Orbital Insights Data Analysis

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```
In [1]: %%bash
        date
```

```
Mon Mar 14 15:01:04 PDT 2016
```

```
In [2]: # https://github.com/rasbt/watermark
        %load_ext watermark
        %watermark -p numpy,scipy,pandas,matplotlib
```

```
The watermark extension is already loaded. To reload it, use:
  %reload_ext watermark

numpy 1.10.1
scipy 0.16.0
pandas 0.16.2
matplotlib 1.4.0
```

1 First Look

1.1 Shell

```
In [2]: %%bash
        root="/home/daniel/OrbitalInsights"
        cat $root/data.csv | wc -l
```

```
1827
```

1826 rows of data

```
In [6]: %%bash
        root="/home/daniel/OrbitalInsights"
        head -n 2 $root/data.csv
        tail -n 1 $root/data.csv
```

```
date,day.of.week,car.count,weather
2010-01-01,friday,94.5,-0.1
2014-12-31,wednesday,166,-0.2
```

Data set for 5 years, Jan 1, 2010 to Dec 31 2014

```
In [9]: 1826 / 5.0 # guess sample rate
```

```
Out[9]: 365.2
```

Probably 365 data points per year, one data point per day.

1.2 Python

1.2.1 Initial Plot

```
In [2]: import matplotlib.pyplot as plt
        import numpy as np
        import pandas as pd
        %matplotlib inline
        import scipy.signal as signal
```

```
In [3]: df = pd.read_csv("/home/daniel/OrbitalInsights/data.csv")
```

```
In [4]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1826 entries, 0 to 1825
Data columns (total 4 columns):
date           1826 non-null object
day.of.week    1826 non-null object
car.count      1799 non-null float64
weather        1826 non-null float64
dtypes: float64(2), object(2)
memory usage: 71.3+ KB
```

```
In [5]: df.head()
```

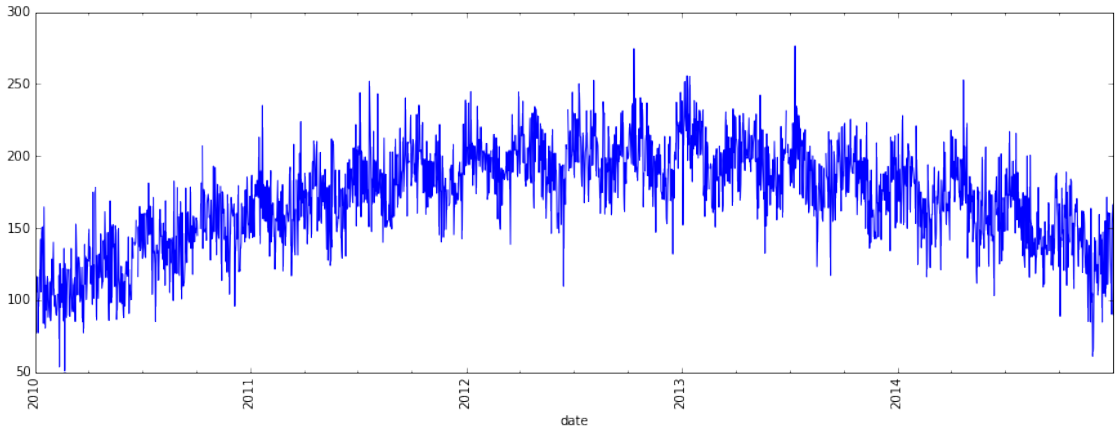
Out[5]:

	date	day.of.week	car.count	weather
0	2010-01-01	friday	94.5	-0.1
1	2010-01-02	saturday	108.4	-2.4
2	2010-01-03	sunday	105.5	-0.5
3	2010-01-04	monday	109.6	-2.1
4	2010-01-05	tuesday	116.1	1.9

```
In [6]: # like using Pandas b/c of the datetime features, resample or groupby
        # but I haven't used date methods in a while and lost some time to redresh my memory
        df['date'] = pd.to_datetime(df['date'])
        df.set_index(df['date'], inplace=True)
```

```
In [7]: df['car.count'].plot(rot=90, figsize=(15,5))
```

```
Out[7]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd8f85ba690>
```

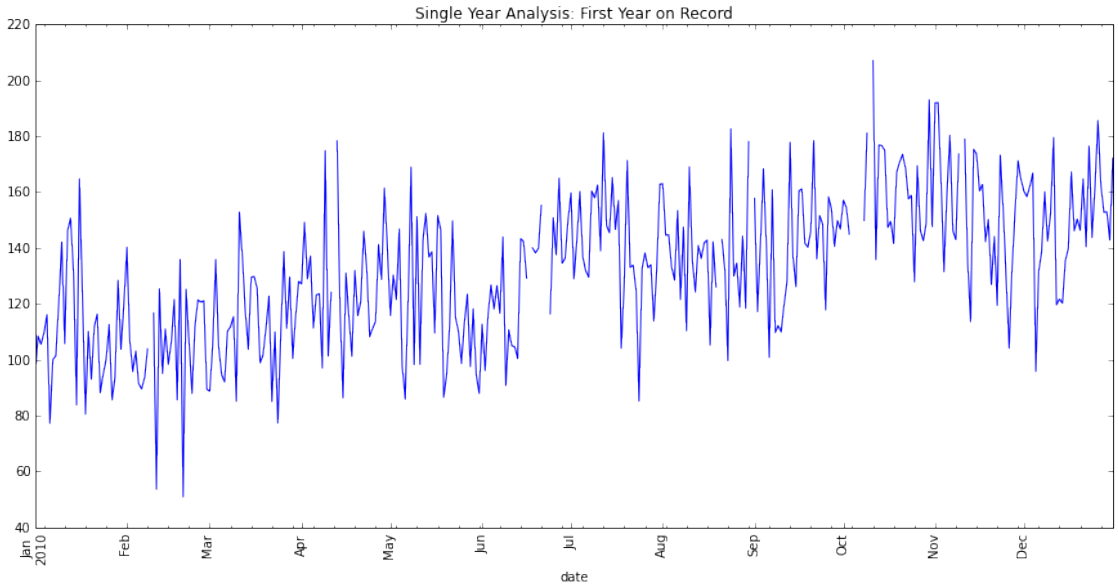


Roughly quadratic over the 5 years, with more interesting shorter trend

1.2.2 Single Year Analysis: first year on record

```
In [9]: df['car.count'][0:365].plot(rot=90, figsize=(15,7), title="Single Year Analysis: First Year on
```

```
Out[9]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd8f1174450>
```



Deal with non finite values so we can detrend.

```
In [10]: year = df['car.count'][0:365]
         year[~np.isfinite(year)]
```

```
Out[10]: date
         2010-02-09   NaN
         2010-04-12   NaN
         2010-06-17   NaN
         2010-06-22   NaN
         2010-06-23   NaN
         2010-08-20   NaN
         2010-08-31   NaN
         2010-10-04   NaN
         2010-10-05   NaN
         2010-10-07   NaN
         2010-10-10   NaN
         2010-11-10   NaN
         Name: car.count, dtype: float64
```

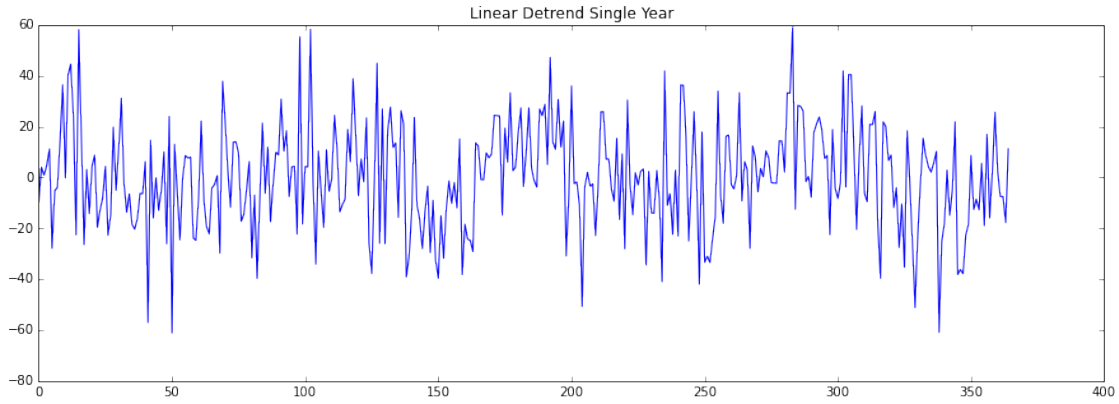
```
In [11]: # I wasted about 10 minutes going for a vectorized method had to move to brute force
         def remove_nans(data):
             for i in range(data.shape[0]):
                 if not np.isfinite(data[i]):
                     data[i] = data[i-1]
             return data
```

```
year = remove_nans(year)
year_linear_det = signal.detrend(year, axis=0, type='linear')
```

Single Year Linear Detrend Time Series

```
In [14]: plt.figure(figsize=(15, 5))
         plt.plot(year_linear_det)
         plt.title("Linear Detrend Single Year")
```

```
Out[14]: <matplotlib.text.Text at 0x7fd8f0b6b490>
```

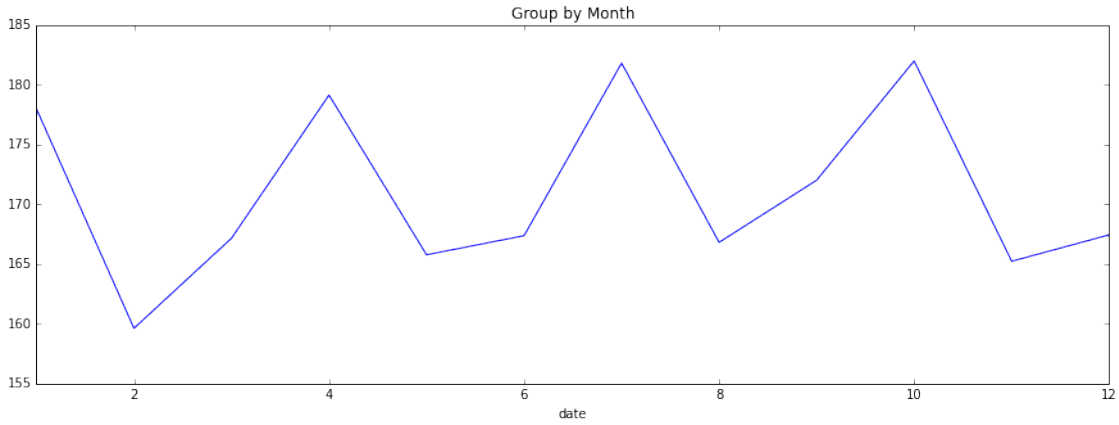


1.3 Summaries All Data

Group by Month: Global monthly trend averaging over the 5 samples of each month

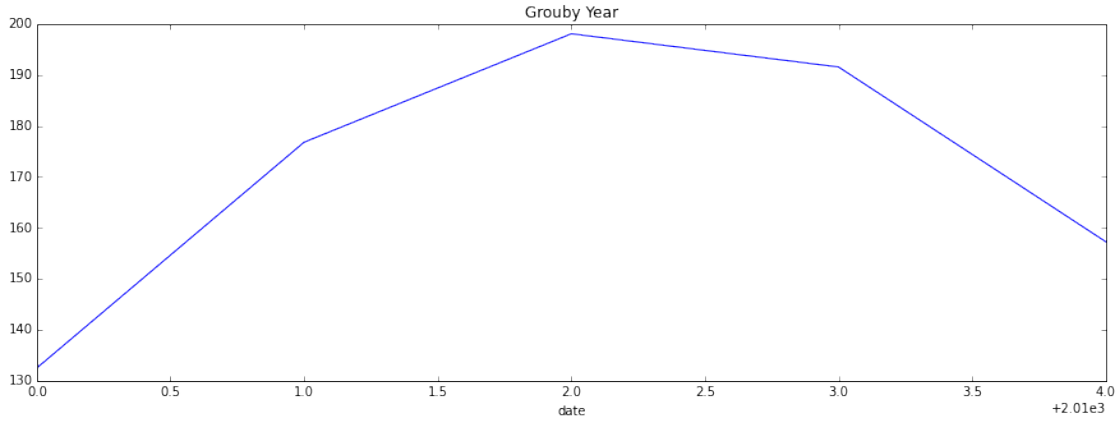
```
In [16]: grp = df.groupby(df.date.map(lambda x:x.month))
         grp.mean()['car.count'].plot(figsize=(15,5), title="Group by Month")
```

```
Out[16]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd8f0ad38d0>
```



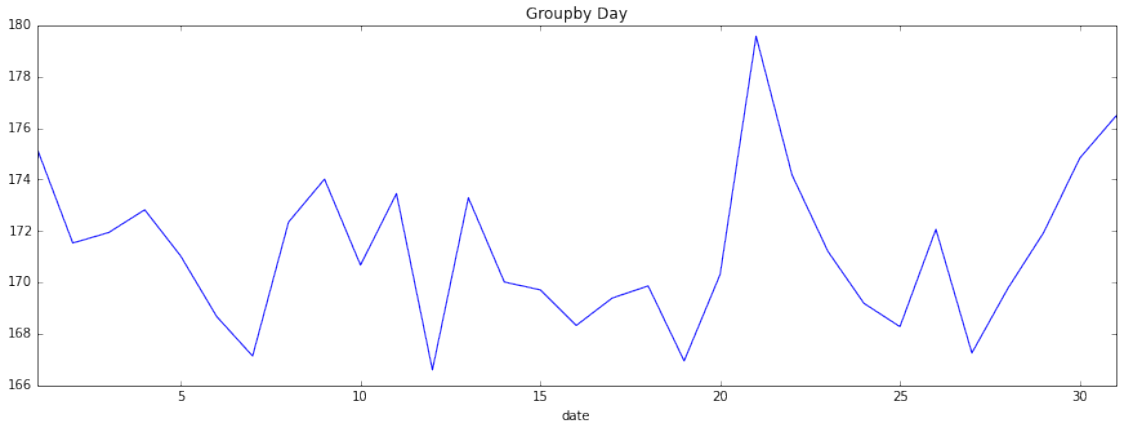
Group by Year: Global year trend averaging over the 5 samples of each year

```
In [17]: grp = df.groupby(df.date.map(lambda x:x.year))
         grp.mean()['car.count'].plot(figsize=(15,5), title="Grouby Year")

Out[17]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd8f0a5fbd0>
```



Group by Day: Global day trend averaging over the 5 samples of each day

```
In [18]: grp = df.groupby(df.date.map(lambda x:x.day))
         grp.mean()['car.count'].plot(figsize=(15,5), title="Groupby Day")

Out[18]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd8f842b690>
```



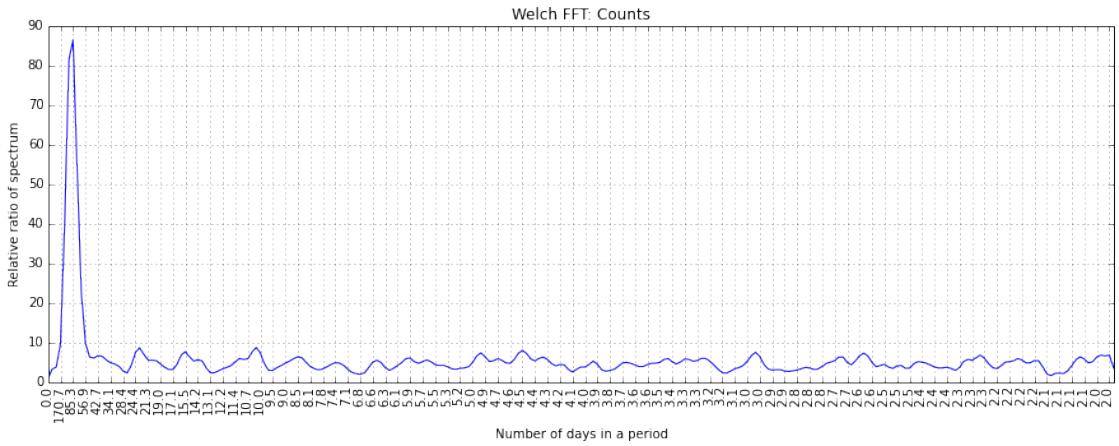
1.4 FFT

I keep this method handy, I didn't re-write just cut and paste rather than import so that you can see what's inside.

```
In [21]: def fft(data):
             '''Plot FFT using Welch's method, daily resolution '''
             #plt.figure(figsize=(13, 7))
             f, y = signal.welch(data, fs=1.0, nperseg=256, noverlap=128, nfft=512, scaling='spectr
```

```
    interval = 3 # days
    periods = np.round(1/f[0::interval], 1)
    # clean up frequency of 0 Hz
    periods[0] = 0

    frqs = f[0::interval]
    plt.xticks(frqs, periods, rotation="vertical")

    plt.plot(f, y)

    plt.grid(True) # not working likely b/c of conflict with seaborn artist
    plt.title("Welch FFT: Counts")
    plt.ylabel("Relative ratio of spectrum")
    plt.xlabel("Number of days in a period")

    return f, y, frqs
```

In [22]:
```
plt.figure(figsize=(15,5))
counts = remove_nans(df['car.count'])
f, y, frqs = fft(counts)
```



In [248]:
```
%%bash
date
```

```
Mon Mar 14 16:29:43 PDT 2016
```

2 Summary Write Up

Longer time scale: If we were asked about global count increase, we could use the yearly and fit a quadratic to see that global trend.

Shorter time scale: There's probably a strong correlation with some external related time series data that characterizes typical driving use cases.

Clearly there's an 85 day period with freqency $f = 1/T$ giving $f \approx 3$ month recurring feature of high counts.

3 Future Analysis

I'd like to fit a quadratic to the global time series and report that fit for prediction or detrending purposes. The Welch FFT shouldn't improve though, because of the sub sampling and linear detrend. The 2nd order curve is rather flat and should look linear in most subsamples.

The Welch FFT I pulled out was not optimized for this data set any known confounds so I'd need to sanity check it more and tweak some values.

4 Note About Time

The additional 30 min is mostly from me trying to be clever with vectorizing and reminding myself how I like to use datetime objects in Pandas.

```
In [ ]:
```