

## MAE 267 - Homework 2

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### Code

```
1 program hw2
2
3 ! MAE 267
4 ! HW2
5 ! Problem 1 - Least-Squares Linear Fit
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7 ! 28 September 2015
8
9 ! DESCRIPTION: Calculate and plot least-squares linear fit
10
11 ! No undeclared variables
12 implicit none
13
14 ! DECLARE VARIABLES
15 integer, parameter :: n = 20, x_unit = 21, y_unit = 22
16 integer :: i
17 ! Pendulum Parameters
18 real, dimension(1:n) :: x, y
19
20 interface
21     subroutine leastSquares(x, y)
22         real, dimension(:) :: x, y
23     end subroutine leastSquares
24 end interface
25
26 ! GIVEN INPUT DATA
27 x = (/ -4.91, -3.84, -2.41, -2.62, -3.78, -0.52, -1.83, &
28 -2.01, 0.28, 1.08, -0.94, 0.59, 0.69, 3.04, 1.01, 3.60, &
29 4.53, 5.13, 4.43, 4.12 /)
30
31 y = (/ -8.18, -7.49, -7.11, -6.15, -5.62, -3.30, -2.05, &
32 -2.83, -1.16, 0.52, 0.21, 1.73, 3.96, 4.26, 5.75, &
33 6.67, 7.70, 7.31, 9.05, 10.95 /)
34
35 open (unit=x_unit,file="x.dat",action="write",status="replace")
36 do i=1,n
37     ! write newline separated file (delimiter is contained in '')
38     write (x_unit,"(32(f0.6,'',:))") x(i)
39 end do
40 close (x_unit)
41 open (unit=y_unit,file="y.dat",action="write",status="replace")
42 do i=1,n
43     write (y_unit,"(32(f0.6,'',:))") y(i)
44 end do
45 close (y_unit)
46
47 call leastSquares(x,y)
48
49 end program hw2
50
51 subroutine leastSquares(x, y)
52 implicit none
53
54 integer :: nx, ny, out_unit = 20
55 real, dimension(:) :: x, y
56 real sumx, sumy, sumxx, sumyy, sumxy, avex, avey, m, b, r
57
58 nx = size(x)
59 ny = size(y)
60 sumx = sum(x)
61 sumy = sum(y)
62 sumxx = sum(x*x)
```

```

63 sumyy = sum(y*y)
64 sumxy = sum(x*y)
65 avex = sum(x)/nx
66 avey = sum(y)/ny
67
68 ! Perform Least Squares Fit
69 m = (sumxy - sumx * avey) / (sumxx - sumx * avex)
70 b = avey - (m * avex)
71
72 ! Correlation Coeff
73 r = (nx * sumxy - sumx * sumy) / &
74     sqrt((nx * sumxx - sumx ** 2) * (nx * sumyy - sumy ** 2))
75
76 ! Output Results
77 ! Create i/o output file
78 open (unit=out_unit,file="output.txt",action="write",status="replace")
79 write (out_unit,*) 'Least-squares linear fit results:'
80 write (out_unit,*) 'm=', m, 'b=', b
81 write (out_unit,*) 'Correlation Coefficient:'
82 write (out_unit,*) 'r=', r
83 close (out_unit)
84
85 end subroutine

```

### Sample Output

```

1 Least-squares linear fit results:
2 m=  1.84419537    b=  0.190936923
3 Correlation Coefficient:
4 r=  0.948222518

```

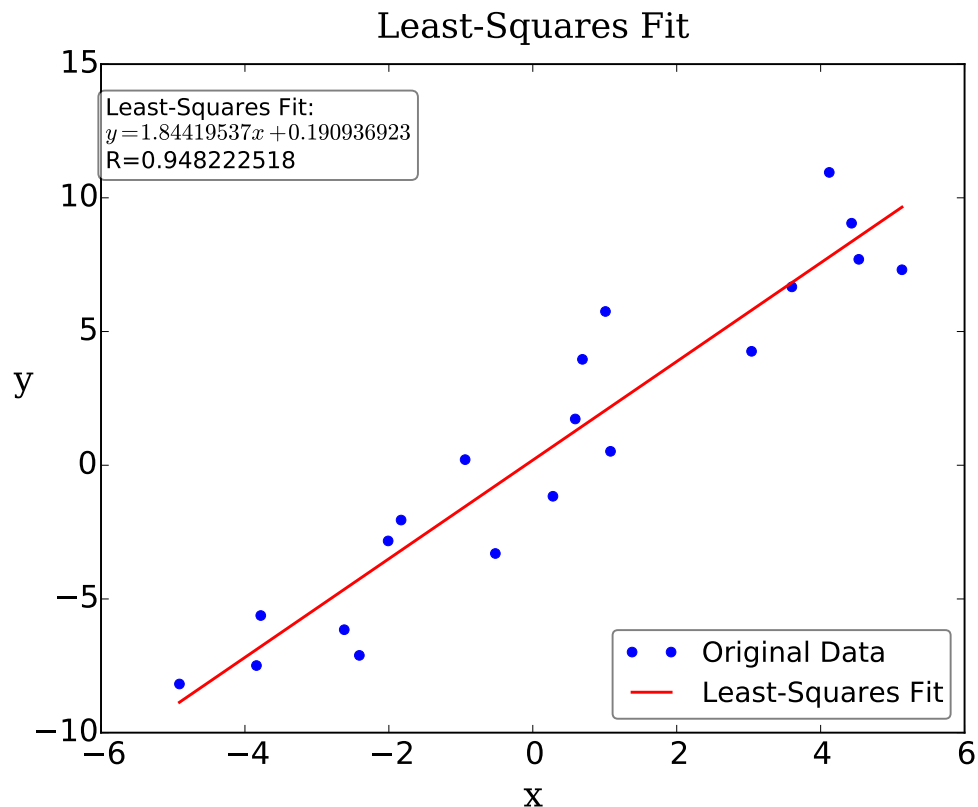


Fig. 1: Least-Squares linear fit of given data

## Plotting Code

```
1 import numpy as np
2 import matplotlib.pyplot as plt
3 import os
4
5 #PLOTING PARAMETERS
6 savedir = 'results/'
7 #Save filetype
8 savetype = '.png'
9 #Plot Colors
10 colors = ['green', 'red', 'blue', 'cyan']
11 #Plot Markers
12 markers = ['.', 'x', '*', 'o']
13 #Line Styles
14 mark = 5
15 minimark = 0.75
16 line = 1.5
17 #Font Styles
18 font_ttl = {'family' : 'serif',
19             'color' : 'black',
20             'weight' : 'normal',
21             'size' : 18,
22             }
23 font_lbl = {'family' : 'serif',
24            'color' : 'black',
25            'weight' : 'normal',
26            'size' : 18,
27            }
28 font_box = {'family' : 'arial',
29            'color' : 'black',
30            'weight' : 'normal',
31            'size' : 12,
32            }
33 font_tick = 16
34
35 def PlotStart(title, xlabel, ylabel, horzy='vertical'):
36     fig = plt.figure()
37     ax = fig.add_subplot(1, 1, 1)
38     plt.title(title, fontdict=font_ttl)
39     plt.xlabel(xlabel, fontdict=font_lbl)
40     plt.xticks(fontsize=font_tick)
41     plt.ylabel(ylabel, fontdict=font_lbl, rotation=horzy)
42     plt.yticks(fontsize=font_tick)
43     #increase title spacing
44     ttl = ax.title
45     ttl.set_position([.5, 1.025])
46     return fig, ax
47
48 def MakeOutputDir(savedir):
49     """make results output directory if it does not already exist.
50     inststring --> directory path from script containing folder
51     """
52     #split individual directories
53     splitstring = savedir.split('/')
54     prestring = ''
55     for string in splitstring:
56         prestring += string + '/'
57         try:
58             os.mkdir(prestring)
59         except Exception:
60             pass
61
62 def GetParentDir(savename):
63     """Get parent directory from path of file"""
64     #split individual directories
65     splitstring = savename.split('/')
66     parent = ''
67     #concatenate all dirs except bottommost
```

```

68     for string in splitstring[:-1]:
69         parent += string + '/'
70     return parent
71
72 def SavePlot(savename, overwrite=1):
73     """Save file given save path. Do not save if file exists
74     or if variable overwrite is 1"""
75     if os.path.isfile(savename):
76         if overwrite == 0:
77             print('    Overwrite is off')
78             return
79         else: os.remove(savename)
80     MakeOutputDir(GetParentDir(savename))
81     plt.savefig(savename, bbox_inches='tight')
82
83 def TextBox(ax, boxttext, x=0.005, y=0.95, fontsize=font_box['size'],
84            alpha=0.5, props=None):
85     if props == None:
86         props = dict(boxstyle='round', facecolor='white', alpha=alpha)
87     ax.text(x, y, boxttext, transform=ax.transAxes, fontsize=fontsize,
88            verticalalignment='top', bbox=props)
89
90 #####
91 ### LOAD DATA #####
92 #####
93 x = np.loadtxt('x.dat', delimiter='\n')
94 y = np.loadtxt('y.dat', delimiter='\n')
95
96 #FIT DATA
97 m = 1.84419537
98 b = 0.190936923
99 r = 0.948222518
100 def lineeqn(x, m, b):
101     return m * x + b
102 xfit = np.linspace(min(x), max(x))
103 yfit = []
104 for xx in xfit:
105     yfit.append(lineeqn(xx, m, b))
106 print(xfit, yfit)
107
108 #PLOT DATA
109 title = 'Least-Squares Fit'
110 xlabel = 'x'
111 ylabel = 'y'
112 _, ax = PlotStart(title, xlabel, ylabel, 'horizontal')
113 ax.plot(x, y, label='Original Data', color='blue', linestyle='', linewidth=line,
114         marker='.', markersize=mark*2)
115 ax.plot(xfit, yfit, label='Least-Squares Fit', color='red',
116         linestyle='-', linewidth=line)
117 boxttext = 'Least-Squares Fit:\n$y={}\n$x+{}\nR={}'.format(m, b, r)
118 TextBox(ax, boxttext,)
119 plt.legend(loc='lower right', fancybox=True, framealpha=0.5)
120 # plt.savefig('PlotFit.png', bbox_inches='tight')
121 SavePlot('PlotFit.pdf')

```