Practice Project - Dataframe based: Advanced GroupBy

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Groupby operations

Some imports:

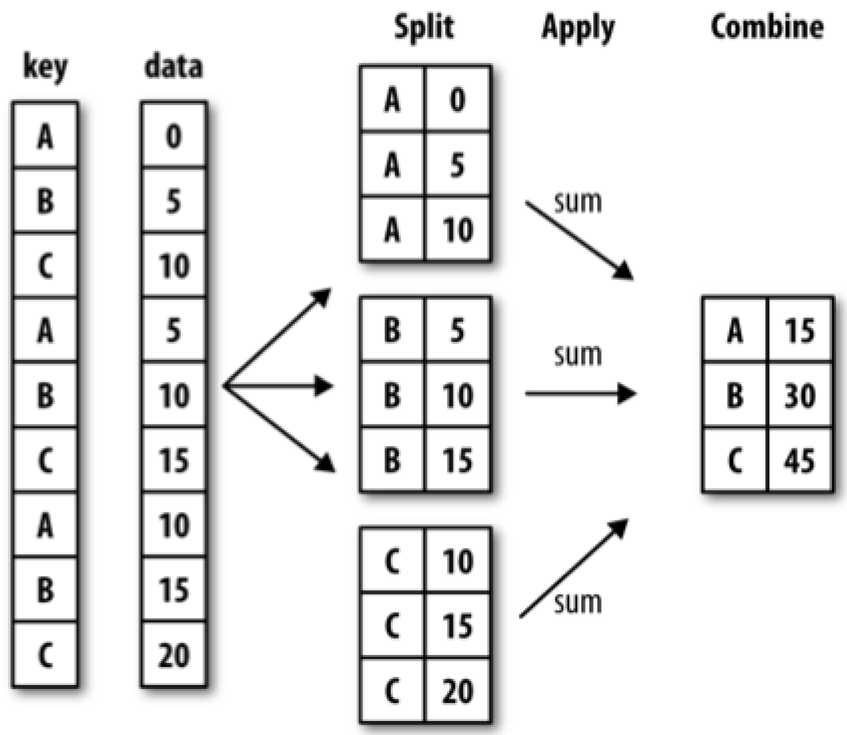
In [ ]:
```
%matplotlib inline
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
try:
    import seaborn
except ImportError:
    pass

pd.options.display.max_rows = 10
```

Recap: the groupby operation (split-apply-combine)

The "group by" concept: we want to **apply the same function on subsets of your dataframe, based on some key to split the dataframe in subsets**

This operation is also referred to as the "split-apply-combine" operation, involving the following steps:

- **Splitting** the data into groups based on some criteria
- **Applying** a function to each group independently
- **Combining** the results into a data structure



Similar to SQL `GROUP BY`

The example of the image in pandas syntax:

In [ ]:
```
df = pd.DataFrame({'key':['A','B','C','A','B','C','A','B','C'],
                   'data': [0, 5, 10, 5, 10, 15, 10, 15, 20]})
df
```

Out[ ]:

	data	key
0	0	A
1	5	B
2	10	C
3	5	A

	data	key
4	10	B
5	15	C
6	10	A
7	15	B
8	20	C

Using the filtering and reductions operations we have seen in the previous notebooks, we could do something like:

```
df[df['key'] == "A"].sum()
df[df['key'] == "B"].sum()
...
```

But pandas provides the `groupby` method to do this:

```
In [ ]: df.groupby('key').aggregate('sum')  # np.sum
```

Out[ ]:

key	data
A	15
B	30
C	45

```
In [ ]: df.groupby('key').sum()
```

Out[ ]:

key	data
A	15

	data
key	
B	30
C	45

Pandas does not only let you group by a column name. In `df.groupby(grouper)` can be many things:

- Series (or string indicating a column in df)
- function (to be applied on the index)
- dict : groups by values
- levels=[], names of levels in a MultiIndex

In [ ]:
```
df.groupby(lambda x: x % 2).mean()
```

Out[ ]:

	data
0	10
1	10

And now applying this on some real data

These exercises are based on the PyCon tutorial of Brandon Rhodes (so all credit to him!) and the datasets he prepared for that. You can download these data from here: `titles.csv` and `cast.csv` and put them in the `/data` folder.

`cast` dataset: different roles played by actors/actresses in films

- title: title of the film
- name: name of the actor/actress
- type: actor/actress
- n: the order of the role (n=1: leading role)

In [ ]:
```
cast = pd.read_csv('data/cast.csv')
cast.head()
```

Out[ ]:

	title	year	name	type	character	n
0	Suuri illusioni	1985	Homo $	actor	Guests	22.0
1	Gangsta Rap: The Glockumentary	2007	Too $hort	actor	Himself	NaN
2	Menace II Society	1993	Too $hort	actor	Lew-Loc	27.0
3	Porndogs: The Adventures of Sadie	2009	Too $hort	actor	Bosco	3.0
4	Stop Pepper Palmer	2014	Too $hort	actor	Himself	NaN

In [ ]:

```
titles = pd.read_csv('data/titles.csv')
titles.head()
```

Out[ ]:

	title	year
0	The Rising Son	1990
1	Ashes of Kukulcan	2016
2	The Thousand Plane Raid	1969
3	Crucea de piatra	1993
4	The 86	2015

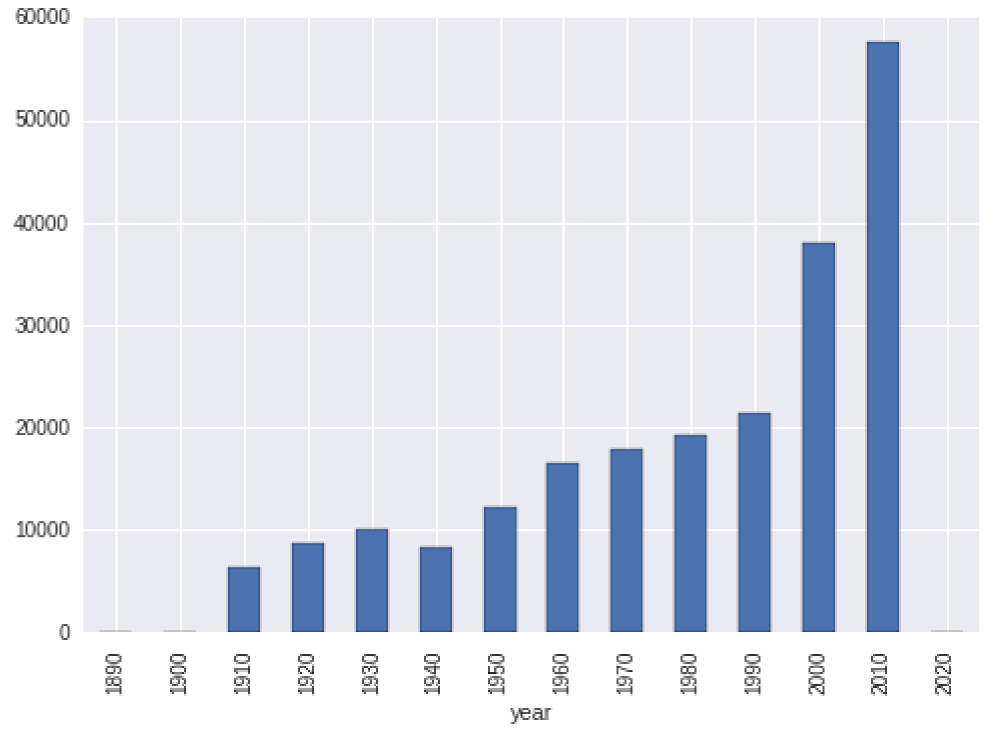
EXERCISE: Using groupby(), plot the number of films that have been released each decade in the history of cinema.

In [ ]:

```
titles.groupby(titles.year // 10 * 10).size().plot(kind='bar')
```

Out[ ]:

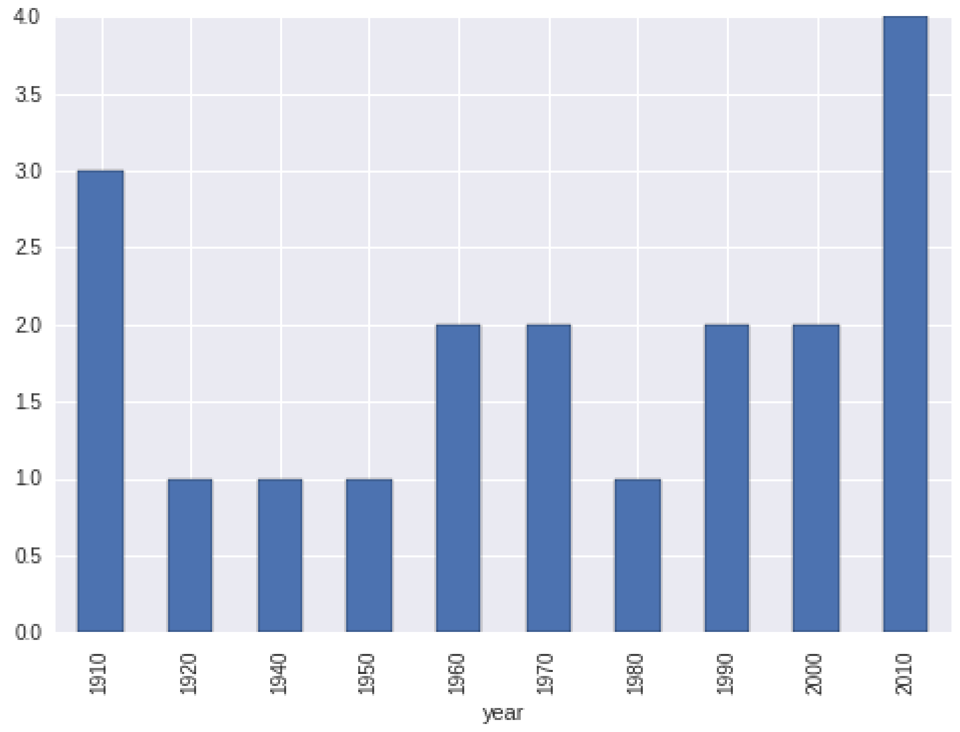
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f710e20d9e8>
```



EXERCISE: Use groupby() to plot the number of "Hamlet" films made each decade.

In [ ]:
```
hamlet = titles[titles['title'] == 'Hamlet']
hamlet.groupby(hamlet.year // 10 * 10).size().plot(kind='bar')
```

Out[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f710c6b4940>
```



EXERCISE: How many leading (n=1) roles were available to actors, and how many to actresses, in each year of the 1950s?

In [ ]:
```
cast1950 = cast[cast.year // 10 == 195]
cast1950 = cast1950[cast1950.n == 1]
cast1950.groupby(['year', 'type']).size()
```

Out[ ]:
```
year  type
1950  actor      604
      actress    271
1951  actor      633
      actress    272
1952  actor      591
                ...
1957  actress    284
1958  actor      694
      actress    275
1959  actor      678
```

```
      actress    287
dtype: int64
```

EXERCISE: List the 10 actors/actresses that have the most leading roles (n=1) since the 1990's.

In [ ]:

```
cast1990 = cast[cast['year'] >= 1990]
cast1990 = cast1990[cast1990.n == 1]
cast1990.groupby('name').size().nlargest(10)
```

Out[ ]:

```
name
Mohanlal              126
Mammootty             118
Akshay Kumar           87
Jayaram                76
Andy Lau               72
Ajay Devgn             69
Amitabh Bachchan       68
Eric Roberts           68
Nagarjuna Akkineni     60
Dilip                  59
dtype: int64
```

EXERCISE: Use groupby() to determine how many roles are listed for each of The Pink Panther movies.

In [ ]:

```
c = cast
c = c[c.title == 'The Pink Panther']
c = c.groupby(['year'])[['n']].max()
c
```

Out[ ]:

	n
year	
1963	15.0
2006	50.0

EXERCISE: List, in order by year, each of the films in which Frank Oz has played more than 1 role.

In [ ]:
```
c = cast
c = c[c.name == 'Frank Oz']
g = c.groupby(['year', 'title']).size()
g[g > 1]
```

Out[ ]:
```
year  title
1979  The Muppet Movie                           8
1981  An American Werewolf in London             2
      The Great Muppet Caper                     6
1982  The Dark Crystal                           2
1984  The Muppets Take Manhattan                 7
1985  Sesame Street Presents: Follow that Bird   3
1992  The Muppet Christmas Carol                 7
1996  Muppet Treasure Island                     4
1999  Muppets from Space                         4
      The Adventures of Elmo in Grouchland       3
dtype: int64
```

EXERCISE: List each of the characters that Frank Oz has portrayed at least twice.

In [ ]:
```
c = cast
c = c[c.name == 'Frank Oz']
g = c.groupby(['character']).size()
g[g > 1].sort_values()
```

Out[ ]:
```
character
Grover            2
Bert              3
Cookie Monster    3
Fozzie Bear       4
Sam the Eagle     5
Yoda              5
Animal            6
Miss Piggy        6
dtype: int64
```

Transforms

Sometimes you don't want to aggregate the groups, but transform the values in each group. This can be achieved with `transform` :

In [ ]:
```
df
```

Out[ ]:

	data	key
0	0	A
1	5	B
2	10	C
3	5	A
4	10	B
5	15	C
6	10	A
7	15	B
8	20	C

In [ ]:
```
df.groupby('key').transform('mean')
```

Out[ ]:

	data
0	5
1	10
2	15
3	5
4	10
5	15
6	5
7	10
8	15

In [ ]:
```
def normalize(group):
    return (group - group.mean()) / group.std()
```

In [ ]:
```
df.groupby('key').transform(normalize)
```

Out[ ]:

	data
0	-1.0
1	-1.0
2	-1.0
3	0.0
4	0.0
5	0.0
6	1.0
7	1.0
8	1.0

In [ ]:
```
df.groupby('key').transform('sum')
```

Out[ ]:

	data
0	15
1	30
2	45
3	15
4	30
5	45
6	15

	data
7	30
8	45

EXERCISE: Add a column to the $c*$ dataframe that indicates the number of roles for the film.

In [ ]:
```
cast['n_total'] = cast.groupby('title')['n'].transform('max')
cast.head()
```

Out[ ]:

	title	year	name	type	character	n	n_total
0	Suuri illusioni	1985	Homo $	actor	Guests	22.0	22.0
1	Gangsta Rap: The Glockumentary	2007	Too $hort	actor	Himself	NaN	NaN
2	Menace II Society	1993	Too $hort	actor	Lew-Loc	27.0	45.0
3	Porndogs: The Adventures of Sadie	2009	Too $hort	actor	Bosco	3.0	9.0
4	Stop Pepper Palmer	2014	Too $hort	actor	Himself	NaN	NaN

EXERCISE: Calculate the ratio of leading actor and actress roles to the total number of leading roles per decade.

Tip: you can to do a groupby twice in two steps, once calculating the numbers, and then the ratios.

In [ ]:
```
leading = cast[cast['n'] == 1]
sums_decade = leading.groupby([cast['year'] // 10 * 10, 'type']).size()
sums_decade
```

Out[ ]:
```
year  type
1900  actor          5
      actress        1
1910  actor       2406
      actress     2753
1920  actor       4485
                  ...
2000  actress     7537
```

```
2010  actor      17262
      actress     7384
2020  actor          3
      actress        1
dtype: int64
```

In [ ]:

```
#sums_decade.groupby(level='year').transform(lambda x: x / x.sum())
ratios_decade = sums_decade / sums_decade.groupby(level='year').transform('sum')
ratios_decade
```

Out[ ]:

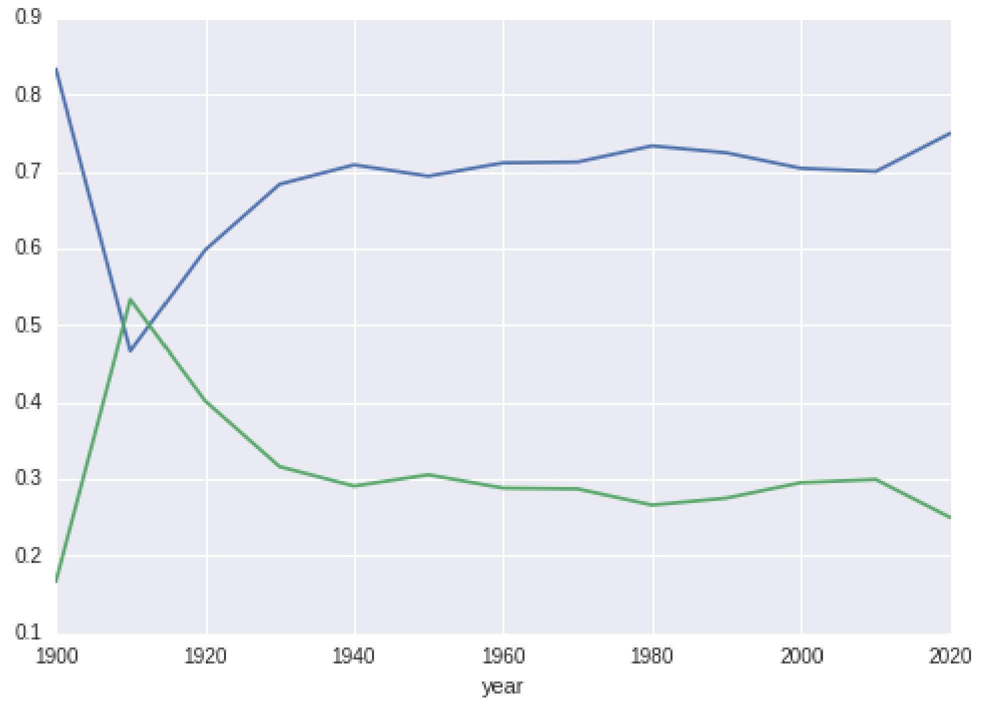
```
year  type
1900  actor      0.833333
      actress    0.166667
1910  actor      0.466369
      actress    0.533631
1920  actor      0.598080
                   ...
2000  actress    0.295464
2010  actor      0.700398
      actress    0.299602
2020  actor      0.750000
      actress    0.250000
dtype: float64
```

In [ ]:

```
ratios_decade[:, 'actor'].plot()
ratios_decade[:, 'actress'].plot()
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f710c5b3e80>
```



Intermezzo: string manipulations

Python strings have a lot of useful methods available to manipulate or check the content of the string:

In [ ]:
```
s = 'Bradwurst'
```

In [ ]:
```
s.startswith('B')
```

Out[ ]:
```
True
```

In pandas, those methods (together with some additional methods) are also available for string Series through the `.str` accessor:

In [ ]:
```
s = pd.Series(['Bradwurst', 'Kartoffelsalat', 'Sauerkraut'])
```

In [ ]:
```
s.str.startswith('B')
```

Out[ ]:
```
0     True
1    False
2    False
dtype: bool
```

For an overview of all string methods, see: http://pandas.pydata.org/pandas-docs/stable/api.html#string-handling

EXERCISE: We already plotted the number of 'Hamlet' films released each decade, but not all titles are exactly called 'Hamlet'. Give an overview of the titles that contain 'Hamlet', and that start with 'Hamlet':

In [ ]:
```
hamlets = titles[titles['title'].str.contains('Hamlet')]
hamlets['title'].value_counts()
```

Out[ ]:
```
Hamlet                             19
Hamlet (II)                         5
Hamlet (III)                        2
Han, hun og Hamlet                  2
Fuck Hamlet                         1
                                   ..
Hamlet: Prince of Denmark           1
Zombie Hamlet                       1
Hamlet_X                            1
Dogg's Hamlet, Cahoot's Macbeth     1
Predstava 'Hamleta' u Mrdusi Donjoj     1
Name: title, dtype: int64
```

In [ ]:
```
hamlets = titles[titles['title'].str.match('Hamlet')]
hamlets['title'].value_counts()
```

Out[ ]:
```
Hamlet                          19
Hamlet (II)                      5
Hamlet (III)                     2
Hamlet the Vampire Slayer        1
Hamlet's Ghost                   1
                                ..
Hamlet: Prince of Denmark        1
Hamlet (A Modern Adaptation)     1
Hamlet_X                         1
Hamlet: The Fall of a Sparrow    1
Hamlet in the Hamptons           1
Name: title, dtype: int64
```

EXERCISE: List the 10 movie titles with the longest name.

In [ ]:
```
title_longest = titles['title'].str.len().nlargest(10)
title_longest
```

Out[ ]:
```
127048    208
28483     196
103597    116
8396      114
85693     104
108020    104
206303    101
122757     99
52929      94
187654     92
Name: title, dtype: int64
```

In [ ]:
```
pd.options.display.max_colwidth = 210
titles.loc[title_longest.index]
```

Out[ ]:

	title	year
127048	Night of the Day of the Dawn of the Son of the Bride of the Return of the Revenge of the Terror of the Attack of the Evil Mutant Hellbound Flesh Eating Crawling Alien Zombified Subhumanoid Living Dead, Part 5	2011
28483	Night of the Day of the Dawn of the Son of the Bride of the Return of the Revenge of the Terror of the Attack of the Evil, Mutant, Hellbound, Flesh-Eating Subhumanoid Zombified Living Dead, Part 3	2005
103597	Maverick and Ariel's First Ever Ever Movie Hollywood or Else... (Ang pinakamahabang title ng movie sa balat ng lupa)	2010
8396	The Fable of the Kid Who Shifted His Ideals to Golf and Finally Became a Baseball Fan and Took the Only Known Cure	1916
85693	Film d'amore e d'anarchia, ovvero 'stamattina alle 10 in via dei Fiori nella nota casa di tolleranza...'	1973
108020	Those Magnificent Men in Their Flying Machines or How I Flew from London to Paris in 25 hours 11 minutes	1965
206303	Ontologica! or a Brief Explanation of Absolutely Everything that is Known about Absolutely Everything	2012
122757	The Official Motion Pictures of the Heavyweight Boxing Contest Between Gene Tunney and Jack Dempsey	1927
52929	Something Strange: 23 Peculiar Perspectives of Metaphysical Phenomena in a Modern American Age	2012
187654	The Personal History, Adventures, Experience, & Observation of David Copperfield the Younger	1935

Value counts

A useful shortcut to calculate the number of occurences of certain values is `value_counts` (this is somewhat equivalent to `df.groupby(key).size())`)

For example, what are the most occuring movie titles?

In [ ]:

```
titles.title.value_counts().head()
```

Out[ ]:

```
Hamlet                  19
Macbeth                 14
Carmen                  14
The Three Musketeers    12
She                     11
Name: title, dtype: int64
```

EXERCISE: Which years saw the most films released?

In [ ]:

```
t = titles
t.year.value_counts().head(3)
```

Out[ ]:

```
2015    13978
2014     8209
2013     7664
Name: year, dtype: int64
```

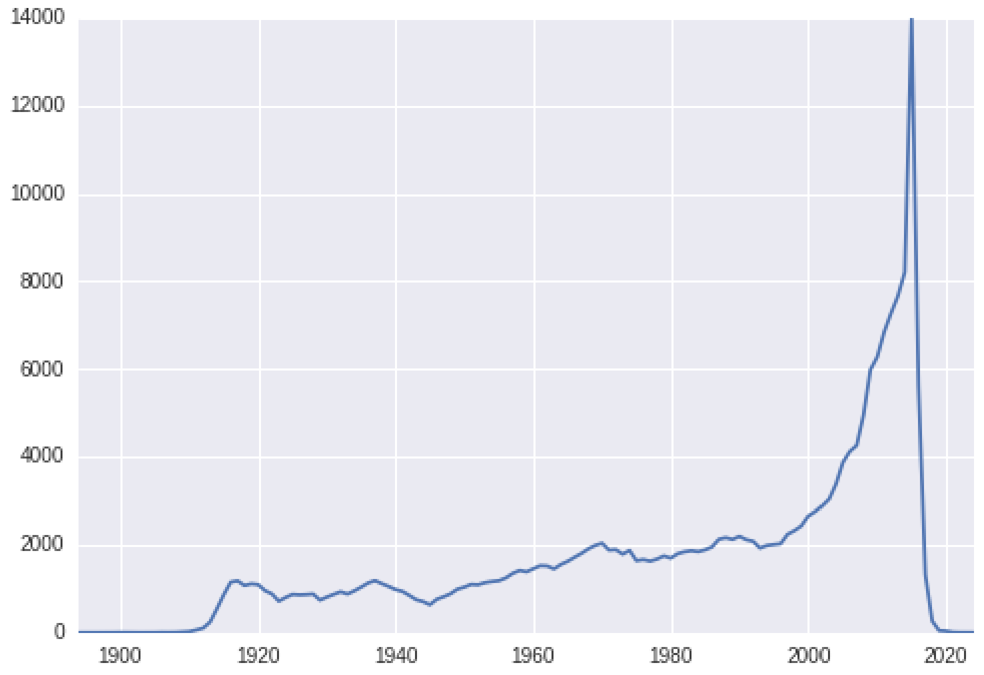
EXERCISE: Plot the number of released films over time

In [ ]:

```
titles.year.value_counts().sort_index().plot()
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f710c4ddcf8>
```



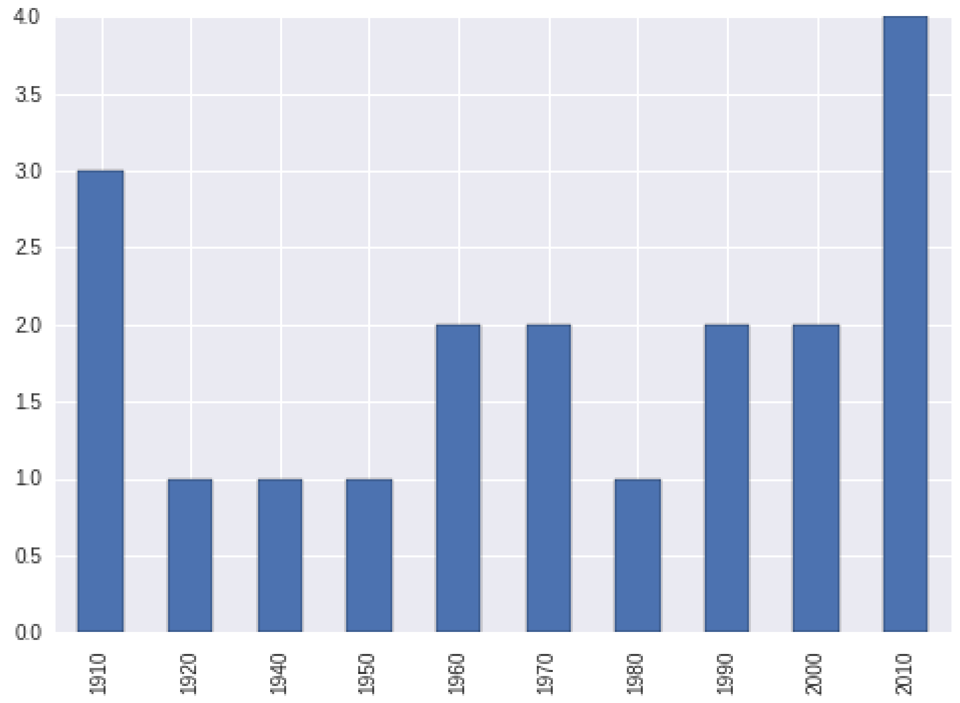
EXERCISE: Plot the number of "Hamlet" films made each decade.

In [ ]:

```
t = titles
t = t[t.title == 'Hamlet']
(t.year // 10 * 10).value_counts().sort_index().plot(kind='bar')
```

Out[ ]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f710c4aeb38>
```



EXERCISE: What are the 11 most common character names in movie history?

In [ ]:
```
cast.character.value_counts().head(11)
```

Out[ ]:
```
Himself        18928
Dancer         11070
Extra           9141
Reporter        7646
Doctor          6846
               ...  
Student         6406
Bartender       6178
Nurse           6164
Party Guest     5917
Minor Role      5880
Name: character, dtype: int64
```

EXERCISE: Which actors or actresses appeared in the most movies in the year 2010?

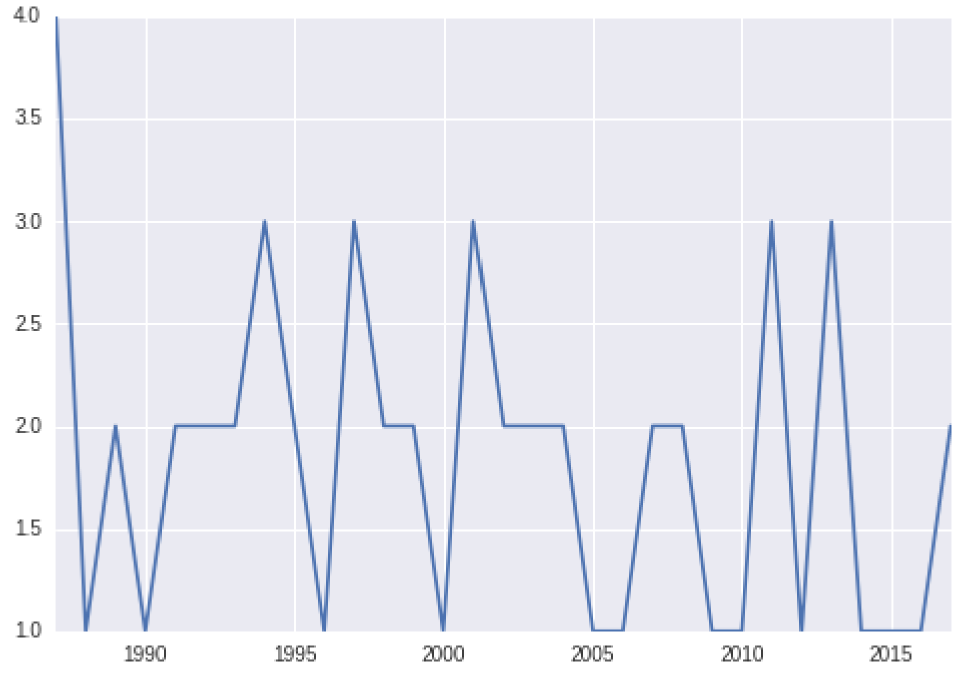
In [ ]:
```
cast[cast.year == 2010].name.value_counts().head(10)
```

Out[ ]:
```
Lloyd Kaufman           23
Jagathi Sreekumar       20
Suraaj Venjarammoodu    20
Chris (II) Eddy         20
Danny Trejo             17
Matt Simpson Siegel     17
Brahmanandam            15
Joe Estevez             15
Ben (II) Bishop         15
Kyle Rea                15
Name: name, dtype: int64
```

EXERCISE: Plot how many roles Brad Pitt has played in each year of his career.

In [ ]:
```
cast[cast.name == 'Brad Pitt'].year.value_counts().sort_index().plot()
```

Out[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f710c490550>
```



EXERCISE: What are the 10 most film titles roles that start with the word "The Life"?

In [ ]:
```
c = cast
c[c.title.str.startswith('The Life')].title.value_counts().head(10)
```

Out[ ]:
```
The Life of David Gale                          137
The Life Aquatic with Steve Zissou               78
The Life Before Her Eyes                         74
The Life of Riley                                73
The Life and Death of Peter Sellers              65
The Life and Death of Colonel Blimp              58
The Life and Hard Times of Guy Terrifico         53
The Life and Times of Judge Roy Bean             50
The Life of Emile Zola                           46
The Life of the Party                            45
Name: title, dtype: int64
```

EXERCISE: How many leading (n=1) roles were available to actors, and how many to actresses, in the 1950s? And in 2000s?

In [ ]:
```
c = cast
c = c[c.year // 10 == 195]
c = c[c.n == 1]
c.type.value_counts()
```

Out[ ]:
```
actor      6388
actress    2813
Name: type, dtype: int64
```

In [ ]:
```
c = cast
c = c[c.year // 10 == 200]
c = c[c.n == 1]
c.type.value_counts()
```

Out[ ]:
```
actor      17972
actress     7537
Name: type, dtype: int64
```

```
In [ ]:
```