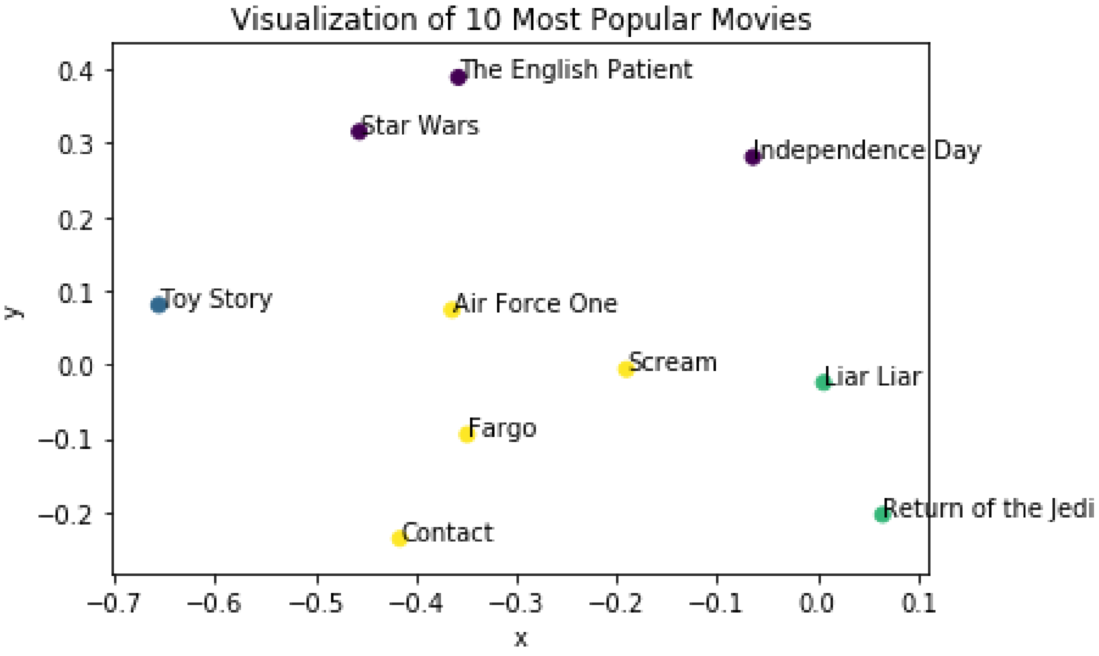
[10]:

```
# visualize 10 most popular movies
pop = data['Movie'].value_counts().head(10).index

for i in pop:
    print(movies[movies['ID'] == i]['Title'])

titles = ['Star Wars', 'Contact', 'Fargo', 'Return of the Jedi', 'Liar Liar',␣
 ↪'The English Patient', 'Scream', 'Toy Story', 'Air Force One', 'Independence␣
 ↪Day']

x = [0]*10
y = [0]*10
for i in range(len(pop)):
    x[i] = V_tilde[0][pop[i]-1]
    y[i] = V_tilde[1][pop[i]-1]

# clustering
X = np.column_stack((x, y))
labels = KMeans(n_clusters=4, random_state=0).fit_predict(X)

# plot visualization
fig, ax = plt.subplots()
plt.scatter(x, y)
```

```
for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Most Popular Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_b.png')

# plot clusters
fig, ax = plt.subplots()
plt.scatter(x, y, c=labels)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Most Popular Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_b_clusters.png')
```

```
49    Star Wars (1977)
Name: Title, dtype: object
257    Contact (1997)
Name: Title, dtype: object
99    Fargo (1996)
Name: Title, dtype: object
180    Return of the Jedi (1983)
Name: Title, dtype: object
292    Liar Liar (1997)
Name: Title, dtype: object
284    English Patient, The (1996)
Name: Title, dtype: object
286    Scream (1996)
Name: Title, dtype: object
0    Toy Story (1995)
Name: Title, dtype: object
298    Air Force One (1997)
Name: Title, dtype: object
120    Independence Day (ID4) (1996)
Name: Title, dtype: object
```



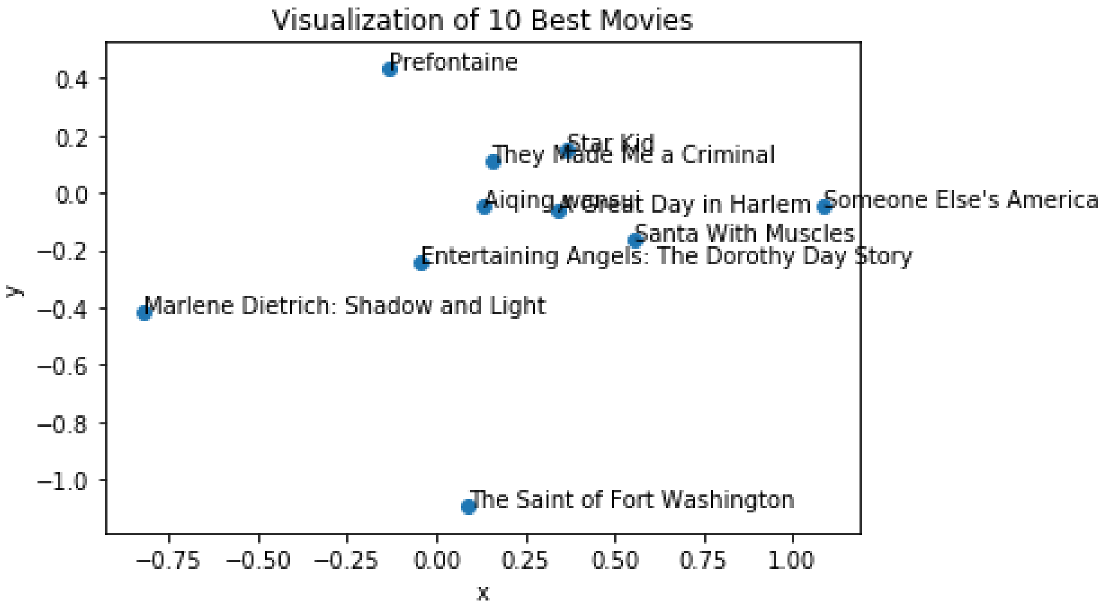


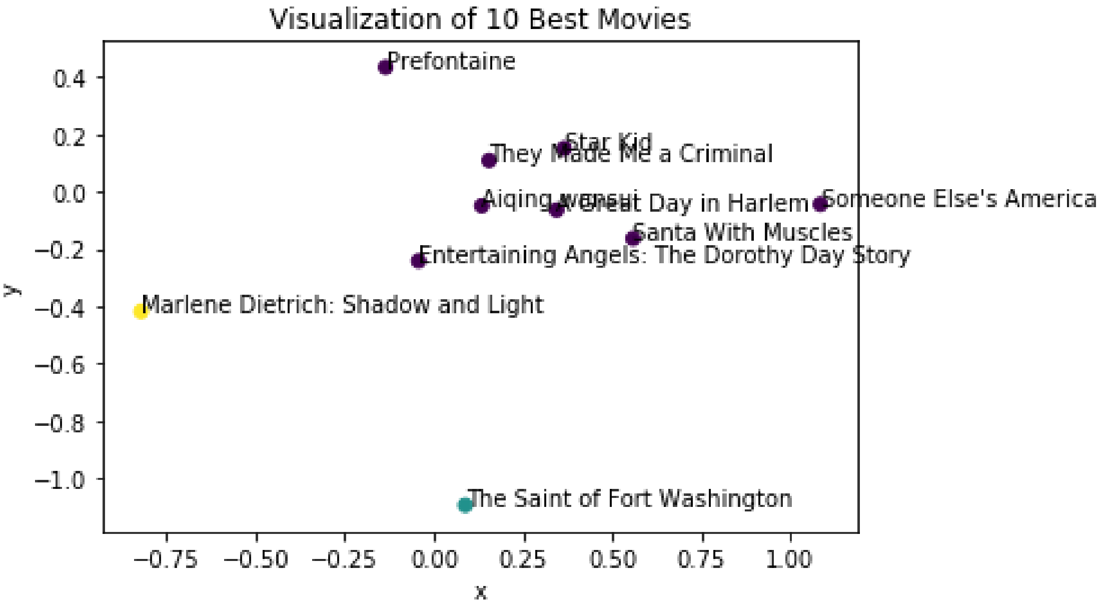
[11]:
```
# visualize 10 best movies
sorted_df = movies.sort_values(by='avg_rating', ascending=False)
best = sorted_df.head(10)['ID']
```

```
for i in best:
    print(movies[movies['ID'] == i]['Title'])

titles = ["Someone Else's America", 'Prefontaine', 'Aiqing wansui', 'Star Kid',␣
 ↪'Entertaining Angels: The Dorothy Day Story', 'They Made Me a Criminal',␣
 ↪'Marlene Dietrich: Shadow and Light', 'A Great Day in Harlem', 'The Saint of␣
 ↪Fort Washington', 'Santa With Muscles']

x = [0]*10
y = [0]*10
count = 0
for i in best:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1

# clustering
X = np.column_stack((x, y))
labels = KMeans(n_clusters=3, random_state=0).fit_predict(X)

# plot visualization
fig, ax = plt.subplots()
plt.scatter(x, y)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Best Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_c.png')

# plot clusters
fig, ax = plt.subplots()
plt.scatter(x, y, c=labels)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Best Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_c_clusters.png')
```

```
1588    Someone Else's America (1995)
Name: Title, dtype: object
```

```
1179    Prefontaine (1997)
Name: Title, dtype: object
1525    Aiqing wansui (1994)
Name: Title, dtype: object
1282    Star Kid (1997)
Name: Title, dtype: object
1637    Entertaining Angels: The Dorothy Day Story (1996)
Name: Title, dtype: object
1112    They Made Me a Criminal (1939)
Name: Title, dtype: object
1191    Marlene Dietrich: Shadow and Light (1996)
Name: Title, dtype: object
807    Great Day in Harlem, A (1994)
Name: Title, dtype: object
1456    Saint of Fort Washington, The (1993)
Name: Title, dtype: object
1489    Santa with Muscles (1996)
Name: Title, dtype: object
```



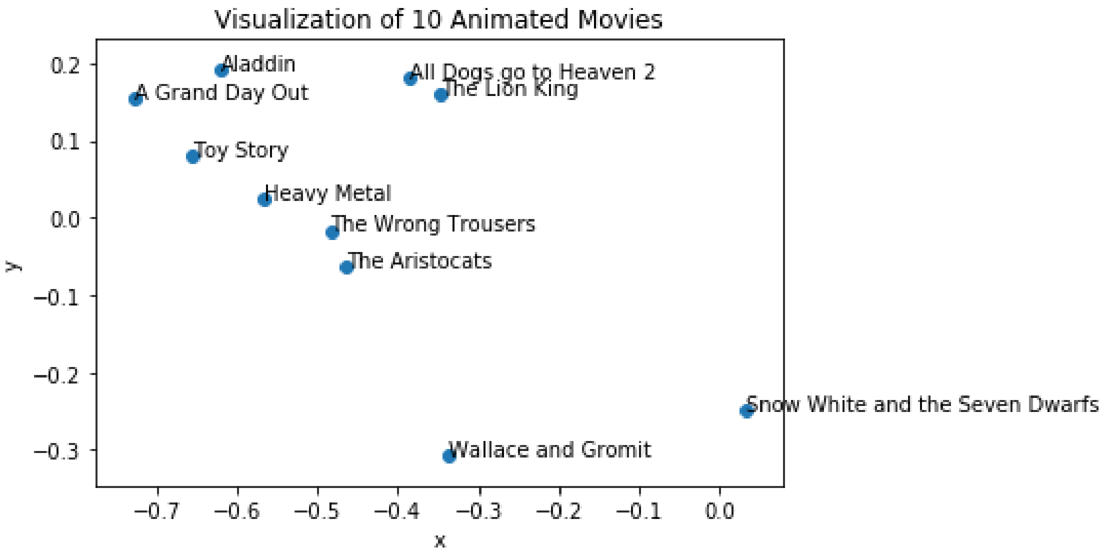


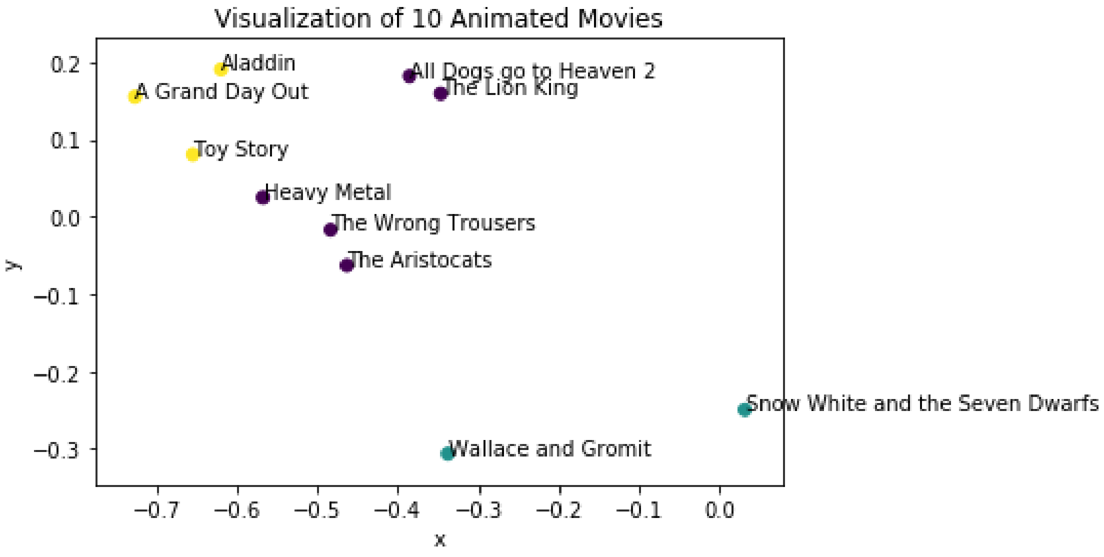
[12]:

```python
# Visualize 10 animated movies
# get all animated movies
animated = movies[movies['Animation'] == 1]['ID'].head(10)

for i in animated:
    print(movies[movies['ID'] == i]['Title'])

titles = ['Toy Story', 'The Lion King', 'Aladdin', 'Snow White and the Seven␣
 ↪Dwarfs', 'Heavy Metal', 'The Aristocats', 'All Dogs go to Heaven 2',␣
 ↪'Wallace and Gromit', 'The Wrong Trousers', 'A Grand Day Out']

x = [0]*10
y = [0]*10
count = 0

for i in animated:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1

# clustering
X = np.column_stack((x, y))
labels = KMeans(n_clusters=3, random_state=0).fit_predict(X)

# plot visualization
fig, ax = plt.subplots()
plt.scatter(x, y)
```

```python

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Animated Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_d_1.png')

# plot clusters
fig, ax = plt.subplots()
plt.scatter(x, y, c=labels)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Animated Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_d_1_clusters.png')
```

```
0    Toy Story (1995)
Name: Title, dtype: object
70    Lion King, The (1994)
Name: Title, dtype: object
94    Aladdin (1992)
Name: Title, dtype: object
98    Snow White and the Seven Dwarfs (1937)
Name: Title, dtype: object
100    Heavy Metal (1981)
Name: Title, dtype: object
101    Aristocats, The (1970)
Name: Title, dtype: object
102    All Dogs Go to Heaven 2 (1996)
Name: Title, dtype: object
113    Wallace & Gromit: The Best of Aardman Animatio…
Name: Title, dtype: object
168    Wrong Trousers, The (1993)
Name: Title, dtype: object
188    Grand Day Out, A (1992)
Name: Title, dtype: object
```





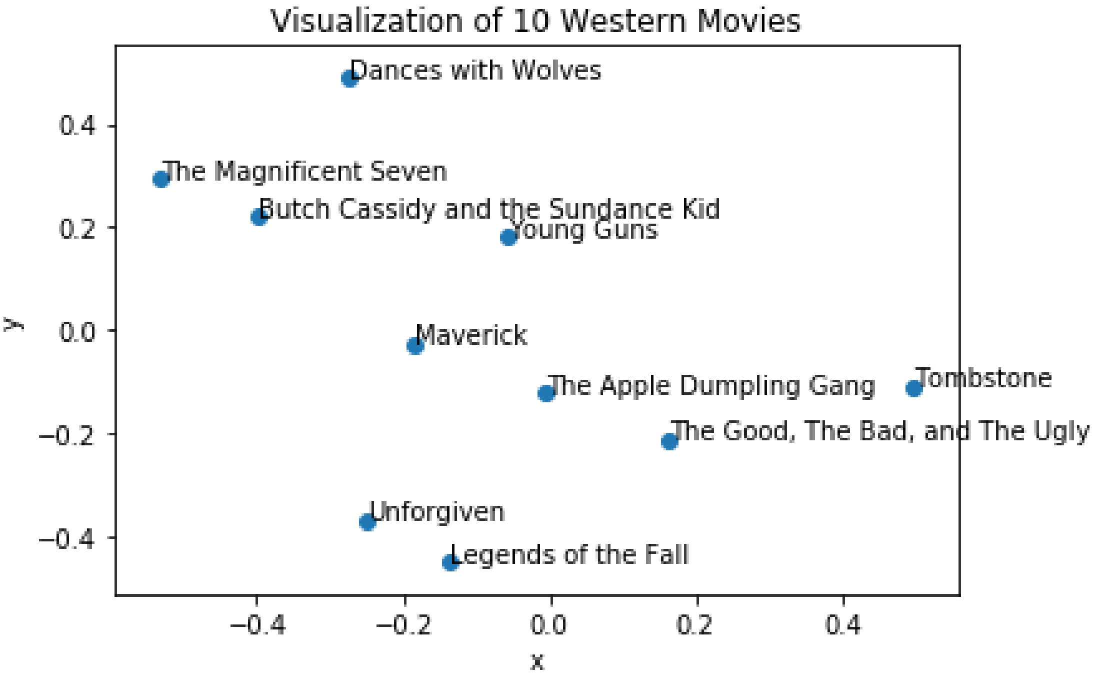
[13]:

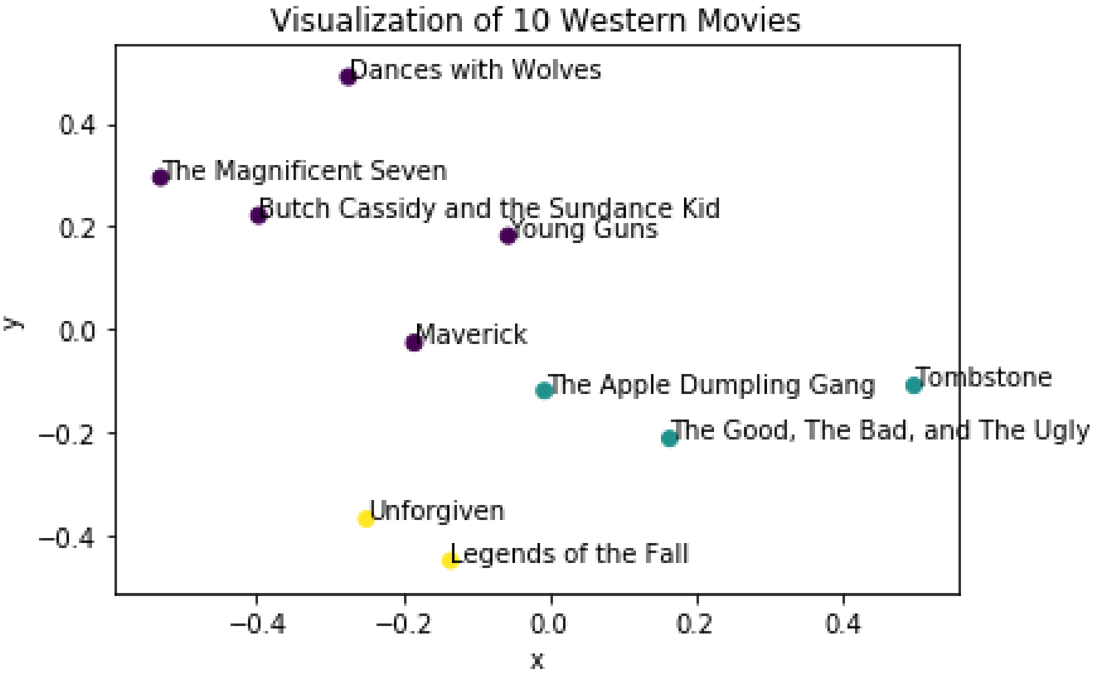
```
# Visualize 10 Western movies
# get all Western movies
western = movies[movies['Western'] == 1]['ID'].head(10)

for i in western:
    print(movies[movies['ID'] == i]['Title'])
```

```
titles = ['Legends of the Fall', 'Maverick', 'Dances with Wolves', 'The Good,␣
 ↪The Bad, and The Ugly', 'Unforgiven', 'Young Guns', 'The Apple Dumpling␣
 ↪Gang', 'Butch Cassidy and the Sundance Kid', 'Tombstone', 'The Magnificent␣
 ↪Seven']

x = [0]*10
y = [0]*10
count = 0

for i in western:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1

# clustering
X = np.column_stack((x, y))
labels = KMeans(n_clusters=3, random_state=0).fit_predict(X)

# plot visualization
fig, ax = plt.subplots()
plt.scatter(x, y)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Western Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_d_2.png')

# plot clusters
fig, ax = plt.subplots()
plt.scatter(x, y, c=labels)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Western Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_d_2_clusters.png')
```

```
50    Legends of the Fall (1994)
Name: Title, dtype: object
72    Maverick (1994)
Name: Title, dtype: object
96    Dances with Wolves (1990)
```

```
Name: Title, dtype: object
176    Good, The Bad and The Ugly, The (1966)
Name: Title, dtype: object
202    Unforgiven (1992)
Name: Title, dtype: object
231    Young Guns (1988)
Name: Title, dtype: object
411    Apple Dumpling Gang, The (1975)
Name: Title, dtype: object
431    Butch Cassidy and the Sundance Kid (1969)
Name: Title, dtype: object
466    Tombstone (1993)
Name: Title, dtype: object
505    Magnificent Seven, The (1954)
Name: Title, dtype: object
```



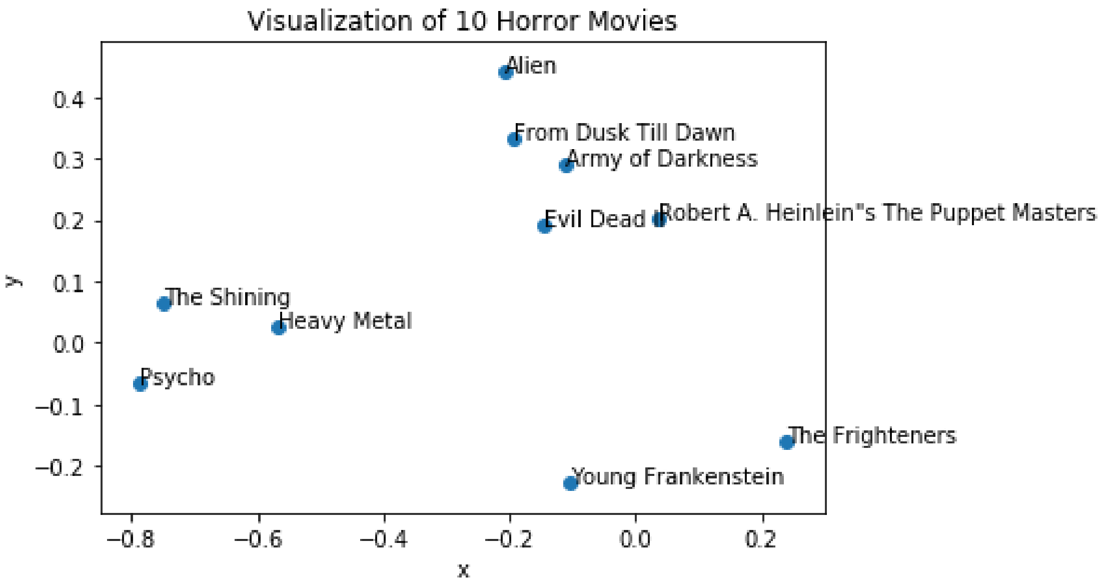


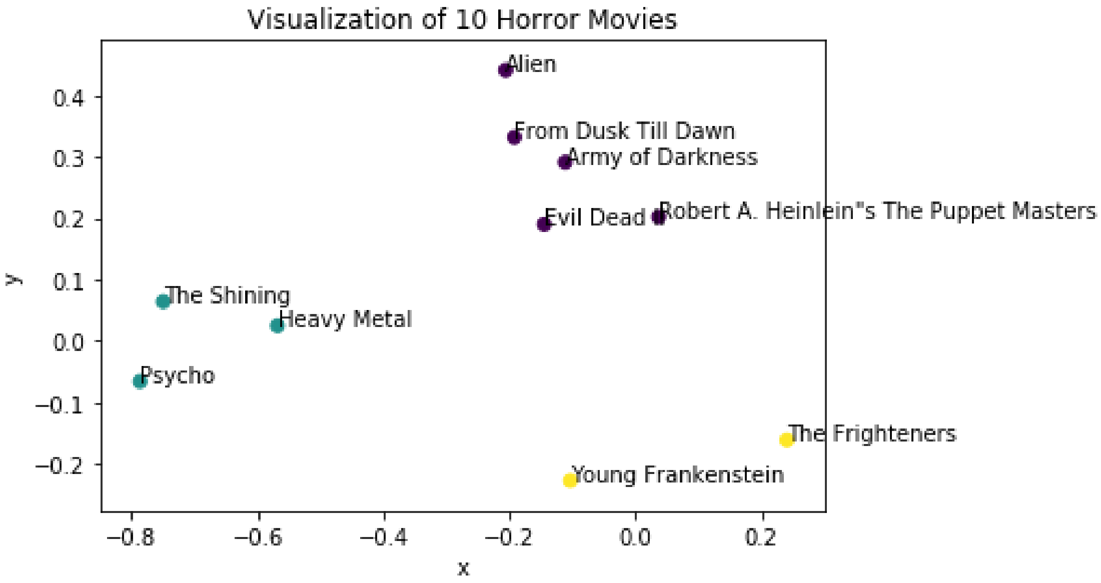
[14]:

```
# Visualize 10 horror movies
horror = movies[movies['Horror'] == 1]['ID'].head(10)

for i in horror:
    print(movies[movies['ID'] == i]['Title'])

titles = ['From Dusk Till Dawn', 'Robert A. Heinlein"s The Puppet Masters',␣
 ↪'Heavy Metal', 'The Frighteners', 'Alien', 'Army of Darkness', 'Psycho',␣
 ↪'The Shining', 'Evil Dead II', 'Young Frankenstein']

x = [0]*10
y = [0]*10
count = 0

for i in horror:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1

# clustering
X = np.column_stack((x, y))
labels = KMeans(n_clusters=3, random_state=0).fit_predict(X)

# plot visualization
```

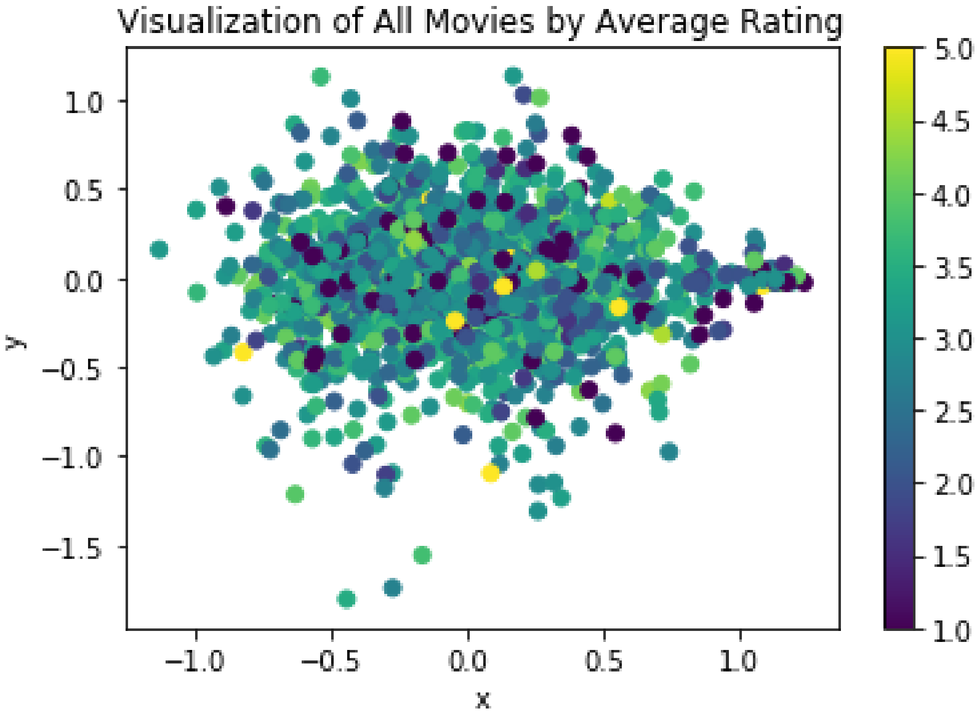
```python
fig, ax = plt.subplots()
plt.scatter(x, y)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Horror Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_d_3_.png')

# plot clusters
fig, ax = plt.subplots()
plt.scatter(x, y, c=labels)

for i, txt in enumerate(titles):
    ax.annotate(txt, (x[i], y[i]))

plt.title('Visualization of 10 Horror Movies')
plt.xlabel('x')
plt.ylabel('y')
plt.savefig('matrix_5_d_3_clusters.png')
```

```
16    From Dusk Till Dawn (1996)
Name: Title, dtype: object
83    Robert A. Heinlein's The Puppet Masters (1994)
Name: Title, dtype: object
100    Heavy Metal (1981)
Name: Title, dtype: object
122    Frighteners, The (1996)
Name: Title, dtype: object
182    Alien (1979)
Name: Title, dtype: object
183    Army of Darkness (1993)
Name: Title, dtype: object
184    Psycho (1960)
Name: Title, dtype: object
199    Shining, The (1980)
Name: Title, dtype: object
200    Evil Dead II (1987)
Name: Title, dtype: object
207    Young Frankenstein (1974)
Name: Title, dtype: object
```



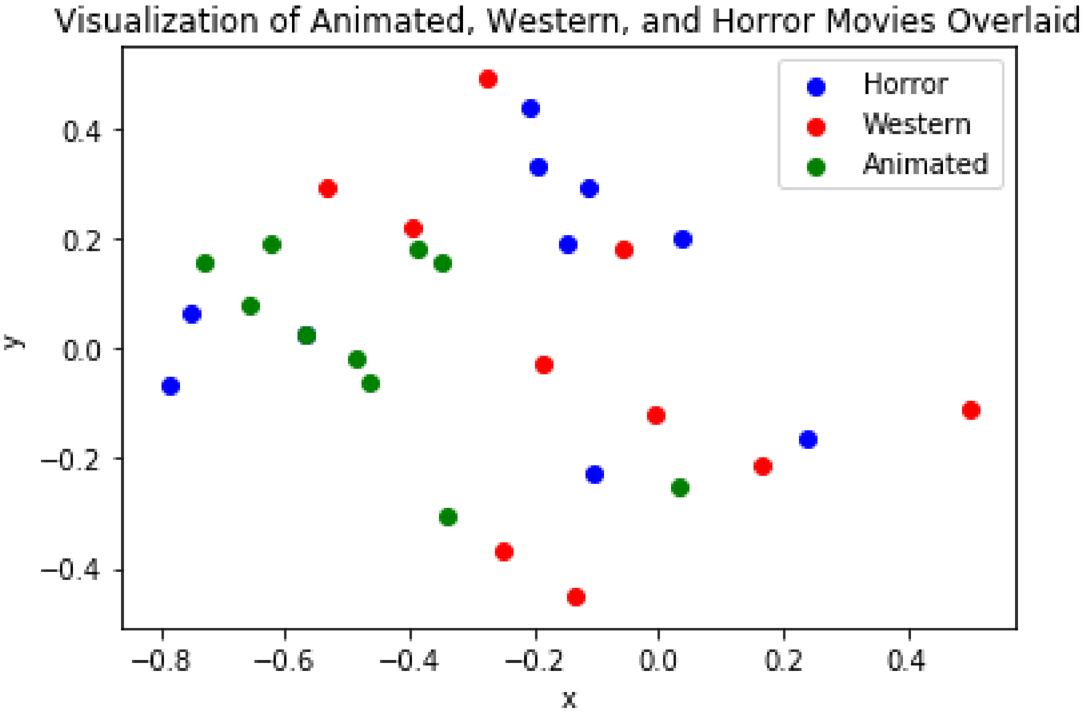


[15]:
```
# visualization of all movies by average rating
ratings = []
for i in range(len(movies)):
    ratings.append(movies['avg_rating'][i])

fig, ax = plt.subplots()
plt.scatter(V_tilde[0], V_tilde[1], c=ratings)
plt.title('Visualization of All Movies by Average Rating')
plt.xlabel('x')
plt.ylabel('y')
plt.colorbar()
plt.savefig('matrix_5_avg_rating.png')
```



[16]:
```
x = [0]*30
y = [0]*30
count = 0

for i in horror:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1
for i in western:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1
for i in animated:
    x[count] = V_tilde[0][i-1]
    y[count] = V_tilde[1][i-1]
    count += 1
```

```
fig, ax = plt.subplots()
plt.scatter(x[:10], y[:10], c='b')
plt.scatter(x[10:20], y[10:20], c='r')
plt.scatter(x[20:30], y[20:30], c='g')

plt.title('Visualization of Animated, Western, and Horror Movies Overlaid')
plt.xlabel('x')
plt.ylabel('y')
plt.legend(['Horror', 'Western', 'Animated'])
plt.savefig('matrix_5_genres.png')
```



```
[ ]:
```