project_1_starter

March 14, 2020

1 Project 1: Trading with Momentum

1.1 Instructions

Each problem consists of a function to implement and instructions on how to implement the function. The parts of the function that need to be implemented are marked with a `# TODO` comment. After implementing the function, run the cell to test it against the unit tests we've provided. For each problem, we provide one or more unit tests from our `project_tests` package. These unit tests won't tell you if your answer is correct, but will warn you of any major errors. Your code will be checked for the correct solution when you submit it to Udacity.

1.2 Packages

When you implement the functions, you'll only need to you use the packages you've used in the classroom, like Pandas and Numpy. These packages will be imported for you. We recommend you don't add any import statements, otherwise the grader might not be able to run your code.

The other packages that we're importing are `helper`, `project_helper`, and `project_tests`. These are custom packages built to help you solve the problems. The `helper` and `project_helper` module contains utility functions and graph functions. The `project_tests` contains the unit tests for all the problems.

1.2.1 Install Packages

```
In [1]: import sys
        !{sys.executable} -m pip install -r requirements.txt
```

```
Requirement already satisfied: colour==0.1.5 in /opt/conda/lib/python3.6/site-packages (from -r
Requirement already satisfied: cvxpy==1.0.3 in /opt/conda/lib/python3.6/site-packages (from -r r
Requirement already satisfied: cycler==0.10.0 in /opt/conda/lib/python3.6/site-packages/cycler-0
Requirement already satisfied: numpy==1.13.3 in /opt/conda/lib/python3.6/site-packages (from -r
Requirement already satisfied: pandas==0.21.1 in /opt/conda/lib/python3.6/site-packages (from -r
Requirement already satisfied: plotly==2.2.3 in /opt/conda/lib/python3.6/site-packages (from -r
Requirement already satisfied: pyparsing==2.2.0 in /opt/conda/lib/python3.6/site-packages (from
Requirement already satisfied: python-dateutil==2.6.1 in /opt/conda/lib/python3.6/site-packages
Requirement already satisfied: pytz==2017.3 in /opt/conda/lib/python3.6/site-packages (from -r r
Requirement already satisfied: requests==2.18.4 in /opt/conda/lib/python3.6/site-packages (from
Requirement already satisfied: scipy==1.0.0 in /opt/conda/lib/python3.6/site-packages (from -r r
Requirement already satisfied: scikit-learn==0.19.1 in /opt/conda/lib/python3.6/site-packages (f
```

```
Requirement already satisfied: six==1.11.0 in /opt/conda/lib/python3.6/site-packages (from -r re
Requirement already satisfied: tqdm==4.19.5 in /opt/conda/lib/python3.6/site-packages (from -r r
Requirement already satisfied: osqp in /opt/conda/lib/python3.6/site-packages (from cvxpy==1.0.3
Requirement already satisfied: toolz in /opt/conda/lib/python3.6/site-packages (from cvxpy==1.0.
Requirement already satisfied: multiprocess in /opt/conda/lib/python3.6/site-packages (from cvxp
Requirement already satisfied: fastcache in /opt/conda/lib/python3.6/site-packages (from cvxpy==
Requirement already satisfied: ecos>=2 in /opt/conda/lib/python3.6/site-packages (from cvxpy==1.
Requirement already satisfied: scs>=1.1.3 in /opt/conda/lib/python3.6/site-packages (from cvxpy=
Requirement already satisfied: nbformat>=4.2 in /opt/conda/lib/python3.6/site-packages (from plo
Requirement already satisfied: decorator>=4.0.6 in /opt/conda/lib/python3.6/site-packages (from
Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /opt/conda/lib/python3.6/site-packages (
Requirement already satisfied: idna<2.7,>=2.5 in /opt/conda/lib/python3.6/site-packages (from re
Requirement already satisfied: urllib3<1.23,>=1.21.1 in /opt/conda/lib/python3.6/site-packages (
Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/lib/python3.6/site-packages (fro
Requirement already satisfied: future in /opt/conda/lib/python3.6/site-packages (from osqp->cvxp
Requirement already satisfied: dill>=0.3.1 in /opt/conda/lib/python3.6/site-packages (from multi
Requirement already satisfied: jupyter-core in /opt/conda/lib/python3.6/site-packages (from nbfo
Requirement already satisfied: ipython-genutils in /opt/conda/lib/python3.6/site-packages (from
Requirement already satisfied: traitlets>=4.1 in /opt/conda/lib/python3.6/site-packages (from nb
Requirement already satisfied: jsonschema!=2.5.0,>=2.4 in /opt/conda/lib/python3.6/site-packages
```

1.2.2 Load Packages

```
In [2]: import pandas as pd
        import numpy as np
        import helper
        import project_helper
        import project_tests
```

1.3 Market Data

1.3.1 Load Data

The data we use for most of the projects is end of day data. This contains data for many stocks, but we'll be looking at stocks in the S&P 500. We also made things a little easier to run by narrowing down our range of time period instead of using all of the data.

```
In [3]: df = pd.read_csv('../../data/project_1/eod-quotemedia.csv', parse_dates=['date'], index_

        close = df.reset_index().pivot(index='date', columns='ticker', values='adj_close')

        print('Loaded Data')

Loaded Data
```

1.3.2 View Data

Run the cell below to see what the data looks like for `close`.

```
In [4]: project_helper.print_dataframe(close)
```

1.3.3 Stock Example

Let's see what a single stock looks like from the closing prices. For this example and future display examples in this project, we'll use Apple's stock (AAPL). If we tried to graph all the stocks, it would be too much information.

```
In [5]: apple_ticker = 'AAPL'
        project_helper.plot_stock(close[apple_ticker], '{} Stock'.format(apple_ticker))
```

1.4 Resample Adjusted Prices

The trading signal you'll develop in this project does not need to be based on daily prices, for instance, you can use month-end prices to perform trading once a month. To do this, you must first resample the daily adjusted closing prices into monthly buckets, and select the last observation of each month.

Implement the `resample_prices` to resample `close_prices` at the sampling frequency of `freq`.

```
In [6]: def resample_prices(close_prices, freq='M'):
            """
            Resample close prices for each ticker at specified frequency.

            Parameters
            ----------
            close_prices : DataFrame
                Close prices for each ticker and date
            freq : str
                What frequency to sample at
                For valid freq choices, see http://pandas.pydata.org/pandas-docs/stable/timeseri

            Returns
            -------
            prices_resampled : DataFrame
                Resampled prices for each ticker and date
            """
            # TODO: Implement Function
            check = close_prices.resample(freq).last()
            print(check)
            return check


        project_tests.test_resample_prices(resample_prices)

                          HCEX        YORZ         GHLV       ODTT        NSJK
        2008-08-31   21.05081048  17.01384381   10.98450376  11.24809343  12.96171273
        2008-09-30  482.34539247  35.20258059  3516.54167823  66.40531433  13.50396048
        2008-10-31   10.91893302  17.90864387   24.80126542  12.48895419  10.52435923
        2008-11-30   11.54549538  23.98146843   24.97476306  36.03196210  14.30433232
        Tests Passed
```

1.4.1   View Data

Let's apply this function to `close` and view the results.

```
In [7]: monthly_close = resample_prices(close)
        project_helper.plot_resampled_prices(
            monthly_close.loc[:, apple_ticker],
            close.loc[:, apple_ticker],
            '{} Stock - Close Vs Monthly Close'.format(apple_ticker))
```

```
ticker              A         AAL         AAP          AAPL         ABBV  \
date
2013-07-31  30.77861719  18.63139292   81.73270857   58.73000866  38.52144972
2013-08-31  32.09288410  15.55986096   79.33492514   63.64994327  36.09056668
2013-09-30  35.34697923  18.25587647   81.98212977   62.28266407  37.88620154
2013-10-31  35.00902763  21.15409315   98.34285959   68.28583759  41.39637606
2013-11-30  36.94707663  22.60801580  100.15741326   73.07037475  41.39637606
2013-12-31  39.53485221  24.31228275  109.80605374   73.72082947  45.12162270
2014-01-31  40.19849023  32.30404302  113.90344263   65.78133976  42.40046983
2014-02-28  39.35511692  35.55851889  126.35434591   69.56208595  43.84740848
2014-03-31  38.65691442  35.24077420  125.56160936   70.95004943  44.26943225
2014-04-30  37.44602782  33.76759430  120.39025770   78.00222579  45.26058952
2014-05-31  39.45552968  38.66856535  123.24889355   84.14255587  47.21597213
2014-06-30  39.89336706  41.36458087  133.98342494   86.47010113  49.04968649
2014-07-31  38.95576181  37.50350151  120.26928991   88.95449982  45.83414944
2014-08-31  39.69890079  37.53342708  135.47301238   95.84930753  48.40870808
2014-09-30  39.66634256  34.25030202  129.45327437   94.21285594  50.58044463
2014-10-31  38.48289605  40.01590351  146.00501306  100.99244110  55.99653498
2014-11-30  41.16610236  46.96425145  146.12423326  111.69411705  61.06145951
2014-12-31  39.43238724  51.89970750  158.30385803  103.66431211  57.74366923
2015-01-31  36.46881439  47.49650651  158.02557400  110.03180655  53.66393519
2015-02-28  40.75585532  46.44954689  153.98051686  121.11705716  53.79731697
2015-03-31  40.21618088  51.18177630  148.83252640  117.31741727  52.05446174
2015-04-30  40.04195916  46.91986067  142.18084892  117.99626112  57.97557525
2015-05-31  39.86773744  41.17209272  152.34230539  123.34294830  59.70605561
2015-06-30  37.43482962  38.80593634  158.43730330  118.74646370  60.24402878
2015-07-31  39.73448090  38.96627137  173.27743492  114.84110860  63.23267196
2015-08-31  35.23221004  37.96773731  174.31186769  107.23801710  56.36839104
2015-09-30  33.40767610  37.82163263  188.57875989  104.56562594  49.14283218
2015-10-31  36.74552431  45.01972341  197.43409130  113.64795179  54.29511396
2015-11-30  40.69644669  40.27495546  161.91326754  112.99053695  53.01865452
2015-12-31  40.79862571  41.33893271  149.81538015  100.53578968  54.01246937
2016-01-31  36.73925516  38.05914962  151.34827289   92.97124993  50.61292076
2016-02-29  36.44651209  40.13373983  147.75493343   92.84754723  50.34556653
2016-03-31  38.88603766  40.14352854  159.66025522  104.65874623  52.65956346
2016-04-30  40.04407095  33.95705938  155.43823026   90.01478000  56.77932921
2016-05-31  44.90768367  31.32651866  153.18781130   96.47778143  58.57578996
2016-06-30  43.52297301  27.79234545  161.00763909   92.36206594  57.62636511
2016-07-31  47.20221441  34.85087472  169.20594924  100.68044865  62.18997907
```

```
2016-08-31  46.09353634  35.74268695  156.77400383  103.05832580  60.18990877
2016-09-30  46.31429082  36.04792753  148.60671775  109.80908324  59.22273863
2016-10-31  42.85227545  39.97666915  139.59783411  110.28503592  52.86517692
2016-11-30  43.25552156  45.84312511  169.13581100  107.90875084  57.62285329
2016-12-31  44.93909238  46.08991196  168.59615688  113.08352807  59.34774792
2017-01-31  48.30261971  43.68127231  163.73127251  118.48287110  58.52291275
2017-02-28  50.60086565  45.86299598  156.12490616  134.32908516  59.22200826
2017-03-31  52.27967020  41.84652135  147.85939394  140.86952606  62.40145631
2017-04-30  54.43532901  42.16309078  141.75593049  140.85972030  63.77814835
2017-05-31  59.66626253  47.99551598  133.26892494  150.40575387  63.85552554
2017-06-30  58.77942143  49.88916265  116.33305213  141.80044954  70.13275003

ticker             ABC          ABT          ACN         ADBE          ADI  \
date
2013-07-31   53.87744989  32.99081455   66.22844876   47.28000000  43.44107832
2013-08-31   53.01732111  30.01866909   64.82868748   45.75000000  41.01373554
2013-09-30   56.91072241  29.89257807   66.07591068   51.94000000  41.69611619
2013-10-31   60.85069550  33.05576095   66.82299697   54.22000000  43.69008561
2013-11-30   65.91719111  34.53897430   70.43234797   56.78000000  42.73298029
2013-12-31   65.71157957  34.66559008   74.75084097   59.87900000  45.44926154
2014-01-31   62.82367201  33.34174832   72.62341494   59.19000000  43.07551255
2014-02-28   63.63196980  36.17934393   75.77818772   68.63000000  45.68115222
2014-03-31   61.51246720  35.02429700   72.47794991   65.74000000  47.76655705
2014-04-30   61.12795566  35.44286191   73.79678974   61.69000000  46.10362647
2014-05-31   68.86955598  36.60477297   74.92830371   64.54000000  47.41554943
2014-06-30   68.38018499  37.41902561   74.36714638   72.36000000  48.94537529
2014-07-31   72.37985174  38.74046435   72.93205548   69.24990000  44.92618783
2014-08-31   73.05495940  38.85083604   74.56953099   71.90000000  46.27496921
2014-09-30   72.97000080  38.25298937   74.80871281   69.19000000  45.12932334
2014-10-31   80.62571498  40.30485158   75.62824982   70.12000000  45.24786874
2014-11-30   86.22959708  41.15551603   80.48553756   73.68000000  49.82554510
2014-12-31   85.38671579  41.62708002   83.26379427   72.70000000  50.95949386
2015-01-31   90.01782759  41.60933349   78.34124546   70.13000000  47.82500770
2015-02-28   97.60234947  44.03561500   83.93505092   79.10000000  54.09576859
2015-03-31  107.96476318  43.06882084   87.34727226   73.94000000  58.21717495
2015-04-30  108.56314271  43.37506462   87.30393281   76.06000000  57.14523966
2015-05-31  107.18087522  45.41206680   90.49832387   79.09000000  63.16846904
2015-06-30  101.25812252  45.86058104   91.19562458   81.01000000  59.65962603
2015-07-31  100.69631800  47.59360476   97.16037250   81.99000000  54.21743377
2015-08-31   95.52512638  42.52346340   88.83045597   78.57000000  52.30462528
2015-09-30   90.70303633  37.76316400   92.59022599   82.22000000  52.81961891
2015-10-31   92.15443769  42.31010114  102.09916985   88.66000000  56.29348500
2015-11-30   94.51876053  42.42343177  102.11821821   91.46000000  57.70737659
2015-12-31   99.37693283  42.41398755   99.52764225   93.94000000  52.14011467
2016-01-31   85.81812848  35.97710518  100.51815659   89.13000000  50.76403789
2016-02-29   83.32649499  36.82306617   95.48939151   85.15000000  50.34892051
2016-03-31   83.25915657  39.76016670  109.90899441   93.80000000  56.23990573
2016-04-30   81.86428912  37.19691465  108.57606705   94.22000000  53.51294967
```

5

```
2016-05-31    72.45584367 37.89495443 114.39332888  99.47000000 55.98493800
2016-06-30    76.64974019 37.58896439 108.93183348  95.79000000 54.20490408
2016-07-31    82.32213019 43.05587987 108.47029866  97.86000000 61.08578791
2016-08-31    84.36337595 40.42923066 110.57605128 102.31000000 60.27143407
2016-09-30    78.35889972 40.68900916 117.47022770 108.54000000 62.09229421
2016-10-31    68.21240194 37.99400979 112.92602551 107.51000000 61.75509788
2016-11-30    75.99699597 36.86116088 116.02507938 102.81000000 71.92879264
2016-12-31    76.19188505 37.19036483 113.79065183 102.95000000 70.35922577
2017-01-31    85.04959364 40.70456972 110.62359364 113.38000000 72.60700054
2017-02-28    89.53185633 43.93014132 119.00755442 118.34000000 79.81469100
2017-03-31    86.58692258 43.27723105 116.46224999 130.13000000 79.83417463
2017-04-30    80.27635025 42.78546766 119.07013051 133.74000000 74.23263096
2017-05-31    90.16427240 44.76591323 122.18185609 141.86000000 83.54580618
2017-06-30    92.87597984 47.65814810 121.40637874 141.44000000 76.21326984

ticker          ...           XL        XLNX         XOM        XRAY \
date            ...
2013-07-31      ...    28.32843198 41.28388974 79.23671352 41.69639686
2013-08-31      ...    26.71095532 38.60058125 74.17847651 40.83096325
2013-09-30      ...    27.97701372 41.65075616 73.22528819 42.27738327
2013-10-31      ...    27.75007493 40.38659157 76.27208656 45.87069305
2013-11-30      ...    29.03908724 39.71607441 80.10221273 46.31377055
2013-12-31      ...    29.03762468 41.04798868 86.71741472 47.27020113
2014-01-31      ...    26.21046901 41.49493978 78.97111601 44.98859489
2014-02-28      ...    27.72436527 46.91977904 83.07167653 44.24756038
2014-03-31      ...    28.65004581 48.78039097 84.28836983 44.95649687
2014-04-30      ...    28.74172595 42.41655887 88.36990125 43.57967974
2014-05-31      ...    29.75937558 42.46894464 87.33475361 46.17707943
2014-06-30      ...    30.15342116 42.78547212 87.46506509 46.29945567
2014-07-31      ...    29.70199506 37.19650113 85.95345193 45.39008938
2014-08-31      ...    31.48927392 38.47755759 87.00906335 46.64657936
2014-09-30      ...    30.70386959 38.56862873 82.27631618 44.65219370
2014-10-31      ...    31.36108235 40.24433775 84.60332311 49.71473409
2014-11-30      ...    32.87915127 41.65411985 79.77153052 53.83722829
2014-12-31      ...    31.95893586 39.68324930 81.45436267 52.22676701
2015-01-31      ...    32.07051783 35.36108436 77.02261098 49.04531669
2015-02-28      ...    33.66056090 39.12997398 78.59767023 51.97185882
2015-03-31      ...    34.37230484 39.06532687 75.45518376 49.96473725
2015-04-30      ...    34.63383325 40.04426887 77.55905182 50.07273728
2015-05-31      ...    35.19425126 44.10319245 76.26895364 51.08891930
2015-06-30      ...    34.89283405 41.07121423 74.47860261 50.68301939
2015-07-31      ...    35.66197716 38.82978248 70.90685232 55.95287359
2015-08-31      ...    34.97725219 39.24982927 67.98750927 51.52855570
2015-09-30      ...    34.25161012 39.69957666 67.18329763 49.78755231
2015-10-31      ...    35.91137978 44.61868870 74.76457359 59.90849433
2015-11-30      ...    36.00568487 46.86342730 74.44597631 59.72143412
2015-12-31      ...    37.14621703 44.29815215 71.06372586 59.98019070
2016-01-31      ...    34.37779044 47.41043450 70.97256007 58.04820756
```

```
2016-02-29       ...       32.59537880 44.82629704 73.73546496 60.08861832
2016-03-31       ...       35.08467460 45.02565160 76.90015616 60.82633633
2016-04-30       ...       31.20438586 40.89616426 81.32520403 58.82280781
2016-05-31       ...       32.74887425 45.32888670 82.58719221 61.34942506
2016-06-30       ...       31.95111137 44.12368735 86.96611321 61.30575593
2016-07-31       ...       33.19807759 48.85839909 82.52225059 63.28208591
2016-08-31       ...       32.83357977 52.18139308 81.54472705 60.73262024
2016-09-30       ...       32.44904599 52.30652831 81.67573763 58.80295844
2016-10-31       ...       33.48147177 48.96638011 77.97000984 56.96258316
2016-11-30       ...       34.86125577 52.30410593 82.41266747 57.56614710
2016-12-31       ...       36.14475876 58.49571832 85.20695722 57.19702346
2017-01-31       ...       36.44548005 56.39308939 79.19357015 56.17653266
2017-02-28       ...       39.27808058 57.31683497 77.47406925 62.93356886
2017-03-31       ...       38.88040598 56.41060144 78.13143654 61.94954316
2017-04-30       ...       40.82150000 61.49720257 77.78846230 62.74325928
2017-05-31       ...       42.61628041 65.35904193 77.41380602 63.02105992
2017-06-30       ...       42.94541296 63.01744232 77.63498832 64.41695873

ticker             XRX         XYL         YUM         ZBH        ZION  \
date
2013-07-31 23.20721320 23.21996075 47.44778390  80.02819050 28.13385091
2013-08-31 23.87711213 23.18866549 45.56080402  75.81970579 26.58466104
2013-09-30 24.75516170 26.13637721 46.45223934  78.93635707 26.06190225
2013-10-31 23.91314940 32.41710942 44.24404652  84.05847719 26.98861102
2013-11-30 27.37742858 32.47348700 50.82634626  87.84481134 27.91674534
2013-12-31 29.41596107 32.51107205 49.47193667  89.74777084 28.51638903
2014-01-31 26.22540490 31.34593537 44.15869815  90.49895842 27.36469241
2014-02-28 26.56379722 37.09867860 48.71595471  90.37375551 29.73505750
2014-03-31 27.46956274 34.33631194 49.57742745  91.30285476 29.52538722
2014-04-30 29.39000119 35.43937303 50.87349483  93.44593389 27.56211099
2014-05-31 30.02204423 35.28473104 51.08494461 100.73432555 27.28625466
2014-06-30 30.39399301 36.96856003 53.65538096 100.47064033 28.12612539
2014-07-31 32.39745557 33.38332865 46.06203349  96.80432199 27.50576633
2014-08-31 33.74124143 35.24689219 48.07309922  96.06912184 27.85038596
2014-09-30 32.47709229 33.68659998 47.77442609  97.47515588 27.77392642
2014-10-31 32.59983262 34.63853619 47.96561204 107.83824785 27.68790944
2014-11-30 34.26910116 36.52479311 51.58490227 108.85614147 27.09273552
2014-12-31 34.17400779 36.26757625 48.64673308 110.16356556 27.52722344
2015-01-31 32.47270437 32.48553586 48.53977698 108.88146444 23.13406782
2015-02-28 33.65621979 34.14257860 54.46958094 116.93344897 25.85223444
2015-03-31 31.85985442 33.49224377 52.86457172 114.35730077 26.10848438
2015-04-30 28.51271018 35.40499327 58.02888019 106.88398383 27.39940388
2015-05-31 28.31436089 35.11013446 60.83041407 111.23799412 27.98334305
2015-06-30 26.54863674 35.59017458 60.81016202 106.49948745 30.74970193
2015-07-31 27.49680234 33.15157077 59.51729361 101.46847624 30.22162291
2015-08-31 25.37590561 31.28978316 54.09861567 100.97122513 28.15471462
2015-09-30 24.45432240 31.67548157 54.22068852  91.79998287 26.73727036
2015-10-31 23.59980342 35.10819738 48.41248187 102.19870338 27.93141860
```

```
2015-11-30 26.51522110 36.12390903 49.50485207  98.71943223 29.14561278
2015-12-31 26.89106382 35.33018970 49.87352701 100.47823768 26.55791819
2016-01-31 24.66489861 34.79781698 49.73852166  97.21678402 22.06350126
2016-02-29 24.31073596 36.36262153 49.80724975  94.81721601 20.79786927
2016-03-31 28.43385069 39.75491100 56.25394497 104.67189060 23.61709263
2016-04-30 24.45922640 40.61027339 54.98625339 113.64404740 26.84603012
2016-05-31 25.40192575 43.56421944 56.73481072 119.86762225 27.39638148
2016-06-30 24.38556528 43.55446481 57.30844811 118.40845940 24.57070188
2016-07-31 26.46694651 46.63693085 62.13235384 128.99223597 27.25949735
2016-08-31 25.31062361 49.76283955 63.02869399 127.48729377 29.99272827
2016-09-30 26.23024573 51.31853981 63.09817772 128.13190088 30.41433249
2016-10-31 25.29807511 47.28741714 60.30309303 103.86942280 31.58109767
2016-11-30 24.21054271 50.62829165 61.76028216 100.38082929 39.09431152
2016-12-31 22.79351388 48.60630094 61.70182472 101.93820644 42.28748851
2017-01-31 26.32055115 48.40017568 64.14226484 116.88321674 41.45234991
2017-02-28 28.25756141 47.41055399 63.93671203 115.64850010 44.19325569
2017-03-31 28.11741981 49.47959312 62.54678351 120.85551089 41.33890287
2017-04-30 27.54281314 50.65204864 64.65857676 118.42078354 39.39991148
2017-05-31 27.08312780 51.54641544 71.43420556 117.98530385 39.51688006
2017-06-30 27.74892476 54.79896064 72.53561401 127.31820357 43.30387330

ticker            ZTS
date
2013-07-31 28.74031861
2013-08-31 28.10400159
2013-09-30 30.00331147
2013-10-31 30.58582019
2013-11-30 30.09312378
2013-12-31 31.58087372
2014-01-31 29.39709516
2014-02-28 30.03616245
2014-03-31 28.02213221
2014-04-30 29.37084621
2014-05-31 29.79791734
2014-06-30 31.32178478
2014-07-31 31.94297914
2014-08-31 34.47163259
2014-09-30 35.94037314
2014-10-31 36.07460241
2014-11-30 43.78574560
2014-12-31 41.93413384
2015-01-31 41.72111906
2015-02-28 45.00178745
2015-03-31 45.19706533
2015-04-30 43.44886622
2015-05-31 48.68190166
2015-06-30 47.16578859
2015-07-31 47.90917307
```

```
2015-08-31  43.96458895
2015-09-30  40.34904776
2015-10-31  42.14212103
2015-11-30  45.83910949
2015-12-31  47.03661941
2016-01-31  42.34934182
2016-02-29  40.39172997
2016-03-31  43.60850924
2016-04-30  46.36042449
2016-05-31  46.74487199
2016-06-30  46.88004805
2016-07-31  49.85326644
2016-08-31  50.47556796
2016-09-30  51.37444794
2016-10-31  47.21589332
2016-11-30  49.86442156
2016-12-31  52.98218512
2017-01-31  54.48487863
2017-02-28  52.86838150
2017-03-31  52.92788446
2017-04-30  55.75615969
2017-05-31  61.88725050
2017-06-30  62.09166499

[48 rows x 495 columns]
```

1.5 Compute Log Returns

Compute log returns (R_t) from prices (P_t) as your primary momentum indicator:

$$R_t = log_e(P_t) - log_e(P_{t-1})$$

Implement the `compute_log_returns` function below, such that it accepts a dataframe (like one returned by `resample_prices`), and produces a similar dataframe of log returns. Use Numpy's log function to help you calculate the log returns.

```
In [8]: def compute_log_returns(prices):
            """
            Compute log returns for each ticker.

            Parameters
            ----------
            prices : DataFrame
                Prices for each ticker and date

            Returns
            -------
            log_returns : DataFrame
```

```python
        Log returns for each ticker and date
    """
    # TODO: Implement Function
    log_r = np.log(prices) - np.log(prices.shift(1))
    print(log_r)
    return log_r


project_tests.test_compute_log_returns(compute_log_returns)
```

```
                GZEM        IFWS        ESWE         FNW         WSE
2008-08-31       nan         nan         nan         nan         nan
2008-09-30  3.13172138  0.72709204  5.76874778  1.77557845  0.04098317
2008-10-31 -3.78816218 -0.67583590 -4.95433863 -1.67093250 -0.24929051
2008-11-30  0.05579709  0.29199789  0.00697116  1.05956179  0.30686995
Tests Passed
```

1.5.1   View Data

Using the same data returned from `resample_prices`, we'll generate the log returns.

```
In [9]: monthly_close_returns = compute_log_returns(monthly_close)
        project_helper.plot_returns(
            monthly_close_returns.loc[:, apple_ticker],
            'Log Returns of {} Stock (Monthly)'.format(apple_ticker))
```

```
ticker               A          AAL         AAP         AAPL        ABBV  \
date
2013-07-31         nan         nan         nan         nan         nan
2013-08-31  0.04181412 -0.18015337 -0.02977582  0.08044762 -0.06518370
2013-09-30  0.09657861  0.15979244  0.03282284 -0.02171531  0.04855545
2013-10-31 -0.00960698  0.14734639  0.18195865  0.09201927  0.08860637
2013-11-30  0.05388057  0.06647111  0.01828314  0.06772063  0.00000000
2013-12-31  0.06769609  0.07267716  0.09197258  0.00886237  0.08616823
2014-01-31  0.01664682  0.28421071  0.03663543 -0.11394918 -0.06220213
2014-02-28 -0.02120344  0.09598737  0.10373913  0.05588347  0.03355617
2014-03-31 -0.01790035 -0.00897599 -0.00629368  0.01975642  0.00957880
2014-04-30 -0.03182502 -0.04270218 -0.04205794  0.09476126  0.02214224
2014-05-31  0.05227357  0.13552541  0.02346722  0.07577509  0.04229556
2014-06-30  0.01103586  0.06739797  0.08351026  0.02728625  0.03810157
2014-07-31 -0.02378338 -0.09799068 -0.10798279  0.02832630 -0.06780436
2014-08-31  0.01889681  0.00079762  0.11903914  0.07465224  0.05465028
2014-09-30 -0.00082047 -0.09153654 -0.04545245 -0.01722060  0.04388532
2014-10-31 -0.03028915  0.15558158  0.12032096  0.06948903  0.10172478
2014-11-30  0.06740128  0.16010974  0.00081622  0.10071836  0.08659108
2014-12-31 -0.04302767  0.09992645  0.08005917 -0.07460613 -0.05586717
2015-01-31 -0.07812999 -0.08865699 -0.00175946  0.05961156 -0.07327254
2015-02-28  0.11114202 -0.02228945 -0.02593080  0.09598802  0.00248242
2015-03-31 -0.01333009  0.09701683 -0.03400439 -0.03187426 -0.03293308
```

```
2015-04-30 -0.00434154 -0.08694248 -0.04572186  0.00576971  0.10773129
2015-05-31 -0.00436047 -0.13068039  0.06903017  0.04431573  0.02941164
2015-06-30 -0.06296587 -0.05918743  0.03922895 -0.03797801  0.00897001
2015-07-31  0.05961780  0.00412320  0.08953503 -0.03344115  0.04841767
2015-08-31 -0.12025862 -0.02595965  0.00595206 -0.06849869 -0.11491257
2015-09-30 -0.05317503 -0.00385555  0.07866971 -0.02523595 -0.13717756
2015-10-31  0.09523073  0.17421946  0.04588907  0.08329065  0.09970324
2015-11-30  0.10212435 -0.11137087 -0.19834401 -0.00580146 -0.02379042
2015-12-31  0.00250761  0.02607491 -0.07765707 -0.11679029  0.01857111
2016-01-31 -0.10480259 -0.08266322  0.01017989 -0.07822348 -0.06500804
2016-02-29 -0.00800004  0.05307585 -0.02402858 -0.00133143 -0.00529633
2016-03-31  0.06478949  0.00024387  0.07749311  0.11974615  0.04493730
2016-04-30  0.02934536 -0.16736448 -0.02679973 -0.15073114  0.07532447
2016-05-31  0.11462829 -0.08063179 -0.01458373  0.06933886  0.03114913
2016-06-30 -0.03131999 -0.11970434  0.04978712 -0.04359639 -0.01634128
2016-07-31  0.08115189  0.22631760  0.04966480  0.08623527  0.07621369
2016-08-31 -0.02376808  0.02526745 -0.07631131  0.02334347 -0.03268917
2016-09-30  0.00477784  0.00850369 -0.05350196  0.06344815 -0.01619914
2016-10-31 -0.07769182  0.10344664 -0.06253766  0.00432500 -0.11356073
2016-11-30  0.00936614  0.13692923  0.19193633 -0.02178228  0.08617441
2016-12-31  0.03818318  0.00536885 -0.00319576  0.04684076  0.02949493
2017-01-31  0.07217773 -0.05367464 -0.02927975  0.04664167 -0.01399583
2017-02-28  0.04648289  0.04873915 -0.04757013  0.12552425  0.01187489
2017-03-31  0.03263890 -0.09164993 -0.05439459  0.04754147  0.05229538
2017-04-30  0.04040579  0.00753654 -0.04215500 -0.00006961  0.02182202
2017-05-31  0.09175337  0.12956238 -0.06173770  0.06557216  0.00121249
2017-06-30 -0.01497493  0.03869621 -0.13591186 -0.05891588  0.09376676

ticker             ABC         ABT         ACN        ADBE         ADI  \
date
2013-07-31         nan         nan         nan         nan         nan
2013-08-31 -0.01609335 -0.09440968 -0.02136190 -0.03289558 -0.05749847
2013-09-30  0.07086509 -0.00420927  0.01905603  0.12689741  0.01650096
2013-10-31  0.06693948  0.10058564  0.01124304  0.04296064  0.04671322
2013-11-30  0.07997603  0.04389252  0.05260536  0.04613431 -0.02215021
2013-12-31 -0.00312412  0.00365918  0.05950782  0.05314171  0.06162558
2014-01-31 -0.04494321 -0.03893724 -0.02887307 -0.01157325 -0.05364189
2014-02-28  0.01278407  0.08167803  0.04252310  0.14797715  0.05873111
2014-03-31 -0.03387614 -0.03244633 -0.04452811 -0.04302219  0.04463996
2014-04-30 -0.00627057  0.01187986  0.01803285 -0.06358573 -0.03543414
2014-05-31  0.11924492  0.03225676  0.01521647  0.04516334  0.02805861
2014-06-30 -0.00713113  0.02200064 -0.00751744  0.11436847  0.03175466
2014-07-31  0.05684488  0.03470536 -0.01948600 -0.04393196 -0.08568401
2014-08-31  0.00928406  0.00284495  0.02220373  0.03755456  0.02958032
2014-09-30 -0.00116362 -0.01550789  0.00320237 -0.03841992 -0.02506897
2014-10-31  0.09976923  0.05225014  0.01089553  0.01335172  0.00262335
2014-11-30  0.06719583  0.02088612  0.06224762  0.04952333  0.09637224
2014-12-31 -0.00982294  0.01139295  0.03393630 -0.01339001  0.02250327
```

```
2015-01-31   0.05281720  -0.00042641  -0.06093959  -0.03599072  -0.06348240
2015-02-28   0.08089383   0.05667423   0.06896907   0.12036221   0.12320729
2015-03-31   0.10090334  -0.02219942   0.03984851  -0.06745892   0.07342445
2015-04-30   0.00552706   0.00708541  -0.00049630   0.02826855  -0.01858432
2015-05-31  -0.01281413   0.04589313   0.03593582   0.03906394   0.10020918
2015-06-30  -0.05684490   0.00982809   0.00767559   0.02398616  -0.05714976
2015-07-31  -0.00556369   0.03709245   0.06335602   0.01202468  -0.09565300
2015-08-31  -0.05271992  -0.11264239  -0.08963337  -0.04260734  -0.03591771
2015-09-30  -0.05179848  -0.11872187   0.04145402   0.04540863   0.00979789
2015-10-31   0.01587501   0.11369172   0.09776101   0.07541025   0.06369612
2015-11-30   0.02533250   0.00267499   0.00018655   0.03109289   0.02480620
2015-12-31   0.05012168  -0.00022264  -0.02569573   0.02675456  -0.10145040
2016-01-31  -0.14668975  -0.16459543   0.00990296  -0.05256030  -0.02674642
2016-02-29  -0.02946371   0.02324168  -0.05132322  -0.04568157  -0.00821101
2016-03-31  -0.00080845   0.07674113   0.14063754   0.09675045   0.11064939
2016-04-30  -0.01689525  -0.06663976  -0.01220169   0.00446762  -0.04970290
2016-05-31  -0.12208554   0.01859216   0.05219176   0.05422362   0.04515902
2016-06-30   0.05626889  -0.00810747  -0.04892046  -0.03769780  -0.03231130
2016-07-31   0.07139375   0.13578830  -0.00424592   0.02137959   0.11950785
2016-08-31   0.02449340  -0.06294575   0.01922714   0.04446953  -0.01342097
2016-09-30  -0.07383382   0.00640496   0.06048139   0.05911135   0.02976363
2016-10-31  -0.13867316  -0.06852950  -0.03945196  -0.00953490  -0.00544537
2016-11-30   0.10806742  -0.03027006   0.02707341  -0.04470124   0.15250011
2016-12-31   0.00256115   0.00889127  -0.01944600   0.00136081  -0.02206272
2017-01-31   0.10997958   0.09029065  -0.02822698   0.09650158   0.03144743
2017-02-28   0.05135996   0.07626031   0.07305358   0.04281683   0.09464624
2017-03-31  -0.03344570  -0.01497402  -0.02161979   0.09497211   0.00024408
2017-04-30  -0.07567373  -0.01142815   0.02214547   0.02736367  -0.07274784
2017-05-31   0.11615820   0.04524848   0.02579791   0.05894304   0.11819123
2017-06-30   0.02963180   0.06260663  -0.00636714  -0.00296506  -0.09185947

ticker         ...           XL         XLNX          XOM         XRAY  \
date           ...
2013-07-31     ...          nan          nan          nan          nan
2013-08-31     ...  -0.05879217  -0.06720501  -0.06596571  -0.02097402
2013-09-30     ...   0.04630944   0.07605219  -0.01293321   0.03481157
2013-10-31     ...  -0.00814469  -0.03082169   0.04076620   0.08157415
2013-11-30     ...   0.04540422  -0.01674184   0.04899644   0.00961292
2013-12-31     ...  -0.00005037   0.03298584   0.07935125   0.02044076
2014-01-31     ...  -0.10243348   0.01082965  -0.09357256  -0.04947109
2014-02-28     ...   0.05615273   0.12286783   0.05062164  -0.01660877
2014-03-31     ...   0.03284340   0.03888909   0.01454009   0.01589505
2014-04-30     ...   0.00319489  -0.13978958   0.04728753  -0.03110431
2014-05-31     ...   0.03479430   0.00123427  -0.01178295   0.05789258
2014-06-30     ...   0.01315416   0.00742551   0.00149098   0.00264665
2014-07-31     ...  -0.01508417  -0.13998391  -0.01743356  -0.01983642
2014-08-31     ...   0.05843276   0.03386045   0.01220640   0.02730581
2014-09-30     ...  -0.02525829   0.00236407  -0.05592900  -0.04369616
```

```
2014-10-31        ...        0.02117902  0.04253010  0.02789025  0.10739791
2014-11-30        ...        0.04727105  0.03443096 -0.05880687  0.07966385
2014-12-31        ...       -0.02838693 -0.04847111  0.02087622 -0.03037006
2015-01-31        ...        0.00348534 -0.11531726 -0.05594387 -0.06285044
2015-02-28        ...        0.04838969  0.10127687  0.02024303  0.05795769
2015-03-31        ...        0.02092430 -0.00165348 -0.04080317 -0.03938489
2015-04-30        ...        0.00757990  0.02475027  0.02750072  0.00215919
2015-05-31        ...        0.01605171  0.09654661 -0.01677365  0.02009094
2015-06-30        ...       -0.00860127 -0.07122468 -0.02375409 -0.00797670
2015-07-31        ...        0.02180358 -0.05611995 -0.04914479  0.09891886
2015-08-31        ...       -0.01938714  0.01075955 -0.04204308 -0.08237366
2015-09-30        ...       -0.02096434  0.01139343 -0.01189933 -0.03437113
2015-10-31        ...        0.04732066  0.11681228  0.10691949  0.18505330
2015-11-30        ...        0.00262261  0.04908477 -0.00427045 -0.00312732
2015-12-31        ...        0.03118510 -0.05629461 -0.04649669  0.00432337
2016-01-31        ...       -0.07745121  0.06789938 -0.00128370 -0.03274052
2016-02-29        ...       -0.05324021 -0.05604739  0.03819057  0.03454661
2016-03-31        ...        0.07359389  0.00443741  0.04202402  0.01220241
2016-04-30        ...       -0.11720576 -0.09619609  0.05594807 -0.03349319
2016-05-31        ...        0.04830993  0.10290823  0.01539863  0.04205613
2016-06-30        ...       -0.02466162 -0.02694774  0.05166393 -0.00071206
2016-07-31        ...        0.03828501  0.10192953 -0.05245058  0.03172855
2016-08-31        ...       -0.01104021  0.06579968 -0.01191629 -0.04112133
2016-09-30        ...       -0.01178072  0.00239521  0.00160532 -0.03228879
2016-10-31        ...        0.03132116 -0.06598725 -0.04643273 -0.03179755
2016-11-30        ...        0.04038386  0.06594093  0.05541489  0.01054005
2016-12-31        ...        0.03615589  0.11187869  0.03334393 -0.00643281
2017-01-31        ...        0.00828549 -0.03660694 -0.07318798 -0.01800276
2017-02-28        ...        0.07484917  0.01624776 -0.02195182  0.11358061
2017-03-31        ...       -0.01017620 -0.01593728  0.00844920 -0.01575947
2017-04-30        ...        0.04871848  0.08633458 -0.00439937  0.01273092
2017-05-31        ...        0.04302745  0.06090411 -0.00482798  0.00441780
2017-06-30        ...        0.00769349 -0.03648424  0.00285307  0.02190798

ticker            XRX         XYL         YUM         ZBH        ZION  \
date
2013-07-31        nan         nan         nan         nan         nan
2013-08-31  0.02845720 -0.00134868 -0.04058203 -0.05402072 -0.05663911
2013-09-30  0.03611367  0.11966450  0.01937689  0.04028369 -0.01985983
2013-10-31 -0.03460553  0.21535825 -0.04870385  0.06287079  0.03494040
2013-11-30  0.13529041  0.00173762  0.13869403  0.04405904  0.03381174
2013-12-31  0.07181852  0.00115674 -0.02700927  0.02143144  0.02125228
2014-01-31 -0.11480883 -0.03649610 -0.11361565  0.00833515 -0.04122539
2014-02-28  0.01282069  0.16849675  0.09821667 -0.00138443  0.08307315
2014-03-31  0.03352930 -0.07737790  0.01752905  0.01022814 -0.00707626
2014-04-30  0.06757594  0.03161998  0.02580642  0.02320097 -0.06880844
2014-05-31  0.02127740 -0.00437311  0.00414777  0.07510359 -0.01005896
2014-06-30  0.01231307  0.04661750  0.04909193 -0.00262106  0.03031579
```

13

```
2014-07-31   0.06383490 -0.10201119 -0.15259272 -0.03717391 -0.02230321
2014-08-31   0.04064098  0.05432073  0.04273371 -0.00762369  0.01245116
2014-09-30  -0.03818588 -0.04527723 -0.00623228  0.01452958 -0.00274914
2014-10-31   0.00377217  0.02786669  0.00399386  0.10103487 -0.00310185
2014-11-30   0.04993695  0.05302447  0.07274470  0.00939481 -0.02173021
2014-12-31  -0.00277876 -0.00706717 -0.05864438  0.01193901  0.01590983
2015-01-31  -0.05106548 -0.11012919 -0.00220105 -0.01170641 -0.17386913
2015-02-28   0.03579801  0.04975030  0.11525879  0.07134515  0.11109071
2015-03-31  -0.05485114 -0.01923136 -0.02990901 -0.02227720  0.00986330
2015-04-30  -0.11099678  0.05553898  0.09320743 -0.06758378  0.04826092
2015-05-31  -0.00698083 -0.00836304  0.04714907  0.03992801  0.02108818
2015-06-30  -0.06439073  0.01357979 -0.00033298 -0.04353182  0.09427086
2015-07-31   0.03509132 -0.07097951 -0.02148999 -0.04839200 -0.01732264
2015-08-31  -0.08026959 -0.05779847 -0.09545832 -0.00491259 -0.07084284
2015-09-30  -0.03699314  0.01225130  0.00225395 -0.09522347 -0.05165634
2015-10-31  -0.03556860  0.10289172 -0.11330487  0.10730688  0.04369368
2015-11-30   0.11648057  0.02852030  0.02231302 -0.03463718  0.04255223
2015-12-31   0.01407508 -0.02221712  0.00741965  0.01765935 -0.09297646
2016-01-31  -0.08641291 -0.01518318 -0.00271062 -0.03299779 -0.18540322
2016-02-29  -0.01446306  0.04398671  0.00138083 -0.02499238 -0.05907417
2016-03-31   0.15666230  0.08919201  0.12171562  0.09887961  0.12712017
2016-04-30  -0.15057286  0.02128769 -0.02279296  0.08224057  0.12814724
2016-05-31   0.03781749  0.07021508  0.03130475  0.05331681  0.02029299
2016-06-30  -0.04083362 -0.00022394  0.01006008 -0.01224782 -0.10885619
2016-07-31   0.08190528  0.06838052  0.08081880  0.08561205  0.10384723
2016-08-31  -0.04467244  0.06487578  0.01432323 -0.01173551  0.09555297
2016-09-30   0.03568895  0.03078357  0.00110181  0.00504351  0.01395900
2016-10-31  -0.03618485 -0.08180785 -0.04530849 -0.20992565  0.03764481
2016-11-30  -0.04394012  0.06826631  0.02387708 -0.03416331  0.21341820
2016-12-31  -0.06031217 -0.04075737 -0.00094697  0.01539556  0.07851429
2017-01-31   0.14387403 -0.00424973  0.03879000  0.13680848 -0.01994669
2017-02-28   0.07101104 -0.02065858 -0.00320978 -0.01061987  0.06402762
2017-03-31  -0.00497178  0.04271546 -0.02197891  0.04404029 -0.06676818
2017-04-30  -0.02064767  0.02341935  0.03320595 -0.02035146 -0.04804045
2017-05-31  -0.01683069  0.01750300  0.09965606 -0.00368417  0.00296435
2017-06-30   0.02428615  0.06118855  0.01530084  0.07612942  0.09151416

ticker             ZTS
date
2013-07-31         nan
2013-08-31 -0.02238899
2013-09-30  0.06539579
2013-10-31  0.01922875
2013-11-30 -0.01623981
2013-12-31  0.04825498
2014-01-31 -0.07165581
2014-02-28  0.02150621
2014-03-31 -0.06940744
```

```
2014-04-30   0.04700792
2014-05-31   0.01443595
2014-06-30   0.04987535
2014-07-31   0.01963856
2014-08-31   0.07618433
2014-09-30   0.04172452
2014-10-31   0.00372782
2014-11-30   0.19371924
2014-12-31  -0.04320818
2015-01-31  -0.00509269
2015-02-28   0.07569476
2015-03-31   0.00432995
2015-04-30  -0.03944740
2015-05-31   0.11372257
2015-06-30  -0.03163852
2015-07-31   0.01563818
2015-08-31  -0.08592248
2015-09-30  -0.08581672
2015-10-31   0.04347995
2015-11-30   0.08408991
2015-12-31   0.02578879
2016-01-31  -0.10497356
2016-02-29  -0.04732782
2016-03-31   0.07662724
2016-04-30   0.06119388
2016-05-31   0.00825838
2016-06-30   0.00288761
2016-07-31   0.06149185
2016-08-31   0.01240540
2016-09-30   0.01765151
2016-10-31  -0.08441037
2016-11-30   0.05457719
2016-12-31   0.06064797
2017-01-31   0.02796748
2017-02-28  -0.03011775
2017-03-31   0.00112486
2017-04-30   0.05205758
2017-05-31   0.10432630
2017-06-30   0.00329757

[48 rows x 495 columns]
```

1.6   Shift Returns

Implement the `shift_returns` function to shift the log returns to the previous or future returns in the time series. For example, the parameter `shift_n` is 2 and `returns` is the following:

```
                         Returns
                A         B         C         D
2013-07-08    0.015     0.082     0.096     0.020        ...
2013-07-09    0.037     0.095     0.027     0.063        ...
2013-07-10    0.094     0.001     0.093     0.019        ...
2013-07-11    0.092     0.057     0.069     0.087        ...

...             ...       ...       ...       ...
```

the output of the `shift_returns` function would be:

```
                      Shift Returns
                A         B         C         D
2013-07-08    NaN       NaN       NaN       NaN          ...
2013-07-09    NaN       NaN       NaN       NaN          ...
2013-07-10    0.015     0.082     0.096     0.020        ...
2013-07-11    0.037     0.095     0.027     0.063        ...

...             ...       ...       ...       ...
```

Using the same `returns` data as above, the `shift_returns` function should generate the following with `shift_n` as -2:

```
                      Shift Returns
                A         B         C         D
2013-07-08    0.094     0.001     0.093     0.019        ...
2013-07-09    0.092     0.057     0.069     0.087        ...
...             ...       ...       ...       ...          ...
...             ...       ...       ...       ...          ...
...           NaN       NaN       NaN       NaN          ...
...           NaN       NaN       NaN       NaN          ...
```

Note: The "..." represents data points we're not showing.

```python
In [10]: def shift_returns(returns, shift_n):
             """
             Generate shifted returns

             Parameters
             ----------
             returns : DataFrame
                 Returns for each ticker and date
             shift_n : int
                 Number of periods to move, can be positive or negative

             Returns
             -------
             shifted_returns : DataFrame
                 Shifted returns for each ticker and date
             """
             # TODO: Implement Function
```

16

```
            print(returns)
            s_return = returns.shift(shift_n)
            print(s_return)
            return s_return


        project_tests.test_shift_returns(shift_returns)
```

```
                 GVMQ         QZM         GGL         EZWF         YFXD
2008-08-31        nan         nan         nan          nan          nan
2008-09-30   3.13172138  0.72709204  5.76874778   1.77557845   0.04098317
2008-10-31  -3.78816218 -0.67583590 -4.95433863  -1.67093250  -0.24929051
2008-11-30   0.05579709  0.29199789  0.00697116   1.05956179   0.30686995
                 GVMQ         QZM         GGL         EZWF         YFXD
2008-08-31        nan         nan         nan          nan          nan
2008-09-30        nan         nan         nan          nan          nan
2008-10-31   3.13172138  0.72709204  5.76874778   1.77557845   0.04098317
2008-11-30  -3.78816218 -0.67583590 -4.95433863  -1.67093250  -0.24929051
Tests Passed
```

1.6.1 View Data

Let's get the previous month's and next month's returns.

```
In [11]: prev_returns = shift_returns(monthly_close_returns, 1)
         lookahead_returns = shift_returns(monthly_close_returns, -1)

         project_helper.plot_shifted_returns(
             prev_returns.loc[:, apple_ticker],
             monthly_close_returns.loc[:, apple_ticker],
             'Previous Returns of {} Stock'.format(apple_ticker))
         project_helper.plot_shifted_returns(
             lookahead_returns.loc[:, apple_ticker],
             monthly_close_returns.loc[:, apple_ticker],
             'Lookahead Returns of {} Stock'.format(apple_ticker))
```

ticker	A	AAL	AAP	AAPL	ABBV \
date					
2013-07-31	nan	nan	nan	nan	nan
2013-08-31	0.04181412	-0.18015337	-0.02977582	0.08044762	-0.06518370
2013-09-30	0.09657861	0.15979244	0.03282284	-0.02171531	0.04855545
2013-10-31	-0.00960698	0.14734639	0.18195865	0.09201927	0.08860637
2013-11-30	0.05388057	0.06647111	0.01828314	0.06772063	0.00000000
2013-12-31	0.06769609	0.07267716	0.09197258	0.00886237	0.08616823
2014-01-31	0.01664682	0.28421071	0.03663543	-0.11394918	-0.06220213
2014-02-28	-0.02120344	0.09598737	0.10373913	0.05588347	0.03355617
2014-03-31	-0.01790035	-0.00897599	-0.00629368	0.01975642	0.00957880
2014-04-30	-0.03182502	-0.04270218	-0.04205794	0.09476126	0.02214224
2014-05-31	0.05227357	0.13552541	0.02346722	0.07577509	0.04229556

```
2014-06-30   0.01103586   0.06739797   0.08351026   0.02728625   0.03810157
2014-07-31  -0.02378338  -0.09799068  -0.10798279   0.02832630  -0.06780436
2014-08-31   0.01889681   0.00079762   0.11903914   0.07465224   0.05465028
2014-09-30  -0.00082047  -0.09153654  -0.04545245  -0.01722060   0.04388532
2014-10-31  -0.03028915   0.15558158   0.12032096   0.06948903   0.10172478
2014-11-30   0.06740128   0.16010974   0.00081622   0.10071836   0.08659108
2014-12-31  -0.04302767   0.09992645   0.08005917  -0.07460613  -0.05586717
2015-01-31  -0.07812999  -0.08865699  -0.00175946   0.05961156  -0.07327254
2015-02-28   0.11114202  -0.02228945  -0.02593080   0.09598802   0.00248242
2015-03-31  -0.01333009   0.09701683  -0.03400439  -0.03187426  -0.03293308
2015-04-30  -0.00434154  -0.08694248  -0.04572186   0.00576971   0.10773129
2015-05-31  -0.00436047  -0.13068039   0.06903017   0.04431573   0.02941164
2015-06-30  -0.06296587  -0.05918743   0.03922895  -0.03797801   0.00897001
2015-07-31   0.05961780   0.00412320   0.08953503  -0.03344115   0.04841767
2015-08-31  -0.12025862  -0.02595965   0.00595206  -0.06849869  -0.11491257
2015-09-30  -0.05317503  -0.00385555   0.07866971  -0.02523595  -0.13717756
2015-10-31   0.09523073   0.17421946   0.04588907   0.08329065   0.09970324
2015-11-30   0.10212435  -0.11137087  -0.19834401  -0.00580146  -0.02379042
2015-12-31   0.00250761   0.02607491  -0.07765707  -0.11679029   0.01857111
2016-01-31  -0.10480259  -0.08266322   0.01017989  -0.07822348  -0.06500804
2016-02-29  -0.00800004   0.05307585  -0.02402858  -0.00133143  -0.00529633
2016-03-31   0.06478949   0.00024387   0.07749311   0.11974615   0.04493730
2016-04-30   0.02934536  -0.16736448  -0.02679973  -0.15073114   0.07532447
2016-05-31   0.11462829  -0.08063179  -0.01458373   0.06933886   0.03114913
2016-06-30  -0.03131999  -0.11970434   0.04978712  -0.04359639  -0.01634128
2016-07-31   0.08115189   0.22631760   0.04966480   0.08623527   0.07621369
2016-08-31  -0.02376808   0.02526745  -0.07631131   0.02334347  -0.03268917
2016-09-30   0.00477784   0.00850369  -0.05350196   0.06344815  -0.01619914
2016-10-31  -0.07769182   0.10344664  -0.06253766   0.00432500  -0.11356073
2016-11-30   0.00936614   0.13692923   0.19193633  -0.02178228   0.08617441
2016-12-31   0.03818318   0.00536885  -0.00319576   0.04684076   0.02949493
2017-01-31   0.07217773  -0.05367464  -0.02927975   0.04664167  -0.01399583
2017-02-28   0.04648289   0.04873915  -0.04757013   0.12552425   0.01187489
2017-03-31   0.03263890  -0.09164993  -0.05439459   0.04754147   0.05229538
2017-04-30   0.04040579   0.00753654  -0.04215500  -0.00006961   0.02182202
2017-05-31   0.09175337   0.12956238  -0.06173770   0.06557216   0.00121249
2017-06-30  -0.01497493   0.03869621  -0.13591186  -0.05891588   0.09376676

ticker            ABC           ABT           ACN          ADBE           ADI  \
date
2013-07-31        nan           nan           nan           nan           nan
2013-08-31  -0.01609335  -0.09440968  -0.02136190  -0.03289558  -0.05749847
2013-09-30   0.07086509  -0.00420927   0.01905603   0.12689741   0.01650096
2013-10-31   0.06693948   0.10058564   0.01124304   0.04296064   0.04671322
2013-11-30   0.07997603   0.04389252   0.05260536   0.04613431  -0.02215021
2013-12-31  -0.00312412   0.00365918   0.05950782   0.05314171   0.06162558
2014-01-31  -0.04494321  -0.03893724  -0.02887307  -0.01157325  -0.05364189
2014-02-28   0.01278407   0.08167803   0.04252310   0.14797715   0.05873111
```

```
2014-03-31 -0.03387614 -0.03244633 -0.04452811 -0.04302219  0.04463996
2014-04-30 -0.00627057  0.01187986  0.01803285 -0.06358573 -0.03543414
2014-05-31  0.11924492  0.03225676  0.01521647  0.04516334  0.02805861
2014-06-30 -0.00713113  0.02200064 -0.00751744  0.11436847  0.03175466
2014-07-31  0.05684488  0.03470536 -0.01948600 -0.04393196 -0.08568401
2014-08-31  0.00928406  0.00284495  0.02220373  0.03755456  0.02958032
2014-09-30 -0.00116362 -0.01550789  0.00320237 -0.03841992 -0.02506897
2014-10-31  0.09976923  0.05225014  0.01089553  0.01335172  0.00262335
2014-11-30  0.06719583  0.02088612  0.06224762  0.04952333  0.09637224
2014-12-31 -0.00982294  0.01139295  0.03393630 -0.01339001  0.02250327
2015-01-31  0.05281720 -0.00042641 -0.06093959 -0.03599072 -0.06348240
2015-02-28  0.08089383  0.05667423  0.06896907  0.12036221  0.12320729
2015-03-31  0.10090334 -0.02219942  0.03984851 -0.06745892  0.07342445
2015-04-30  0.00552706  0.00708541 -0.00049630  0.02826855 -0.01858432
2015-05-31 -0.01281413  0.04589313  0.03593582  0.03906394  0.10020918
2015-06-30 -0.05684490  0.00982809  0.00767559  0.02398616 -0.05714976
2015-07-31 -0.00556369  0.03709245  0.06335602  0.01202468 -0.09565300
2015-08-31 -0.05271992 -0.11264239 -0.08963337 -0.04260734 -0.03591771
2015-09-30 -0.05179848 -0.11872187  0.04145402  0.04540863  0.00979789
2015-10-31  0.01587501  0.11369172  0.09776101  0.07541025  0.06369612
2015-11-30  0.02533250  0.00267499  0.00018655  0.03109289  0.02480620
2015-12-31  0.05012168 -0.00022264 -0.02569573  0.02675456 -0.10145040
2016-01-31 -0.14668975 -0.16459543  0.00990296 -0.05256030 -0.02674642
2016-02-29 -0.02946371  0.02324168 -0.05132322 -0.04568157 -0.00821101
2016-03-31 -0.00080845  0.07674113  0.14063754  0.09675045  0.11064939
2016-04-30 -0.01689525 -0.06663976 -0.01220169  0.00446762 -0.04970290
2016-05-31 -0.12208554  0.01859216  0.05219176  0.05422362  0.04515902
2016-06-30  0.05626889 -0.00810747 -0.04892046 -0.03769780 -0.03231130
2016-07-31  0.07139375  0.13578830 -0.00424592  0.02137959  0.11950785
2016-08-31  0.02449340 -0.06294575  0.01922714  0.04446953 -0.01342097
2016-09-30 -0.07383382  0.00640496  0.06048139  0.05911135  0.02976363
2016-10-31 -0.13867316 -0.06852950 -0.03945196 -0.00953490 -0.00544537
2016-11-30  0.10806742 -0.03027006  0.02707341 -0.04470124  0.15250011
2016-12-31  0.00256115  0.00889127 -0.01944600  0.00136081 -0.02206272
2017-01-31  0.10997958  0.09029065 -0.02822698  0.09650158  0.03144743
2017-02-28  0.05135996  0.07626031  0.07305358  0.04281683  0.09464624
2017-03-31 -0.03344570 -0.01497402 -0.02161979  0.09497211  0.00024408
2017-04-30 -0.07567373 -0.01142815  0.02214547  0.02736367 -0.07274784
2017-05-31  0.11615820  0.04524848  0.02579791  0.05894304  0.11819123
2017-06-30  0.02963180  0.06260663 -0.00636714 -0.00296506 -0.09185947

ticker          ...          XL        XLNX         XOM        XRAY  \
date            ...
2013-07-31      ...         nan         nan         nan         nan
2013-08-31      ... -0.05879217 -0.06720501 -0.06596571 -0.02097402
2013-09-30      ...  0.04630944  0.07605219 -0.01293321  0.03481157
2013-10-31      ... -0.00814469 -0.03082169  0.04076620  0.08157415
2013-11-30      ...  0.04540422 -0.01674184  0.04899644  0.00961292
```

```
2013-12-31      ...      -0.00005037  0.03298584  0.07935125  0.02044076
2014-01-31      ...      -0.10243348  0.01082965 -0.09357256 -0.04947109
2014-02-28      ...       0.05615273  0.12286783  0.05062164 -0.01660877
2014-03-31      ...       0.03284340  0.03888909  0.01454009  0.01589505
2014-04-30      ...       0.00319489 -0.13978958  0.04728753 -0.03110431
2014-05-31      ...       0.03479430  0.00123427 -0.01178295  0.05789258
2014-06-30      ...       0.01315416  0.00742551  0.00149098  0.00264665
2014-07-31      ...      -0.01508417 -0.13998391 -0.01743356 -0.01983642
2014-08-31      ...       0.05843276  0.03386045  0.01220640  0.02730581
2014-09-30      ...      -0.02525829  0.00236407 -0.05592900 -0.04369616
2014-10-31      ...       0.02117902  0.04253010  0.02789025  0.10739791
2014-11-30      ...       0.04727105  0.03443096 -0.05880687  0.07966385
2014-12-31      ...      -0.02838693 -0.04847111  0.02087622 -0.03037006
2015-01-31      ...       0.00348534 -0.11531726 -0.05594387 -0.06285044
2015-02-28      ...       0.04838969  0.10127687  0.02024303  0.05795769
2015-03-31      ...       0.02092430 -0.00165348 -0.04080317 -0.03938489
2015-04-30      ...       0.00757990  0.02475027  0.02750072  0.00215919
2015-05-31      ...       0.01605171  0.09654661 -0.01677365  0.02009094
2015-06-30      ...      -0.00860127 -0.07122468 -0.02375409 -0.00797670
2015-07-31      ...       0.02180358 -0.05611995 -0.04914479  0.09891886
2015-08-31      ...      -0.01938714  0.01075955 -0.04204308 -0.08237366
2015-09-30      ...      -0.02096434  0.01139343 -0.01189933 -0.03437113
2015-10-31      ...       0.04732066  0.11681228  0.10691949  0.18505330
2015-11-30      ...       0.00262261  0.04908477 -0.00427045 -0.00312732
2015-12-31      ...       0.03118510 -0.05629461 -0.04649669  0.00432337
2016-01-31      ...      -0.07745121  0.06789938 -0.00128370 -0.03274052
2016-02-29      ...      -0.05324021 -0.05604739  0.03819057  0.03454661
2016-03-31      ...       0.07359389  0.00443741  0.04202402  0.01220241
2016-04-30      ...      -0.11720576 -0.09619609  0.05594807 -0.03349319
2016-05-31      ...       0.04830993  0.10290823  0.01539863  0.04205613
2016-06-30      ...      -0.02466162 -0.02694774  0.05166393 -0.00071206
2016-07-31      ...       0.03828501  0.10192953 -0.05245058  0.03172855
2016-08-31      ...      -0.01104021  0.06579968 -0.01191629 -0.04112133
2016-09-30      ...      -0.01178072  0.00239521  0.00160532 -0.03228879
2016-10-31      ...       0.03132116 -0.06598725 -0.04643273 -0.03179755
2016-11-30      ...       0.04038386  0.06594093  0.05541489  0.01054005
2016-12-31      ...       0.03615589  0.11187869  0.03334393 -0.00643281
2017-01-31      ...       0.00828549 -0.03660694 -0.07318798 -0.01800276
2017-02-28      ...       0.07484917  0.01624776 -0.02195182  0.11358061
2017-03-31      ...      -0.01017620 -0.01593728  0.00844920 -0.01575947
2017-04-30      ...       0.04871848  0.08633458 -0.00439937  0.01273092
2017-05-31      ...       0.04302745  0.06090411 -0.00482798  0.00441780
2017-06-30      ...       0.00769349 -0.03648424  0.00285307  0.02190798

ticker           XRX          XYL          YUM          ZBH         ZION  \
date
2013-07-31       nan          nan          nan          nan          nan
2013-08-31  0.02845720  -0.00134868  -0.04058203  -0.05402072  -0.05663911
```

```
2013-09-30  0.03611367  0.11966450  0.01937689  0.04028369 -0.01985983
2013-10-31 -0.03460553  0.21535825 -0.04870385  0.06287079  0.03494040
2013-11-30  0.13529041  0.00173762  0.13869403  0.04405904  0.03381174
2013-12-31  0.07181852  0.00115674 -0.02700927  0.02143144  0.02125228
2014-01-31 -0.11480883 -0.03649610 -0.11361565  0.00833515 -0.04122539
2014-02-28  0.01282069  0.16849675  0.09821667 -0.00138443  0.08307315
2014-03-31  0.03352930 -0.07737790  0.01752905  0.01022814 -0.00707626
2014-04-30  0.06757594  0.03161998  0.02580642  0.02320097 -0.06880844
2014-05-31  0.02127740 -0.00437311  0.00414777  0.07510359 -0.01005896
2014-06-30  0.01231307  0.04661750  0.04909193 -0.00262106  0.03031579
2014-07-31  0.06383490 -0.10201119 -0.15259272 -0.03717391 -0.02230321
2014-08-31  0.04064098  0.05432073  0.04273371 -0.00762369  0.01245116
2014-09-30 -0.03818588 -0.04527723 -0.00623228  0.01452958 -0.00274914
2014-10-31  0.00377217  0.02786669  0.00399386  0.10103487 -0.00310185
2014-11-30  0.04993695  0.05302447  0.07274470  0.00939481 -0.02173021
2014-12-31 -0.00277876 -0.00706717 -0.05864438  0.01193901  0.01590983
2015-01-31 -0.05106548 -0.11012919 -0.00220105 -0.01170641 -0.17386913
2015-02-28  0.03579801  0.04975030  0.11525879  0.07134515  0.11109071
2015-03-31 -0.05485114 -0.01923136 -0.02990901 -0.02227720  0.00986330
2015-04-30 -0.11099678  0.05553898  0.09320743 -0.06758378  0.04826092
2015-05-31 -0.00698083 -0.00836304  0.04714907  0.03992801  0.02108818
2015-06-30 -0.06439073  0.01357979 -0.00033298 -0.04353182  0.09427086
2015-07-31  0.03509132 -0.07097951 -0.02148999 -0.04839200 -0.01732264
2015-08-31 -0.08026959 -0.05779847 -0.09545832 -0.00491259 -0.07084284
2015-09-30 -0.03699314  0.01225130  0.00225395 -0.09522347 -0.05165634
2015-10-31 -0.03556860  0.10289172 -0.11330487  0.10730688  0.04369368
2015-11-30  0.11648057  0.02852030  0.02231302 -0.03463718  0.04255223
2015-12-31  0.01407508 -0.02221712  0.00741965  0.01765935 -0.09297646
2016-01-31 -0.08641291 -0.01518318 -0.00271062 -0.03299779 -0.18540322
2016-02-29 -0.01446306  0.04398671  0.00138083 -0.02499238 -0.05907417
2016-03-31  0.15666230  0.08919201  0.12171562  0.09887961  0.12712017
2016-04-30 -0.15057286  0.02128769 -0.02279296  0.08224057  0.12814724
2016-05-31  0.03781749  0.07021508  0.03130475  0.05331681  0.02029299
2016-06-30 -0.04083362 -0.00022394  0.01006008 -0.01224782 -0.10885619
2016-07-31  0.08190528  0.06838052  0.08081880  0.08561205  0.10384723
2016-08-31 -0.04467244  0.06487578  0.01432323 -0.01173551  0.09555297
2016-09-30  0.03568895  0.03078357  0.00110181  0.00504351  0.01395900
2016-10-31 -0.03618485 -0.08180785 -0.04530849 -0.20992565  0.03764481
2016-11-30 -0.04394012  0.06826631  0.02387708 -0.03416331  0.21341820
2016-12-31 -0.06031217 -0.04075737 -0.00094697  0.01539556  0.07851429
2017-01-31  0.14387403 -0.00424973  0.03879000  0.13680848 -0.01994669
2017-02-28  0.07101104 -0.02065858 -0.00320978 -0.01061987  0.06402762
2017-03-31 -0.00497178  0.04271546 -0.02197891  0.04404029 -0.06676818
2017-04-30 -0.02064767  0.02341935  0.03320595 -0.02035146 -0.04804045
2017-05-31 -0.01683069  0.01750300  0.09965606 -0.00368417  0.00296435
2017-06-30  0.02428615  0.06118855  0.01530084  0.07612942  0.09151416


ticker              ZTS
```

```
date
2013-07-31          nan
2013-08-31  -0.02238899
2013-09-30   0.06539579
2013-10-31   0.01922875
2013-11-30  -0.01623981
2013-12-31   0.04825498
2014-01-31  -0.07165581
2014-02-28   0.02150621
2014-03-31  -0.06940744
2014-04-30   0.04700792
2014-05-31   0.01443595
2014-06-30   0.04987535
2014-07-31   0.01963856
2014-08-31   0.07618433
2014-09-30   0.04172452
2014-10-31   0.00372782
2014-11-30   0.19371924
2014-12-31  -0.04320818
2015-01-31  -0.00509269
2015-02-28   0.07569476
2015-03-31   0.00432995
2015-04-30  -0.03944740
2015-05-31   0.11372257
2015-06-30  -0.03163852
2015-07-31   0.01563818
2015-08-31  -0.08592248
2015-09-30  -0.08581672
2015-10-31   0.04347995
2015-11-30   0.08408991
2015-12-31   0.02578879
2016-01-31  -0.10497356
2016-02-29  -0.04732782
2016-03-31   0.07662724
2016-04-30   0.06119388
2016-05-31   0.00825838
2016-06-30   0.00288761
2016-07-31   0.06149185
2016-08-31   0.01240540
2016-09-30   0.01765151
2016-10-31  -0.08441037
2016-11-30   0.05457719
2016-12-31   0.06064797
2017-01-31   0.02796748
2017-02-28  -0.03011775
2017-03-31   0.00112486
2017-04-30   0.05205758
2017-05-31   0.10432630
```

```
2017-06-30  0.00329757

[48 rows x 495 columns]
ticker              A         AAL         AAP        AAPL        ABBV  \
date
2013-07-31        nan         nan         nan         nan         nan
2013-08-31        nan         nan         nan         nan         nan
2013-09-30  0.04181412 -0.18015337 -0.02977582  0.08044762 -0.06518370
2013-10-31  0.09657861  0.15979244  0.03282284 -0.02171531  0.04855545
2013-11-30 -0.00960698  0.14734639  0.18195865  0.09201927  0.08860637
2013-12-31  0.05388057  0.06647111  0.01828314  0.06772063  0.00000000
2014-01-31  0.06769609  0.07267716  0.09197258  0.00886237  0.08616823
2014-02-28  0.01664682  0.28421071  0.03663543 -0.11394918 -0.06220213
2014-03-31 -0.02120344  0.09598737  0.10373913  0.05588347  0.03355617
2014-04-30 -0.01790035 -0.00897599 -0.00629368  0.01975642  0.00957880
2014-05-31 -0.03182502 -0.04270218 -0.04205794  0.09476126  0.02214224
2014-06-30  0.05227357  0.13552541  0.02346722  0.07577509  0.04229556
2014-07-31  0.01103586  0.06739797  0.08351026  0.02728625  0.03810157
2014-08-31 -0.02378338 -0.09799068 -0.10798279  0.02832630 -0.06780436
2014-09-30  0.01889681  0.00079762  0.11903914  0.07465224  0.05465028
2014-10-31 -0.00082047 -0.09153654 -0.04545245 -0.01722060  0.04388532
2014-11-30 -0.03028915  0.15558158  0.12032096  0.06948903  0.10172478
2014-12-31  0.06740128  0.16010974  0.00081622  0.10071836  0.08659108
2015-01-31 -0.04302767  0.09992645  0.08005917 -0.07460613 -0.05586717
2015-02-28 -0.07812999 -0.08865699 -0.00175946  0.05961156 -0.07327254
2015-03-31  0.11114202 -0.02228945 -0.02593080  0.09598802  0.00248242
2015-04-30 -0.01333009  0.09701683 -0.03400439 -0.03187426 -0.03293308
2015-05-31 -0.00434154 -0.08694248 -0.04572186  0.00576971  0.10773129
2015-06-30 -0.00436047 -0.13068039  0.06903017  0.04431573  0.02941164
2015-07-31 -0.06296587 -0.05918743  0.03922895 -0.03797801  0.00897001
2015-08-31  0.05961780  0.00412320  0.08953503 -0.03344115  0.04841767
2015-09-30 -0.12025862 -0.02595965  0.00595206 -0.06849869 -0.11491257
2015-10-31 -0.05317503 -0.00385555  0.07866971 -0.02523595 -0.13717756
2015-11-30  0.09523073  0.17421946  0.04588907  0.08329065  0.09970324
2015-12-31  0.10212435 -0.11137087 -0.19834401 -0.00580146 -0.02379042
2016-01-31  0.00250761  0.02607491 -0.07765707 -0.11679029  0.01857111
2016-02-29 -0.10480259 -0.08266322  0.01017989 -0.07822348 -0.06500804
2016-03-31 -0.00800004  0.05307585 -0.02402858 -0.00133143 -0.00529633
2016-04-30  0.06478949  0.00024387  0.07749311  0.11974615  0.04493730
2016-05-31  0.02934536 -0.16736448 -0.02679973 -0.15073114  0.07532447
2016-06-30  0.11462829 -0.08063179 -0.01458373  0.06933886  0.03114913
2016-07-31 -0.03131999 -0.11970434  0.04978712 -0.04359639 -0.01634128
2016-08-31  0.08115189  0.22631760  0.04966480  0.08623527  0.07621369
2016-09-30 -0.02376808  0.02526745 -0.07631131  0.02334347 -0.03268917
2016-10-31  0.00477784  0.00850369 -0.05350196  0.06344815 -0.01619914
2016-11-30 -0.07769182  0.10344664 -0.06253766  0.00432500 -0.11356073
2016-12-31  0.00936614  0.13692923  0.19193633 -0.02178228  0.08617441
2017-01-31  0.03818318  0.00536885 -0.00319576  0.04684076  0.02949493
```

```
2017-02-28   0.07217773 -0.05367464 -0.02927975  0.04664167 -0.01399583
2017-03-31   0.04648289  0.04873915 -0.04757013  0.12552425  0.01187489
2017-04-30   0.03263890 -0.09164993 -0.05439459  0.04754147  0.05229538
2017-05-31   0.04040579  0.00753654 -0.04215500 -0.00006961  0.02182202
2017-06-30   0.09175337  0.12956238 -0.06173770  0.06557216  0.00121249

ticker            ABC         ABT         ACN        ADBE         ADI  \
date
2013-07-31        nan         nan         nan         nan         nan
2013-08-31        nan         nan         nan         nan         nan
2013-09-30 -0.01609335 -0.09440968 -0.02136190 -0.03289558 -0.05749847
2013-10-31  0.07086509 -0.00420927  0.01905603  0.12689741  0.01650096
2013-11-30  0.06693948  0.10058564  0.01124304  0.04296064  0.04671322
2013-12-31  0.07997603  0.04389252  0.05260536  0.04613431 -0.02215021
2014-01-31 -0.00312412  0.00365918  0.05950782  0.05314171  0.06162558
2014-02-28 -0.04494321 -0.03893724 -0.02887307 -0.01157325 -0.05364189
2014-03-31  0.01278407  0.08167803  0.04252310  0.14797715  0.05873111
2014-04-30 -0.03387614 -0.03244633 -0.04452811 -0.04302219  0.04463996
2014-05-31 -0.00627057  0.01187986  0.01803285 -0.06358573 -0.03543414
2014-06-30  0.11924492  0.03225676  0.01521647  0.04516334  0.02805861
2014-07-31 -0.00713113  0.02200064 -0.00751744  0.11436847  0.03175466
2014-08-31  0.05684488  0.03470536 -0.01948600 -0.04393196 -0.08568401
2014-09-30  0.00928406  0.00284495  0.02220373  0.03755456  0.02958032
2014-10-31 -0.00116362 -0.01550789  0.00320237 -0.03841992 -0.02506897
2014-11-30  0.09976923  0.05225014  0.01089553  0.01335172  0.00262335
2014-12-31  0.06719583  0.02088612  0.06224762  0.04952333  0.09637224
2015-01-31 -0.00982294  0.01139295  0.03393630 -0.01339001  0.02250327
2015-02-28  0.05281720 -0.00042641 -0.06093959 -0.03599072 -0.06348240
2015-03-31  0.08089383  0.05667423  0.06896907  0.12036221  0.12320729
2015-04-30  0.10090334 -0.02219942  0.03984851 -0.06745892  0.07342445
2015-05-31  0.00552706  0.00708541 -0.00049630  0.02826855 -0.01858432
2015-06-30 -0.01281413  0.04589313  0.03593582  0.03906394  0.10020918
2015-07-31 -0.05684490  0.00982809  0.00767559  0.02398616 -0.05714976
2015-08-31 -0.00556369  0.03709245  0.06335602  0.01202468 -0.09565300
2015-09-30 -0.05271992 -0.11264239 -0.08963337 -0.04260734 -0.03591771
2015-10-31 -0.05179848 -0.11872187  0.04145402  0.04540863  0.00979789
2015-11-30  0.01587501  0.11369172  0.09776101  0.07541025  0.06369612
2015-12-31  0.02533250  0.00267499  0.00018655  0.03109289  0.02480620
2016-01-31  0.05012168 -0.00022264 -0.02569573  0.02675456 -0.10145040
2016-02-29 -0.14668975 -0.16459543  0.00990296 -0.05256030 -0.02674642
2016-03-31 -0.02946371  0.02324168 -0.05132322 -0.04568157 -0.00821101
2016-04-30 -0.00080845  0.07674113  0.14063754  0.09675045  0.11064939
2016-05-31 -0.01689525 -0.06663976 -0.01220169  0.00446762 -0.04970290
2016-06-30 -0.12208554  0.01859216  0.05219176  0.05422362  0.04515902
2016-07-31  0.05626889 -0.00810747 -0.04892046 -0.03769780 -0.03231130
2016-08-31  0.07139375  0.13578830 -0.00424592  0.02137959  0.11950785
2016-09-30  0.02449340 -0.06294575  0.01922714  0.04446953 -0.01342097
2016-10-31 -0.07383382  0.00640496  0.06048139  0.05911135  0.02976363
```

24

```
2016-11-30 -0.13867316 -0.06852950 -0.03945196 -0.00953490 -0.00544537
2016-12-31  0.10806742 -0.03027006  0.02707341 -0.04470124  0.15250011
2017-01-31  0.00256115  0.00889127 -0.01944600  0.00136081 -0.02206272
2017-02-28  0.10997958  0.09029065 -0.02822698  0.09650158  0.03144743
2017-03-31  0.05135996  0.07626031  0.07305358  0.04281683  0.09464624
2017-04-30 -0.03344570 -0.01497402 -0.02161979  0.09497211  0.00024408
2017-05-31 -0.07567373 -0.01142815  0.02214547  0.02736367 -0.07274784
2017-06-30  0.11615820  0.04524848  0.02579791  0.05894304  0.11819123

ticker           ...           XL        XLNX         XOM        XRAY  \
date             ...
2013-07-31       ...          nan         nan         nan         nan
2013-08-31       ...          nan         nan         nan         nan
2013-09-30       ...  -0.05879217 -0.06720501 -0.06596571 -0.02097402
2013-10-31       ...   0.04630944  0.07605219 -0.01293321  0.03481157
2013-11-30       ...  -0.00814469 -0.03082169  0.04076620  0.08157415
2013-12-31       ...   0.04540422 -0.01674184  0.04899644  0.00961292
2014-01-31       ...  -0.00005037  0.03298584  0.07935125  0.02044076
2014-02-28       ...  -0.10243348  0.01082965 -0.09357256 -0.04947109
2014-03-31       ...   0.05615273  0.12286783  0.05062164 -0.01660877
2014-04-30       ...   0.03284340  0.03888909  0.01454009  0.01589505
2014-05-31       ...   0.00319489 -0.13978958  0.04728753 -0.03110431
2014-06-30       ...   0.03479430  0.00123427 -0.01178295  0.05789258
2014-07-31       ...   0.01315416  0.00742551  0.00149098  0.00264665
2014-08-31       ...  -0.01508417 -0.13998391 -0.01743356 -0.01983642
2014-09-30       ...   0.05843276  0.03386045  0.01220640  0.02730581
2014-10-31       ...  -0.02525829  0.00236407 -0.05592900 -0.04369616
2014-11-30       ...   0.02117902  0.04253010  0.02789025  0.10739791
2014-12-31       ...   0.04727105  0.03443096 -0.05880687  0.07966385
2015-01-31       ...  -0.02838693 -0.04847111  0.02087622 -0.03037006
2015-02-28       ...   0.00348534 -0.11531726 -0.05594387 -0.06285044
2015-03-31       ...   0.04838969  0.10127687  0.02024303  0.05795769
2015-04-30       ...   0.02092430 -0.00165348 -0.04080317 -0.03938489
2015-05-31       ...   0.00757990  0.02475027  0.02750072  0.00215919
2015-06-30       ...   0.01605171  0.09654661 -0.01677365  0.02009094
2015-07-31       ...  -0.00860127 -0.07122468 -0.02375409 -0.00797670
2015-08-31       ...   0.02180358 -0.05611995 -0.04914479  0.09891886
2015-09-30       ...  -0.01938714  0.01075955 -0.04204308 -0.08237366
2015-10-31       ...  -0.02096434  0.01139343 -0.01189933 -0.03437113
2015-11-30       ...   0.04732066  0.11681228  0.10691949  0.18505330
2015-12-31       ...   0.00262261  0.04908477 -0.00427045 -0.00312732
2016-01-31       ...   0.03118510 -0.05629461 -0.04649669  0.00432337
2016-02-29       ...  -0.07745121  0.06789938 -0.00128370 -0.03274052
2016-03-31       ...  -0.05324021 -0.05604739  0.03819057  0.03454661
2016-04-30       ...   0.07359389  0.00443741  0.04202402  0.01220241
2016-05-31       ...  -0.11720576 -0.09619609  0.05594807 -0.03349319
2016-06-30       ...   0.04830993  0.10290823  0.01539863  0.04205613
2016-07-31       ...  -0.02466162 -0.02694774  0.05166393 -0.00071206
```

```
2016-08-31      ...        0.03828501  0.10192953 -0.05245058  0.03172855
2016-09-30      ...       -0.01104021  0.06579968 -0.01191629 -0.04112133
2016-10-31      ...       -0.01178072  0.00239521  0.00160532 -0.03228879
2016-11-30      ...        0.03132116 -0.06598725 -0.04643273 -0.03179755
2016-12-31      ...        0.04038386  0.06594093  0.05541489  0.01054005
2017-01-31      ...        0.03615589  0.11187869  0.03334393 -0.00643281
2017-02-28      ...        0.00828549 -0.03660694 -0.07318798 -0.01800276
2017-03-31      ...        0.07484917  0.01624776 -0.02195182  0.11358061
2017-04-30      ...       -0.01017620 -0.01593728  0.00844920 -0.01575947
2017-05-31      ...        0.04871848  0.08633458 -0.00439937  0.01273092
2017-06-30      ...        0.04302745  0.06090411 -0.00482798  0.00441780

ticker            XRX         XYL         YUM         ZBH        ZION  \
date
2013-07-31        nan         nan         nan         nan         nan
2013-08-31        nan         nan         nan         nan         nan
2013-09-30  0.02845720 -0.00134868 -0.04058203 -0.05402072 -0.05663911
2013-10-31  0.03611367  0.11966450  0.01937689  0.04028369 -0.01985983
2013-11-30 -0.03460553  0.21535825 -0.04870385  0.06287079  0.03494040
2013-12-31  0.13529041  0.00173762  0.13869403  0.04405904  0.03381174
2014-01-31  0.07181852  0.00115674 -0.02700927  0.02143144  0.02125228
2014-02-28 -0.11480883 -0.03649610 -0.11361565  0.00833515 -0.04122539
2014-03-31  0.01282069  0.16849675  0.09821667 -0.00138443  0.08307315
2014-04-30  0.03352930 -0.07737790  0.01752905  0.01022814 -0.00707626
2014-05-31  0.06757594  0.03161998  0.02580642  0.02320097 -0.06880844
2014-06-30  0.02127740 -0.00437311  0.00414777  0.07510359 -0.01005896
2014-07-31  0.01231307  0.04661750  0.04909193 -0.00262106  0.03031579
2014-08-31  0.06383490 -0.10201119 -0.15259272 -0.03717391 -0.02230321
2014-09-30  0.04064098  0.05432073  0.04273371 -0.00762369  0.01245116
2014-10-31 -0.03818588 -0.04527723 -0.00623228  0.01452958 -0.00274914
2014-11-30  0.00377217  0.02786669  0.00399386  0.10103487 -0.00310185
2014-12-31  0.04993695  0.05302447  0.07274470  0.00939481 -0.02173021
2015-01-31 -0.00277876 -0.00706717 -0.05864438  0.01193901  0.01590983
2015-02-28 -0.05106548 -0.11012919 -0.00220105 -0.01170641 -0.17386913
2015-03-31  0.03579801  0.04975030  0.11525879  0.07134515  0.11109071
2015-04-30 -0.05485114 -0.01923136 -0.02990901 -0.02227720  0.00986330
2015-05-31 -0.11099678  0.05553898  0.09320743 -0.06758378  0.04826092
2015-06-30 -0.00698083 -0.00836304  0.04714907  0.03992801  0.02108818
2015-07-31 -0.06439073  0.01357979 -0.00033298 -0.04353182  0.09427086
2015-08-31  0.03509132 -0.07097951 -0.02148999 -0.04839200 -0.01732264
2015-09-30 -0.08026959 -0.05779847 -0.09545832 -0.00491259 -0.07084284
2015-10-31 -0.03699314  0.01225130  0.00225395 -0.09522347 -0.05165634
2015-11-30 -0.03556860  0.10289172 -0.11330487  0.10730688  0.04369368
2015-12-31  0.11648057  0.02852030  0.02231302 -0.03463718  0.04255223
2016-01-31  0.01407508 -0.02221712  0.00741965  0.01765935 -0.09297646
2016-02-29 -0.08641291 -0.01518318 -0.00271062 -0.03299779 -0.18540322
2016-03-31 -0.01446306  0.04398671  0.00138083 -0.02499238 -0.05907417
2016-04-30  0.15666230  0.08919201  0.12171562  0.09887961  0.12712017
```

```
2016-05-31 -0.15057286  0.02128769 -0.02279296  0.08224057  0.12814724
2016-06-30  0.03781749  0.07021508  0.03130475  0.05331681  0.02029299
2016-07-31 -0.04083362 -0.00022394  0.01006008 -0.01224782 -0.10885619
2016-08-31  0.08190528  0.06838052  0.08081880  0.08561205  0.10384723
2016-09-30 -0.04467244  0.06487578  0.01432323 -0.01173551  0.09555297
2016-10-31  0.03568895  0.03078357  0.00110181  0.00504351  0.01395900
2016-11-30 -0.03618485 -0.08180785 -0.04530849 -0.20992565  0.03764481
2016-12-31 -0.04394012  0.06826631  0.02387708 -0.03416331  0.21341820
2017-01-31 -0.06031217 -0.04075737 -0.00094697  0.01539556  0.07851429
2017-02-28  0.14387403 -0.00424973  0.03879000  0.13680848 -0.01994669
2017-03-31  0.07101104 -0.02065858 -0.00320978 -0.01061987  0.06402762
2017-04-30 -0.00497178  0.04271546 -0.02197891  0.04404029 -0.06676818
2017-05-31 -0.02064767  0.02341935  0.03320595 -0.02035146 -0.04804045
2017-06-30 -0.01683069  0.01750300  0.09965606 -0.00368417  0.00296435

ticker              ZTS
date
2013-07-31          nan
2013-08-31          nan
2013-09-30 -0.02238899
2013-10-31  0.06539579
2013-11-30  0.01922875
2013-12-31 -0.01623981
2014-01-31  0.04825498
2014-02-28 -0.07165581
2014-03-31  0.02150621
2014-04-30 -0.06940744
2014-05-31  0.04700792
2014-06-30  0.01443595
2014-07-31  0.04987535
2014-08-31  0.01963856
2014-09-30  0.07618433
2014-10-31  0.04172452
2014-11-30  0.00372782
2014-12-31  0.19371924
2015-01-31 -0.04320818
2015-02-28 -0.00509269
2015-03-31  0.07569476
2015-04-30  0.00432995
2015-05-31 -0.03944740
2015-06-30  0.11372257
2015-07-31 -0.03163852
2015-08-31  0.01563818
2015-09-30 -0.08592248
2015-10-31 -0.08581672
2015-11-30  0.04347995
2015-12-31  0.08408991
2016-01-31  0.02578879
```

```
2016-02-29 -0.10497356
2016-03-31 -0.04732782
2016-04-30  0.07662724
2016-05-31  0.06119388
2016-06-30  0.00825838
2016-07-31  0.00288761
2016-08-31  0.06149185
2016-09-30  0.01240540
2016-10-31  0.01765151
2016-11-30 -0.08441037
2016-12-31  0.05457719
2017-01-31  0.06064797
2017-02-28  0.02796748
2017-03-31 -0.03011775
2017-04-30  0.00112486
2017-05-31  0.05205758
2017-06-30  0.10432630

[48 rows x 495 columns]
ticker             A         AAL         AAP        AAPL        ABBV  \
date
2013-07-31       nan         nan         nan         nan         nan
2013-08-31  0.04181412 -0.18015337 -0.02977582  0.08044762 -0.06518370
2013-09-30  0.09657861  0.15979244  0.03282284 -0.02171531  0.04855545
2013-10-31 -0.00960698  0.14734639  0.18195865  0.09201927  0.08860637
2013-11-30  0.05388057  0.06647111  0.01828314  0.06772063  0.00000000
2013-12-31  0.06769609  0.07267716  0.09197258  0.00886237  0.08616823
2014-01-31  0.01664682  0.28421071  0.03663543 -0.11394918 -0.06220213
2014-02-28 -0.02120344  0.09598737  0.10373913  0.05588347  0.03355617
2014-03-31 -0.01790035 -0.00897599 -0.00629368  0.01975642  0.00957880
2014-04-30 -0.03182502 -0.04270218 -0.04205794  0.09476126  0.02214224
2014-05-31  0.05227357  0.13552541  0.02346722  0.07577509  0.04229556
2014-06-30  0.01103586  0.06739797  0.08351026  0.02728625  0.03810157
2014-07-31 -0.02378338 -0.09799068 -0.10798279  0.02832630 -0.06780436
2014-08-31  0.01889681  0.00079762  0.11903914  0.07465224  0.05465028
2014-09-30 -0.00082047 -0.09153654 -0.04545245 -0.01722060  0.04388532
2014-10-31 -0.03028915  0.15558158  0.12032096  0.06948903  0.10172478
2014-11-30  0.06740128  0.16010974  0.00081622  0.10071836  0.08659108
2014-12-31 -0.04302767  0.09992645  0.08005917 -0.07460613 -0.05586717
2015-01-31 -0.07812999 -0.08865699 -0.00175946  0.05961156 -0.07327254
2015-02-28  0.11114202 -0.02228945 -0.02593080  0.09598802  0.00248242
2015-03-31 -0.01333009  0.09701683 -0.03400439 -0.03187426 -0.03293308
2015-04-30 -0.00434154 -0.08694248 -0.04572186  0.00576971  0.10773129
2015-05-31 -0.00436047 -0.13068039  0.06903017  0.04431573  0.02941164
2015-06-30 -0.06296587 -0.05918743  0.03922895 -0.03797801  0.00897001
2015-07-31  0.05961780  0.00412320  0.08953503 -0.03344115  0.04841767
2015-08-31 -0.12025862 -0.02595965  0.00595206 -0.06849869 -0.11491257
2015-09-30 -0.05317503 -0.00385555  0.07866971 -0.02523595 -0.13717756
```

```
2015-10-31   0.09523073   0.17421946   0.04588907   0.08329065   0.09970324
2015-11-30   0.10212435  -0.11137087  -0.19834401  -0.00580146  -0.02379042
2015-12-31   0.00250761   0.02607491  -0.07765707  -0.11679029   0.01857111
2016-01-31  -0.10480259  -0.08266322   0.01017989  -0.07822348  -0.06500804
2016-02-29  -0.00800004   0.05307585  -0.02402858  -0.00133143  -0.00529633
2016-03-31   0.06478949   0.00024387   0.07749311   0.11974615   0.04493730
2016-04-30   0.02934536  -0.16736448  -0.02679973  -0.15073114   0.07532447
2016-05-31   0.11462829  -0.08063179  -0.01458373   0.06933886   0.03114913
2016-06-30  -0.03131999  -0.11970434   0.04978712  -0.04359639  -0.01634128
2016-07-31   0.08115189   0.22631760   0.04966480   0.08623527   0.07621369
2016-08-31  -0.02376808   0.02526745  -0.07631131   0.02334347  -0.03268917
2016-09-30   0.00477784   0.00850369  -0.05350196   0.06344815  -0.01619914
2016-10-31  -0.07769182   0.10344664  -0.06253766   0.00432500  -0.11356073
2016-11-30   0.00936614   0.13692923   0.19193633  -0.02178228   0.08617441
2016-12-31   0.03818318   0.00536885  -0.00319576   0.04684076   0.02949493
2017-01-31   0.07217773  -0.05367464  -0.02927975   0.04664167  -0.01399583
2017-02-28   0.04648289   0.04873915  -0.04757013   0.12552425   0.01187489
2017-03-31   0.03263890  -0.09164993  -0.05439459   0.04754147   0.05229538
2017-04-30   0.04040579   0.00753654  -0.04215500  -0.00006961   0.02182202
2017-05-31   0.09175337   0.12956238  -0.06173770   0.06557216   0.00121249
2017-06-30  -0.01497493   0.03869621  -0.13591186  -0.05891588   0.09376676

ticker              ABC          ABT          ACN         ADBE          ADI  \
date
2013-07-31          nan          nan          nan          nan          nan
2013-08-31  -0.01609335  -0.09440968  -0.02136190  -0.03289558  -0.05749847
2013-09-30   0.07086509  -0.00420927   0.01905603   0.12689741   0.01650096
2013-10-31   0.06693948   0.10058564   0.01124304   0.04296064   0.04671322
2013-11-30   0.07997603   0.04389252   0.05260536   0.04613431  -0.02215021
2013-12-31  -0.00312412   0.00365918   0.05950782   0.05314171   0.06162558
2014-01-31  -0.04494321  -0.03893724  -0.02887307  -0.01157325  -0.05364189
2014-02-28   0.01278407   0.08167803   0.04252310   0.14797715   0.05873111
2014-03-31  -0.03387614  -0.03244633  -0.04452811  -0.04302219   0.04463996
2014-04-30  -0.00627057   0.01187986   0.01803285  -0.06358573  -0.03543414
2014-05-31   0.11924492   0.03225676   0.01521647   0.04516334   0.02805861
2014-06-30  -0.00713113   0.02200064  -0.00751744   0.11436847   0.03175466
2014-07-31   0.05684488   0.03470536  -0.01948600  -0.04393196  -0.08568401
2014-08-31   0.00928406   0.00284495   0.02220373   0.03755456   0.02958032
2014-09-30  -0.00116362  -0.01550789   0.00320237  -0.03841992  -0.02506897
2014-10-31   0.09976923   0.05225014   0.01089553   0.01335172   0.00262335
2014-11-30   0.06719583   0.02088612   0.06224762   0.04952333   0.09637224
2014-12-31  -0.00982294   0.01139295   0.03393630  -0.01339001   0.02250327
2015-01-31   0.05281720  -0.00042641  -0.06093959  -0.03599072  -0.06348240
2015-02-28   0.08089383   0.05667423   0.06896907   0.12036221   0.12320729
2015-03-31   0.10090334  -0.02219942   0.03984851  -0.06745892   0.07342445
2015-04-30   0.00552706   0.00708541  -0.00049630   0.02826855  -0.01858432
2015-05-31  -0.01281413   0.04589313   0.03593582   0.03906394   0.10020918
2015-06-30  -0.05684490   0.00982809   0.00767559   0.02398616  -0.05714976
```

```
2015-07-31  -0.00556369   0.03709245   0.06335602   0.01202468  -0.09565300
2015-08-31  -0.05271992  -0.11264239  -0.08963337  -0.04260734  -0.03591771
2015-09-30  -0.05179848  -0.11872187   0.04145402   0.04540863   0.00979789
2015-10-31   0.01587501   0.11369172   0.09776101   0.07541025   0.06369612
2015-11-30   0.02533250   0.00267499   0.00018655   0.03109289   0.02480620
2015-12-31   0.05012168  -0.00022264  -0.02569573   0.02675456  -0.10145040
2016-01-31  -0.14668975  -0.16459543   0.00990296  -0.05256030  -0.02674642
2016-02-29  -0.02946371   0.02324168  -0.05132322  -0.04568157  -0.00821101
2016-03-31  -0.00080845   0.07674113   0.14063754   0.09675045   0.11064939
2016-04-30  -0.01689525  -0.06663976  -0.01220169   0.00446762  -0.04970290
2016-05-31  -0.12208554   0.01859216   0.05219176   0.05422362   0.04515902
2016-06-30   0.05626889  -0.00810747  -0.04892046  -0.03769780  -0.03231130
2016-07-31   0.07139375   0.13578830  -0.00424592   0.02137959   0.11950785
2016-08-31   0.02449340  -0.06294575   0.01922714   0.04446953  -0.01342097
2016-09-30  -0.07383382   0.00640496   0.06048139   0.05911135   0.02976363
2016-10-31  -0.13867316  -0.06852950  -0.03945196  -0.00953490  -0.00544537
2016-11-30   0.10806742  -0.03027006   0.02707341  -0.04470124   0.15250011
2016-12-31   0.00256115   0.00889127  -0.01944600   0.00136081  -0.02206272
2017-01-31   0.10997958   0.09029065  -0.02822698   0.09650158   0.03144743
2017-02-28   0.05135996   0.07626031   0.07305358   0.04281683   0.09464624
2017-03-31  -0.03344570  -0.01497402  -0.02161979   0.09497211   0.00024408
2017-04-30  -0.07567373  -0.01142815   0.02214547   0.02736367  -0.07274784
2017-05-31   0.11615820   0.04524848   0.02579791   0.05894304   0.11819123
2017-06-30   0.02963180   0.06260663  -0.00636714  -0.00296506  -0.09185947

ticker         ...          XL         XLNX          XOM         XRAY  \
date           ...
2013-07-31     ...         nan          nan          nan          nan
2013-08-31     ...  -0.05879217  -0.06720501  -0.06596571  -0.02097402
2013-09-30     ...   0.04630944   0.07605219  -0.01293321   0.03481157
2013-10-31     ...  -0.00814469  -0.03082169   0.04076620   0.08157415
2013-11-30     ...   0.04540422  -0.01674184   0.04899644   0.00961292
2013-12-31     ...  -0.00005037   0.03298584   0.07935125   0.02044076
2014-01-31     ...  -0.10243348   0.01082965  -0.09357256  -0.04947109
2014-02-28     ...   0.05615273   0.12286783   0.05062164  -0.01660877
2014-03-31     ...   0.03284340   0.03888909   0.01454009   0.01589505
2014-04-30     ...   0.00319489  -0.13978958   0.04728753  -0.03110431
2014-05-31     ...   0.03479430   0.00123427  -0.01178295   0.05789258
2014-06-30     ...   0.01315416   0.00742551   0.00149098   0.00264665
2014-07-31     ...  -0.01508417  -0.13998391  -0.01743356  -0.01983642
2014-08-31     ...   0.05843276   0.03386045   0.01220640   0.02730581
2014-09-30     ...  -0.02525829   0.00236407  -0.05592900  -0.04369616
2014-10-31     ...   0.02117902   0.04253010   0.02789025   0.10739791
2014-11-30     ...   0.04727105   0.03443096  -0.05880687   0.07966385
2014-12-31     ...  -0.02838693  -0.04847111   0.02087622  -0.03037006
2015-01-31     ...   0.00348534  -0.11531726  -0.05594387  -0.06285044
2015-02-28     ...   0.04838969   0.10127687   0.02024303   0.05795769
2015-03-31     ...   0.02092430  -0.00165348  -0.04080317  -0.03938489
```

```
2015-04-30      ...       0.00757990  0.02475027  0.02750072  0.00215919
2015-05-31      ...       0.01605171  0.09654661 -0.01677365  0.02009094
2015-06-30      ...      -0.00860127 -0.07122468 -0.02375409 -0.00797670
2015-07-31      ...       0.02180358 -0.05611995 -0.04914479  0.09891886
2015-08-31      ...      -0.01938714  0.01075955 -0.04204308 -0.08237366
2015-09-30      ...      -0.02096434  0.01139343 -0.01189933 -0.03437113
2015-10-31      ...       0.04732066  0.11681228  0.10691949  0.18505330
2015-11-30      ...       0.00262261  0.04908477 -0.00427045 -0.00312732
2015-12-31      ...       0.03118510 -0.05629461 -0.04649669  0.00432337
2016-01-31      ...      -0.07745121  0.06789938 -0.00128370 -0.03274052
2016-02-29      ...      -0.05324021 -0.05604739  0.03819057  0.03454661
2016-03-31      ...       0.07359389  0.00443741  0.04202402  0.01220241
2016-04-30      ...      -0.11720576 -0.09619609  0.05594807 -0.03349319
2016-05-31      ...       0.04830993  0.10290823  0.01539863  0.04205613
2016-06-30      ...      -0.02466162 -0.02694774  0.05166393 -0.00071206
2016-07-31      ...       0.03828501  0.10192953 -0.05245058  0.03172855
2016-08-31      ...      -0.01104021  0.06579968 -0.01191629 -0.04112133
2016-09-30      ...      -0.01178072  0.00239521  0.00160532 -0.03228879
2016-10-31      ...       0.03132116 -0.06598725 -0.04643273 -0.03179755
2016-11-30      ...       0.04038386  0.06594093  0.05541489  0.01054005
2016-12-31      ...       0.03615589  0.11187869  0.03334393 -0.00643281
2017-01-31      ...       0.00828549 -0.03660694 -0.07318798 -0.01800276
2017-02-28      ...       0.07484917  0.01624776 -0.02195182  0.11358061
2017-03-31      ...      -0.01017620 -0.01593728  0.00844920 -0.01575947
2017-04-30      ...       0.04871848  0.08633458 -0.00439937  0.01273092
2017-05-31      ...       0.04302745  0.06090411 -0.00482798  0.00441780
2017-06-30      ...       0.00769349 -0.03648424  0.00285307  0.02190798

ticker             XRX         XYL         YUM         ZBH        ZION  \
date
2013-07-31         nan         nan         nan         nan         nan
2013-08-31  0.02845720 -0.00134868 -0.04058203 -0.05402072 -0.05663911
2013-09-30  0.03611367  0.11966450  0.01937689  0.04028369 -0.01985983
2013-10-31 -0.03460553  0.21535825 -0.04870385  0.06287079  0.03494040
2013-11-30  0.13529041  0.00173762  0.13869403  0.04405904  0.03381174
2013-12-31  0.07181852  0.00115674 -0.02700927  0.02143144  0.02125228
2014-01-31 -0.11480883 -0.03649610 -0.11361565  0.00833515 -0.04122539
2014-02-28  0.01282069  0.16849675  0.09821667 -0.00138443  0.08307315
2014-03-31  0.03352930 -0.07737790  0.01752905  0.01022814 -0.00707626
2014-04-30  0.06757594  0.03161998  0.02580642  0.02320097 -0.06880844
2014-05-31  0.02127740 -0.00437311  0.00414777  0.07510359 -0.01005896
2014-06-30  0.01231307  0.04661750  0.04909193 -0.00262106  0.03031579
2014-07-31  0.06383490 -0.10201119 -0.15259272 -0.03717391 -0.02230321
2014-08-31  0.04064098  0.05432073  0.04273371 -0.00762369  0.01245116
2014-09-30 -0.03818588 -0.04527723 -0.00623228  0.01452958 -0.00274914
2014-10-31  0.00377217  0.02786669  0.00399386  0.10103487 -0.00310185
2014-11-30  0.04993695  0.05302447  0.07274470  0.00939481 -0.02173021
2014-12-31 -0.00277876 -0.00706717 -0.05864438  0.01193901  0.01590983
```

```
2015-01-31 -0.05106548 -0.11012919 -0.00220105 -0.01170641 -0.17386913
2015-02-28  0.03579801  0.04975030  0.11525879  0.07134515  0.11109071
2015-03-31 -0.05485114 -0.01923136 -0.02990901 -0.02227720  0.00986330
2015-04-30 -0.11099678  0.05553898  0.09320743 -0.06758378  0.04826092
2015-05-31 -0.00698083 -0.00836304  0.04714907  0.03992801  0.02108818
2015-06-30 -0.06439073  0.01357979 -0.00033298 -0.04353182  0.09427086
2015-07-31  0.03509132 -0.07097951 -0.02148999 -0.04839200 -0.01732264
2015-08-31 -0.08026959 -0.05779847 -0.09545832 -0.00491259 -0.07084284
2015-09-30 -0.03699314  0.01225130  0.00225395 -0.09522347 -0.05165634
2015-10-31 -0.03556860  0.10289172 -0.11330487  0.10730688  0.04369368
2015-11-30  0.11648057  0.02852030  0.02231302 -0.03463718  0.04255223
2015-12-31  0.01407508 -0.02221712  0.00741965  0.01765935 -0.09297646
2016-01-31 -0.08641291 -0.01518318 -0.00271062 -0.03299779 -0.18540322
2016-02-29 -0.01446306  0.04398671  0.00138083 -0.02499238 -0.05907417
2016-03-31  0.15666230  0.08919201  0.12171562  0.09887961  0.12712017
2016-04-30 -0.15057286  0.02128769 -0.02279296  0.08224057  0.12814724
2016-05-31  0.03781749  0.07021508  0.03130475  0.05331681  0.02029299
2016-06-30 -0.04083362 -0.00022394  0.01006008 -0.01224782 -0.10885619
2016-07-31  0.08190528  0.06838052  0.08081880  0.08561205  0.10384723
2016-08-31 -0.04467244  0.06487578  0.01432323 -0.01173551  0.09555297
2016-09-30  0.03568895  0.03078357  0.00110181  0.00504351  0.01395900
2016-10-31 -0.03618485 -0.08180785 -0.04530849 -0.20992565  0.03764481
2016-11-30 -0.04394012  0.06826631  0.02387708 -0.03416331  0.21341820
2016-12-31 -0.06031217 -0.04075737 -0.00094697  0.01539556  0.07851429
2017-01-31  0.14387403 -0.00424973  0.03879000  0.13680848 -0.01994669
2017-02-28  0.07101104 -0.02065858 -0.00320978 -0.01061987  0.06402762
2017-03-31 -0.00497178  0.04271546 -0.02197891  0.04404029 -0.06676818
2017-04-30 -0.02064767  0.02341935  0.03320595 -0.02035146 -0.04804045
2017-05-31 -0.01683069  0.01750300  0.09965606 -0.00368417  0.00296435
2017-06-30  0.02428615  0.06118855  0.01530084  0.07612942  0.09151416

ticker            ZTS
date
2013-07-31        nan
2013-08-31 -0.02238899
2013-09-30  0.06539579
2013-10-31  0.01922875
2013-11-30 -0.01623981
2013-12-31  0.04825498
2014-01-31 -0.07165581
2014-02-28  0.02150621
2014-03-31 -0.06940744
2014-04-30  0.04700792
2014-05-31  0.01443595
2014-06-30  0.04987535
2014-07-31  0.01963856
2014-08-31  0.07618433
2014-09-30  0.04172452
```

```
2014-10-31   0.00372782
2014-11-30   0.19371924
2014-12-31  -0.04320818
2015-01-31  -0.00509269
2015-02-28   0.07569476
2015-03-31   0.00432995
2015-04-30  -0.03944740
2015-05-31   0.11372257
2015-06-30  -0.03163852
2015-07-31   0.01563818
2015-08-31  -0.08592248
2015-09-30  -0.08581672
2015-10-31   0.04347995
2015-11-30   0.08408991
2015-12-31   0.02578879
2016-01-31  -0.10497356
2016-02-29  -0.04732782
2016-03-31   0.07662724
2016-04-30   0.06119388
2016-05-31   0.00825838
2016-06-30   0.00288761
2016-07-31   0.06149185
2016-08-31   0.01240540
2016-09-30   0.01765151
2016-10-31  -0.08441037
2016-11-30   0.05457719
2016-12-31   0.06064797
2017-01-31   0.02796748
2017-02-28  -0.03011775
2017-03-31   0.00112486
2017-04-30   0.05205758
2017-05-31   0.10432630
2017-06-30   0.00329757

[48 rows x 495 columns]
ticker             A         AAL         AAP        AAPL        ABBV  \
date
2013-07-31   0.04181412 -0.18015337 -0.02977582  0.08044762 -0.06518370
2013-08-31   0.09657861  0.15979244  0.03282284 -0.02171531  0.04855545
2013-09-30  -0.00960698  0.14734639  0.18195865  0.09201927  0.08860637
2013-10-31   0.05388057  0.06647111  0.01828314  0.06772063  0.00000000
2013-11-30   0.06769609  0.07267716  0.09197258  0.00886237  0.08616823
2013-12-31   0.01664682  0.28421071  0.03663543 -0.11394918 -0.06220213
2014-01-31  -0.02120344  0.09598737  0.10373913  0.05588347  0.03355617
2014-02-28  -0.01790035 -0.00897599 -0.00629368  0.01975642  0.00957880
2014-03-31  -0.03182502 -0.04270218 -0.04205794  0.09476126  0.02214224
2014-04-30   0.05227357  0.13552541  0.02346722  0.07577509  0.04229556
2014-05-31   0.01103586  0.06739797  0.08351026  0.02728625  0.03810157
```

```
2014-06-30 -0.02378338 -0.09799068 -0.10798279  0.02832630 -0.06780436
2014-07-31  0.01889681  0.00079762  0.11903914  0.07465224  0.05465028
2014-08-31 -0.00082047 -0.09153654 -0.04545245 -0.01722060  0.04388532
2014-09-30 -0.03028915  0.15558158  0.12032096  0.06948903  0.10172478
2014-10-31  0.06740128  0.16010974  0.00081622  0.10071836  0.08659108
2014-11-30 -0.04302767  0.09992645  0.08005917 -0.07460613 -0.05586717
2014-12-31 -0.07812999 -0.08865699 -0.00175946  0.05961156 -0.07327254
2015-01-31  0.11114202 -0.02228945 -0.02593080  0.09598802  0.00248242
2015-02-28 -0.01333009  0.09701683 -0.03400439 -0.03187426 -0.03293308
2015-03-31 -0.00434154 -0.08694248 -0.04572186  0.00576971  0.10773129
2015-04-30 -0.00436047 -0.13068039  0.06903017  0.04431573  0.02941164
2015-05-31 -0.06296587 -0.05918743  0.03922895 -0.03797801  0.00897001
2015-06-30  0.05961780  0.00412320  0.08953503 -0.03344115  0.04841767
2015-07-31 -0.12025862 -0.02595965  0.00595206 -0.06849869 -0.11491257
2015-08-31 -0.05317503 -0.00385555  0.07866971 -0.02523595 -0.13717756
2015-09-30  0.09523073  0.17421946  0.04588907  0.08329065  0.09970324
2015-10-31  0.10212435 -0.11137087 -0.19834401 -0.00580146 -0.02379042
2015-11-30  0.00250761  0.02607491 -0.07765707 -0.11679029  0.01857111
2015-12-31 -0.10480259 -0.08266322  0.01017989 -0.07822348 -0.06500804
2016-01-31 -0.00800004  0.05307585 -0.02402858 -0.00133143 -0.00529633
2016-02-29  0.06478949  0.00024387  0.07749311  0.11974615  0.04493730
2016-03-31  0.02934536 -0.16736448 -0.02679973 -0.15073114  0.07532447
2016-04-30  0.11462829 -0.08063179 -0.01458373  0.06933886  0.03114913
2016-05-31 -0.03131999 -0.11970434  0.04978712 -0.04359639 -0.01634128
2016-06-30  0.08115189  0.22631760  0.04966480  0.08623527  0.07621369
2016-07-31 -0.02376808  0.02526745 -0.07631131  0.02334347 -0.03268917
2016-08-31  0.00477784  0.00850369 -0.05350196  0.06344815 -0.01619914
2016-09-30 -0.07769182  0.10344664 -0.06253766  0.00432500 -0.11356073
2016-10-31  0.00936614  0.13692923  0.19193633 -0.02178228  0.08617441
2016-11-30  0.03818318  0.00536885 -0.00319576  0.04684076  0.02949493
2016-12-31  0.07217773 -0.05367464 -0.02927975  0.04664167 -0.01399583
2017-01-31  0.04648289  0.04873915 -0.04757013  0.12552425  0.01187489
2017-02-28  0.03263890 -0.09164993 -0.05439459  0.04754147  0.05229538
2017-03-31  0.04040579  0.00753654 -0.04215500 -0.00006961  0.02182202
2017-04-30  0.09175337  0.12956238 -0.06173770  0.06557216  0.00121249
2017-05-31 -0.01497493  0.03869621 -0.13591186 -0.05891588  0.09376676
2017-06-30         nan         nan         nan         nan         nan

ticker            ABC         ABT         ACN        ADBE         ADI  \
date
2013-07-31 -0.01609335 -0.09440968 -0.02136190 -0.03289558 -0.05749847
2013-08-31  0.07086509 -0.00420927  0.01905603  0.12689741  0.01650096
2013-09-30  0.06693948  0.10058564  0.01124304  0.04296064  0.04671322
2013-10-31  0.07997603  0.04389252  0.05260536  0.04613431 -0.02215021
2013-11-30 -0.00312412  0.00365918  0.05950782  0.05314171  0.06162558
2013-12-31 -0.04494321 -0.03893724 -0.02887307 -0.01157325 -0.05364189
2014-01-31  0.01278407  0.08167803  0.04252310  0.14797715  0.05873111
2014-02-28 -0.03387614 -0.03244633 -0.04452811 -0.04302219  0.04463996
```

```
2014-03-31 -0.00627057  0.01187986  0.01803285 -0.06358573 -0.03543414
2014-04-30  0.11924492  0.03225676  0.01521647  0.04516334  0.02805861
2014-05-31 -0.00713113  0.02200064 -0.00751744  0.11436847  0.03175466
2014-06-30  0.05684488  0.03470536 -0.01948600 -0.04393196 -0.08568401
2014-07-31  0.00928406  0.00284495  0.02220373  0.03755456  0.02958032
2014-08-31 -0.00116362 -0.01550789  0.00320237 -0.03841992 -0.02506897
2014-09-30  0.09976923  0.05225014  0.01089553  0.01335172  0.00262335
2014-10-31  0.06719583  0.02088612  0.06224762  0.04952333  0.09637224
2014-11-30 -0.00982294  0.01139295  0.03393630 -0.01339001  0.02250327
2014-12-31  0.05281720 -0.00042641 -0.06093959 -0.03599072 -0.06348240
2015-01-31  0.08089383  0.05667423  0.06896907  0.12036221  0.12320729
2015-02-28  0.10090334 -0.02219942  0.03984851 -0.06745892  0.07342445
2015-03-31  0.00552706  0.00708541 -0.00049630  0.02826855 -0.01858432
2015-04-30 -0.01281413  0.04589313  0.03593582  0.03906394  0.10020918
2015-05-31 -0.05684490  0.00982809  0.00767559  0.02398616 -0.05714976
2015-06-30 -0.00556369  0.03709245  0.06335602  0.01202468 -0.09565300
2015-07-31 -0.05271992 -0.11264239 -0.08963337 -0.04260734 -0.03591771
2015-08-31 -0.05179848 -0.11872187  0.04145402  0.04540863  0.00979789
2015-09-30  0.01587501  0.11369172  0.09776101  0.07541025  0.06369612
2015-10-31  0.02533250  0.00267499  0.00018655  0.03109289  0.02480620
2015-11-30  0.05012168 -0.00022264 -0.02569573  0.02675456 -0.10145040
2015-12-31 -0.14668975 -0.16459543  0.00990296 -0.05256030 -0.02674642
2016-01-31 -0.02946371  0.02324168 -0.05132322 -0.04568157 -0.00821101
2016-02-29 -0.00080845  0.07674113  0.14063754  0.09675045  0.11064939
2016-03-31 -0.01689525 -0.06663976 -0.01220169  0.00446762 -0.04970290
2016-04-30 -0.12208554  0.01859216  0.05219176  0.05422362  0.04515902
2016-05-31  0.05626889 -0.00810747 -0.04892046 -0.03769780 -0.03231130
2016-06-30  0.07139375  0.13578830 -0.00424592  0.02137959  0.11950785
2016-07-31  0.02449340 -0.06294575  0.01922714  0.04446953 -0.01342097
2016-08-31 -0.07383382  0.00640496  0.06048139  0.05911135  0.02976363
2016-09-30 -0.13867316 -0.06852950 -0.03945196 -0.00953490 -0.00544537
2016-10-31  0.10806742 -0.03027006  0.02707341 -0.04470124  0.15250011
2016-11-30  0.00256115  0.00889127 -0.01944600  0.00136081 -0.02206272
2016-12-31  0.10997958  0.09029065 -0.02822698  0.09650158  0.03144743
2017-01-31  0.05135996  0.07626031  0.07305358  0.04281683  0.09464624
2017-02-28 -0.03344570 -0.01497402 -0.02161979  0.09497211  0.00024408
2017-03-31 -0.07567373 -0.01142815  0.02214547  0.02736367 -0.07274784
2017-04-30  0.11615820  0.04524848  0.02579791  0.05894304  0.11819123
2017-05-31  0.02963180  0.06260663 -0.00636714 -0.00296506 -0.09185947
2017-06-30         nan         nan         nan         nan         nan

ticker           ...          XL        XLNX         XOM        XRAY  \
date             ...
2013-07-31       ...  -0.05879217 -0.06720501 -0.06596571 -0.02097402
2013-08-31       ...   0.04630944  0.07605219 -0.01293321  0.03481157
2013-09-30       ...  -0.00814469 -0.03082169  0.04076620  0.08157415
2013-10-31       ...   0.04540422 -0.01674184  0.04899644  0.00961292
2013-11-30       ...  -0.00005037  0.03298584  0.07935125  0.02044076
```

date		XRX	XYL	YUM	ZBH	ZION	
2013-12-31	...	-0.10243348	0.01082965	-0.09357256	-0.04947109		
2014-01-31	...	0.05615273	0.12286783	0.05062164	-0.01660877		
2014-02-28	...	0.03284340	0.03888909	0.01454009	0.01589505		
2014-03-31	...	0.00319489	-0.13978958	0.04728753	-0.03110431		
2014-04-30	...	0.03479430	0.00123427	-0.01178295	0.05789258		
2014-05-31	...	0.01315416	0.00742551	0.00149098	0.00264665		
2014-06-30	...	-0.01508417	-0.13998391	-0.01743356	-0.01983642		
2014-07-31	...	0.05843276	0.03386045	0.01220640	0.02730581		
2014-08-31	...	-0.02525829	0.00236407	-0.05592900	-0.04369616		
2014-09-30	...	0.02117902	0.04253010	0.02789025	0.10739791		
2014-10-31	...	0.04727105	0.03443096	-0.05880687	0.07966385		
2014-11-30	...	-0.02838693	-0.04847111	0.02087622	-0.03037006		
2014-12-31	...	0.00348534	-0.11531726	-0.05594387	-0.06285044		
2015-01-31	...	0.04838969	0.10127687	0.02024303	0.05795769		
2015-02-28	...	0.02092430	-0.00165348	-0.04080317	-0.03938489		
2015-03-31	...	0.00757990	0.02475027	0.02750072	0.00215919		
2015-04-30	...	0.01605171	0.09654661	-0.01677365	0.02009094		
2015-05-31	...	-0.00860127	-0.07122468	-0.02375409	-0.00797670		
2015-06-30	...	0.02180358	-0.05611995	-0.04914479	0.09891886		
2015-07-31	...	-0.01938714	0.01075955	-0.04204308	-0.08237366		
2015-08-31	...	-0.02096434	0.01139343	-0.01189933	-0.03437113		
2015-09-30	...	0.04732066	0.11681228	0.10691949	0.18505330		
2015-10-31	...	0.00262261	0.04908477	-0.00427045	-0.00312732		
2015-11-30	...	0.03118510	-0.05629461	-0.04649669	0.00432337		
2015-12-31	...	-0.07745121	0.06789938	-0.00128370	-0.03274052		
2016-01-31	...	-0.05324021	-0.05604739	0.03819057	0.03454661		
2016-02-29	...	0.07359389	0.00443741	0.04202402	0.01220241		
2016-03-31	...	-0.11720576	-0.09619609	0.05594807	-0.03349319		
2016-04-30	...	0.04830993	0.10290823	0.01539863	0.04205613		
2016-05-31	...	-0.02466162	-0.02694774	0.05166393	-0.00071206		
2016-06-30	...	0.03828501	0.10192953	-0.05245058	0.03172855		
2016-07-31	...	-0.01104021	0.06579968	-0.01191629	-0.04112133		
2016-08-31	...	-0.01178072	0.00239521	0.00160532	-0.03228879		
2016-09-30	...	0.03132116	-0.06598725	-0.04643273	-0.03179755		
2016-10-31	...	0.04038386	0.06594093	0.05541489	0.01054005		
2016-11-30	...	0.03615589	0.11187869	0.03334393	-0.00643281		
2016-12-31	...	0.00828549	-0.03660694	-0.07318798	-0.01800276		
2017-01-31	...	0.07484917	0.01624776	-0.02195182	0.11358061		
2017-02-28	...	-0.01017620	-0.01593728	0.00844920	-0.01575947		
2017-03-31	...	0.04871848	0.08633458	-0.00439937	0.01273092		
2017-04-30	...	0.04302745	0.06090411	-0.00482798	0.00441780		
2017-05-31	...	0.00769349	-0.03648424	0.00285307	0.02190798		
2017-06-30	...	nan	nan	nan	nan		

ticker	XRX	XYL	YUM	ZBH	ZION	\
date						
2013-07-31	0.02845720	-0.00134868	-0.04058203	-0.05402072	-0.05663911	
2013-08-31	0.03611367	0.11966450	0.01937689	0.04028369	-0.01985983	

```
2013-09-30 -0.03460553  0.21535825 -0.04870385  0.06287079  0.03494040
2013-10-31  0.13529041  0.00173762  0.13869403  0.04405904  0.03381174
2013-11-30  0.07181852  0.00115674 -0.02700927  0.02143144  0.02125228
2013-12-31 -0.11480883 -0.03649610 -0.11361565  0.00833515 -0.04122539
2014-01-31  0.01282069  0.16849675  0.09821667 -0.00138443  0.08307315
2014-02-28  0.03352930 -0.07737790  0.01752905  0.01022814 -0.00707626
2014-03-31  0.06757594  0.03161998  0.02580642  0.02320097 -0.06880844
2014-04-30  0.02127740 -0.00437311  0.00414777  0.07510359 -0.01005896
2014-05-31  0.01231307  0.04661750  0.04909193 -0.00262106  0.03031579
2014-06-30  0.06383490 -0.10201119 -0.15259272 -0.03717391 -0.02230321
2014-07-31  0.04064098  0.05432073  0.04273371 -0.00762369  0.01245116
2014-08-31 -0.03818588 -0.04527723 -0.00623228  0.01452958 -0.00274914
2014-09-30  0.00377217  0.02786669  0.00399386  0.10103487 -0.00310185
2014-10-31  0.04993695  0.05302447  0.07274470  0.00939481 -0.02173021
2014-11-30 -0.00277876 -0.00706717 -0.05864438  0.01193901  0.01590983
2014-12-31 -0.05106548 -0.11012919 -0.00220105 -0.01170641 -0.17386913
2015-01-31  0.03579801  0.04975030  0.11525879  0.07134515  0.11109071
2015-02-28 -0.05485114 -0.01923136 -0.02990901 -0.02227720  0.00986330
2015-03-31 -0.11099678  0.05553898  0.09320743 -0.06758378  0.04826092
2015-04-30 -0.00698083 -0.00836304  0.04714907  0.03992801  0.02108818
2015-05-31 -0.06439073  0.01357979 -0.00033298 -0.04353182  0.09427086
2015-06-30  0.03509132 -0.07097951 -0.02148999 -0.04839200 -0.01732264
2015-07-31 -0.08026959 -0.05779847 -0.09545832 -0.00491259 -0.07084284
2015-08-31 -0.03699314  0.01225130  0.00225395 -0.09522347 -0.05165634
2015-09-30 -0.03556860  0.10289172 -0.11330487  0.10730688  0.04369368
2015-10-31  0.11648057  0.02852030  0.02231302 -0.03463718  0.04255223
2015-11-30  0.01407508 -0.02221712  0.00741965  0.01765935 -0.09297646
2015-12-31 -0.08641291 -0.01518318 -0.00271062 -0.03299779 -0.18540322
2016-01-31 -0.01446306  0.04398671  0.00138083 -0.02499238 -0.05907417
2016-02-29  0.15666230  0.08919201  0.12171562  0.09887961  0.12712017
2016-03-31 -0.15057286  0.02128769 -0.02279296  0.08224057  0.12814724
2016-04-30  0.03781749  0.07021508  0.03130475  0.05331681  0.02029299
2016-05-31 -0.04083362 -0.00022394  0.01006008 -0.01224782 -0.10885619
2016-06-30  0.08190528  0.06838052  0.08081880  0.08561205  0.10384723
2016-07-31 -0.04467244  0.06487578  0.01432323 -0.01173551  0.09555297
2016-08-31  0.03568895  0.03078357  0.00110181  0.00504351  0.01395900
2016-09-30 -0.03618485 -0.08180785 -0.04530849 -0.20992565  0.03764481
2016-10-31 -0.04394012  0.06826631  0.02387708 -0.03416331  0.21341820
2016-11-30 -0.06031217 -0.04075737 -0.00094697  0.01539556  0.07851429
2016-12-31  0.14387403 -0.00424973  0.03879000  0.13680848 -0.01994669
2017-01-31  0.07101104 -0.02065858 -0.00320978 -0.01061987  0.06402762
2017-02-28 -0.00497178  0.04271546 -0.02197891  0.04404029 -0.06676818
2017-03-31 -0.02064767  0.02341935  0.03320595 -0.02035146 -0.04804045
2017-04-30 -0.01683069  0.01750300  0.09965606 -0.00368417  0.00296435
2017-05-31  0.02428615  0.06118855  0.01530084  0.07612942  0.09151416
2017-06-30         nan         nan         nan         nan         nan

ticker              ZTS
```

```
date
2013-07-31 -0.02238899
2013-08-31  0.06539579
2013-09-30  0.01922875
2013-10-31 -0.01623981
2013-11-30  0.04825498
2013-12-31 -0.07165581
2014-01-31  0.02150621
2014-02-28 -0.06940744
2014-03-31  0.04700792
2014-04-30  0.01443595
2014-05-31  0.04987535
2014-06-30  0.01963856
2014-07-31  0.07618433
2014-08-31  0.04172452
2014-09-30  0.00372782
2014-10-31  0.19371924
2014-11-30 -0.04320818
2014-12-31 -0.00509269
2015-01-31  0.07569476
2015-02-28  0.00432995
2015-03-31 -0.03944740
2015-04-30  0.11372257
2015-05-31 -0.03163852
2015-06-30  0.01563818
2015-07-31 -0.08592248
2015-08-31 -0.08581672
2015-09-30  0.04347995
2015-10-31  0.08408991
2015-11-30  0.02578879
2015-12-31 -0.10497356
2016-01-31 -0.04732782
2016-02-29  0.07662724
2016-03-31  0.06119388
2016-04-30  0.00825838
2016-05-31  0.00288761
2016-06-30  0.06149185
2016-07-31  0.01240540
2016-08-31  0.01765151
2016-09-30 -0.08441037
2016-10-31  0.05457719
2016-11-30  0.06064797
2016-12-31  0.02796748
2017-01-31 -0.03011775
2017-02-28  0.00112486
2017-03-31  0.05205758
2017-04-30  0.10432630
2017-05-31  0.00329757
```

```
2017-06-30          nan


[48 rows x 495 columns]
```

1.7 Generate Trading Signal

A trading signal is a sequence of trading actions, or results that can be used to take trading actions. A common form is to produce a "long" and "short" portfolio of stocks on each date (e.g. end of each month, or whatever frequency you desire to trade at). This signal can be interpreted as rebalancing your portfolio on each of those dates, entering long ("buy") and short ("sell") positions as indicated.

Here's a strategy that we will try: > For each month-end observation period, rank the stocks by *previous* returns, from the highest to the lowest. Select the top performing stocks for the long portfolio, and the bottom performing stocks for the short portfolio.

Implement the `get_top_n` function to get the top performing stock for each month. Get the top performing stocks from `prev_returns` by assigning them a value of 1. For all other stocks, give them a value of 0. For example, using the following `prev_returns`:

```
                           Previous Returns
            A         B         C         D         E         F         G
2013-07-08  0.015     0.082     0.096     0.020     0.075     0.043     0.074
2013-07-09  0.037     0.095     0.027     0.063     0.024     0.086     0.025
...         ...       ...       ...       ...       ...       ...       ...
```

The function `get_top_n` with `top_n` set to 3 should return the following:

```
                           Previous Returns
            A         B         C         D         E         F         G
2013-07-08  0         1         1         0         1         0         0
2013-07-09  0         1         0         1         0         1         0
...         ...       ...       ...       ...       ...       ...       ...
```

Note: You may have to use Panda's `DataFrame.iterrows` with `Series.nlargest` in order to imple-ment the function. This is one of those cases where creating a vecorization solution is too difficult.

```
In [12]: def get_top_n(prev_returns, top_n):
             """
             Select the top performing stocks

             Parameters
             ----------
             prev_returns : DataFrame
                 Previous shifted returns for each ticker and date
             top_n : int
                 The number of top performing stocks to get

             Returns
             -------
```

```python
                top_stocks : DataFrame
                    Top stocks for each ticker and date marked with a 1
                """
                # TODO: Implement Function
                top_stocks = pd.DataFrame(columns=prev_returns.columns)

                for index, row in prev_returns.iterrows():
                    curr_month = row
                    curr_top = pd.Series(curr_month).nlargest(top_n)
                    top = list(curr_top.index.values)
                    for col in top_stocks.columns:
                        if(col in top):
                            top_stocks.loc[index, col] = True
                        else:
                            top_stocks.loc[index, col] = False

                for index, row in top_stocks.iterrows():
                    top_stocks.loc[index] = top_stocks.loc[index].astype('int64')
                print(top_stocks.head())
                return top_stocks


        project_tests.test_get_top_n(get_top_n)

            YTOA  XQS  HCD  NHSA  UZZ
2008-08-31     0    0    0     0    0
2008-09-30     0    0    0     0    0
2008-10-31     1    0    1     1    0
2008-11-30     0    1    0     1    1
Tests Passed
```

1.7.1   View Data

We want to get the best performing and worst performing stocks. To get the best performing stocks, we'll use the `get_top_n` function. To get the worst performing stocks, we'll also use the `get_top_n` function. However, we pass in `-1*prev_returns` instead of just `prev_returns`. Multiplying by negative one will flip all the positive returns to negative and negative returns to positive. Thus, it will return the worst performing stocks.

```python
In [13]: top_bottom_n = 50
         df_long = get_top_n(prev_returns, top_bottom_n)
         df_short = get_top_n(-1*prev_returns, top_bottom_n)
         project_helper.print_top(df_long, 'Longed Stocks')
         project_helper.print_top(df_short, 'Shorted Stocks')
```

ticker	A	AAL	AAP	AAPL	ABBV	ABC	ABT	ACN	ADBE	ADI	...	XL	XLNX	\
2013-07-31	0	0	0	0	0	0	0	0	0	0	...	0	0	
2013-08-31	0	0	0	0	0	0	0	0	0	0	...	0	0	
2013-09-30	1	0	0	1	0	0	0	0	0	0	...	0	0	

```
2013-10-31  0    1    0    0    0    0    0    0    1    0 ...   0    0
2013-11-30  0    1    1    0    0    0    0    0    0    0 ...   0    0

ticker      XOM  XRAY  XRX  XYL  YUM  ZBH  ZION  ZTS
2013-07-31    0    0    0    0    0    0    0    0
2013-08-31    0    0    0    0    0    0    0    0
2013-09-30    0    0    0    0    0    0    0    0
2013-10-31    0    0    0    1    0    0    0    0
2013-11-30    0    0    0    1    0    0    0    0

[5 rows x 495 columns]
ticker      A  AAL  AAP  AAPL  ABBV  ABC  ABT  ACN  ADBE  ADI ...  XL  XLNX  \
2013-07-31  0    0    0    0     0    0    0    0    0     0 ...   0    0
2013-08-31  0    0    0    0     0    0    0    0    0     0 ...   0    0
2013-09-30  0    1    0    0     0    0    1    0    0     0 ...   0    0
2013-10-31  0    0    0    1     0    0    0    0    0     0 ...   0    0
2013-11-30  0    0    0    0     0    0    0    0    0     0 ...   0    1

ticker      XOM  XRAY  XRX  XYL  YUM  ZBH  ZION  ZTS
2013-07-31    0    0    0    0    0    0    0    0
2013-08-31    0    0    0    0    0    0    0    0
2013-09-30    0    0    0    0    0    0    0    0
2013-10-31    1    0    0    0    0    0    1    0
2013-11-30    0    0    1    0    1    0    0    0

[5 rows x 495 columns]
10 Most Longed Stocks:
INCY, AMD, AVGO, NFX, SWKS, NFLX, ILMN, UAL, NVDA, MU
10 Most Shorted Stocks:
RRC, FCX, CHK, MRO, GPS, WYNN, DVN, FTI, SPLS, TRIP
```

1.8 Projected Returns

It's now time to check if your trading signal has the potential to become profitable!

We'll start by computing the net returns this portfolio would return. For simplicity, we'll assume every stock gets an equal dollar amount of investment. This makes it easier to compute a portfolio's returns as the simple arithmetic average of the individual stock returns.

Implement the `portfolio_returns` function to compute the expected portfolio returns. Using `df_long` to indicate which stocks to long and `df_short` to indicate which stocks to short, calculate the returns using `lookahead_returns`. To help with calculation, we've provided you with `n_stocks` as the number of stocks we're investing in a single period.

```
In [14]: def portfolio_returns(df_long, df_short, lookahead_returns, n_stocks):
             """
             Compute expected returns for the portfolio, assuming equal investment in each long/

             Parameters
```

```
            ----------
            df_long : DataFrame
                Top stocks for each ticker and date marked with a 1
            df_short : DataFrame
                Bottom stocks for each ticker and date marked with a 1
            lookahead_returns : DataFrame
                Lookahead returns for each ticker and date
            n_stocks: int
                The number number of stocks chosen for each month


            Returns
            -------
            portfolio_returns : DataFrame
                Expected portfolio returns for each ticker and date
            """
            # TODO: Implement Function

            portfolio_returns = (df_long*lookahead_returns-df_short*lookahead_returns)/n_stocks
            print(portfolio_returns)
            return portfolio_returns

        project_tests.test_portfolio_returns(portfolio_returns)

                     PUUD         JJET         UPRS        ISPO         SLCA
2008-08-31   0.00000000   0.00000000   0.00000000 0.00000000   0.00000000
2008-09-30   0.00000000   0.00000000   0.00000000 0.00000000   0.00000000
2008-10-31   0.01859903  -0.09733263   0.00232372 0.00000000  -0.10228998
2008-11-30  -0.41819699   0.00000000  -0.86088613 2.30892279   0.28210892
Tests Passed
```

1.8.1 View Data

Time to see how the portfolio did.

```
In [15]: expected_portfolio_returns = portfolio_returns(df_long, df_short, lookahead_returns, 2*
         project_helper.plot_returns(expected_portfolio_returns.T.sum(), 'Portfolio Returns')

ticker               A          AAL          AAP         AAPL          ABBV  \
2013-07-31   0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2013-08-31   0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2013-09-30  -0.00009607  -0.00147346   0.00000000   0.00092019   0.00000000
2013-10-31   0.00000000   0.00066471   0.00000000  -0.00067721   0.00000000
2013-11-30   0.00000000   0.00072677   0.00091973   0.00000000   0.00000000
2013-12-31   0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2014-01-31   0.00000000   0.00000000   0.00103739   0.00000000   0.00033556
2014-02-28   0.00000000  -0.00008976   0.00000000  -0.00019756   0.00000000
2014-03-31   0.00031825   0.00000000   0.00000000   0.00000000   0.00000000
2014-04-30   0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
```

```
2014-05-31  0.00000000   0.00000000   0.00000000   0.00027286   0.00000000
2014-06-30  0.00000000  -0.00097991   0.00000000   0.00028326   0.00000000
2014-07-31  0.00000000   0.00000000   0.00119039   0.00000000   0.00000000
2014-08-31  0.00000000   0.00091537   0.00045452   0.00000000   0.00000000
2014-09-30  0.00000000   0.00000000   0.00120321   0.00000000   0.00000000
2014-10-31  0.00000000  -0.00160110   0.00000000   0.00000000   0.00086591
2014-11-30  0.00000000   0.00099926   0.00080059   0.00000000   0.00000000
2014-12-31  0.00000000  -0.00088657   0.00000000   0.00059612   0.00000000
2015-01-31  0.00000000  -0.00022289  -0.00025931  -0.00095988  -0.00002482
2015-02-28  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2015-03-31  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2015-04-30  0.00000000  -0.00130680   0.00000000   0.00000000   0.00000000
2015-05-31  0.00000000   0.00059187   0.00000000   0.00000000   0.00008970
2015-06-30  0.00000000  -0.00004123   0.00089535   0.00000000   0.00000000
2015-07-31  0.00000000   0.00000000   0.00005952   0.00000000   0.00000000
2015-08-31  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2015-09-30 -0.00095231   0.00000000   0.00000000   0.00000000  -0.00099703
2015-10-31  0.00000000   0.00000000  -0.00198344   0.00000000   0.00023790
2015-11-30  0.00000000   0.00026075   0.00000000   0.00000000   0.00000000
2015-12-31 -0.00104803   0.00082663  -0.00010180   0.00000000   0.00000000
2016-01-31  0.00000000   0.00000000   0.00000000   0.00001331   0.00000000
2016-02-29  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2016-03-31  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2016-04-30  0.00000000   0.00080632   0.00000000   0.00000000   0.00000000
2016-05-31  0.00000000   0.00119704   0.00000000   0.00043596   0.00000000
2016-06-30  0.00081152  -0.00226318   0.00000000   0.00000000   0.00000000
2016-07-31  0.00000000  -0.00025267   0.00000000   0.00000000   0.00000000
2016-08-31  0.00000000   0.00008504   0.00000000   0.00000000   0.00000000
2016-09-30  0.00000000   0.00000000   0.00062538   0.00000000   0.00000000
2016-10-31  0.00000000   0.00000000  -0.00191936  -0.00021782   0.00000000
2016-11-30  0.00000000   0.00005369   0.00000000   0.00000000  -0.00029495
2016-12-31  0.00000000   0.00000000  -0.00029280   0.00000000   0.00000000
2017-01-31  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2017-02-28  0.00000000   0.00091650   0.00000000   0.00000000   0.00000000
2017-03-31  0.00000000   0.00000000   0.00042155  -0.00000070   0.00000000
2017-04-30  0.00000000  -0.00129562   0.00000000   0.00000000   0.00001212
2017-05-31  0.00000000   0.00000000   0.00000000   0.00000000   0.00000000
2017-06-30         nan          nan          nan          nan          nan

ticker            ABC          ABT         ACN        ADBE          ADI  \
2013-07-31  0.00000000   0.00000000  0.00000000  0.00000000  0.00000000
2013-08-31  0.00000000   0.00000000  0.00000000  0.00000000  0.00000000
2013-09-30  0.00000000  -0.00100586  0.00000000  0.00000000  0.00000000
2013-10-31  0.00000000   0.00000000  0.00000000  0.00046134  0.00000000
2013-11-30  0.00000000   0.00000000  0.00000000  0.00000000  0.00000000
2013-12-31  0.00000000   0.00000000  0.00000000  0.00000000  0.00000000
2014-01-31  0.00000000   0.00000000  0.00000000  0.00000000  0.00000000
2014-02-28  0.00000000   0.00000000  0.00000000  0.00000000  0.00000000
```

```
2014-03-31  0.00000000   0.00000000 0.00000000 -0.00063586   0.00000000
2014-04-30  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2014-05-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2014-06-30  0.00056845   0.00000000 0.00000000  0.00000000   0.00000000
2014-07-31  0.00000000   0.00000000 0.00000000  0.00037555   0.00000000
2014-08-31 -0.00001164   0.00000000 0.00000000  0.00000000   0.00000000
2014-09-30  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2014-10-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2014-11-30  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2014-12-31  0.00000000   0.00000000 0.00000000  0.00000000  -0.00063482
2015-01-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2015-02-28  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2015-03-31  0.00000000   0.00000000 0.00000000  0.00028269  -0.00018584
2015-04-30 -0.00012814   0.00000000 0.00000000 -0.00039064   0.00100209
2015-05-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2015-06-30  0.00000000   0.00000000 0.00000000  0.00000000  -0.00095653
2015-07-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2015-08-31  0.00000000   0.00000000 0.00000000  0.00000000  -0.00009798
2015-09-30  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2015-10-31  0.00000000  -0.00002675 0.00000000  0.00031093   0.00000000
2015-11-30  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2015-12-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2016-01-31 -0.00029464   0.00000000 0.00000000  0.00000000   0.00000000
2016-02-29  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2016-03-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2016-04-30  0.00122086   0.00000000 0.00000000  0.00000000   0.00000000
2016-05-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2016-06-30 -0.00071394   0.00000000 0.00000000  0.00000000   0.00000000
2016-07-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2016-08-31  0.00000000   0.00006405 0.00000000  0.00000000   0.00029764
2016-09-30  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2016-10-31 -0.00108067   0.00000000 0.00027073 -0.00044701   0.00000000
2016-11-30 -0.00002561   0.00000000 0.00000000  0.00000000   0.00000000
2016-12-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2017-01-31  0.00000000   0.00000000 0.00000000  0.00000000   0.00000000
2017-02-28 -0.00033446  -0.00014974 0.00000000  0.00094972   0.00000000
2017-03-31  0.00000000   0.00000000 0.00000000  0.00000000  -0.00072748
2017-04-30  0.00000000   0.00000000 0.00000000  0.00058943   0.00000000
2017-05-31 -0.00029632   0.00000000 0.00000000  0.00000000   0.00091859
2017-06-30         nan          nan        nan         nan          nan

ticker           ...              XL       XLNX        XOM        XRAY  \
2013-07-31       ...      0.00000000  0.00000000  0.00000000  0.00000000
2013-08-31       ...      0.00000000  0.00000000  0.00000000  0.00000000
2013-09-30       ...      0.00000000  0.00000000  0.00000000  0.00000000
2013-10-31       ...      0.00000000  0.00000000 -0.00048996  0.00000000
2013-11-30       ...      0.00000000 -0.00032986  0.00000000  0.00000000
2013-12-31       ...      0.00000000  0.00000000  0.00000000  0.00000000
```

```
2014-01-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-02-28    ...       -0.00032843   0.00000000   0.00000000   0.00000000
2014-03-31    ...        0.00000000  -0.00139790   0.00000000   0.00031104
2014-04-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-05-31    ...        0.00000000  -0.00007426   0.00000000   0.00000000
2014-06-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-07-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-08-31    ...        0.00000000  -0.00002364   0.00000000   0.00000000
2014-09-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-10-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-11-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2014-12-31    ...        0.00000000   0.00000000   0.00055944   0.00000000
2015-01-31    ...        0.00000000  -0.00101277   0.00000000   0.00000000
2015-02-28    ...        0.00000000   0.00001653   0.00000000   0.00000000
2015-03-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2015-04-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2015-05-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2015-06-30    ...        0.00000000  -0.00056120   0.00000000   0.00000000
2015-07-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2015-08-31    ...        0.00000000   0.00000000   0.00000000  -0.00034371
2015-09-30    ...        0.00000000   0.00116812   0.00000000   0.00000000
2015-10-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2015-11-30    ...        0.00000000   0.00000000   0.00000000   0.00004323
2015-12-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-01-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-02-29    ...        0.00000000   0.00004437   0.00000000   0.00000000
2016-03-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-04-30    ...        0.00000000  -0.00102908   0.00000000   0.00000000
2016-05-31    ...        0.00024662   0.00026948   0.00000000   0.00000000
2016-06-30    ...        0.00000000   0.00101930   0.00000000   0.00000000
2016-07-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-08-31    ...        0.00000000   0.00000000  -0.00001605   0.00000000
2016-09-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-10-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-11-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2016-12-31    ...        0.00000000   0.00000000   0.00000000   0.00000000
2017-01-31    ...        0.00000000   0.00016248   0.00000000   0.00000000
2017-02-28    ...        0.00000000   0.00000000  -0.00008449   0.00000000
2017-03-31    ...        0.00000000   0.00000000   0.00000000   0.00012731
2017-04-30    ...        0.00000000   0.00000000   0.00000000   0.00000000
2017-05-31    ...        0.00000000  -0.00036484   0.00000000   0.00000000
2017-06-30    ...               nan          nan          nan          nan

ticker           XRX         XYL         YUM         ZBH        ZION  \
2013-07-31  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
2013-08-31  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
2013-09-30  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
2013-10-31  0.00000000  0.00001738  0.00000000  0.00000000 -0.00033812
```

2013-11-30	-0.00071819	0.00001157	0.00027009	0.00000000	0.00000000
2013-12-31	-0.00114809	0.00000000	-0.00113616	0.00000000	0.00000000
2014-01-31	0.00000000	0.00000000	-0.00098217	0.00000000	0.00000000
2014-02-28	-0.00033529	0.00000000	-0.00017529	0.00000000	0.00000000
2014-03-31	0.00000000	0.00031620	0.00000000	0.00000000	0.00000000
2014-04-30	0.00000000	0.00004373	0.00000000	0.00000000	0.00000000
2014-05-31	0.00012313	0.00000000	0.00000000	0.00000000	-0.00030316
2014-06-30	0.00000000	0.00000000	0.00000000	-0.00037174	0.00000000
2014-07-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2014-08-31	-0.00038186	0.00045277	0.00006232	0.00000000	0.00000000
2014-09-30	0.00000000	0.00000000	0.00000000	-0.00101035	0.00000000
2014-10-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2014-11-30	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2014-12-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-01-31	0.00000000	0.00000000	-0.00115259	0.00000000	0.00000000
2015-02-28	0.00000000	0.00000000	0.00000000	0.00000000	-0.00009863
2015-03-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-04-30	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-05-31	0.00064391	0.00000000	-0.00000333	0.00000000	0.00000000
2015-06-30	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-07-31	0.00000000	0.00000000	0.00000000	0.00000000	-0.00070843
2015-08-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-09-30	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-10-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2015-11-30	-0.00014075	0.00000000	-0.00007420	0.00000000	0.00000000
2015-12-31	-0.00086413	0.00000000	0.00000000	0.00000000	0.00000000
2016-01-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2016-02-29	0.00000000	0.00000000	0.00000000	0.00000000	-0.00127120
2016-03-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2016-04-30	0.00037817	0.00000000	0.00000000	0.00000000	0.00000000
2016-05-31	0.00040834	0.00000000	0.00000000	0.00000000	-0.00108856
2016-06-30	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2016-07-31	0.00000000	0.00000000	0.00000000	0.00000000	-0.00095553
2016-08-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2016-09-30	0.00000000	0.00000000	0.00000000	0.00000000	0.00037645
2016-10-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2016-11-30	0.00000000	0.00000000	0.00000000	-0.00015396	0.00000000
2016-12-31	0.00000000	0.00000000	0.00000000	0.00000000	-0.00019947
2017-01-31	-0.00071011	0.00000000	0.00000000	0.00000000	0.00064028
2017-02-28	-0.00004972	0.00000000	0.00000000	0.00044040	0.00000000
2017-03-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2017-04-30	0.00000000	0.00000000	0.00000000	0.00000000	-0.00002964
2017-05-31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
2017-06-30	nan	nan	nan	nan	nan

ticker	ZTS
2013-07-31	0.00000000
2013-08-31	0.00000000

```
2013-09-30   0.00000000
2013-10-31   0.00000000
2013-11-30   0.00000000
2013-12-31   0.00000000
2014-01-31   0.00000000
2014-02-28   0.00000000
2014-03-31   0.00000000
2014-04-30  -0.00014436
2014-05-31   0.00000000
2014-06-30   0.00000000
2014-07-31   0.00000000
2014-08-31   0.00000000
2014-09-30   0.00000000
2014-10-31   0.00193719
2014-11-30   0.00000000
2014-12-31  -0.00005093
2015-01-31   0.00000000
2015-02-28   0.00000000
2015-03-31   0.00000000
2015-04-30   0.00000000
2015-05-31   0.00000000
2015-06-30   0.00015638
2015-07-31   0.00000000
2015-08-31   0.00000000
2015-09-30   0.00000000
2015-10-31   0.00000000
2015-11-30   0.00000000
2015-12-31  -0.00104974
2016-01-31   0.00000000
2016-02-29   0.00000000
2016-03-31   0.00000000
2016-04-30   0.00000000
2016-05-31   0.00000000
2016-06-30   0.00000000
2016-07-31   0.00000000
2016-08-31   0.00000000
2016-09-30   0.00000000
2016-10-31   0.00000000
2016-11-30   0.00000000
2016-12-31   0.00000000
2017-01-31   0.00000000
2017-02-28   0.00000000
2017-03-31   0.00000000
2017-04-30   0.00000000
2017-05-31   0.00000000
2017-06-30          nan

[48 rows x 495 columns]
```

1.9 Statistical Tests

1.9.1 Annualized Rate of Return

```
In [16]: expected_portfolio_returns_by_date = expected_portfolio_returns.T.sum().dropna()
         portfolio_ret_mean = expected_portfolio_returns_by_date.mean()
         portfolio_ret_ste = expected_portfolio_returns_by_date.sem()
         portfolio_ret_annual_rate = (np.exp(portfolio_ret_mean * 12) - 1) * 100

         print("""
Mean:                          {:.6f}
Standard Error:                {:.6f}
Annualized Rate of Return:  {:.2f}%
""".format(portfolio_ret_mean, portfolio_ret_ste, portfolio_ret_annual_rate))


Mean:                          0.003253
Standard Error:                0.002203
Annualized Rate of Return:  3.98%
```

The annualized rate of return allows you to compare the rate of return from this strategy to other quoted rates of return, which are usually quoted on an annual basis.

1.9.2 T-Test

Our null hypothesis (H_0) is that the actual mean return from the signal is zero. We'll perform a one-sample, one-sided t-test on the observed mean return, to see if we can reject H_0.

We'll need to first compute the t-statistic, and then find its corresponding p-value. The p-value will indicate the probability of observing a t-statistic equally or more extreme than the one we observed if the null hypothesis were true. A small p-value means that the chance of observing the t-statistic we observed under the null hypothesis is small, and thus casts doubt on the null hypothesis. It's good practice to set a desired level of significance or alpha (α) *before* computing the p-value, and then reject the null hypothesis if $p < \alpha$.

For this project, we'll use $\alpha = 0.05$, since it's a common value to use.

Implement the `analyze_alpha` function to perform a t-test on the sample of portfolio returns. We've imported the `scipy.stats` module for you to perform the t-test.

Note: `scipy.stats.ttest_1samp` performs a two-sided test, so divide the p-value by 2 to get 1-sided p-value

```
In [17]: from scipy import stats

         def analyze_alpha(expected_portfolio_returns_by_date):
             """
             Perform a t-test with the null hypothesis being that the expected mean return is ze
```

```
            Parameters
            ----------
            expected_portfolio_returns_by_date : Pandas Series
                Expected portfolio returns for each date

            Returns
            -------
            t_value
                T-statistic from t-test
            p_value
                Corresponding p-value
            """
            # TODO: Implement Function
            null_hypothesis = 0.0
            t_statistic, p_value = stats.ttest_1samp(expected_portfolio_returns_by_date, null_h
            # divide the p-value by 2 to get 1-sided p-value
            p_value = p_value / 2

            return t_statistic, p_value

        project_tests.test_analyze_alpha(analyze_alpha)
```

Tests Passed

1.9.3 View Data

Let's see what values we get with our portfolio. After you run this, make sure to answer the question below.

```
In [18]: t_value, p_value = analyze_alpha(expected_portfolio_returns_by_date)
         print("""
         Alpha analysis:
          t-value:        {:.3f}
          p-value:        {:.6f}
         """.format(t_value, p_value))
```

```
Alpha analysis:
 t-value:        1.476
 p-value:        0.073359
```

1.9.4 Question: What p-value did you observe? And what does that indicate about your signal?

The observed p-value is 0.073359, which is higher than $\alpha = 0.05$. This means that we cannot reject the null hypothesis. In other words: the probability of observing a mean return equally or higher than the observed one, if the null hypothesis is true, is too high. Thus, the signal is useless.

1.10 Submission

Now that you're done with the project, it's time to submit it. Click the submit button in the bottom right. One of our reviewers will give you feedback on your project with a pass or not passed grade. You can continue to the next section while you wait for feedback.