STATA FOR ONE-WAY ANALYSIS OF VARIANCE
GPA BY SEAT LOCATION EXAMPLE

There are 384 students in the dataset. Y = GPA and there is one categorical variable, “seat” which is a response to the question “Where do you typically sit in a classroom – in the front, middle or back?” We want to know if population mean GPA differs for students who typically sit in the 3 classroom locations.

For one-way ANOVA, you can use the special command “oneway” or you can use the more general command “anova.” Both are illustrated below. If the categorical variable is a “string” variable (i.e. not numerical), before you use the “anova” command, you need to “encode” it to give integer values to the categories. In this example, the “seat” variable was recorded as strings, like “3_Back.” So we need to:

```
encode seat, generate(location)
```

Let’s see what happened, by listing the first few rows of data:

```
list seat gpa location in 1/3
     +----------------------------+
     |     seat    gpa   location |
     |----------------------------|
  1. | 2_Middle    2.6   2_Middle |
  2. | 2_Middle    2.7   2_Middle |
  3. |  1_Front      3    1_Front |
     +----------------------------+
```

Notice that Stata kept the labels when it created the variable “location” so it’s hard to see that it’s numerical. We can list the variables without the labels attached, which makes it clearer:

```
list seat gpa location in 1/3, nolabel
     +----------------------------+
     |     seat    gpa   location |
     |----------------------------|
  1. | 2_Middle    2.6          2 |
  2. | 2_Middle    2.7          2 |
  3. |  1_Front      3          1 |
     +----------------------------+
```

We can use either “seat” or “location” with the oneway command, but we can use only “location” with the anova command. Here are the results (using “oneway gpa location” would be identical):

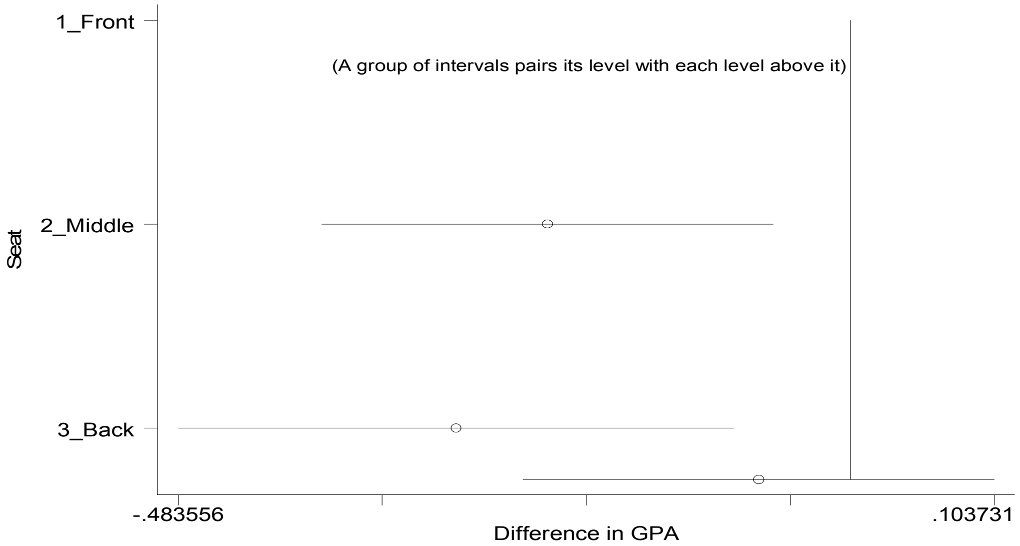
```
oneway gpa seat
                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      3.99726251      2   1.99863125      6.69     0.0014
 Within groups      113.777936    381   .298629753
------------------------------------------------------------------------
    Total           117.775198    383   .307507046

Bartlett's test for equal variances:  chi2(2) =   0.8641  Prob>chi2 = 0.649
```

Notice the difference between the names given for the “Sources” for the oneway command (above) and the anova command (below).

```
anova gpa location
                           Number of obs =     384     R-squared     =  0.0339
                           Root MSE      =  .54647     Adj R-squared =  0.0289

                  Source |  Partial SS    df       MS           F     Prob > F
              -----------+----------------------------------------------------
                   Model |  3.99726251     2  1.99863125       6.69     0.0014
                location |  3.99726251     2  1.99863125       6.69     0.0014
                Residual |  113.777936   381  .298629753
              -----------+----------------------------------------------------
                   Total |  117.775198   383  .307507046
```

Next, we would like to use the Tukey method to find out which population means are significantly different. Stata doesn’t do this automatically, but we can install the “prcomp” software:

```
findit prcomp
prcomp gpa location, tukey order(m) graph xlin(0)

                   Pairwise Comparisons of Means
Response variable (Y): gpa        GPA
Group variable (X):    location    Seat

 Group variable (X): location       Response variable (Y): gpa
-------------------------------    -------------------------------
      Level         Label                n         Mean         S.E.
------------------------------------------------------------------
          1       1_Front               88     3.202955     .0585445
          2      2_Middle              218     2.985275     .0377666
          3        3_Back               78     2.919359     .0577982
------------------------------------------------------------------

Simultaneous confidence level: 95%    (Tukey wsd method)
Homogeneous error SD = .5464703, degrees of freedom = 381

                                                                   95%
Level(X)    Mean(Y)    Level(X)    Mean(Y)      Diff Mean     Confidence Limits
-------------------------------------------------------------------------------
2_Middle   2.985275    1_Front   3.202955      -.2176793   -.3800729  -.0552858

  3_Back   2.919359    1_Front   3.202955      -.2835956   -.4835555  -.0836356
                      2_Middle   2.985275      -.0659162   -.2355639   .1037314
-------------------------------------------------------------------------------
```



Stata will also provide output similar to regression output, with the following command:

```
anova gpa location, regress

      Source |       SS       df       MS              Number of obs =     384
-------------+------------------------------           F(  2,   381) =    6.69
       Model |  3.99726251     2  1.99863125           Prob > F      =  0.0014
    Residual |  113.777936   381  .298629753           R-squared     =  0.0339
-------------+------------------------------           Adj R-squared =  0.0289
       Total |  117.775198   383  .307507046           Root MSE      =  .54647

------------------------------------------------------------------------------
         gpa        Coef.   Std. Err.       t     P>|t|     [95% Conf. Interval]
------------------------------------------------------------------------------
_cons            2.919359   .0618756    47.18   0.000     2.797699    3.041019
location
           1     .2835956    .084983     3.34   0.001     .1165012    .4506899
           2     .0659162   .0721003     0.91   0.361     -.075848    .2076805
           3    (dropped)
------------------------------------------------------------------------------
```

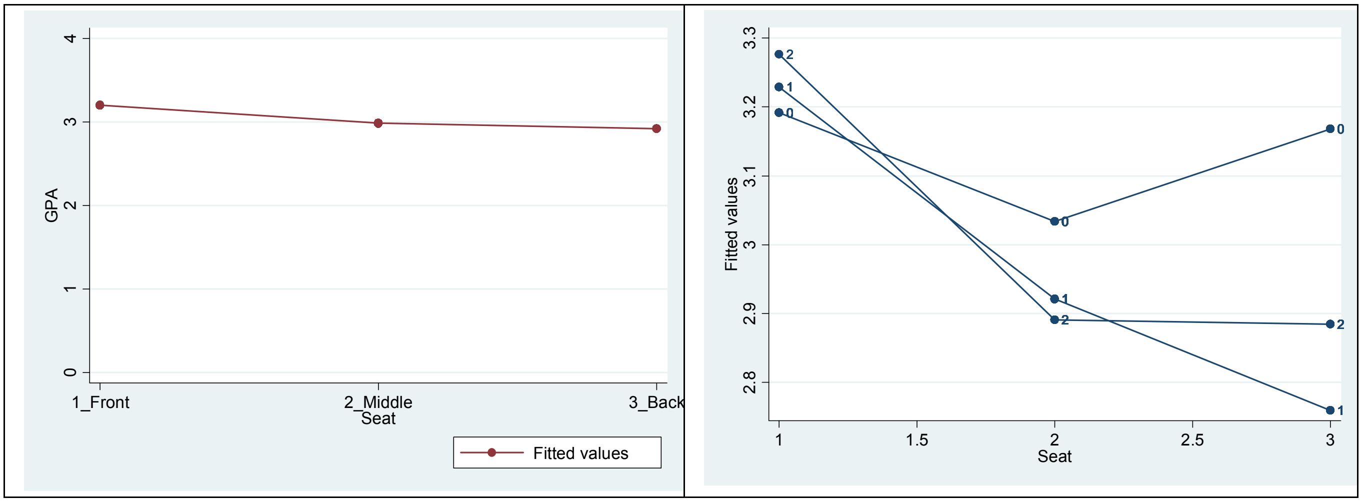
Notice that it has made the 3rd category ("back") the reference, and the coefficients for locations 1 and 2 are the additional terms needed to get the average GPA for those two locations. The test of interest is the overall F test, F* = 6.69. That's the test of whether anything other than the constant is needed.

CELL MEANS PLOT

Especially with two factor ANOVA and higher, it's useful to plot the "cell means." Again you need to install software:

```
findit anovaplot
anovaplot, scatter(ms(i))
```

This command follows the anova command, so Stata knows what variables you want to plot. Including "scatter(ms(i))" eliminates the actual data, and just plots the means. This will be more important for two-factor ANOVA when looking for interactions. The right hand side shows an example of a cell means plot with interactions, to be discussed next.


GPA
1_Front
2_Middle
3_Back
Seat
Fitted values
Fitted values
Seat