Module 10: Logscale

In [1]:
```
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns
import numpy as np
import scipy.stats as ss
import vega_datasets
%matplotlib inline
```

Ratio and logarithm

If you use linear scale to visualize ratios, it can be quite misleading.

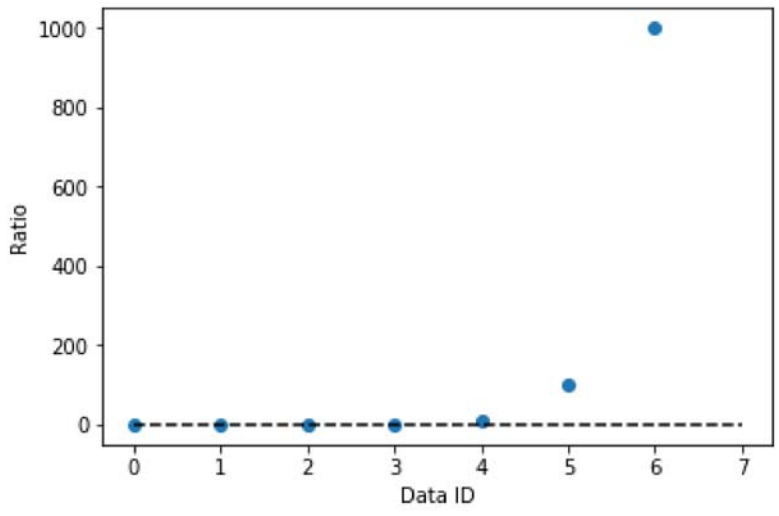
Let's first create some ratios.

In [2]:
```
x = np.array([1,    1,   1,  1, 10, 100, 1000])
y = np.array([1000, 100, 10, 1, 1,  1,   1   ])
ratio = x/y
print(ratio)
```

```
[1.e-03 1.e-02 1.e-01 1.e+00 1.e+01 1.e+02 1.e+03]
```

Q: Plot on the linear scale using the `scatter()` (http://matplotlib.org/examples/shapes_and_collections/scatter_demo.html) function. Also draw a horizontal line at ratio=1 for a reference.

In [86]:
```
x1 = [0,len(ratio)] # create an array of integers 0 to 7
y1 = [1,1] # create an array of 1s
plt.scatter(np.arange(len(ratio)), ratio)
plt.ylabel("Ratio")
plt.xlabel("Data ID")
plt.plot(x1, y1, 'k--')
plt.show()
```

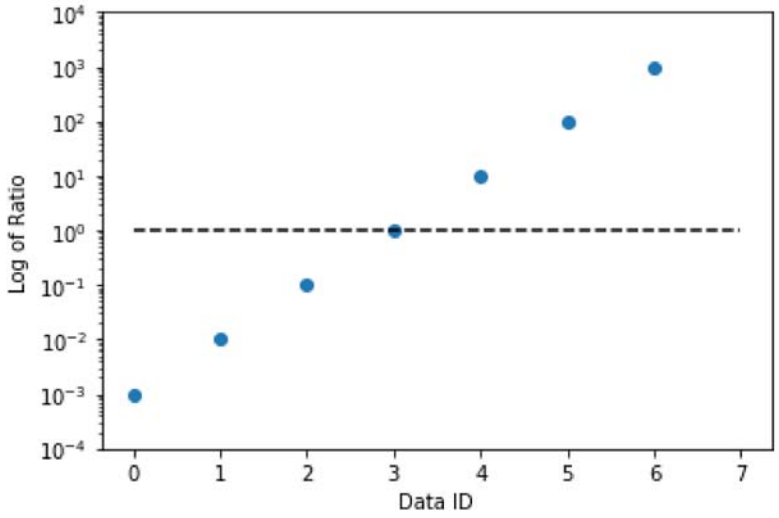


Q: Explain what's bad about this plot.

In [ ]:
```
The Y axis is hiding the ratio points for the first 5 points since the distance between
0 and 200 is too short.
It is impossible to distinguish the ratio points on this scale
```

Q: Can you fix it?

In [89]:
```
# Implement
plt.scatter(np.arange(len(ratio)), ratio)
plt.yscale('log')
plt.ylim((0.0001,10000))
plt.ylabel("Log of Ratio")
plt.xlabel("Data ID")
plt.plot(x1, y1, 'k--')
plt.show()
```



Log-binning

Let's first see what happens if we do not use the log scale for a dataset with a heavy tail.

Q: Load the movie dataset from `vega_datasets` and remove the NaN rows based on the following three columns: `IMDB_Rating`, `IMDB_Votes`, `Rotten_Tomatoes_Rating`.

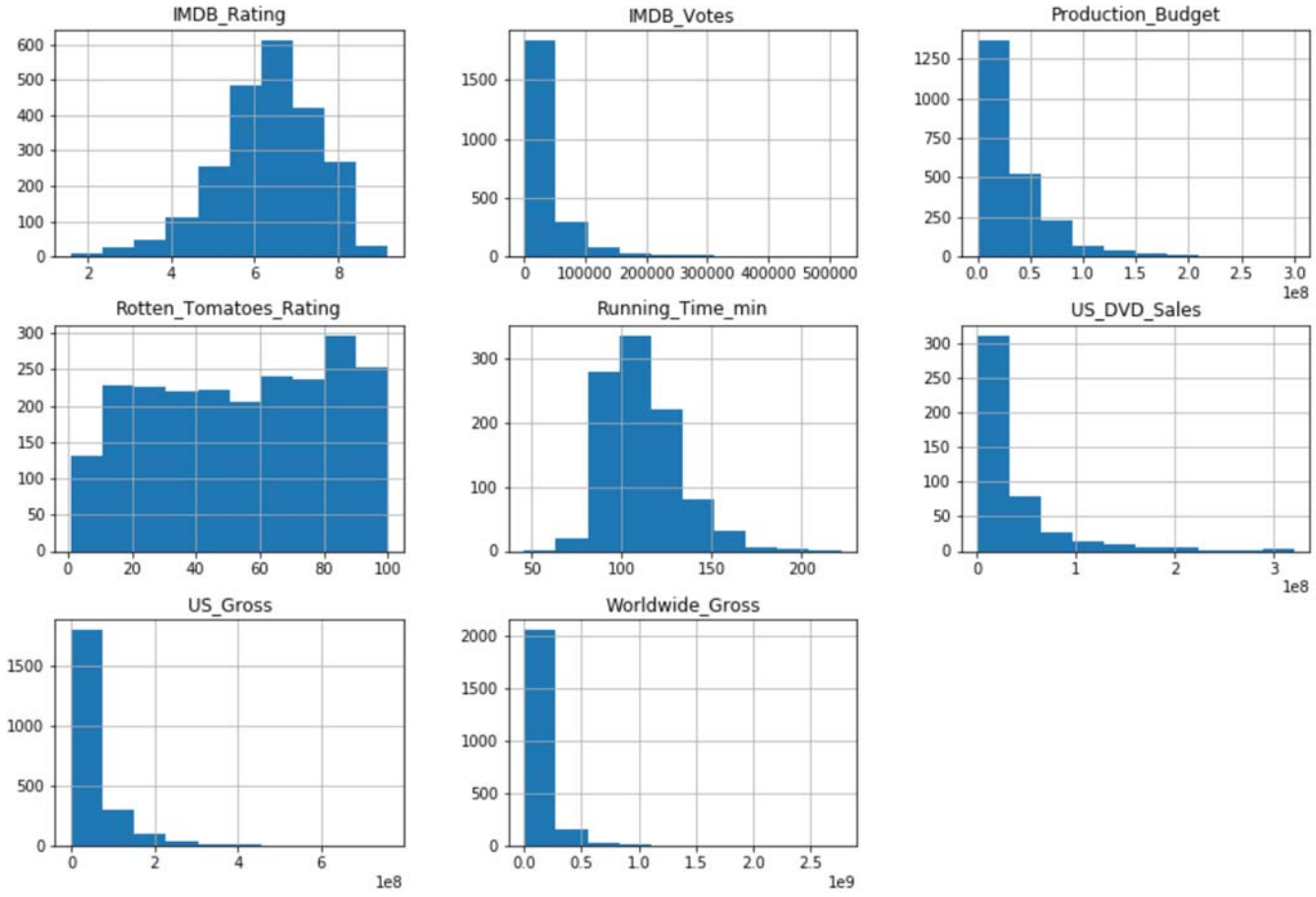
In [30]:
```
# Implement
import vega_datasets

movies = vega_datasets.data.movies()
movies=movies.dropna(subset=['IMDB_Rating', 'IMDB_Votes', 'Rotten_Tomatoes_Rating'])
```

If you simply call `hist()` method with a dataframe object, it identifies all the numeric columns and draw a histogram for each.

Q: draw all possible histograms of the movie dataframe. Adjust the size of the plots if needed.

In [61]:
```
# Implement
movies.hist(figsize=(15,10), layout=(3,3))
```

Out[61]:
```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x0000016C2FF9F518>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x0000016C2FFC5128>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x0000016C30202780>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x0000016C30225E10>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x0000016C302554E0>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x0000016C30255518>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x0000016C302A8240>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x0000016C302CB8D0>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x0000016C302F1F60>]],
      dtype=object)
```

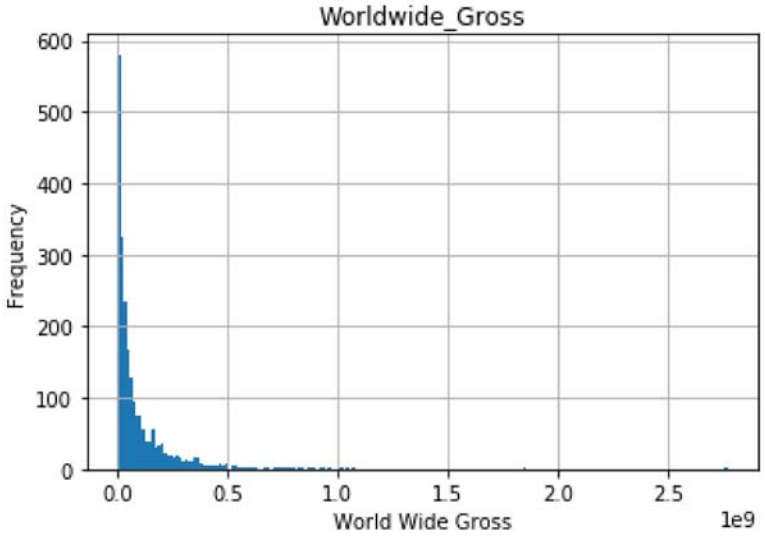


As we can see, a majority of the columns are not normally distributed. In particular, if you look at the worldwide gross variable, you only see a couple of meaningful data from the histogram. Is this a problem of resolution? How about increasing the number of bins?

Q: Play with the number of bins, and then increase the number of bins to 200.

In [66]:
```
movies.hist(column= 'Worldwide_Gross', bins=200)
plt.xlabel("World Wide Gross")
plt.ylabel("Frequency")
```

Out[66]: Text(0,0.5,'Frequency')

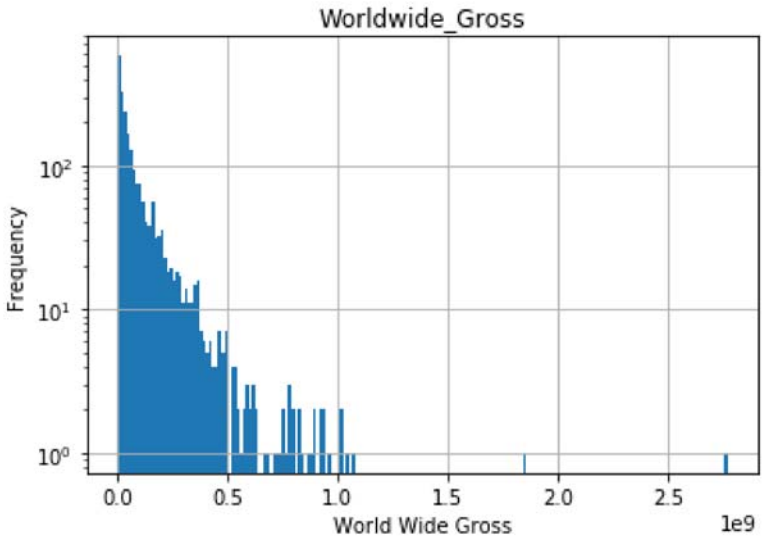


Maybe a bit more useful, but it doesn't tell anything about the data distribution above certain point.

Q: How about changing the vertical scale to logarithmic scale?

In [75]:
```
movies.hist(column='Worldwide_Gross',log=True,  bins=200)

plt.xlabel("World Wide Gross")
plt.ylabel("Frequency")
```

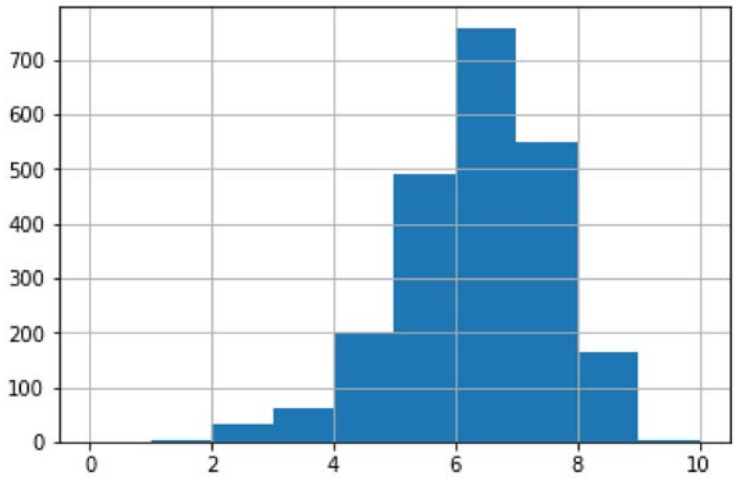
Out[75]: Text(0,0.5,'Frequency')



Now, let's try log-bin. Recall that when plotting histgrams we can specify the edges of bins through the `bins` parameter. For example, we can specify the edges of bins to [1, 2, 3, ... , 10] as follows.

In [76]:
```
movies.IMDB_Rating.hist(bins=range(0,11))
```

Out[76]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x16c352445c0>
```



Here, we can specify the edges of bins in a similar way. Instead of specifying on the linear scale, we do it on the log space. Some useful resources:

- Google query: python log-bin (https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=python+log-bin&pws=0)
- numpy.logspace (http://docs.scipy.org/doc/numpy/reference/generated/numpy.logspace.html)
- numpy.linspace vs numpy.logspace (http://stackoverflow.com/questions/31480033/difference-in-output-between-numpy-linspace-and-numpy-logspace)

Hint: since $10^{\text{start}} = \min(\text{Worldwide\_Gross}), \text{start} = \log_{10}(\min(\text{Worldwide\_Gross}))$

In [77]:
```
min(movies.Worldwide_Gross)
```

Out[77]:
```
0.0
```

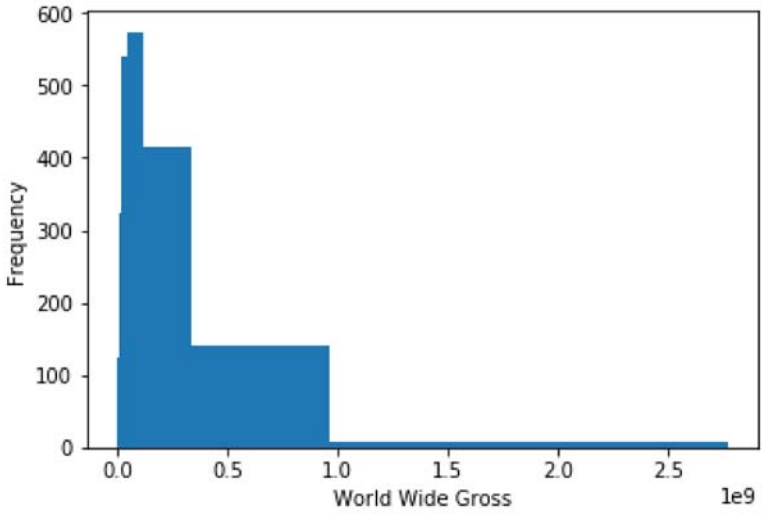
Because there seems to be movie(s) that made $0, and because log(0) is undefined & log(1) = 0, let's add 1 to the variable.

In [96]:
```
movies.Worldwide_Gross = movies.Worldwide_Gross+1.0
```

Q: now create logarithmic bins. Create 20 bins from the minimum value to the maximum value.

In [201]:
```
bins=np.logspace(np.log10(min(movies.Worldwide_Gross)), np.log10(max(movies.Worldwide_Gr
oss)+1),20)
plt.hist(movies['Worldwide_Gross'], bins=bins)
plt.xlabel("World Wide Gross")
plt.ylabel("Frequency")
```

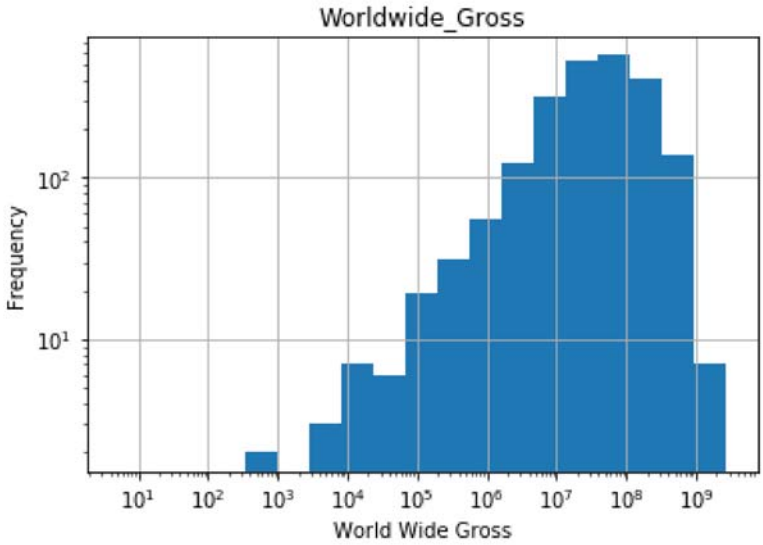
Out[201]: Text(0,0.5,'Frequency')



Now we can plot a histgram with log-bin. Set both axis to be log-scale.

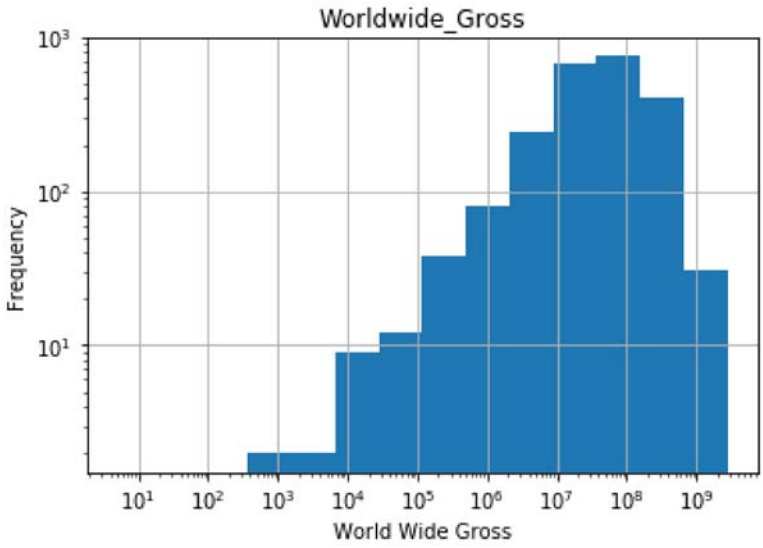
In [202]:
```
bins=np.logspace(np.log10(min(movies.Worldwide_Gross)), np.log10(max(movies.Worldwide_Gr
oss)+1),20)
movies.hist(column='Worldwide_Gross',log=True, bins=bins) # yaxis is log
plt.xscale('log') #xaxis is log
plt.xlabel("World Wide Gross")
plt.ylabel("Frequency")
```

Out[202]: Text(0,0.5,'Frequency')



In [203]:
```
bins=np.logspace(np.log10(min(movies.Worldwide_Gross)), np.log10(max(movies.Worldwide_Gr
oss)),15)
movies.hist(column='Worldwide_Gross',log=True, bins=bins) # yaxis is log
plt.xscale('log') #xaxis is log
plt.xlabel("World Wide Gross")
plt.ylabel("Frequency")
```

Out[203]: Text(0,0.5,'Frequency')



Q: explain and fix Q: Can you explain the plot? Why are there gaps?

Answers: When plotting discrete data, it is ineviteble that, dpending on the size of the bins, not all the bins will contain the data. There is an isolated occurance of movies < 1000 in World Wide Gross value, majority of the data is located above 2000 We could decrease the number of bins to impute .

CCDF

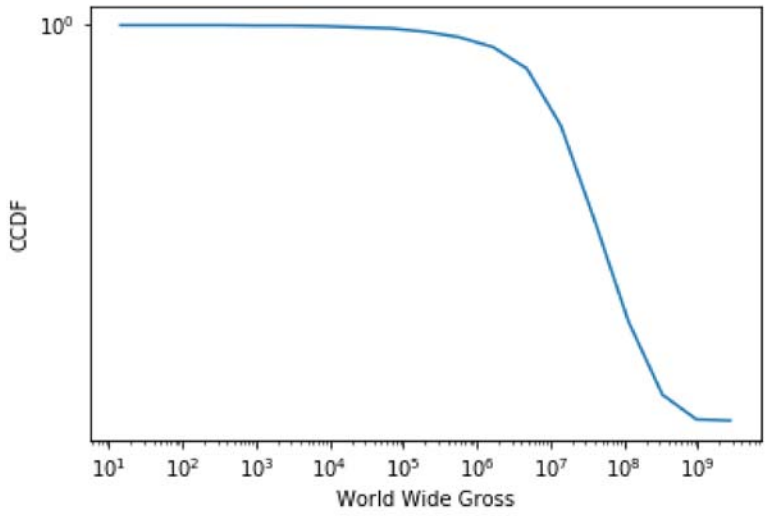
CCDF is a nice alternative to examine distributions with heavy tails. The idea is same as CDF, but the direction of aggregation is opposite. We have done CDF before. It's just a small change to that code.

Q: Draw a CCDF in log-log scale

In [194]:
```
counts, bin_edges = np.histogram (movies.Worldwide_Gross, bins=bins, normed=True)
ccdf = 1-np.cumsum(counts)
plt.xscale('log') #xaxis is log
plt.yscale('log') #yaxis is log
plt.xlabel("World Wide Gross")
plt.ylabel("CCDF")
plt.plot (bin_edges[1:], ccdf)
```

```
C:\Users\yyezeret\AppData\Local\Continuum\Anaconda2\envs\dviz\lib\site-packages\ipykern
el_launcher.py:1: VisibleDeprecationWarning: Passing `normed=True` on non-uniform bins
has always been broken, and computes neither the probability density function nor the p
robability mass function. The result is only correct if the bins are uniform, when dens
ity=True will produce the same result anyway. The argument will be removed in a future
version of numpy.
  """Entry point for launching an IPython kernel.
```

Out[194]:
```
[<matplotlib.lines.Line2D at 0x16c45bf00f0>]
```



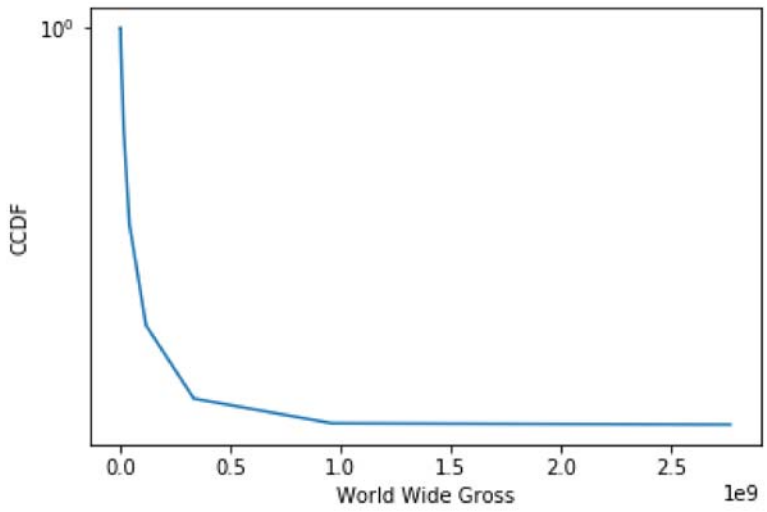
We can also try in semilog scale (only one axis is in a log-scale), where the horizontal axis is linear.

Q: Draw a CCDF in semilog scale

In [200]:
```
counts, bin_edges = np.histogram (movies.Worldwide_Gross, bins=bins, normed=True)
ccdf = 1-np.cumsum (counts)
plt.yscale('log') #yaxis is log
plt.xlabel("World Wide Gross")
plt.ylabel("CCDF")
plt.plot (bin_edges[1:], ccdf)
```

```
C:\Users\yyezeret\AppData\Local\Continuum\Anaconda2\envs\dviz\lib\site-packages\ipykern
el_launcher.py:1: VisibleDeprecationWarning: Passing `normed=True` on non-uniform bins
has always been broken, and computes neither the probability density function nor the p
robability mass function. The result is only correct if the bins are uniform, when dens
ity=True will produce the same result anyway. The argument will be removed in a future
version of numpy.
  """Entry point for launching an IPython kernel.
```

Out[200]:
```
[<matplotlib.lines.Line2D at 0x16c471a1828>]
```



A straight line in semilog scale means exponential decay (cf. a straight line in log-log scale means power-law decay). So it seems like the amount of money a movie makes across the world follows *roughly* an exponential distribution, while there are some outliers that make insane amount of money.

Q: Which is the most successful movie in our dataset?

You can use the following

- `idxmax()`: https://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.idxmax.html (https://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.idxmax.html)
- `loc`: https://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.loc.html (https://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.loc.html) or `iloc`: https://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.iloc.html (https://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.iloc.html)

Which one should you use, `loc` or `iloc`? How are they different from each other?

In [207]:
```
# Return label of an index of first occurrence of maximum Worldwide_Gross.
max_gross_index= movies.Worldwide_Gross.idxmax()
```

In [210]:
```
# loc interprets the label of an index, never the integer position of an index
movies.loc[lambda movies: movies['Worldwide_Gross'] == max(movies.Worldwide_Gross)]
```

Out[210]:

	Creative_Type	Director	Distributor	IMDB_Rating	IMDB_Votes	MPAA_Rating	Major_Genre
1234	Science Fiction	James Cameron	20th Century Fox	8.3	261439.0	PG-13	Action

In [208]:
```
# Returns the row per index, Access group of values using labels of index
movies.loc[max_gross_index]
```

Out[208]:
```
Creative_Type                 Science Fiction
Director                        James Cameron
Distributor                   20th Century Fox
IMDB_Rating                                8.3
IMDB_Votes                              261439
MPAA_Rating                              PG-13
Major_Genre                             Action
Production_Budget                     2.37e+08
Release_Date                         18-Dec-09
Rotten_Tomatoes_Rating                      83
Running_Time_min                           NaN
Source                     Original Screenplay
Title                                   Avatar
US_DVD_Sales                         1.46154e+08
US_Gross                             7.60168e+08
Worldwide_Gross                      2.76789e+09
Name: 1234, dtype: object
```

In [209]:
```
# Access group of rows and columns by integer position of an index
movies.iloc[max_gross_index]
```

Out[209]:
```
Creative_Type              Contemporary Fiction
Director                         Garry Marshall
Distributor                           Universal
IMDB_Rating                                 5.8
IMDB_Votes                                10902
MPAA_Rating                                   R
Major_Genre                               Drama
Production_Budget                           2e+07
Release_Date                          11-May-07
Rotten_Tomatoes_Rating                       17
Running_Time_min                            111
Source                      Original Screenplay
Title                              Georgia Rule
US_DVD_Sales                          1.93823e+07
US_Gross                              1.88829e+07
Worldwide_Gross                       2.08196e+07
Name: 1808, dtype: object
```

In [ ]:
```
#After comparing loc() and iloc() we can easily see that the loc function is based on th
e label of the index and returns, in our case,
# the correct row ("Avatar"), identified by the max_gross_index that was computed by idx
max().
# iloc() function is based on the integer position of the row. By providing max_gross_in
dex as an input for iloc
# we mistakenly selected a movie that locates on the respective row without a reference
 to the index of the most
# successful movie in the dataset.
```