

TI-83/83 Plus: Comparing Three or More Population Means: Analysis of Variance (ANOVA)

The following pages contain some instructions on the usage of the TI-83/83 Plus graphing calculator.

The examples used below are taken out of David Moore's text titled "The Basic Practice of Statistics, 2nd Edition".

Example#10.6 and 10.7 on pages 513 and 519: To detect the presence of harmful insects in farm fields, the boards covered with a sticky material are put up and the insects that are trapped on the boards are examined. Which colors attract insects best? Experimenters placed six boards of each of four colors at random locations in a field of oats and measured the number of cereal leaf beetles trapped. Here are the data:

Board Color	Insects Trapped					
Blue	16	11	20	21	14	7
Green	37	32	20	29	37	32
White	21	12	14	17	13	20
Yellow	45	59	48	46	38	47

We would like to use ANOVA to compare the mean numbers of beetles that would be trapped by all boards of each color.

The data set for each color is entered into the TI-83 or 83 Plus by using the STAT menu, which is accessed by pressing [STAT]. Press [ENTER] to select **1:Edit** from the STAT EDIT menu. At this point, your screen will display all the list names and their contents stored in memory. Press [▲] to move the cursor to the top line where the list names are located and then press [▶] until you reach the unnamed column. The cursor is in alpha mode as it is indicated by the highlighted capital A in the upper right hand corner of your display. Type in the name BLUE for the color Blue. Press [ENTER] to store the list name. Press [▼] to begin entering the data set. Start typing in the number of insects trapped from the color Blue data set, pressing [ENTER] after each data point. When you have finished entering the last data point for the color Blue, your screen should look like the screen on the left below.

HT	HS	BLUE 1B
118	124	16
126	98	11
126	110	20
120	140	21
129	110	14
-----	-----	7
BLUE(?) =		

HS	BLUE	GREEN 19
124	16	37
98	11	32
110	20	20
140	21	29
110	14	37
-----	7	32
GREEN(?) =		

Press [STAT]. Press [ENTER] to select **1:Edit** from the STAT EDIT menu. Press [▲] to move the cursor to the top line where the list names are located and then press [▶] until you reach the unnamed column. Type in the name GREEN for the color Green. Press [ENTER] to store the list name. Press [▼] to begin entering the data set. Start typing in the number of insects trapped from the color Green data set, pressing [ENTER] after each data point. When you have finished entering the last data point for the color Green, your screen should look like the screen on the right above.

Press **[STAT]**. Press **[ENTER]** to select **1:Edit** from the STAT EDIT menu. Press **[▲]** to move the cursor to the top line where the list names are located and then press **[▶]** until you reach the unnamed column. Type in the name **WHITE** for the color White. Press **[ENTER]** to store the list name. Press **[▼]** to begin entering the data set. Start typing in the number of insects trapped from the color White data set, pressing **[ENTER]** after each data point. When you have finished entering the last data point for the color White, your screen should look like the screen on the left below.

BLUE	GREEN	WHITE 20
16	37	21
11	32	12
20	20	14
21	29	17
14	37	13
7	32	20
-----	-----	-----
WHITE(?) =		

GREEN	WHITE	YELLO 20
37	21	45
32	12	59
20	14	48
29	17	46
37	13	38
32	20	47
-----	-----	-----
YELLO(?) =		

Press **[STAT]**. Press **[ENTER]** to select **1:Edit** from the STAT EDIT menu. Press **[▲]** to move the cursor to the top line where the list names are located and then press **[▶]** until you reach the unnamed column. Type in the name **YELLO** for the color Yellow. Press **[ENTER]** to store the list name. Press **[▼]** to begin entering the data set. Start typing in the number of insects trapped from the color Yellow data set, pressing **[ENTER]** after each data point. When you have finished entering the last data point for the color Yellow, your screen should look like the screen on the right above.

To do the ANOVA test comparing the board colors, press **[STAT]**. Press **[▶]** two times to scroll right to the TESTS menu option. Press **[▼]** several times to move the cursor down to **F:ANOVA(**. At this point, your screen should look like the screen on the left given below. Press **[ENTER]** to select **F:ANOVA(** from the STAT TESTS menu screen and paste it onto the Home screen. At this point, your screen should look like the screen in the middle given below with the cursor blinking by the left parenthesis.

EDIT CALC	LISTS
0:12-SamFTInt...	
A:1-PropZInt...	
B:2-PropZInt...	
C:χ ² -Test...	
D:2-SamFTTest...	
E:LinRegTTest...	
F:ANOVA(

ANOVA(

ANOVA(LBLUE, LGRE
EN, LWHITE, LYELLO
)

The **ANOVA(** command takes four arguments. These arguments are the names of the lists for each board color. These list names must be pasted, as they are separated by comas, in the order given above starting from the location of the blinking cursor on the Home screen. To accomplish this, the LIST menu is accessed by pressing **[2nd]** and **[STAT]**. Press **[▼]** till you move the cursor by the name **BLUE** and press **[ENTER]** to paste the list name **BLUE** by the **ANOVA(** command on the Home screen. Press **[,]**. Press **[2nd]** and **[STAT]** to access the LIST menu. Press **[▼]** till you move the cursor by the name **GREEN** and press **[ENTER]** to paste the list name **GREEN** by the coma on your screen. Press **[,]**. Press **[2nd]** and **[STAT]** to access the LIST menu. Press **[▼]** till you move the cursor by the name **WHITE** and press **[ENTER]** to paste the list name **WHITE** by the coma on your screen. Press **[,]**. Press **[2nd]** and **[STAT]** to access the LIST menu. Press **[▼]** till you move the cursor by the name **YELLO** and press **[ENTER]** to paste the list name **YELLO** by the coma on your screen. Press **[)]**. At this point, your screen should look like the screen on the right given above.

Press **[ENTER]**. Your calculated result screen should look like the screen on the left given below. Press **[↓]** several times to go all the way to the end of your calculated result screen. At this point your screen should look like the screen on the right given below.

```
One-way ANOVA
F=42.83937824
P=6.7976263E-9
Factor
df=3
SS=4134
↓ MS=1378
```

```
One-way ANOVA
↑ MS=1378
Error
df=20
SS=643.333333
MS=32.1666667
Sxp=5.67156651
```

The ANOVA F statistic is $F=42.839$. As it is indicated by the scientific notation, the P-value is very close to 0. Despite the small samples, the experiment gives very strong evidence of differences among the colors.

The degrees of freedom $df=4-1=3$ under the Factor heading indicates the degrees of freedom for the numerator of the F statistics. The degrees of freedom $df=24-4=20$ under the Error heading indicates the degrees of freedom for the denominator of the F statistics. The value $MS=1378$ under the Factor heading is the mean square for groups, which is abbreviated as MSG in your text. The value $MS=32.167$ under the Error heading is the mean square for error, which is abbreviated as MSE in your text. The last item displayed on your calculated result screen is the value $S_{xp}=\sqrt{MSE}=\sqrt{32.167}=5.672$, which is the pooled standard deviation and denoted by s_p .