1

October 3, 2017

0.1 Evgenii Safronov, Mikhail Kurenkov, Taras Melnik


```
In [1]: import numpy as np
        import scipy as sp
        from matplotlib import pyplot as plt
        from numpy.linalg import inv
        from matplotlib.font_manager import FontProperties
        %matplotlib inline
```

0.2 Reading the data

```
In [2]: year, month, monthly_flux, monthly_number = [],[],[],[]
```

```
In [3]: with open('data_group6.txt') as f:
            for line in f:
                y,m,mf,mn =  map(float, line.split())
                year.append( y )
                month.append( m )
                monthly_flux.append( mf )
                monthly_number.append( mn )
```

```
In [4]: year = np.array(year)
        month = np.array(month)
        monthly_flux = np.array(monthly_flux)
        monthly_number = np.array(monthly_number)
```

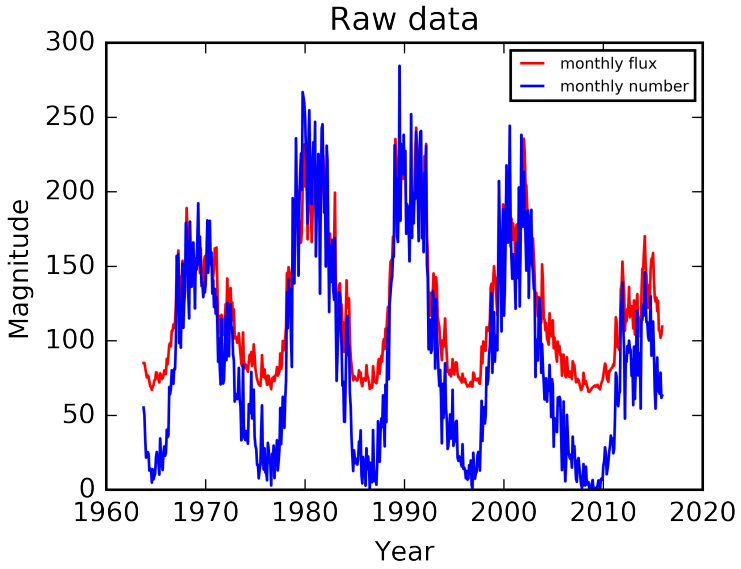
0.3 Alternative reading

```
In [5]: year, month, monthly_flux, monthly_number = np.loadtxt('data_group6.txt', unpack = True)
```

0.4 Plotting

```
In [6]: fig, ax = plt.subplots(1,1, figsize=(4,3), dpi = 600)
        ax.set_title('Raw data')
        ax.plot((year + month/12), monthly_flux,'r', label = 'monthly flux')
        ax.plot((year + month/12), monthly_number,'b', label = 'monthly number')
        fontP = FontProperties()
        fontP.set_size('xx-small')
        ax.legend(prop = fontP, loc = 'upper right')
```

```
ax.set_xlabel('Year')
ax.set_ylabel('Magnitude');
#fig.show();
```

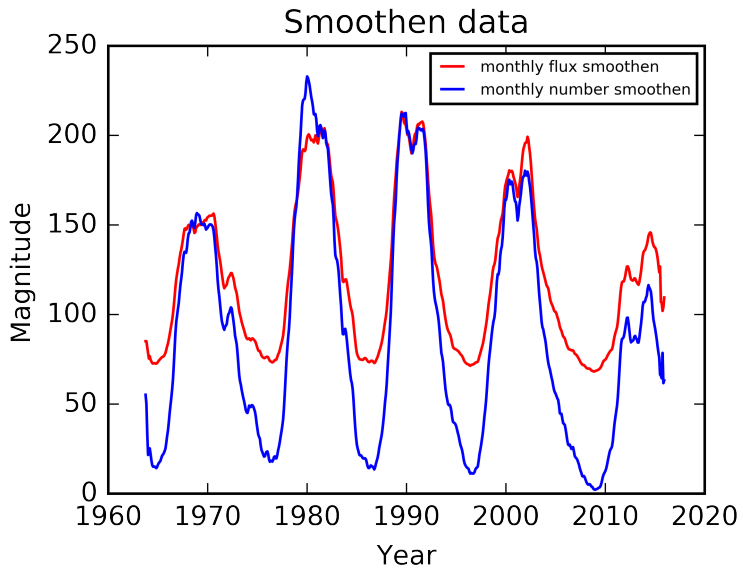


0.5 Smoothing

In [7]:
```
averager = np.ones(13)
averager[0] = averager[-1] = 0.5
averager/=12
```

In [8]:
```
mf_smooth = np.convolve(monthly_flux,  averager, mode = 'same')
mf_smooth[:6] = monthly_flux[:6]
mf_smooth[-6:] = monthly_flux[-6:]
mn_smooth = np.convolve(monthly_number,averager, mode = 'same')
mn_smooth[:6] = monthly_number[:6]
mn_smooth[-6:] = monthly_number[-6:]
```

In [9]:
```
fig, ax = plt.subplots(1,1, figsize=(4,3), dpi = 600)
ax.set_title('Smoothen data')
ax.plot((year + month/12), mf_smooth,'r', label = 'monthly flux smoothen')
ax.plot((year + month/12), mn_smooth,'b', label = 'monthly number smoothen')
fontP = FontProperties()
fontP.set_size('xx-small')
ax.legend(prop = fontP, loc = 'upper right')
ax.set_xlabel('Year')
ax.set_ylabel('Magnitude');
#fig.show()
```

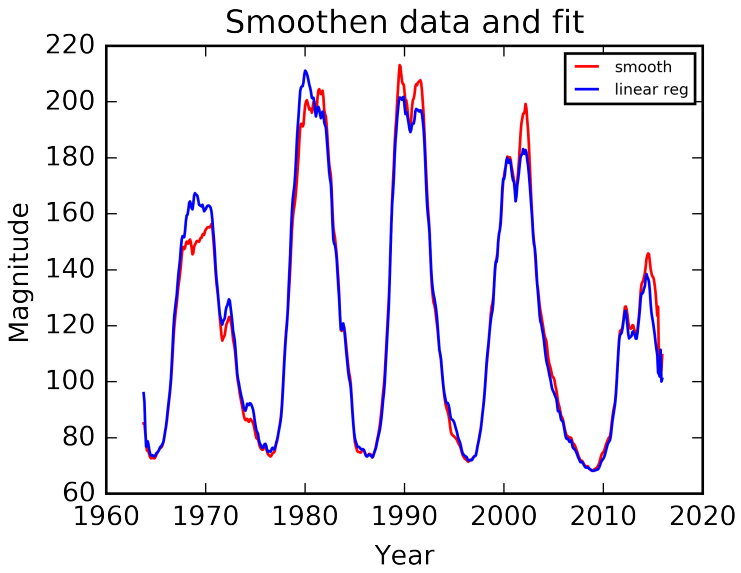


0.6 Linear regression

```
In [10]: F = mf_smooth
         sp = mn_smooth
         R = np.array([np.ones_like(sp), sp, sp**2, sp**3])
         R = R.transpose()

In [11]: beta = (inv(R.transpose().dot(R))).dot(R.transpose()).dot(F)

In [12]: fig, ax = plt.subplots(1,1, figsize=(4,3), dpi = 600)
         ax.set_title('Smoothen data and fit')
         ax.plot((year + month/12), mf_smooth,'r',label = 'smooth')
         ax.plot((year + month/12), R.dot(beta) ,'b', label = 'linear reg')
         fontP = FontProperties()
         fontP.set_size('xx-small')
         ax.legend(prop = fontP, loc = 'upper right')
         ax.set_xlabel('Year')
         ax.set_ylabel('Magnitude');
         #fig.show();
```



0.7 Dispersion

```
In [13]: sigma_sq = np.sum( (F - R.dot(beta))**2 ) / (len(F) - 1)

In [14]: print('sigma_squared = %.2f' % (sigma_sq))

sigma_squared = 30.18
```

0.8 Today we learned how to use linear regression in matrix form via Python.