project_2_starter

July 27, 2024

1 Project 2: Breakout Strategy

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
Collecting cvxpy==1.0.3 (from -r requirements.txt (line 2))
  Downloading https://files.pythonhosted.org/packages/a1/59/2613468ffbbe3a818934d06b81b9f4877fe0
    100% || 880kB 13.7MB/s ta 0:00:01
Requirement already satisfied: cycler==0.10.0 in /opt/conda/lib/python3.6/site-packages/cycler-0
Collecting numpy==1.13.3 (from -r requirements.txt (line 4))
  Downloading https://files.pythonhosted.org/packages/57/a7/e3e6bd9d595125e1abbe162e323fd2d06f6f
    100% || 17.0MB 2.2MB/s eta 0:00:01
Collecting pandas==0.21.1 (from -r requirements.txt (line 5))
  Downloading https://files.pythonhosted.org/packages/3a/e1/6c514df670b887c77838ab856f57783c07e8
    100% || 26.2MB 1.4MB/s eta 0:00:01
Collecting plotly==3.10.0 (from -r requirements.txt (line 6))
```

```
  Downloading https://files.pythonhosted.org/packages/ff/75/3982bac5076d0ce6d23103c03840fcaec90c
    100% || 41.5MB 674kB/s eta 0:00:01
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
Collecting scipy==1.0.0 (from -r requirements.txt (line 11))
  Downloading https://files.pythonhosted.org/packages/d8/5e/caa01ba7be11600b6a9d39265440d7b3be3d
    100% || 50.0MB 614kB/s eta 0:00:01
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
Collecting tqdm==4.19.5 (from -r requirements.txt (line 14))
  Downloading https://files.pythonhosted.org/packages/71/3c/341b4fa23cb3abc335207dba057c790f3bb3
    100% || 61kB 25.2MB/s ta 0:00:01
Collecting zipline==1.2.0 (from -r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/15/d3/689f2a940478b82ac57c751a40460598221f
    100% || 665kB 30.9MB/s ta 0:00:01
Collecting osqp (from cvxpy==1.0.3->-r requirements.txt (line 2))
  Downloading https://files.pythonhosted.org/packages/22/60/07ac2f5bb3adbfcedd10cf3a61f9d04a2187
    100% || 235kB 32.5MB/s ta 0:00:01
Collecting ecos>=2 (from cvxpy==1.0.3->-r requirements.txt (line 2))
  Downloading https://files.pythonhosted.org/packages/2e/5f/17716c533da95ed110815b159efa22b1064c
    100% || 143kB 37.8MB/s ta 0:00:01
  Installing build dependencies ... done
Collecting scs>=1.1.3 (from cvxpy==1.0.3->-r requirements.txt (line 2))
  Downloading https://files.pythonhosted.org/packages/b5/21/0391cc2f02ee80bbb44fec4f1f22d00066b6
    100% || 1.2MB 19.3MB/s ta 0:00:01
  Installing build dependencies ... done
Collecting multiprocess (from cvxpy==1.0.3->-r requirements.txt (line 2))
  Downloading https://files.pythonhosted.org/packages/df/d0/c3011a5bb77f307e68682a5046cce1a2c659
    100% || 112kB 36.8MB/s ta 0:00:01
Requirement already satisfied: fastcache in /opt/conda/lib/python3.6/site-packages (from cvxpy==
Requirement already satisfied: toolz in /opt/conda/lib/python3.6/site-packages (from cvxpy==1.0.
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
Collecting retrying>=1.3.3 (from plotly==3.10.0->-r requirements.txt (line 6))
  Downloading https://files.pythonhosted.org/packages/8f/04/9e36f28be4c0532c0e9207ff9dc01fb13a2b
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: pip>=7.1.0 in /opt/conda/lib/python3.6/site-packages (from ziplin
Requirement already satisfied: setuptools>18.0 in /opt/conda/lib/python3.6/site-packages (from z
Collecting Logbook>=0.12.5 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/2f/d9/16ac346f7c0102835814cc9e5b684aaadea1
    100% || 92kB 33.6MB/s ta 0:00:01
Collecting requests-file>=1.4.1 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/d7/25/dd878a121fcfdf38f52850f11c512e13ec87
```

```
Collecting pandas-datareader<0.6,>=0.2.1 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/40/c5/cc720f531bbde0efeab940de400d0fcc95e8
    100% || 81kB 29.6MB/s ta 0:00:01
Requirement already satisfied: patsy>=0.4.0 in /opt/conda/lib/python3.6/site-packages (from zipl
Requirement already satisfied: statsmodels>=0.6.1 in /opt/conda/lib/python3.6/site-packages (fro
Requirement already satisfied: Cython>=0.25.2 in /opt/conda/lib/python3.6/site-packages (from zi
Collecting cyordereddict>=0.2.2 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/d1/1a/364cbfd927be1b743c7f0a985a7f1f7e8a51
    100% || 143kB 36.6MB/s ta 0:00:01
Collecting bottleneck>=1.0.0 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/6c/12/88a08fad308482554e1fe010ea5d605e423b
    100% || 112kB 38.4MB/s ta 0:00:01
  Installing build dependencies ... done
Collecting contextlib2>=0.4.0 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/76/56/6d6872f79d14c0cb02f1646cbb4592eef935
Requirement already satisfied: networkx<2.0,>=1.9.1 in /opt/conda/lib/python3.6/site-packages (f
Requirement already satisfied: numexpr>=2.6.1 in /opt/conda/lib/python3.6/site-packages (from zi
Collecting bcolz<1,>=0.12.1 (from zipline==1.2.0->-r requirements.txt (line 15))
  Downloading https://files.pythonhosted.org/packages/6c/8b/1ffa01f872cac36173c5eb95b58c01040d8d
    100% || 624kB 26.9MB/s ta 0:00:01
    Complete output from command python setup.py egg_info:
    Traceback (most recent call last):
      File "<string>", line 1, in <module>
      File "/tmp/pip-install-mptqeoh5/bcolz/setup.py", line 211, in <module>
        cmdclass=LazyCommandClass(),
      File "/opt/conda/lib/python3.6/site-packages/setuptools/__init__.py", line 129, in setup
        return distutils.core.setup(**attrs)
      File "/opt/conda/lib/python3.6/distutils/core.py", line 108, in setup
        _setup_distribution = dist = klass(attrs)
      File "/opt/conda/lib/python3.6/site-packages/setuptools/dist.py", line 333, in __init__
        _Distribution.__init__(self, attrs)
      File "/opt/conda/lib/python3.6/distutils/dist.py", line 281, in __init__
        self.finalize_options()
      File "/opt/conda/lib/python3.6/site-packages/setuptools/dist.py", line 476, in finalize_op
        ep.load()(self, ep.name, value)
      File "/opt/conda/lib/python3.6/site-packages/pkg_resources/__init__.py", line 2408, in loa
        return self.resolve()
      File "/opt/conda/lib/python3.6/site-packages/pkg_resources/__init__.py", line 2414, in res
        module = __import__(self.module_name, fromlist=['__name__'], level=0)
      File "/tmp/pip-install-mptqeoh5/bcolz/.eggs/setuptools_scm-8.1.0-py3.6.egg/setuptools_scm/
        from __future__ import annotations
        ^
    SyntaxError: future feature annotations is not defined

    ----------------------------------------
Command "python setup.py egg_info" failed with error code 1 in /tmp/pip-install-mptqeoh5/bcolz/
```

```
In [2]: !python -m pip install plotly==3.10.0 --no-cache
```

```
Collecting plotly==3.10.0
  Downloading https://files.pythonhosted.org/packages/ff/75/3982bac5076d0ce6d23103c03840fcaec90c
    100% || 41.5MB 78.9MB/s ta 0:00:01
Requirement already satisfied: six in /opt/conda/lib/python3.6/site-packages (from plotly==3.10.
Collecting retrying>=1.3.3 (from plotly==3.10.0)
  Downloading https://files.pythonhosted.org/packages/8f/04/9e36f28be4c0532c0e9207ff9dc01fb13a2b
Requirement already satisfied: pytz in /opt/conda/lib/python3.6/site-packages (from plotly==3.10
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: requests in /opt/conda/lib/python3.6/site-packages (from plotly==
Requirement already satisfied: jsonschema!=2.5.0,>=2.4 in /opt/conda/lib/python3.6/site-packages
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: 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
Installing collected packages: retrying, plotly
  Found existing installation: plotly 2.0.15
    Uninstalling plotly-2.0.15:
      Successfully uninstalled plotly-2.0.15
Successfully installed plotly-3.10.0 retrying-1.3.4
```

```
In [3]: # Restart the Kernel
        import plotly
        print(plotly.__version__)
        # Should return plotly==3.10.0
```

```
3.10.0
```

1.2.2 Load Packages

```
In [4]: 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

While using real data will give you hands on experience, it's doesn't cover all the topics we try to condense in one project. We'll solve this by creating new stocks. We've create a scenario where companies mining Terbium are making huge profits. All the companies in this sector of the market are made up. They represent a sector with large growth that will be used for demonstration latter in this project.

```
In [5]: df_original = pd.read_csv('../../data/project_2/eod-quotemedia.csv', parse_dates=['date'

        # Add TB sector to the market
        df = df_original
        df = pd.concat([df] + project_helper.generate_tb_sector(df[df['ticker'] == 'AAPL']['date

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

        print('Loaded Data')
```

```
/opt/conda/lib/python3.6/site-packages/ipykernel_launcher.py:5: FutureWarning:

Sorting because non-concatenation axis is not aligned. A future version
of pandas will change to not sort by default.

To accept the future behavior, pass 'sort=False'.

To retain the current behavior and silence the warning, pass 'sort=True'.



Loaded Data
```

1.3.2 View Data

To see what one of these 2-d matrices looks like, let's take a look at the closing prices matrix.

```
In [6]: close
```

```
Out[6]: ticker                A          AAL          AAP         AAPL        ABBV  \
        date
        2013-07-01 29.99418563 16.17609308  81.13821681  53.10917319 34.92447839
        2013-07-02 29.65013670 15.81983388  80.72207258  54.31224742 35.42807578
        2013-07-03 29.70518453 16.12794994  81.23729877  54.61204262 35.44486235
        2013-07-05 30.43456826 16.21460758  81.82188233  54.17338125 35.85613355
        2013-07-08 30.52402098 16.31089385  82.95141667  53.86579916 36.66188936
        2013-07-09 30.68916447 16.71529618  82.43619048  54.81320389 36.35973093
        2013-07-10 31.17771395 16.53235227  81.99032166  54.60295791 36.85493502
        2013-07-11 31.45983407 16.72492481  82.00022986  55.45406479 37.08155384
        2013-07-12 31.48047700 16.90786872  81.91105609  55.35309481 38.15724076
        2013-07-15 31.72819223 17.10044125  82.61453801  55.47379158 37.79303181
```

2013-07-16	31.59057266	17.28338516	81.62371841	55.83133953	37.10696377
2013-07-17	31.38414330	17.76481650	80.74188897	55.84626440	37.23401341
2013-07-18	31.58369168	17.73593062	81.74261676	56.03418797	37.53893253
2013-07-19	31.79012104	17.55298671	81.45527908	55.15063572	37.70833205
2013-07-22	32.20297975	17.47595770	81.99032166	55.32713852	38.08948096
2013-07-23	31.97590746	17.37967143	81.94078068	54.37713815	37.53046256
2013-07-24	32.17545584	17.81295964	80.78152175	57.17003539	36.96297418
2013-07-25	32.10664605	18.13070432	81.46518728	56.90917464	37.47117273
2013-07-26	31.37726233	18.38104862	81.88133151	57.23233050	37.93702140
2013-07-29	31.19835688	18.51584940	81.57417743	58.11484449	38.16571074
2013-07-30	30.86118893	18.48696352	81.43546269	58.83253602	37.86079161
2013-07-31	30.77861719	18.63139292	81.73270857	58.73000866	38.52144972
2013-08-01	31.68002538	18.66027880	82.66407899	59.26808264	38.32664028
2013-08-02	31.91397865	18.21736196	82.70371177	60.02912118	38.38593011
2013-08-05	31.61121560	18.45807764	82.64426260	60.92591114	37.86926159
2013-08-06	31.70754930	18.21736196	82.41637409	60.38082896	38.01325118
2013-08-07	31.84516887	18.16921883	81.53454465	60.34578796	37.75068193
2013-08-08	31.54928679	18.27513373	80.90042011	60.22638901	38.16571074
2013-08-09	31.80388300	17.90924591	82.40646589	59.36939001	37.86926159
2013-08-12	31.96214550	18.12107570	81.69307578	61.05595360	38.14877079
...	...	...	...	...	...
2017-05-19	55.50327007	44.83282860	151.06072036	150.70113045	63.42995100
2017-05-22	55.45382835	45.81435227	146.97179877	151.61679784	63.29454092
2017-05-23	58.00502088	46.26049939	140.27992953	151.42972601	63.68142686
2017-05-24	58.56865644	46.36955757	132.66057320	150.97681525	63.76847620
2017-05-25	58.63787484	47.60885514	131.61341035	151.49864721	64.14569000
2017-05-26	58.84553005	48.32269053	133.79749286	151.24265417	63.89421413
2017-05-30	59.69592756	47.54936885	132.63065426	151.30172949	63.85552554
2017-05-31	59.66626253	47.99551598	133.26892494	150.40575387	63.85552554
2017-06-01	60.05190791	48.63003633	136.72954883	150.81928108	64.52290380
2017-06-02	60.13101466	49.09601221	137.42765739	153.05429719	65.04519983
2017-06-05	59.72559259	49.31412858	135.20368297	151.55772252	65.29667569
2017-06-06	59.42894229	49.31412858	130.94522072	152.06970859	65.64487304
2017-06-07	59.95302448	50.42453920	130.26705812	152.97553010	66.49602213
2017-06-08	59.47838401	50.98965889	125.57975776	152.60138644	66.50569428
2017-06-09	58.54887976	49.83959075	128.01316475	146.68400898	67.38585980
2017-06-12	58.33133621	49.05635469	130.59616644	143.17887358	67.25044972
2017-06-13	58.61809816	49.02661155	131.27432905	144.33084223	67.38585980
2017-06-14	58.71698159	48.96712526	130.23713918	142.92288054	68.20799244
2017-06-15	58.54887976	48.68952261	130.79562603	142.06628846	68.28536963
2017-06-16	58.84553005	48.37226243	129.80830106	140.07741950	68.72061632
2017-06-19	59.87391774	49.23481354	129.24981421	144.08469508	69.00110863
2017-06-20	59.65637419	47.61876952	123.24608056	142.77519225	68.88504285
2017-06-21	59.12240366	48.01534474	119.84529455	143.62193844	69.00110863
2017-06-22	59.93324780	48.55072128	120.43399427	143.38563718	70.78078399
2017-06-23	59.10262697	48.21363235	119.47610998	144.02561977	70.25848796
2017-06-26	58.57854478	48.36234805	121.52159207	143.57270901	70.35520945
2017-06-27	58.22256443	48.08474540	121.69121741	141.51491885	70.01668424

```
2017-06-28 58.73675827 48.82832394 116.45278767 143.58255490 70.52930812
2017-06-29 58.27398382 49.19515602 115.79424221 141.46568942 70.10373358
2017-06-30 58.77942143 49.88916265 116.33305213 141.80044954 70.13275003

ticker             ABC         ABT          ACN         ADBE         ADI  \
date
2013-07-01 50.86319750 31.42538772  64.69409505  46.23500000 39.91336014
2013-07-02 50.69676639 31.27288084  64.71204071  46.03000000 39.86057632
2013-07-03 50.93716689 30.72565028  65.21451912  46.42000000 40.18607651
2013-07-05 51.37173702 31.32670680  66.07591068  47.00000000 40.65233352
2013-07-08 52.03746147 31.76628544  66.82065546  46.62500000 40.25645492
2013-07-09 51.69535307 31.16522893  66.48866080  47.26000000 40.69632003
2013-07-10 52.28710814 31.16522893  66.71298151  47.25000000 41.10979324
2013-07-11 53.72026495 31.85599537  67.47567196  47.99000000 42.22705062
2013-07-12 53.98840397 31.81096287  67.76280247  48.39000000 42.53495620
2013-07-15 53.84971137 31.95506689  68.41781897  48.12000000 42.57894271
2013-07-16 53.88669607 32.15320992  67.55642741  47.48500000 42.68451033
2013-07-17 54.06237335 32.26128793  67.43978064  48.04000000 42.80767257
2013-07-18 53.91443458 32.15320992  67.69101984  48.19000000 42.52615889
2013-07-19 54.37674323 32.30632044  67.49361761  48.07000000 42.20945601
2013-07-22 54.54317435 32.24327493  67.29621538  48.28000000 42.17426681
2013-07-23 53.28569482 33.03584705  66.62325323  48.07000000 42.56134810
2013-07-24 52.49052395 32.82869752  66.14769330  47.80000000 42.42938857
2013-07-25 53.26720248 32.94578204  65.62726924  47.79000000 42.88684829
2013-07-26 54.06237335 33.12591207  65.60932358  47.64000000 42.71969954
2013-07-29 53.98840397 33.08988606  64.93636143  47.17000000 42.66691573
2013-07-30 53.84046520 33.21597708  66.16563896  47.36000000 43.04519972
2013-07-31 53.87744989 32.99081455  66.22844876  47.28000000 43.44107832
2013-08-01 54.36749706 33.17995107  67.16162295  47.70000000 43.93372725
2013-08-02 54.07161953 33.09889256  66.92832940  47.45000000 43.87214613
2013-08-05 54.58015904 32.82869752  66.60530757  47.63000000 43.61702437
2013-08-06 54.23805064 32.51346997  65.72597036  47.39000000 43.47626753
2013-08-07 54.31202002 32.36035945  65.50164964  47.10000000 43.23874037
2013-08-08 55.11643707 32.35135295  65.48370398  47.51000000 43.19475386
2013-08-09 55.00548300 32.32433344  65.97720956  47.18000000 43.10678084
2013-08-12 54.24729681 32.33333995  65.31322023  47.20000000 43.46747023
...                ...         ...          ...          ...         ...
2017-05-19 87.59994036 42.31486674 118.75601310 136.43000000 79.14250576
2017-05-22 87.91434122 42.87370534 120.45421034 138.86000000 79.97056004
2017-05-23 87.62941544 42.82468441 119.90450488 139.52000000 79.84391644
2017-05-24 88.39576754 42.67762162 119.70818149 141.12000000 79.99978549
2017-05-25 89.51582062 43.08939743 120.83704093 142.85000000 80.21410542
2017-05-26 89.40774532 43.83451556 120.63090138 141.89000000 80.67197073
2017-05-30 89.43722040 44.11883696 121.49472426 142.41000000 82.61059193
2017-05-31 90.16427240 44.76591323 122.18185609 141.86000000 83.54580618
2017-06-01 91.51030109 45.19729742 122.98678196 141.38000000 80.08746182
2017-06-02 91.94260228 45.58946486 123.42850956 143.48000000 78.82102586
2017-06-05 91.68715157 45.70711509 124.25306776 143.59000000 76.71679380
```

```
2017-06-06 90.08567218 45.45220625 124.00766354 143.03000000 78.03193884
2017-06-07 90.32147283 45.64828997 124.22361925 143.62000000 79.18147302
2017-06-08 89.96777186 45.80515695 123.85060483 142.63000000 80.75863709
2017-06-09 90.48849829 46.36399555 123.50703891 138.05000000 76.99695384
2017-06-12 90.74394899 46.24634532 123.97821503 137.25000000 78.11370356
2017-06-13 91.37275071 46.53066671 124.73406004 139.09000000 79.57331502
2017-06-14 92.25700314 46.70714206 124.91075109 138.25000000 79.28922957
2017-06-15 92.77772957 47.17774299 124.69479537 137.52000000 78.12349961
2017-06-16 90.91097444 47.26598066 125.21505233 137.84000000 78.40758506
2017-06-19 92.10962773 47.93266531 125.42119188 140.35000000 78.73085471
2017-06-20 91.61837639 47.81501508 124.20398692 140.91000000 77.58471685
2017-06-21 93.94690777 47.61893136 124.77332472 144.24000000 78.34880876
2017-06-22 94.68378480 48.30522438 119.83579169 143.69000000 79.66147947
2017-06-23 94.14340831 48.11894484 120.48365885 145.41000000 79.88678863
2017-06-26 94.31043377 47.95227368 120.09101209 144.96000000 78.92677572
2017-06-27 93.85848253 47.71697322 119.94376955 142.54000000 76.54633554
2017-06-28 94.69360982 47.53069368 121.46527575 143.81000000 77.58471685
2017-06-29 94.08445815 47.77579833 120.72906307 141.24000000 76.15449354
2017-06-30 92.87597984 47.65814810 121.40637874 141.44000000 76.21326984

ticker          ...              XL        XLNX         XOM        XRAY  \
date            ...
2013-07-01      ...     27.66879066 35.28892781 76.32080247 40.02387348
2013-07-02      ...     27.54228410 35.05903252 76.60816761 39.96552964
2013-07-03      ...     27.33445191 35.28008569 76.65042719 40.00442554
2013-07-05      ...     27.69589920 35.80177117 77.39419581 40.67537968
2013-07-08      ...     27.98505704 35.20050655 77.96892611 40.64620776
2013-07-09      ...     28.31939579 35.50113886 78.89018496 40.80179133
2013-07-10      ...     27.95794850 36.39419366 78.45068533 40.71427558
2013-07-11      ...     28.50011944 37.00430040 78.83102155 41.01571874
2013-07-12      ...     28.92482002 38.00346072 78.94089646 40.83096325
2013-07-15      ...     29.27723113 38.17146113 78.81411772 40.84068723
2013-07-16      ...     29.04229039 38.27314559 78.85637730 40.86013517
2013-07-17      ...     29.18686931 38.48977769 78.99160796 40.93792696
2013-07-18      ...     29.55735279 40.52346684 79.76918424 41.22964615
2013-07-19      ...     29.71096789 40.54999322 80.43688561 41.24909410
2013-07-22      ...     29.84651063 40.59420386 80.14952046 41.49219343
2013-07-23      ...     29.13265221 40.52346684 80.46224136 41.32688588
2013-07-24      ...     28.73506019 40.24051879 80.28475112 41.15185437
2013-07-25      ...     29.02421802 41.05399445 80.26784729 40.91847901
2013-07-26      ...     29.11457985 40.83294128 80.11571280 40.98654682
2013-07-29      ...     28.92482002 40.38199282 79.47336717 40.93792696
2013-07-30      ...     28.38264907 40.88599404 79.28742502 41.08378656
2013-07-31      ...     28.32843198 41.28388974 79.23671352 41.69639686
2013-08-01      ...     28.97000093 41.69062757 78.37461808 41.71584481
2013-08-02      ...     28.87060292 41.12473146 77.71536862 41.78391262
2013-08-05      ...     28.60855363 41.00978381 77.41109964 41.52136535
2013-08-06      ...     28.34650434 40.50305117 77.30967665 41.40467767
```

```
2013-08-07     ...     28.19288924 40.52972131 77.19980174 41.22964615
2013-08-08     ...     28.02120177 40.52083127 77.57168605 41.57970919
2013-08-09     ...     27.86758667 40.27190997 77.20825366 41.39495370
2013-08-12     ...     27.76818866 40.35192038 76.50187303 41.53108932
...            ...             ...         ...         ...         ...
2017-05-19     ...     40.43133035 65.31985198 78.78898294 61.13598414
2017-05-22     ...     40.86051697 66.15263846 79.13518133 62.09836493
2017-05-23     ...     41.31896631 62.67453024 79.41406336 62.65396622
2017-05-24     ...     41.61159355 63.13501218 79.13518133 62.23726525
2017-05-25     ...     42.29439045 64.10496348 78.61588375 62.57459460
2017-05-26     ...     42.23586500 64.51645797 78.42355131 62.22734380
2017-05-30     ...     42.33340741 64.38909063 77.99080333 62.12812929
2017-05-31     ...     42.61628041 65.35904193 77.41380602 63.02105992
2017-06-01     ...     42.54800072 65.30025701 77.60613845 63.55681830
2017-06-02     ...     42.21635651 65.52559923 76.45214383 63.94375491
2017-06-05     ...     41.72864445 65.79013140 77.04837438 63.39807508
2017-06-06     ...     41.48478841 66.24081585 78.09658617 63.05082428
2017-06-07     ...     41.45552569 66.49555053 77.80808751 63.10043153
2017-06-08     ...     41.18240693 66.69150029 77.52920548 62.95160976
2017-06-09     ...     41.52380538 64.07557102 78.98131538 62.84247379
2017-06-12     ...     41.13363573 62.92926493 79.75064513 62.25710816
2017-06-13     ...     41.54331386 63.46812677 79.77949499 62.78294509
2017-06-14     ...     41.97472897 63.56610164 78.92361565 63.22941040
2017-06-15     ...     42.63165652 63.54650667 79.10633146 62.81270944
2017-06-16     ...     43.18073029 63.42893681 80.28917595 63.19964605
2017-06-19     ...     43.23955963 64.56544541 79.58716256 63.47744669
2017-06-20     ...     43.33760851 63.93840619 79.15441457 62.85239525
2017-06-21     ...     43.15131563 64.78099015 78.31776847 63.26909621
2017-06-22     ...     42.42575385 65.23167459 77.97157008 63.32862492
2017-06-23     ...     42.56302230 66.16243594 78.48125104 63.33854637
2017-06-26     ...     42.76892496 65.99587865 78.12543603 63.56673975
2017-06-27     ...     43.14151074 63.78164638 78.00041995 63.92391201
2017-06-28     ...     43.30819385 64.67321778 78.40431807 64.82428373
2017-06-29     ...     43.27877918 62.88027749 77.60613845 64.10898129
2017-06-30     ...     42.94541296 63.01744232 77.63498832 64.41695873

ticker             XRX         XYL         YUM          ZBH        ZION  \
date
2013-07-01 22.10666494 25.75338607 45.48038323  71.89882693 27.85858718
2013-07-02 22.08273998 25.61367511 45.40266113  72.93417195 28.03893238
2013-07-03 22.20236479 25.73475794 46.06329899  72.30145844 28.18131017
2013-07-05 22.58516418 26.06075017 46.41304845  73.16424628 29.39626730
2013-07-08 22.48946433 26.22840332 46.95062632  73.89282298 29.57661249
2013-07-09 22.48946433 26.58233774 47.28094525  73.70108798 28.91218282
2013-07-10 22.96796358 26.98284247 47.08340158  74.00785631 28.32368796
2013-07-11 23.23113816 27.03872686 46.54333492  74.93774876 27.84909533
2013-07-12 23.49431274 27.08529718 45.96422730  75.68549560 28.44708204
2013-07-15 23.54216266 27.06666905 46.69299195  76.27027369 28.77929688
```

2013-07-16	23.27898808	26.61959399	46.56936223	76.81670381	28.06740794
2013-07-17	23.18328823	26.66616431	46.45874617	78.30261578	28.06740794
2013-07-18	23.49431274	26.94558622	46.97929234	78.81069986	28.77929688
2013-07-19	23.20721320	26.81518933	46.90121042	81.16898043	28.99760949
2013-07-22	23.47038778	26.88970184	46.50429396	81.02518181	29.27287321
2013-07-23	23.42253785	26.74067682	45.82758393	81.00601167	28.38063907
2013-07-24	23.51823770	26.62890805	46.49128030	80.56503316	28.53250871
2013-07-25	23.44646282	26.85244558	46.91422407	79.47217195	28.19080202
2013-07-26	23.18328823	26.70342056	48.15052124	80.98684153	28.04842424
2013-07-29	23.08758839	26.50782523	47.83819353	80.16240164	27.71620940
2013-07-30	23.06366342	23.78811863	47.53237266	79.55844670	27.77316051
2013-07-31	23.20721320	23.21996075	47.44778390	80.02819050	28.13385091
2013-08-01	23.70963740	23.46212640	48.08545297	80.97725310	28.61793539
2013-08-02	23.92496206	23.53663891	48.40428750	80.52668616	28.61793539
2013-08-05	24.09243679	23.54595298	48.68408107	80.46916901	28.39962278
2013-08-06	23.85318717	23.68566393	48.15052124	79.56803513	27.88706274
2013-08-07	23.61393755	23.19201856	48.07243931	79.17498438	27.57383161
2013-08-08	23.87711213	23.26653107	48.21558951	79.84604489	28.01994868
2013-08-09	23.99673694	23.26653107	48.41079433	79.15581519	27.99147312
2013-08-12	24.28383649	23.12682011	48.45634212	78.90656401	28.10537535
...	...	...	...	...	...
2017-05-19	26.81497802	51.24320268	68.90686651	116.46112494	39.54646594
2017-05-22	26.73836380	51.49936943	69.83126290	116.57989212	39.65494752
2017-05-23	26.62344247	52.19890171	69.74275686	116.59968666	40.76934918
2017-05-24	26.89159225	52.01106475	70.75565928	117.87643393	40.13818363
2017-05-25	26.77667091	51.53652928	70.93267135	118.07437924	40.31569894
2017-05-26	26.81497802	50.82472608	70.89333534	118.00509838	39.89163460
2017-05-30	27.12143491	51.20039999	71.20802347	117.21331713	39.31964082
2017-05-31	27.08312780	51.54641544	71.43420556	117.98530385	39.51688006
2017-06-01	27.19804914	51.84300011	72.60445204	121.40975776	39.99025421
2017-06-02	27.12143491	52.39662482	72.76179611	122.66671050	39.54646594
2017-06-05	26.73836380	52.59434793	72.96831019	122.65681324	39.90149656
2017-06-06	26.81497802	52.09015400	73.08631824	122.89434761	39.70425733
2017-06-07	26.96820647	52.85138798	73.02731422	123.07249839	39.90149656
2017-06-08	26.81497802	52.97002185	72.74212810	123.88407418	40.81865898
2017-06-09	26.58513535	53.35558192	71.88656975	123.72571793	41.75554533
2017-06-12	27.04482069	53.40501269	70.71632326	123.71582066	42.33740107
2017-06-13	26.85328513	53.17763111	71.46370757	124.18099215	42.53464030
2017-06-14	26.54682824	53.04911109	71.82756572	124.30965660	42.63325991
2017-06-15	26.61386569	53.34569576	71.40470355	124.54719098	42.27822930
2017-06-16	27.29381692	53.43467116	71.57188162	124.62636910	42.49519245
2017-06-19	27.57154347	53.55330503	72.70279208	125.78434918	42.76146542
2017-06-20	27.13101169	53.26660652	72.68312408	125.91301364	42.36698695
2017-06-21	26.70005669	52.93047722	73.16499028	127.43719255	41.74568337
2017-06-22	26.78624769	53.23694805	73.30266633	128.29986262	41.71609749
2017-06-23	27.23635625	53.71148352	73.57801845	128.00239018	41.35120491
2017-06-26	27.95461459	54.05749897	73.49934641	127.97264293	41.75554533
2017-06-27	27.75350225	53.87954816	72.74212810	127.16946735	41.95278457

```
2017-06-28 28.28980181 54.34419748 72.91914017 127.42727680 42.37684891
2017-06-29 28.12560699 54.27499439 72.23075989 126.81250043 43.38276899
2017-06-30 27.74892476 54.79896064 72.53561401 127.31820357 43.30387330

ticker              ZTS
date
2013-07-01 29.44789315
2013-07-02 28.57244125
2013-07-03 28.16838652
2013-07-05 29.02459772
2013-07-08 29.76536472
2013-07-09 29.80384612
2013-07-10 29.86156823
2013-07-11 29.74612402
2013-07-12 30.15979909
2013-07-15 30.38106716
2013-07-16 29.97701243
2013-07-17 29.81346647
2013-07-18 29.64992051
2013-07-19 29.09194018
2013-07-22 29.12080123
2013-07-23 28.91877387
2013-07-24 28.76484826
2013-07-25 29.36130999
2013-07-26 29.27472684
2013-07-29 28.94763492
2013-07-30 28.96206545
2013-07-31 28.74031861
2013-08-01 29.07775945
2013-08-02 29.82977047
2013-08-05 30.12864664
2013-08-06 30.01295264
2013-08-07 30.11900548
2013-08-08 30.11900548
2013-08-09 29.80084697
2013-08-12 29.24165929
...                 ...
2017-05-19 59.92967369
2017-05-22 59.92967369
2017-05-23 61.04261076
2017-05-24 61.90712437
2017-05-25 62.18535864
2017-05-26 62.21516946
2017-05-30 61.86737662
2017-05-31 61.88725050
2017-06-01 62.24498027
2017-06-02 62.10586314
2017-06-05 62.27479108
```

```
2017-06-06 62.58283617
2017-06-07 62.86107043
2017-06-08 62.18535864
2017-06-09 62.19529558
2017-06-12 61.45996216
2017-06-13 61.67360633
2017-06-14 61.94235833
2017-06-15 62.10161877
2017-06-16 62.26087921
2017-06-19 62.73866054
2017-06-20 62.70879921
2017-06-21 62.70879921
2017-06-22 63.21644187
2017-06-23 62.48981610
2017-06-26 62.43009343
2017-06-27 62.46990854
2017-06-28 62.65903032
2017-06-29 62.21111032
2017-06-30 62.09166499

[1009 rows x 519 columns]
```

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

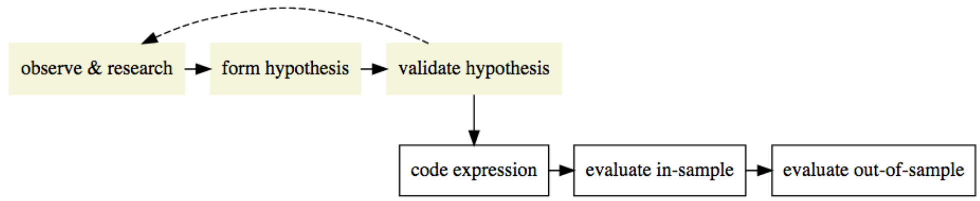
1.4 The Alpha Research Process

In this project you will code and evaluate a "breakout" signal. It is important to understand where these steps fit in the alpha research workflow. The signal-to-noise ratio in trading signals is very low and, as such, it is very easy to fall into the trap of *overfitting* to noise. It is therefore inadvisable to jump right into signal coding. To help mitigate overfitting, it is best to start with a general observation and hypothesis; i.e., you should be able to answer the following question *before* you touch any data:

> What feature of markets or investor behaviour would lead to a persistent anomaly that my signal will try to use?

Ideally the assumptions behind the hypothesis will be testable *before* you actually code and evaluate the signal itself. The workflow therefore is as follows:

In this project, we assume that the first three steps area done ("observe & research", "form hypothesis", "validate hypothesis"). The hypothesis you'll be using for this project is the following: - In the absence of news or significant investor trading interest, stocks oscillate in a range. - Traders seek to capitalize on this range-bound behaviour periodically by selling/shorting at the top of the



image

range and buying/covering at the bottom of the range. This behaviour reinforces the existence of the range. - When stocks break out of the range, due to, e.g., a significant news release or from market pressure from a large investor: - the liquidity traders who have been providing liquidity at the bounds of the range seek to cover their positions to mitigate losses, thus magnifying the move out of the range, *and* - the move out of the range attracts other investor interest; these investors, due to the behavioural bias of *herding* (e.g., Herd Behavior) build positions which favor continuation of the trend.

Using this hypothesis, let start coding.. ## Compute the Highs and Lows in a Window You'll use the price highs and lows as an indicator for the breakout strategy. In this section, implement `get_high_lows_lookback` to get the maximum high price and minimum low price over a window of days. The variable `lookback_days` contains the number of days to look in the past. Make sure this doesn't include the current day.

```
In [8]: lookback_days = 3
        len_df = len(high)
        end = len_df - 1
        start = end - lookback_days
        # print(high.shape)
        # print(high.iloc[start:end].max())
        high.iloc[len_df-1] = high.iloc[start:end].max()
        # print(high.iloc[len_df-1])
        # print(high.iloc[0])

        # print(low.rolling(window = lookback_days).max())
```

```
In [9]: def get_high_lows_lookback(high, low, lookback_days):
            """
            Get the highs and lows in a lookback window.

            Parameters
            ----------
            high : DataFrame
                High price for each ticker and date
            low : DataFrame
                Low price for each ticker and date
            lookback_days : int
                The number of days to look back

            Returns
```

```
    -------
    lookback_high : DataFrame
        Lookback high price for each ticker and date
    lookback_low : DataFrame
        Lookback low price for each ticker and date
    """
    #TODO: Implement function
    lookback_high = high.rolling(window = lookback_days).max().shift(1)
    lookback_low = low.rolling(window = lookback_days).min().shift(1)


    return lookback_high, lookback_low

project_tests.test_get_high_lows_lookback(get_high_lows_lookback)
```

```
Tests Passed
```

1.4.1 View Data

Let's use your implementation of `get_high_lows_lookback` to get the highs and lows for the past 50 days and compare it to it their respective stock. Just like last time, we'll use Apple's stock as the example to look at.

```
In [10]: lookback_days = 50
         lookback_high, lookback_low = get_high_lows_lookback(high, low, lookback_days)
         project_helper.plot_high_low(
             close[apple_ticker],
             lookback_high[apple_ticker],
             lookback_low[apple_ticker],
             'High and Low of {} Stock'.format(apple_ticker))
```

1.5 Compute Long and Short Signals

Using the generated indicator of highs and lows, create long and short signals using a breakout strategy. Implement `get_long_short` to generate the following signals:

Signal	Condition
-1	Low > Close Price
1	High < Close Price
0	Otherwise

In this chart, **Close Price** is the `close` parameter. **Low** and **High** are the values generated from `get_high_lows_lookback`, the `lookback_high` and `lookback_low` parameters.

```
In [11]: """
         short = lookback_low - close
         long = close - lookback_high
```

```
        comp_sh = short > 0
        comp_sh = - comp_sh.astype(int)
        comp_l = long > 0
        comp_l = comp_l.astype(int)

        long_short = comp_sh + comp_l
        # print(np.sign(short))
        # print(comp_sh)
        # print(comp_l)
        print(long_short)
        """
```

```
Out[11]: '\nshort = lookback_low - close\nlong = close - lookback_high\n\ncomp_sh = short > 0\nc
```

```
In [12]: def get_long_short(close, lookback_high, lookback_low):
             """
             Generate the signals long, short, and do nothing.

             Parameters
             ----------
             close : DataFrame
                 Close price for each ticker and date
             lookback_high : DataFrame
                 Lookback high price for each ticker and date
             lookback_low : DataFrame
                 Lookback low price for each ticker and date

             Returns
             -------
             long_short : DataFrame
                 The long, short, and do nothing signals for each ticker and date
             """
             #TODO: Implement function
             short = lookback_low - close
             long = close - lookback_high

             comp_sh = short > 0
             comp_sh = - comp_sh.astype(int)
             comp_l = long > 0
             comp_l = comp_l.astype(int)
             long_short = comp_sh + comp_l

             return long_short

         project_tests.test_get_long_short(get_long_short)
```

```
Tests Passed
```

1.5.1 View Data

Let's compare the signals you generated against the close prices. This chart will show a lot of signals. Too many in fact. We'll talk about filtering the redundant signals in the next problem.

```
In [13]: signal = get_long_short(close, lookback_high, lookback_low)
         project_helper.plot_signal(
             close[apple_ticker],
             signal[apple_ticker],
             'Long and Short of {} Stock'.format(apple_ticker))
```

```
In [14]: print(signal)
```

```
ticker      A  AAL  AAP  AAPL  ABBV  ABC  ABT  ACN  ADBE  ADI ...   XL  XLNX  \
date                                                          ...
2013-07-01  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-02  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-03  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-05  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-08  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-09  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-10  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-11  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-12  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-15  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-16  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-17  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-18  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-19  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-22  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-23  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-24  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-25  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-26  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-29  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-30  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-07-31  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-01  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-02  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-05  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-06  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-07  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-08  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-09  0    0    0     0     0    0    0    0     0    0 ...    0     0
2013-08-12  0    0    0     0     0    0    0    0     0    0 ...    0     0
...        ..  ...  ...   ...   ...  ...  ...  ...   ...  ... ...   ..   ...
2017-05-19  0    0    0     0     0    0    0    0     0    0 ...    0     1
2017-05-22  0    0    0     0     0    0    0    0     1    0 ...    0     1
2017-05-23  1    0    0     0     0    0    0    0     1    0 ...    0     0
```

```
2017-05-24  0    0   -1     0     0    0    0    0     1    0 ...     0      0
2017-05-25  0    1    0     0     0    1    0    0     1    0 ...     0      0
2017-05-26  0    1    0     0     0    0    0    0     0    0 ...     0      0
2017-05-30  1    0    0     0     0    0    0    0     0    1 ...     0      0
2017-05-31  0    0    0     0     0    1    1    0     0    1 ...     1      0
2017-06-01  0    1    0     0     0    1    1    1     0    0 ...     0      0
2017-06-02  0    1    0     0     0    1    1    1     0    0 ...     0      0
2017-06-05  0    0    0     0     1    0    1    1     1    0 ...     0      0
2017-06-06  0    0    0     0     1    0    0    0     0    0 ...     0      0
2017-06-07  0    1    0     0     1    0    0    0     0    0 ...     0      1
2017-06-08  0    1   -1     0     0    0    0    0     0    0 ...     0      1
2017-06-09  0    0    0     0     1    0    1    0     0    0 ...     0      0
2017-06-12  0    0    0     0     0    0    0    0     0    0 ...     0      0
2017-06-13  0    0    0     0     0    0    0    1     0    0 ...     0      0
2017-06-14  0    0    0     0     1    1    0    0     0    0 ...     0      0
2017-06-15  0    0    0     0     0    0    1    0     0    0 ...     0      0
2017-06-16  0    0    0     0     1    0    0    0     0    0 ...     1      0
2017-06-19  0    0    0     0     1    0    1    0     0    0 ...     1      0
2017-06-20  0    0    0     0     0    0    0    0     0    0 ...     0      0
2017-06-21  0    0   -1     0     0    1    0    0     0    0 ...     0      0
2017-06-22  0    0    0     0     1    1    0    0     0    0 ...     0      0
2017-06-23  0    0    0     0     0    0    0    0     0    0 ...     0      0
2017-06-26  0    0    0     0     0    0    0    0     0    0 ...     0      0
2017-06-27  0    0    0     0     0    0    0    0     0    0 ...     0      0
2017-06-28  0    0   -1     0     0    0    0    0     0    0 ...     0      0
2017-06-29  0    0   -1     0     0    0    0    0     0    0 ...     0      0
2017-06-30  0    0    0     0     0    0    0    0     0    0 ...     0      0

ticker      XOM  XRAY  XRX  XYL  YUM  ZBH  ZION  ZTS
date
2013-07-01    0     0    0    0    0    0     0    0
2013-07-02    0     0    0    0    0    0     0    0
2013-07-03    0     0    0    0    0    0     0    0
2013-07-05    0     0    0    0    0    0     0    0
2013-07-08    0     0    0    0    0    0     0    0
2013-07-09    0     0    0    0    0    0     0    0
2013-07-10    0     0    0    0    0    0     0    0
2013-07-11    0     0    0    0    0    0     0    0
2013-07-12    0     0    0    0    0    0     0    0
2013-07-15    0     0    0    0    0    0     0    0
2013-07-16    0     0    0    0    0    0     0    0
2013-07-17    0     0    0    0    0    0     0    0
2013-07-18    0     0    0    0    0    0     0    0
2013-07-19    0     0    0    0    0    0     0    0
2013-07-22    0     0    0    0    0    0     0    0
2013-07-23    0     0    0    0    0    0     0    0
2013-07-24    0     0    0    0    0    0     0    0
2013-07-25    0     0    0    0    0    0     0    0
```

```
2013-07-26   0    0    0    0    0    0     0    0
2013-07-29   0    0    0    0    0    0     0    0
2013-07-30   0    0    0    0    0    0     0    0
2013-07-31   0    0    0    0    0    0     0    0
2013-08-01   0    0    0    0    0    0     0    0
2013-08-02   0    0    0    0    0    0     0    0
2013-08-05   0    0    0    0    0    0     0    0
2013-08-06   0    0    0    0    0    0     0    0
2013-08-07   0    0    0    0    0    0     0    0
2013-08-08   0    0    0    0    0    0     0    0
2013-08-09   0    0    0    0    0    0     0    0
2013-08-12   0    0    0    0    0    0     0    0
...         ...  ...  ...  ...  ...  ...   ...  ...
2017-05-19   0    0    0    0    1    0     0    0
2017-05-22   0    0    0    0    1    0     0    0
2017-05-23   0    0    0    1    0    0     0    1
2017-05-24   0    0    0    0    1    0     0    1
2017-05-25   0    0    0    0    0    0     0    1
2017-05-26   0    0    0    0    0    0     0    0
2017-05-30   0    0    0    0    0    0     0    0
2017-05-31   0    0    0    0    1    0     0    0
2017-06-01   0    0    0    0    1    0     0    0
2017-06-02  -1    0    0    1    1    0     0    0
2017-06-05   0    0    0    1    0    0     0    0
2017-06-06   0    0    0    0    0    0     0    0
2017-06-07   0    0    0    0    0    0     0    0
2017-06-08   0    0    0    0    0    0     0    0
2017-06-09   0    0    0    1    0    0     0    0
2017-06-12   0    0    0    0    0    0     1    0
2017-06-13   0    0    0    0    0    0     0    0
2017-06-14   0    0    0    0    0    0     0    0
2017-06-15   0    0    0    0    0    0     0    0
2017-06-16   0    0    0    0    0    0     0    0
2017-06-19   0    0    0    0    0    1     0    0
2017-06-20   0    0    0    0    0    0     0    0
2017-06-21   0    0    0    0    0    1     0    0
2017-06-22   0    0    0    0    0    1     0    0
2017-06-23   0    0    0    0    0    0     0    0
2017-06-26   0    0    1    1    0    0     0    0
2017-06-27   0    0    0    0    0    0     0    0
2017-06-28   0    0    1    1    0    0     0    0
2017-06-29   0    0    0    0    0    0     1    0
2017-06-30   0    0    0    0    0    0     0    0

[1009 rows x 519 columns]
```

1.6 Filter Signals

That was a lot of repeated signals! If we're already shorting a stock, having an additional signal to short a stock isn't helpful for this strategy. This also applies to additional long signals when the last signal was long.

Implement `filter_signals` to filter out repeated long or short signals within the `lookahead_days`. If the previous signal was the same, change the signal to `0` (do nothing signal). For example, say you have a single stock time series that is

`[1, 0, 1, 0, 1, 0, -1, -1]`

Running `filter_signals` with a lookahead of 3 days should turn those signals into

`[1, 0, 0, 0, 1, 0, -1, 0]`

To help you implement the function, we have provided you with the `clear_signals` function. This will remove all signals within a window after the last signal. For example, say you're using a windows size of 3 with `clear_signals`. It would turn the Series of long signals

`[0, 1, 0, 0, 1, 1, 0, 1, 0]`

into

`[0, 1, 0, 0, 0, 1, 0, 0, 0]`

`clear_signals` only takes a Series of the same type of signals, where `1` is the signal and `0` is no signal. It can't take a mix of long and short signals. Using this function, implement `filter_signals`.

For implementing `filter_signals`, we don't reccommend you try to find a vectorized solution. Instead, you should use the `iterrows` over each column.

```
In [15]: def clear_signals(signals, window_size):
             """
             Clear out signals in a Series of just long or short signals.

             Remove the number of signals down to 1 within the window size time period.

             Parameters
             ----------
             signals : Pandas Series
                 The long, short, or do nothing signals
             window_size : int
                 The number of days to have a single signal

             Returns
             -------
             signals : Pandas Series
                 Signals with the signals removed from the window size
             """
             # Start with buffer of window size
             # This handles the edge case of calculating past_signal in the beginning
             clean_signals = [0]*window_size

             for signal_i, current_signal in enumerate(signals):
                 # Check if there was a signal in the past window_size of days
                 has_past_signal = bool(sum(clean_signals[signal_i:signal_i+window_size]))
```

```python
        # Use the current signal if there's no past signal, else 0/False
        clean_signals.append(not has_past_signal and current_signal)

    # Remove buffer
    clean_signals = clean_signals[window_size:]

    # Return the signals as a Series of Ints
    return pd.Series(np.array(clean_signals).astype(np.int), signals.index)


def filter_signals(signal, lookahead_days):
    """
    Filter out signals in a DataFrame.

    Parameters
    ----------
    signal : DataFrame
        The long, short, and do nothing signals for each ticker and date
    lookahead_days : int
        The number of days to look ahead

    Returns
    -------
    filtered_signal : DataFrame
        The filtered long, short, and do nothing signals for each ticker and date
    """
    #TODO: Implement function
    sig_sh = signal < 0
    sig_sh = sig_sh.astype(int).T
    # print(lookahead_days)
    # print(sig_sh)
    for index, row in sig_sh.iterrows():
        new_row = clear_signals(row, lookahead_days)
        sig_sh.loc[index] = new_row
    sig_sh = - sig_sh

    sig_l = signal > 0
    sig_l = sig_l.astype(int).T
    for index, row in sig_l.iterrows():
        new_row = clear_signals(row, lookahead_days)
        sig_l.loc[index] = new_row

    sig = sig_sh + sig_l
    signal = sig.T

    # print(sig_sh)

    return signal
```

```
    project_tests.test_filter_signals(filter_signals)
```

```
Tests Passed
```

1.6.1 View Data

Let's view the same chart as before, but with the redundant signals removed.

```
In [16]: signal_5 = filter_signals(signal, 5)
         signal_10 = filter_signals(signal, 10)
         signal_20 = filter_signals(signal, 20)
         for signal_data, signal_days in [(signal_5, 5), (signal_10, 10), (signal_20, 20)]:
             project_helper.plot_signal(
                 close[apple_ticker],
                 signal_data[apple_ticker],
                 'Long and Short of {} Stock with {} day signal window'.format(apple_ticker, sig
```

1.7 Lookahead Close Prices

With the trading signal done, we can start working on evaluating how many days to short or long the stocks. In this problem, implement `get_lookahead_prices` to get the close price days ahead in time. You can get the number of days from the variable `lookahead_days`. We'll use the lookahead prices to calculate future returns in another problem.

```
In [17]: def get_lookahead_prices(close, lookahead_days):
             """
             Get the lookahead prices for `lookahead_days` number of days.

             Parameters
             ----------
             close : DataFrame
                 Close price for each ticker and date
             lookahead_days : int
                 The number of days to look ahead

             Returns
             -------
             lookahead_prices : DataFrame
                 The lookahead prices for each ticker and date
             """
             #TODO: Implement function
             lookahead_prices = close.shift(-lookahead_days)
             return lookahead_prices

         project_tests.test_get_lookahead_prices(get_lookahead_prices)
```

```
Tests Passed
```

1.7.1 View Data

Using the `get_lookahead_prices` function, let's generate lookahead closing prices for 5, 10, and 20 days.

Let's also chart a subsection of a few months of the Apple stock instead of years. This will allow you to view the differences between the 5, 10, and 20 day lookaheads. Otherwise, they will mesh together when looking at a chart that is zoomed out.

```
In [18]: lookahead_5 = get_lookahead_prices(close, 5)
         lookahead_10 = get_lookahead_prices(close, 10)
         lookahead_20 = get_lookahead_prices(close, 20)
         project_helper.plot_lookahead_prices(
             close[apple_ticker].iloc[150:250],
             [
                 (lookahead_5[apple_ticker].iloc[150:250], 5),
                 (lookahead_10[apple_ticker].iloc[150:250], 10),
                 (lookahead_20[apple_ticker].iloc[150:250], 20)],
             '5, 10, and 20 day Lookahead Prices for Slice of {} Stock'.format(apple_ticker))
```

1.8 Lookahead Price Returns

Implement `get_return_lookahead` to generate the log price return between the closing price and the lookahead price.

```
In [19]: def get_return_lookahead(close, lookahead_prices):
             """
             Calculate the log returns from the lookahead days to the signal day.

             Parameters
             ----------
             close : DataFrame
                 Close price for each ticker and date
             lookahead_prices : DataFrame
                 The lookahead prices for each ticker and date

             Returns
             -------
             lookahead_returns : DataFrame
                 The lookahead log returns for each ticker and date
             """
             #TODO: Implement function
             returns = (lookahead_prices - close)/close
             lookahead_returns = (1 + returns).applymap(np.log)
             return lookahead_returns

         project_tests.test_get_return_lookahead(get_return_lookahead)
```

```
Tests Passed
```

1.8.1 View Data

Using the same lookahead prices and same subsection of the Apple stock from the previous problem, we'll view the lookahead returns.

In order to view price returns on the same chart as the stock, a second y-axis will be added. When viewing this chart, the axis for the price of the stock will be on the left side, like previous charts. The axis for price returns will be located on the right side.

```
In [20]: price_return_5 = get_return_lookahead(close, lookahead_5)
         price_return_10 = get_return_lookahead(close, lookahead_10)
         price_return_20 = get_return_lookahead(close, lookahead_20)
         project_helper.plot_price_returns(
             close[apple_ticker].iloc[150:250],
             [
                 (price_return_5[apple_ticker].iloc[150:250], 5),
                 (price_return_10[apple_ticker].iloc[150:250], 10),
                 (price_return_20[apple_ticker].iloc[150:250], 20)],
             '5, 10, and 20 day Lookahead Returns for Slice {} Stock'.format(apple_ticker))
```

1.9 Compute the Signal Return

Using the price returns generate the signal returns.

```
In [21]: def get_signal_return(signal, lookahead_returns):
             """
             Compute the signal returns.

             Parameters
             ----------
             signal : DataFrame
                 The long, short, and do nothing signals for each ticker and date
             lookahead_returns : DataFrame
                 The lookahead log returns for each ticker and date

             Returns
             -------
             signal_return : DataFrame
                 Signal returns for each ticker and date
             """
             #TODO: Implement function
             signal_return = signal * lookahead_returns
             return signal_return

         project_tests.test_get_signal_return(get_signal_return)
```

```
Tests Passed
```

1.9.1 View Data

Let's continue using the previous lookahead prices to view the signal returns. Just like before, the axis for the signal returns is on the right side of the chart.

```
In [22]: title_string = '{} day LookaheadSignal Returns for {} Stock'
         signal_return_5 = get_signal_return(signal_5, price_return_5)
         signal_return_10 = get_signal_return(signal_10, price_return_10)
         signal_return_20 = get_signal_return(signal_20, price_return_20)
         project_helper.plot_signal_returns(
             close[apple_ticker],
             [
                 (signal_return_5[apple_ticker], signal_5[apple_ticker], 5),
                 (signal_return_10[apple_ticker], signal_10[apple_ticker], 10),
                 (signal_return_20[apple_ticker], signal_20[apple_ticker], 20)],
             [title_string.format(5, apple_ticker), title_string.format(10, apple_ticker), title
```

1.10 Test for Significance

1.10.1 Histogram

Let's plot a histogram of the signal return values.

```
In [23]: project_helper.plot_signal_histograms(
             [signal_return_5, signal_return_10, signal_return_20],
             'Signal Return',
             ('5 Days', '10 Days', '20 Days'))
```

1.10.2 Question: What do the histograms tell you about the signal returns?

To answer this question think about the following: - Are the histograms skewed? If yes, which side? - Is the skewing because of outliers? What could be the reason for this? - Which side do the outliers appear and what does it signify? - What will happen to the distribution of the histograms if the outliers are removed?

Another way to check if a distribution is normal is to create a QQ (quantile-quantile) plot. See this link to learn more about QQ plots.

#TODO: Put Answer In this Cell

1.11 Outliers

You might have noticed the outliers in the 10 and 20 day histograms. To better visualize the outliers, let's compare the 5, 10, and 20 day signals returns to normal distributions with the same mean and deviation for each signal return distributions.

```
In [24]: project_helper.plot_signal_to_normal_histograms(
             [signal_return_5, signal_return_10, signal_return_20],
             'Signal Return',
             ('5 Days', '10 Days', '20 Days'))
```

1.12 Kolmogorov-Smirnov Test

While you can see the outliers in the histogram, we need to find the stocks that are causing these outlying returns. We'll use the Kolmogorov-Smirnov Test or KS-Test. This test will be applied to teach ticker's signal returns where a long or short signal exits.

```
In [25]: # Filter out returns that don't have a long or short signal.
         long_short_signal_returns_5 = signal_return_5[signal_5 != 0].stack()
         long_short_signal_returns_10 = signal_return_10[signal_10 != 0].stack()
         long_short_signal_returns_20 = signal_return_20[signal_20 != 0].stack()

         # Get just ticker and signal return
         long_short_signal_returns_5 = long_short_signal_returns_5.reset_index().iloc[:, [1,2]]
         long_short_signal_returns_5.columns = ['ticker', 'signal_return']
         long_short_signal_returns_10 = long_short_signal_returns_10.reset_index().iloc[:, [1,2]
         long_short_signal_returns_10.columns = ['ticker', 'signal_return']
         long_short_signal_returns_20 = long_short_signal_returns_20.reset_index().iloc[:, [1,2]
         long_short_signal_returns_20.columns = ['ticker', 'signal_return']

         # View some of the data
         long_short_signal_returns_5.head(10)
```

```
Out[25]:   ticker  signal_return
         0      A     0.00732604
         1    ABC     0.01639650
         2    ADP     0.00981520
         3   AKAM     0.04400495
         4   ALGN     0.01545561
         5    APC     0.00305859
         6 ARMENA     0.01704511
         7     BA     0.08061297
         8    BCR     0.00933418
         9 BIFLOR     0.02544933
```

This gives you the data to use in the KS-Test.

Now it's time to implement the function `calculate_kstest` to use Kolmogorov-Smirnov test (KS test) between a distribution of stock returns (the input dataframe in this case) and each stock's signal returns. Run KS test on a normal distribution against each stock's signal returns. Use `scipy.stats.kstest` perform the KS test. When calculating the standard deviation of the signal returns, make sure to set the delta degrees of freedom to 0.

For this function, we don't reccommend you try to find a vectorized solution. Instead, you should iterate over the `groupby` function.

> **Hint**: You should compare the signal return of the individual tickers against a normal distribution whose parameters - mean and standard deviation are computed from all tickers.

```
In [26]: from scipy.stats import kstest
```

```python
def calculate_kstest(long_short_signal_returns):
    """
    Calculate the KS-Test against the signal returns with a long or short signal.

    Parameters
    ----------
    long_short_signal_returns : DataFrame
        The signal returns which have a signal.
        This DataFrame contains two columns, "ticker" and "signal_return"

    Returns
    -------
    ks_values : Pandas Series
        KS static for all the tickers
    p_values : Pandas Series
        P value for all the tickers
    """
    #TODO: Implement function
    # print(long_short_signal_returns)
    ks_values = pd.Series()
    p_values = pd.Series()

    for index, element in long_short_signal_returns.groupby('ticker'):
        # print(index)
        print(element['signal_return'].values)
        mean_return = np.mean(element['signal_return'].values)
        std_dev = np.std(element['signal_return'].values, ddof = 0)
        print(index)
        print(mean_return, std_dev)
        result = kstest(element['signal_return'].values, 'norm',args=(mean_return, mean
        ks_values[index] = result.statistic
        p_values[index] = result.pvalue

    # print(ks_values, p_values)
    return ks_values, p_values
```

```python
project_tests.test_calculate_kstest(calculate_kstest)
```

```
[ 0.37  0.27  0.69  0.56  0.26]
AZS
0.43 0.168878654661
[ 0.12  0.83 -0.68  0.57 -0.97]
GGE
-0.026 0.696867275742
[-0.83 -0.34  0.29  0.39 -0.72]
RSCV
```

```
-0.242 0.503245466944
```

```
---------------------------------------------------------------------------

AssertionError                            Traceback (most recent call last)

<ipython-input-26-1aa4e0765122> in <module>()
     39
     40
---> 41 project_tests.test_calculate_kstest(calculate_kstest)


/workspace/home/tests.py in func_wrapper(*args)
     58 def project_test(func):
     59     def func_wrapper(*args):
---> 60         result = func(*args)
     61         print('Tests Passed')
     62         return result


/workspace/home/project_tests.py in test_calculate_kstest(fn)
    258                 tickers))])
    259
--> 260     assert_output(fn, fn_inputs, fn_correct_outputs)
    261
    262


/workspace/home/tests.py in assert_output(fn, fn_inputs, fn_expected_outputs)
    173                 out_is_close = out_is_close.all()
    174
--> 175         assert out_is_close, err_message


AssertionError: Wrong value for calculate_kstest.

INPUT long_short_signal_returns:
  ticker  signal_return
0    GGE     0.12000000
1   RSCV    -0.83000000
2    AZS     0.37000000
3    GGE     0.83000000
4   RSCV    -0.34000000
5    AZS     0.27000000
6    GGE    -0.68000000
7   RSCV     0.29000000
```

```
8      AZS     0.69000000
9      GGE     0.57000000
10    RSCV     0.39000000
11     AZS     0.56000000
12     GGE    -0.97000000
13    RSCV    -0.72000000
14     AZS     0.26000000

OUTPUT ks_values:
AZS    0.34629273
GGE           nan
RSCV          nan
dtype: float64

OUTPUT p_values:
AZS    0.48778775
GGE           nan
RSCV          nan
dtype: float64

EXPECTED OUTPUT FOR ks_values:
GGE    0.29787827
RSCV   0.35221525
AZS    0.63919407
dtype: float64

EXPECTED OUTPUT FOR p_values:
GGE    0.69536353
RSCV   0.46493498
AZS    0.01650327
dtype: float64
```

1.12.1 View Data

Using the signal returns we created above, let's calculate the ks and p values.

In [ ]:
```
ks_values_5, p_values_5 = calculate_kstest(long_short_signal_returns_5)
ks_values_10, p_values_10 = calculate_kstest(long_short_signal_returns_10)
ks_values_20, p_values_20 = calculate_kstest(long_short_signal_returns_20)

print('ks_values_5')
print(ks_values_5.head(10))
print('p_values_5')
print(p_values_5.head(10))
```

1.13 Find Outliers

With the ks and p values calculate, let's find which symbols are the outliers. Implement the `find_outliers` function to find the following outliers: - Symbols that pass the null hypothesis with a p-value less than `pvalue_threshold` **AND** with a KS value above `ks_threshold`.

Note: your function should return symbols that meet both requirements above.

```
In [ ]: def find_outliers(ks_values, p_values, ks_threshold, pvalue_threshold=0.05):
            """
            Find outlying symbols using KS values and P-values

            Parameters
            ----------
            ks_values : Pandas Series
                KS static for all the tickers
            p_values : Pandas Series
                P value for all the tickers
            ks_threshold : float
                The threshold for the KS statistic
            pvalue_threshold : float
                The threshold for the p-value

            Returns
            -------
            outliers : set of str
                Symbols that are outliers
            """
            #TODO: Implement function

            return None


        project_tests.test_find_outliers(find_outliers)
```

1.13.1 View Data

Using the `find_outliers` function you implemented, let's see what we found.

```
In [ ]: ks_threshold = 0.8
        outliers_5 = find_outliers(ks_values_5, p_values_5, ks_threshold)
        outliers_10 = find_outliers(ks_values_10, p_values_10, ks_threshold)
        outliers_20 = find_outliers(ks_values_20, p_values_20, ks_threshold)

        outlier_tickers = outliers_5.union(outliers_10).union(outliers_20)
        print('{} Outliers Found:\n{}'.format(len(outlier_tickers), ', '.join(list(outlier_ticke
```

1.13.2 Show Significance without Outliers

Let's compare the 5, 10, and 20 day signals returns without outliers to normal distributions. Also, let's see how the P-Value has changed with the outliers removed.

```
In [ ]: good_tickers = list(set(close.columns) - outlier_tickers)

        project_helper.plot_signal_to_normal_histograms(
            [signal_return_5[good_tickers], signal_return_10[good_tickers], signal_return_20[goo
            'Signal Return Without Outliers',
            ('5 Days', '10 Days', '20 Days'))
```

That's more like it! The returns are closer to a normal distribution. You have finished the research phase of a Breakout Strategy. You can now submit your project. ## 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.