Erasmus Mundus JMD Nuclear Physics

Monte Carlo - BootStrapping Exercise Set

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Firstly, Import all required packages

In [1]:
```
%matplotlib inline
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import scipy
import random
np.warnings.filterwarnings('ignore')
from scipy import stats
```

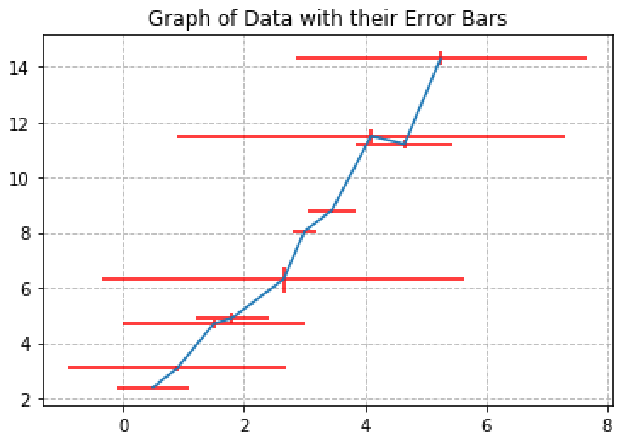
Problem 1: Read or code directly $(x_i \pm \sigma_i, y_i \pm \sigma_i)_{i=1}^N$

In [2]:
```
d = {'x':[0.50,0.90,1.50,1.80,2.65,3.00,3.45,4.10,4.65,5.25],'y':[2.40,3.10,4.70,4.90,6.30,8.05,8.
80,11.50,11.20,14.30],
    '$\sigma_x$':[0.02,0.09,0.15,0.18,0.45,0.05,0.07,0.25,0.15,0.25],'$\sigma_y$':[0.60,1.80,1.50,
0.60,3.00,0.20,0.40
                                                                                       ,3.20,0.80,
2.40]}
fd = pd.DataFrame(data=d)
fd
```

Out[2]:

	x	y	σ_x	σ_y
0	0.50	2.40	0.02	0.6
1	0.90	3.10	0.09	1.8
2	1.50	4.70	0.15	1.5
3	1.80	4.90	0.18	0.6
4	2.65	6.30	0.45	3.0
5	3.00	8.05	0.05	0.2
6	3.45	8.80	0.07	0.4
7	4.10	11.50	0.25	3.2
8	4.65	11.20	0.15	0.8
9	5.25	14.30	0.25	2.4

In [3]:
```python
plt.errorbar(fd['x'],fd['y'],fd['$\sigma_x$'],fd['$\sigma_y$'],ecolor = 'r')
plt.grid(linestyle='dashed')
plt.title('Graph of Data with their Error Bars')
plt.show()
```



Problem 2: Obtain up to M = 1000 sets of datapoints $((x_i, y_i)_k)_{i=1,\ldots,N}^{k=1,\ldots,M}$ by resampling from your experimental data. Use the generator producing random numbers with Guassian Distribution

In [4]:
```python
def newpoint():
    '''
    To acquire a set of data points by resampling the data given to us we will use a loop to gener
ate random values
    inbetween the range of x and y.

    To use np.random.normal (a guassian distribution) we want the mean and standard deviation
    '''
    xmean, xstd = np.mean(fd['x']), np.std(fd['x'])
    ymean, ystd = np.mean(fd['y']), np.std(fd['y'])
    points = []
    pointss = []

    for n in range(1000): #M = 1000 for datasets
        points = []
        for m in range(10): # N = 10 datapoints per data set
            x = np.random.normal(xmean,xstd)
            y = np.random.normal(ymean,ystd)
            point = [x,y]
            points.append(point)
        pointss.append(points)
    a = pointss
    return a
```

In [5]:
```python
a = newpoint()
print(a[0])
```

```
[[3.8856731250207064, 16.904370048922644], [1.4091924431390388, 7.6580985989783095], [2.788422096
0546866, 8.599227494229451], [3.266603795396893, -0.5218327239321088], [3.0696238431134777, 2.220
809598563994], [2.5429703878128147, 8.277294797232111], [2.536813789562086, 14.494685853710747],
[4.350854844130348, 12.61218607990789], [2.049781375103399, 9.862765760177634], [2.20766637569253
6, 4.89831450227951]]
```

Problem 3: For each artificially resampled data set, calculate their own slope and intercept

In [6]:
```
 def slopeintcalc(datasets):
    '''
    This function calculates the slope and intercept for each dataset
    and appends slope and intercept of each dataset to a list that
    is returned

    '''
    a = np.array(datasets)
    slopelist = []
    interceptlist = []
    for n in range(1000):
        slope, intercept, r_value, p_value, std_err = stats.linregress(a[n][:,0],a[n][:,1])
        slopelist.append(slope)
        interceptlist.append(intercept)
    return slopelist, interceptlist
```

In [7]:
```
slope, intercept = slopeintcalc(a)
print(slope[0],intercept[0])
```

```
1.5108701787584424 4.25389822385045
```

Problem 4: Once the loop is finished, provide as output: $\overline{a} \pm \sigma_a$ and $\overline{b} \pm \sigma_b$ using the mean and standard deviation of the $(a_k, b_k)_{k=1}^{M}$ values obtained respectively

In [8]:
```
def meanstdcalc(datasets):
    '''
    Function that takes the created dataset from problem 1, calculates the mean, standard deviatio
n
    and outputs a list of the asked values for all datasets
    '''
    a = np.array(datasets)
    meanlist = []
    stdlist = []
    output = []
    for n in range(1000):
        x_mean, x_std = np.mean(a[n][:,0]), np.std(a[n][:,0])
        y_mean, y_std = np.mean(a[n][:,1]), np.mean(a[n][:,0])
        meanlist.append([x_mean,y_mean])
        stdlist.append([x_std,y_std])
        output.append([x_mean+x_std,y_mean+y_std])
    return meanlist, stdlist ,output
```

In [9]:
```
mean, std, output = meanstdcalc(a)
print(output[0])
```

```
[3.6388056892587595, 11.311352208509616]
```

Problem 5: plot your experimental datapoints with errorbars with the result of this linear regression

In [10]:
```
'''
First we need to calculate the slope and intercept for the given datapoints
'''
l = np.array(fd['x'])
m = np.array(fd['y'])
points1 = []

for n in range(10):
    points1.append([l[n],m[n]])

points1 = np.array(points1)

slope, intercept, r_value, p_value, std_err = stats.linregress(points1[:,0],points1[:,1])
```

In [11]:
```
#Plotting
x = np.linspace(0,6)
plt.errorbar(fd['x'],fd['y'],fd['$\sigma_x$'],fd['$\sigma_y$'], fmt='o', c = 'red')
plt.plot(x,slope*x+intercept, color ='black')
plt.grid(linestyle='dashed')
plt.title('Graph of Data with their Error Bars')
plt.show()
```