```
(* BIOEN 3070/6070: Introduction to Statistics for Bioengineers *)
```



```
(* In-Class Project 5: Kepler's Third Law of Planetary Motion *)
```

```
(* General Commands *)
```

```
Clear["Global`*"]
```

```
stream =
  "http://www.alterlab.org/teaching/BIOEN3070/assignments/Kepler_Third_Law.txt";
data = Import[stream, "Table"];
TableForm[data]
```

```
Planet     Period_(Years)    Mean_Distance_(Astronomical_Units)
Mercury    0.241             0.39
Venus      0.615             0.72
Earth      1                 1
Mars       1.88              1.52
Jupiter    11.8              5.2
Saturn     29.5              9.54
Uranus     84                19.18
Neptune    165               30.06
Pluto      248               39.44
```

```
data = Drop[data, 1];
data = Transpose[Drop[Transpose[data], 1]];
TableForm[data]
```

```
0.241    0.39
0.615    0.72
1        1
1.88     1.52
11.8     5.2
29.5     9.54
84       19.18
165      30.06
248      39.44
```

```
data = Table[{data[[i, 1]]^2, data[[i, 2]]^3}, {i, 1, 9}];
TableForm[data]
Mean[data]
```

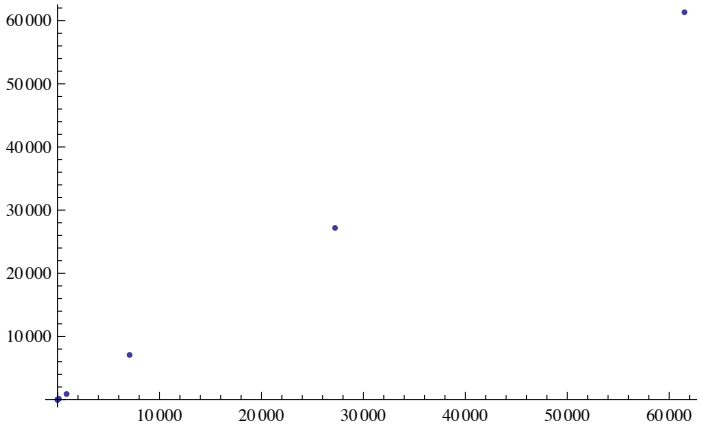
```
0.058081    0.059319
0.378225    0.373248
1           1
3.5344      3.51181
139.24      140.608
870.25      868.251
7056        7055.79
27 225      27 162.3
61 504      61 349.5
```

```
{10 755.5, 10 731.3}
```

```
? ListPlot
```

ListPlot[{y_1, y_2, ...}] plots points corresponding to a list of values, assumed to correspond to x coordinates 1, 2, ...
ListPlot[{{x_1, y_1}, {x_2, y_2}, ...}] plots a list of points with specified x and y coordinates.
ListPlot[{$list_1$, $list_2$, ...}] plots several lists of points. ≫

```
ListPlot[data]
```




```
b = Sum[(data[[i, 1]] - Mean[data][[1]]) * (data[[i, 2]] - Mean[data][[2]]), {i, 1, 9}] /
   Sum[(data[[i, 1]] - Mean[data][[1]])^2, {i, 1, 9}]
a = Mean[data][[2]] - b * Mean[data][[1]]
```

```
0.99749
```

```
2.76475
```

```
? LinearModelFit
LinearModelFit[data, x, x]
```

LinearModelFit[{y_1, y_2, ...}, {f_1, f_2, ...}, x] constructs a linear
model of the form $\beta_0 + \beta_1 f_1 + \beta_2 f_2 + \ldots$ that fits the y_i for successive x values 1, 2, ...
LinearModelFit[{{x_{11}, x_{12}, ..., y_1}, {x_{21}, x_{22}, ..., y_2}, ...}, {f_1, f_2, ...}, {x_1, x_2, ...}] constructs a linear
model of the form $\beta_0 + \beta_1 f_1 + \beta_2 f_2 + \ldots$ where the f_i depend on the variables x_k.
LinearModelFit[{m, v}] constructs a linear model from the design matrix m and response vector v. ≫

```
FittedModel[ 2.76475 + 0.99749 x ]
```

```
data = Table[{data[[i, 1]], data[[i, 2]], a + b * data[[i, 1]]}, {i, 1, 9}];
TableForm[data]
Mean[data]
```

```
0.058081    0.059319    2.82269
0.378225    0.373248    3.14203
1           1           3.76224
3.5344      3.51181     6.29028
139.24      140.608     141.655
870.25      868.251     870.83
7056        7055.79     7041.05
27 225      27 162.3    27 159.4
61 504      61 349.5    61 352.4
```

```
{10 755.5, 10 731.3, 10 731.3}
```

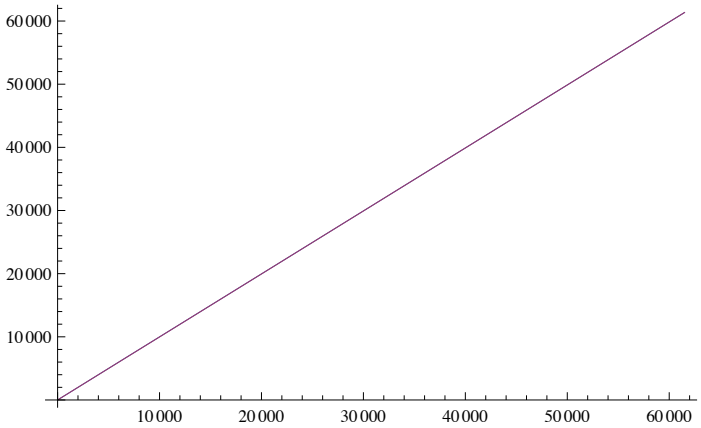
```
rSquared = 1 - Sum[(data[[i, 3]] - data[[i, 2]])^2, {i, 1, 9}] /
    Sum[(Mean[data][[2]] - data[[i, 2]])^2, {i, 1, 9}]
Sum[(data[[i, 3]] - data[[i, 2]])^2, {i, 1, 9}]
Sum[(Mean[data][[2]] - data[[i, 2]])^2, {i, 1, 9}]
```

```
1.
```

```
272.607
```

```
3.51567 × 10^9
```

```
ListLinePlot[
 {Transpose[Drop[Transpose[data], {3}]],
  Transpose[Drop[Transpose[data], {2}]]}]
```



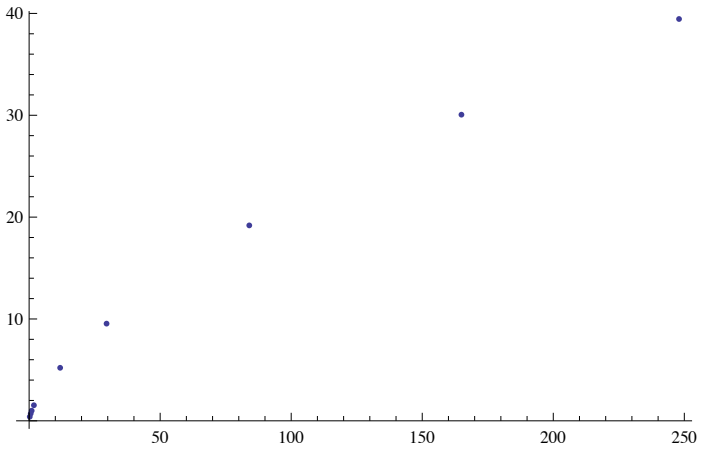
```
stream =
  "http://www.alterlab.org/teaching/BIOEN3070/assignments/Kepler_Third_Law.txt";
data = Import[stream, "Table"];
TableForm[data]
```

Planet	Period_(Years)	Mean_Distance_(Astronomical_Units)
Mercury	0.241	0.39
Venus	0.615	0.72
Earth	1	1
Mars	1.88	1.52
Jupiter	11.8	5.2
Saturn	29.5	9.54
Uranus	84	19.18
Neptune	165	30.06
Pluto	248	39.44

```
data = Drop[data, 1];
data = Transpose[Drop[Transpose[data], 1]];
TableForm[data]
```

0.241	0.39
0.615	0.72
1	1
1.88	1.52
11.8	5.2
29.5	9.54
84	19.18
165	30.06
248	39.44

```
ListPlot[data]
```



```
b = Sum[(data[[i, 1]] - Mean[data][[1]]) * (data[[i, 2]] - Mean[data][[2]]), {i, 1, 9}] /
  Sum[(data[[i, 1]] - Mean[data][[1]])^2, {i, 1, 9}]
a = Mean[data][[2]] - b * Mean[data][[1]]
```

```
0.159803
```

```
2.27012
```

```
LinearModelFit[data, x, x]
```

```
FittedModel[2.27012 + 0.159803 x]
```

```
data = Table[{data[[i, 1]], data[[i, 2]], a + b * data[[i, 1]]}, {i, 1, 9}];
TableForm[data]
Mean[data]
```

```
0.241    0.39     2.30863
0.615    0.72     2.3684
1        1        2.42992
1.88     1.52     2.57055
11.8     5.2      4.15579
29.5     9.54     6.9843
84       19.18    15.6936
165      30.06    28.6376
248      39.44    41.9012
```

```
{60.2262, 11.8944, 11.8944}
```

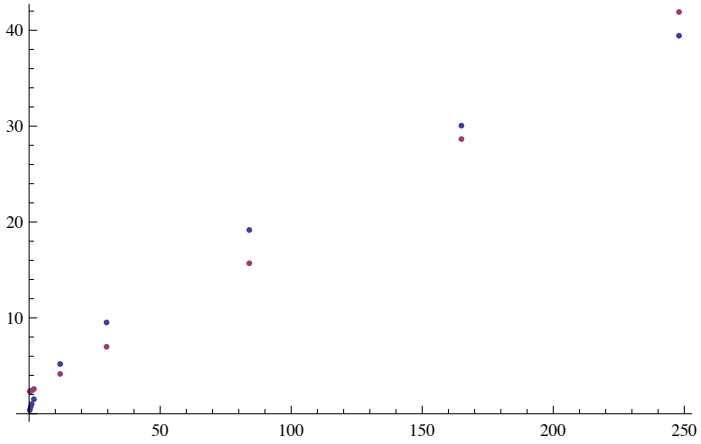
```
rSquared = 1 - Sum[(data[[i, 3]] - data[[i, 2]])^2, {i, 1, 9}] /
   Sum[(Mean[data][[2]] - data[[i, 2]])^2, {i, 1, 9}]
Sum[(data[[i, 3]] - data[[i, 2]])^2, {i, 1, 9}]
Sum[(Mean[data][[2]] - data[[i, 2]])^2, {i, 1, 9}]
```

```
0.977678
```

```
37.4048
```

```
1675.72
```

```
ListPlot[
 {Transpose[Drop[Transpose[data], {3}]],
  Transpose[Drop[Transpose[data], {2}]]}]
```




```
ListLinePlot[
 {Transpose[Drop[Transpose[data], {3}]],
  Transpose[Drop[Transpose[data], {2}]]}]
```