*You are currently looking at **version 1.1** of this notebook. To download notebooks and datafiles, as well as get help on Jupyter notebooks in the Coursera platform, visit the Jupyter Notebook FAQ (https://www.coursera.org/learn/python-data-analysis/resources/0dhYG) course resource.*

In [ ]:

```
import pandas as pd
import numpy as np
from scipy.stats import ttest_ind
```

Assignment 4 - Hypothesis Testing

This assignment requires more individual learning than previous assignments - you are encouraged to check out the pandas documentation (http://pandas.pydata.org/pandas-docs/stable/) to find functions or methods you might not have used yet, or ask questions on Stack Overflow (http://stackoverflow.com/) and tag them as pandas and python related. And of course, the discussion forums are open for interaction with your peers and the course staff.

Definitions:

- A *quarter* is a specific three month period, Q1 is January through March, Q2 is April through June, Q3 is July through September, Q4 is October through December.
- A *recession* is defined as starting with two consecutive quarters of GDP decline, and ending with two consecutive quarters of GDP growth.
- A *recession bottom* is the quarter within a recession which had the lowest GDP.
- A *university town* is a city which has a high percentage of university students compared to the total population of the city.

Hypothesis: University towns have their mean housing prices less effected by recessions. Run a t-test to compare the ratio of the mean price of houses in university towns the quarter before the recession starts compared to the recession bottom. (`price_ratio=quarter_before_recession/recession_bottom`)

The following data files are available for this assignment:

- From the Zillow research data site (http://www.zillow.com/research/data/) there is housing data for the United States. In particular the datafile for all homes at a city level (http://files.zillowstatic.com/research/public/City/City_Zhvi_AllHomes.csv), `City_Zhvi_AllHomes.csv` , has median home sale prices at a fine grained level.
- From the Wikipedia page on college towns is a list of university towns in the United States (https://en.wikipedia.org/wiki/List_of_college_towns#College_towns_in_the_United_States) which has been copy and pasted into the file `university_towns.txt` .
- From Bureau of Economic Analysis, US Department of Commerce, the GDP over time (http://www.bea.gov/national/index.htm#gdp) of the United States in current dollars (use the chained value in 2009 dollars), in quarterly intervals, in the file `gdplev.xls` . For this assignment, only look at GDP data from the first quarter of 2000 onward.

Each function in this assignment below is worth 10%, with the exception of `run_ttest()` , which is worth 50%.

In [ ]:

```
# Use this dictionary to map state names to two letter acronyms
states = {'OH': 'Ohio', 'KY': 'Kentucky', 'AS': 'American Samoa', 'NV': 'Nevada', 'W
```

In [ ]:

```
def get_list_of_university_towns():
    '''Returns a DataFrame of towns and the states they are in from the
    university_towns.txt list. The format of the DataFrame should be:
    DataFrame( [ ["Michigan", "Ann Arbor"], ["Michigan", "Yipsilanti"] ],
    columns=["State", "RegionName"]  )

    The following cleaning needs to be done:

    1. For "State", removing characters from "[" to the end.
    2. For "RegionName", when applicable, removing every character from " (" to the
    3. Depending on how you read the data, you may need to remove newline character

    return "ANSWER"
```

In [ ]:

```
def get_recession_start():
    '''Returns the year and quarter of the recession start time as a
    string value in a format such as 2005q3'''

    return "ANSWER"
```

In [ ]:

```
def get_recession_end():
    '''Returns the year and quarter of the recession end time as a
    string value in a format such as 2005q3'''

    return "ANSWER"
```

In [ ]:

```
def get_recession_bottom():
    '''Returns the year and quarter of the recession bottom time as a
    string value in a format such as 2005q3'''

    return "ANSWER"
```

In [ ]:

```
def convert_housing_data_to_quarters():
    '''Converts the housing data to quarters and returns it as mean
    values in a dataframe. This dataframe should be a dataframe with
    columns for 2000q1 through 2016q3, and should have a multi-index
    in the shape of ["State","RegionName"].

    Note: Quarters are defined in the assignment description, they are
    not arbitrary three month periods.

    The resulting dataframe should have 67 columns, and 10,730 rows.
    '''

    return "ANSWER"
```

In [ ]:

```
def run_ttest():
    '''First creates new data showing the decline or growth of housing prices
    between the recession start and the recession bottom. Then runs a ttest
    comparing the university town values to the non-university towns values,
    return whether the alternative hypothesis (that the two groups are the same)
    is true or not as well as the p-value of the confidence.

    Return the tuple (different, p, better) where different=True if the t-test is
    True at a p<0.01 (we reject the null hypothesis), or different=False if
    otherwise (we cannot reject the null hypothesis). The variable p should
    be equal to the exact p value returned from scipy.stats.ttest_ind(). The
    value for better should be either "university town" or "non-university town"
    depending on which has a lower mean price ratio (which is equivilent to a
    reduced market loss).'''

    return "ANSWER"
```