stat200 2-10-09

A number of statistical routines are programmed into this Mathematica notebook file. To run them you must boot the notebook from a university lab by

a. navigating to www.stt.msu.edu/~lepage
b. clicking on the (folder) STT200
c. clicking on the (program) stat200 2-10-09 (stat200 2-10-09 will launch)
d. **clicking on the 1+1 line just below**
e. **performing SHIFT+ENTER.**
f. **responding YES to the pop-up (evaluates cells).**

```
1 + 1

2
```

A partial list of the commands in this notebook and what they do.

median[{4.5, 7.1, 7.8, 9.1}] returns the median of {4.5, 7.1, 7.8, 9.1}
qtile[{4.5, 7.1, 7.8, 9.1}, 0.7] returns the 70th percentile of {4.5, 7.1, 7.8, 9.1}
iqr[{4.5, 7.1, 7.8, 9.1}] returns the inter-quartile range of {4.5, 7.1, 7.8, 9.1}
boxplot[{4.5, 7.1, 7.8, 9.1}] returns a boxplot of {4.5, 7.1, 7.8, 9.1} except without whiskers but with fences.
size[{4.5, 7.1, 7.8, 9.1}] returns 4
mean[{4.5, 7.1, 7.8, 9.1}] returns the simple (i.e. equally weighted) mean 7.125
avg[{4.5, 7.1, 7.8, 9.1}] also returns the simple (i.e. equally weighted) mean 7.125
mean[{4.5, 7.1}, {2, 5}] returns the {2/7, 5/7} weighted mean 6.357 of {4.5, 7.1}
avg[{4.5, 7.1}, {2, 5}] also returns the {2/7, 5/7} weighted mean 6.357 of {4.5, 7.1}
median[{4.5, 7.1, 7.8, 9.1}] returns the median of the list {4.5, 7.1, 7.8, 9.1}
s[{4.5, 7.1, 7.8, 9.1}] returns the sample standard deviation s = 1.93628
sd[{4.5, 7.1, 7.8, 9.1}] returns the n-divisor version of standard deviation $\hat{\sigma} = 1.67686$
r[x, y] returns the sample correlation $r = \dfrac{\overline{xy} - \bar{x}\,\bar{y}}{\sqrt{\overline{x^2}-\bar{x}^2}\,\sqrt{\overline{y^2}-\bar{y}^2}}$ for paired data.

regrtable[x,y] returns a table illustrating calculations of $\bar{x}$, $\bar{y}$, $\overline{x^2}$, $\overline{y^2}$, $\overline{xy}$.

regrstats[x, y] returns $\bar{x}$, $\bar{y}$, s_x, s_y, r, and the slope of the regression line = $r\,\dfrac{s_y}{s_x} = r\,\dfrac{\hat{\sigma}_y}{\hat{\sigma}_x}$.
regrplot[x,y] returns the plot of (x, y) pairs overlaid with the regression line.
sample[{4.5, 7.1, 7.8, 9.1}, 10] returns 10 samples from `{4.5, 7.1, 7.8, 9.1}`
ci[{4.5, 7.1, 7.8, 9.1}, 1.96] returns a 1.96 coefficient CI for the mean from given data
bootci[mean, {4.5, 7.1, 7.8, 9.1}, 10000, 0.95] returns 0.95 bootstrap ci for pop mean
smooth[{4.5, 7.1, 7.8, 9.1}, 0.2] returns the density for data at bandwidth 0.2
smooth2[{4.5, 7.1, 7.8, 9.1}, 0.2] returns the density for data at bandwidth 0.2
    overlaid with normal densities having sd = 0.2 around each data value
smoothdistribution[{{1, 700},{4 ,300}}, 0.2] returns the density at bandwidth 0.2
    for a list consisting of 700 ones and 300 fours.
popSALES is a file of 4000 sales-amounts (used for examples)

Entering **popSALES** will spill 4000 numbers onto the screen.

To prevent that enter **popSALES;** (append semi-colon to suppress output).

betahat0[list x, list y] returns the least squares intercept and slope for a straight line fit of the model $y = b_0 + b_1 x + \epsilon$.

betahat[matrix x, list y] returns the least squares coefficients $\hat{\beta}$ for a fit of the matrix model $y = x\,\beta + \epsilon$.

resid0[list x, list y] returns the estimated errors $\hat{\epsilon} = y - x\hat{\beta}$ (see **betahat0** above).

resid[matrix x, list y] returns the estimated errors $\hat{\epsilon} = y - x\hat{\beta}$ (see **betahat** above).

R[matrix x, list y] returns the **multiple correlation** R between the fitted values $x\hat{\beta}$ and data y. in the matrix model setup.
xquad[matrix x] returns the full quadratic extension of a design matrix with constant term
xcross[matrix x] returns the extension of x to include all products of differing columns.

betahatCOV[x matrix, list y] returns the estimated covariance matrix of the vector $\hat{\beta}$ in the matrix model setup.
normalprobabilitplot[list, 0.02] returns the normal probability plot of the list using plotting-dot size 0.02.

By clicking on any of the examples below you can execute it afresh by performing SHIFT+ENTER. Or click anywhere between lines, or at the end of the file, to make a fresh line and type your own examples.

Defining data to *Mathematica*, Exercise 33, page 190.

```
calories = {472, 498, 465, 456, 423, 437, 508,
   431, 479, 454, 450, 410, 504, 437, 489, 436, 480, 439, 444, 408}
```

```
{472, 498, 465, 456, 423, 437, 508, 431, 479,
 454, 450, 410, 504, 437, 489, 436, 480, 439, 444, 408}
```

```
Length[calories]
```

```
20
```

```
time = {21.4, 30.8, 37.7, 33.5, 32.8, 39.5, 22.8, 34.1,
   33.9, 43.8, 42.4, 43.1, 29.2, 31.3, 28.6, 32.9, 30.6, 35.1, 33.0, 43.7}
```

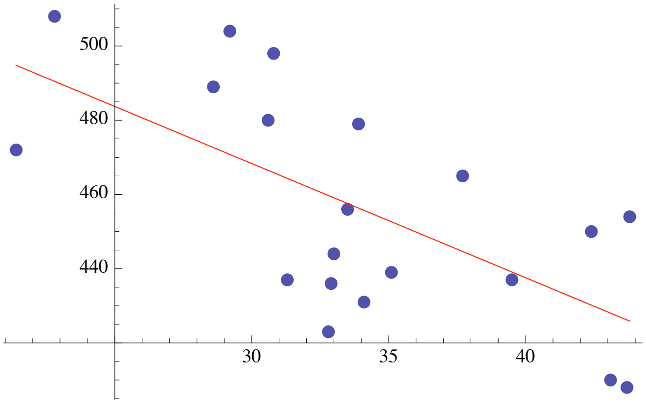
```
{21.4, 30.8, 37.7, 33.5, 32.8, 39.5, 22.8, 34.1, 33.9,
 43.8, 42.4, 43.1, 29.2, 31.3, 28.6, 32.9, 30.6, 35.1, 33., 43.7}
```

```
Length[time]
```

```
20
```

- **Plotting (x, y) data and the regression line for data already defined to Mathematica.**

```
regrplot[time, calories]
```



- **Calculating regression statistics $\bar{x}$, $\bar{y}$, s_x, s_y, r, $r\frac{s_y}{s_x,}$.**

```
regrstats[time, calories]
```

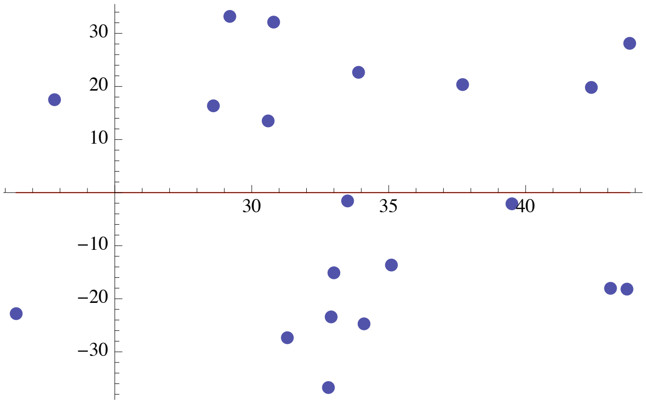
```
{34.01, 456., 6.31647, 29.9403, -0.649167, -3.07707}
```

- **Calculating the intercept $\bar{y} - \bar{x}\, r\, \frac{s_y}{s_x,}$ of the regression line (it is off the plot).**

```
456 - 34.01 (-3.07707)
```

```
560.651
```

```
regrplot[time, resid0[time, calories]]
```



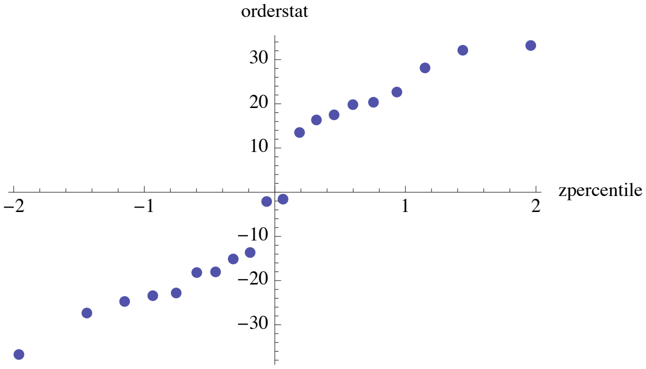
- **Calculating the fraction of $\hat{\sigma}_y^2$ explained by regression of y = calories on x = time.**

```
r[time, calories]^2
```

```
0.421417
```

- **Normal probability plot of residuals with plotting-dot size 0.02.**

```
normalprobabilityplot[resid0[time, calories], 0.02]
```



- **Table illustrating calculations of $\overline{x}$, $\overline{y}$, $\overline{x^2}$, $\overline{y^2}$, $\overline{xy}$.**

In[658]:= `regrtable[time, calories]`

Out[658]//MatrixForm=

```
  x      y      x²        y²        xy
 21.4   472   457.96   222 784   10 100.8
 30.8   498   948.64   248 004   15 338.4
 37.7   465   1421.29  216 225   17 530.5
 33.5   456   1122.25  207 936   15 276.
 32.8   423   1075.84  178 929   13 874.4
 39.5   437   1560.25  190 969   17 261.5
 22.8   508   519.84   258 064   11 582.4
 34.1   431   1162.81  185 761   14 697.1
 33.9   479   1149.21  229 441   16 238.1
 43.8   454   1918.44  206 116   19 885.2
 42.4   450   1797.76  202 500   19 080.
 43.1   410   1857.61  168 100   17 671.
 29.2   504   852.64   254 016   14 716.8
 31.3   437   979.69   190 969   13 678.1
 28.6   489   817.96   239 121   13 985.4
 32.9   436   1082.41  190 096   14 344.4
 30.6   480   936.36   230 400   14 688.
 35.1   439   1232.01  192 721   15 408.9
 33.    444   1089.    197 136   14 652.
 43.7   408   1909.69  166 464   17 829.6
  —      —       —         —         —
34.01   456.  1194.58  208 788.  15 391.9
```

- **Computing correlation r =** $\dfrac{\overline{xy} - \overline{x}\,\overline{y}}{\sqrt{\overline{x^2} - \overline{x}^2}\,\sqrt{\overline{y^2} - \overline{y}^2}}$ **(slight errors due to rounding in the above).**

In[659]:=

$$\frac{15\,391.9 - 34.01 \times 456}{\sqrt{1194.58 - 34.01^2}\,\sqrt{208\,788 - 456^2}}$$

Out[659]= `-0.649207`