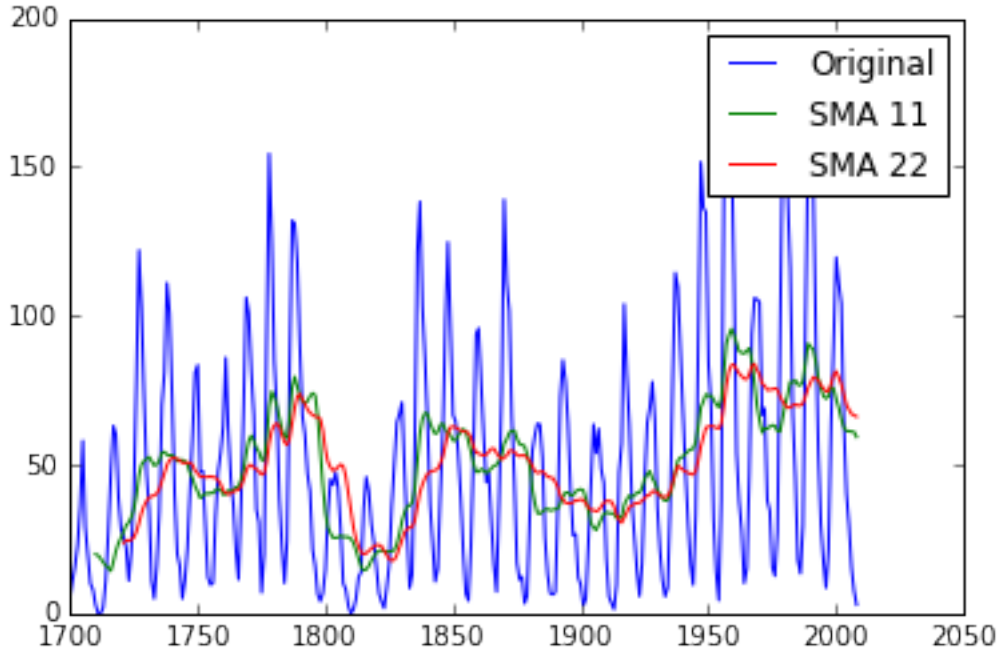
24-signals

April 24, 2016

1 Digital Signal Processing

- audio
- images
- computational finance
- large collection of routines in SciPy

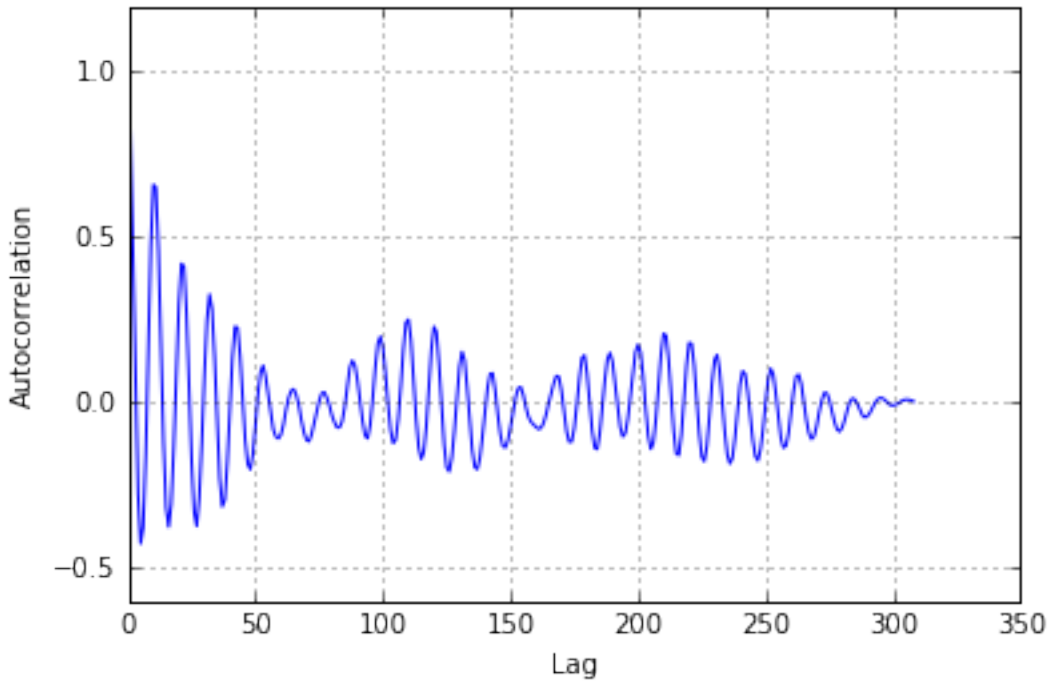
In [1]:
```
%matplotlib inline
import matplotlib.pyplot as plt
import statsmodels.api as sm
from pandas.stats.moments import rolling_mean

data_loader = sm.datasets.sunspots.load_pandas()
df = data_loader.data
year_range = df["YEAR"].values
plt.plot(year_range, df["SUNACTIVITY"].values, label="Original")
plt.plot(year_range, rolling_mean(df, 11)["SUNACTIVITY"].values, label="SMA 11")
plt.plot(year_range, rolling_mean(df, 22)["SUNACTIVITY"].values, label="SMA 22")
plt.legend()
plt.show()
```

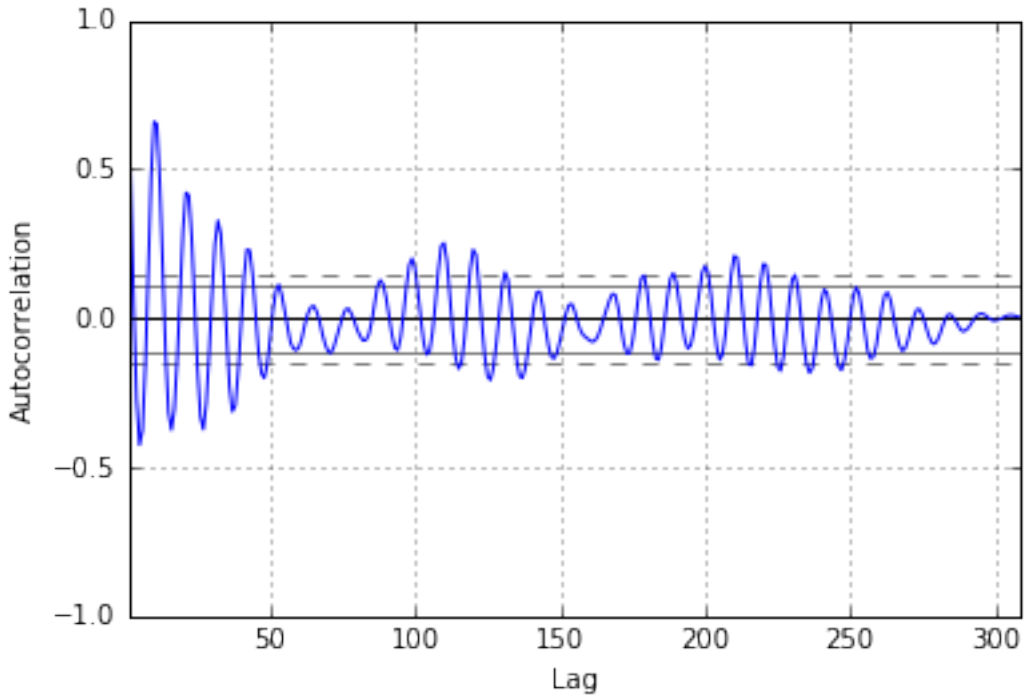


In [2]:
```
import numpy as np
import pandas as pd
import statsmodels.api as sm
import matplotlib.pyplot as plt
from pandas.tools.plotting import autocorrelation_plot


data_loader = sm.datasets.sunspots.load_pandas()
data = data_loader.data["SUNACTIVITY"].values
y = data - np.mean(data)
norm = np.sum(y ** 2)
correlated = np.correlate(y, y, mode='full')/norm
res = correlated[len(correlated)/2:]

print( np.argsort(res)[-5:])
plt.plot(res)
plt.grid(True)
plt.xlabel("Lag")
plt.ylabel("Autocorrelation")
plt.show()
autocorrelation_plot(data)
plt.show()
```

```
[ 9 11 10  1  0]
```

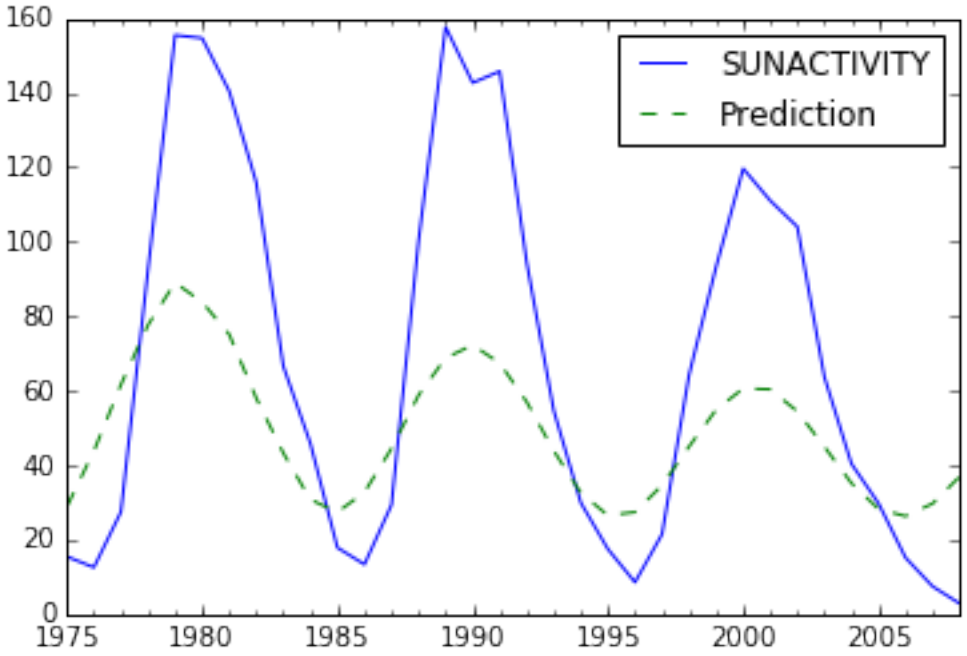
```
/Users/lstead/anaconda/lib/python3.5/site-packages/ipykernel/__main__.py:13: DeprecationWarning: using a
```






```
In [3]: import pandas as pd
        import matplotlib.pyplot as plt
        import statsmodels.api as sm
        import datetime

        data_loader = sm.datasets.sunspots.load_pandas()
        df = data_loader.data
        years = df["YEAR"].values.astype(int)
        df.index = pd.Index(sm.tsa.datetools.dates_from_range(str(years[0]), str(years[-1])))
        del df["YEAR"]

        model = sm.tsa.ARMA(df, (10,1)).fit()
        prediction = model.predict('1975', str(years[-1]), dynamic=True)

        df['1975':].plot()
        prediction.plot(style='--', label='Prediction');
        plt.legend();
        plt.show()
```

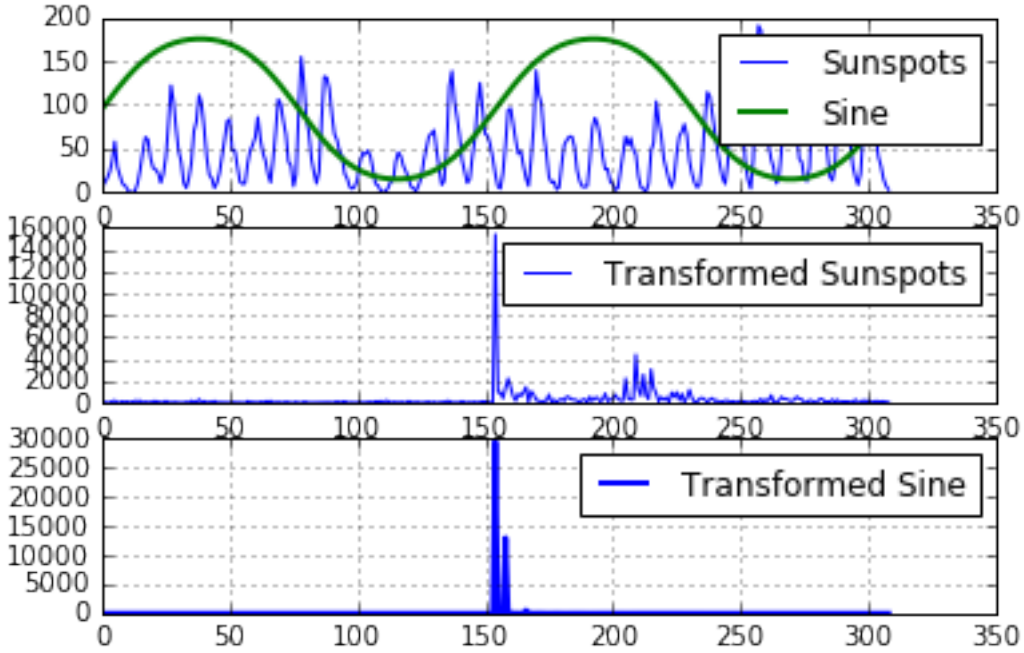
```
/Users/lstead/anaconda/lib/python3.5/site-packages/statsmodels/base/model.py:466: ConvergenceWarning: Ma
  "Check mle_retvals", ConvergenceWarning)
/Users/lstead/anaconda/lib/python3.5/site-packages/statsmodels/base/data.py:503: FutureWarning: TimeSeri
  return TimeSeries(result, index=self.predict_dates)
```



In [4]:
```
import numpy as np
import statsmodels.api as sm
import matplotlib.pyplot as plt
from scipy.fftpack import rfft
from scipy.fftpack import fftshift

data_loader = sm.datasets.sunspots.load_pandas()
sunspots = data_loader.data["SUNACTIVITY"].values

t = np.linspace(-2 * np.pi, 2 * np.pi, len(sunspots))
mid = np.ptp(sunspots)/2
sine = mid + mid * np.sin(np.sin(t))

sine_fft = np.abs(fftshift(rfft(sine)))
print("Index of max sine FFT", np.argsort(sine_fft)[-5:])


transformed = np.abs(fftshift(rfft(sunspots)))
print("Indices of max sunspots FFT", np.argsort(transformed)[-5:])

plt.subplot(311)
plt.plot(sunspots, label="Sunspots")
plt.plot(sine, lw=2, label="Sine")
plt.grid(True)
plt.legend()
plt.subplot(312)
plt.plot(transformed, label="Transformed Sunspots")
plt.grid(True)
plt.legend()
```

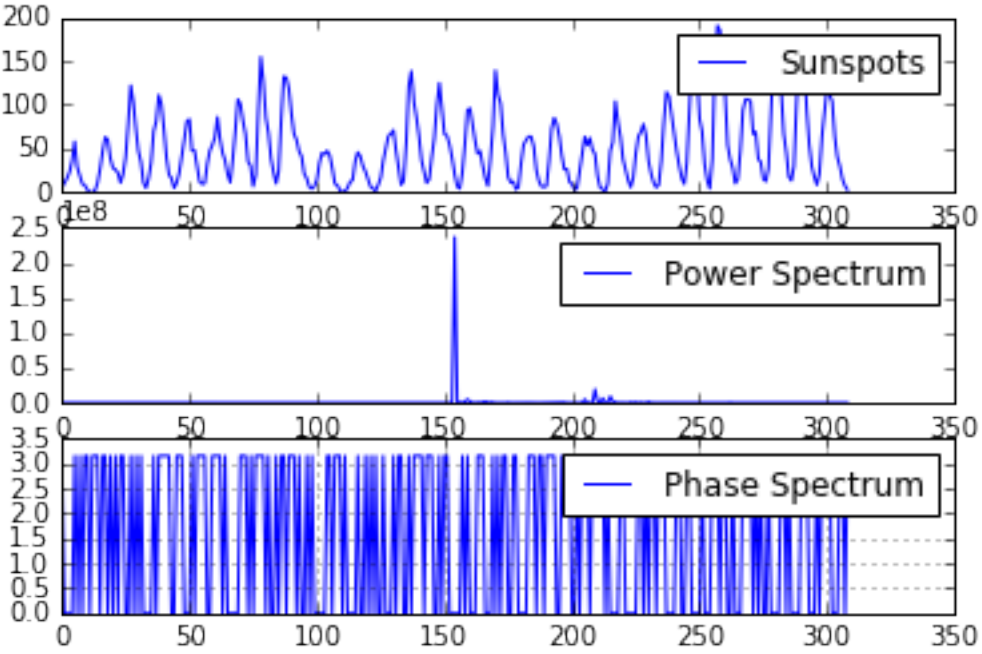
```
        plt.subplot(313)
        plt.plot(sine_fft, lw=2, label="Transformed Sine")
        plt.grid(True)
        plt.legend()
        plt.show()
```

```
Index of max sine FFT [160 157 166 158 154]
Indices of max sunspots FFT [205 212 215 209 154]
```

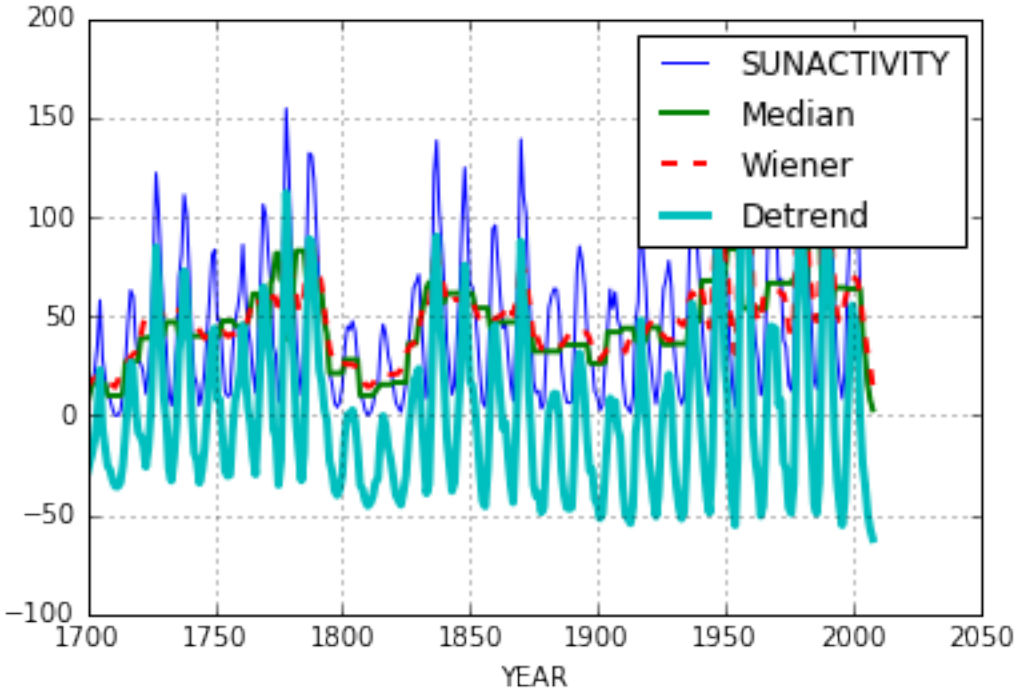



```
In [5]: import numpy as np
        import statsmodels.api as sm
        import matplotlib.pyplot as plt
        from scipy.fftpack import rfft
        from scipy.fftpack import fftshift

        data_loader = sm.datasets.sunspots.load_pandas()
        sunspots = data_loader.data["SUNACTIVITY"].values

        transformed = fftshift(rfft(sunspots))

        plt.subplot(311)
        plt.plot(sunspots, label="Sunspots")
        plt.legend()
        plt.subplot(312)
        plt.plot(transformed ** 2, label="Power Spectrum")
        plt.legend()
        plt.subplot(313)
        plt.plot(np.angle(transformed), label="Phase Spectrum")
        plt.grid(True)
```

```
plt.legend()
plt.show()
```



In [6]:
```
import statsmodels.api as sm
import matplotlib.pyplot as plt
from scipy.signal import medfilt
from scipy.signal import wiener
from scipy.signal import detrend
import numpy as np

data_loader = sm.datasets.sunspots.load_pandas()
sunspots = data_loader.data["SUNACTIVITY"].values
years = data_loader.data["YEAR"].values

plt.plot(years, sunspots, label="SUNACTIVITY")
plt.plot(years, medfilt(sunspots, 11), lw=2, label="Median")
plt.plot(years, wiener(sunspots, 11), '--', lw=2, label="Wiener")
plt.plot(years, detrend(sunspots), lw=3, label="Detrend")
plt.xlabel("YEAR")
plt.grid(True)
plt.legend()
plt.show()
```


SUNACTIVITY
Median
Wiener
Detrend
200
150
100
50
0
−50
−100
1700
1750
1800
1850
1900
1950
2000
2050
YEAR

In [ ]: