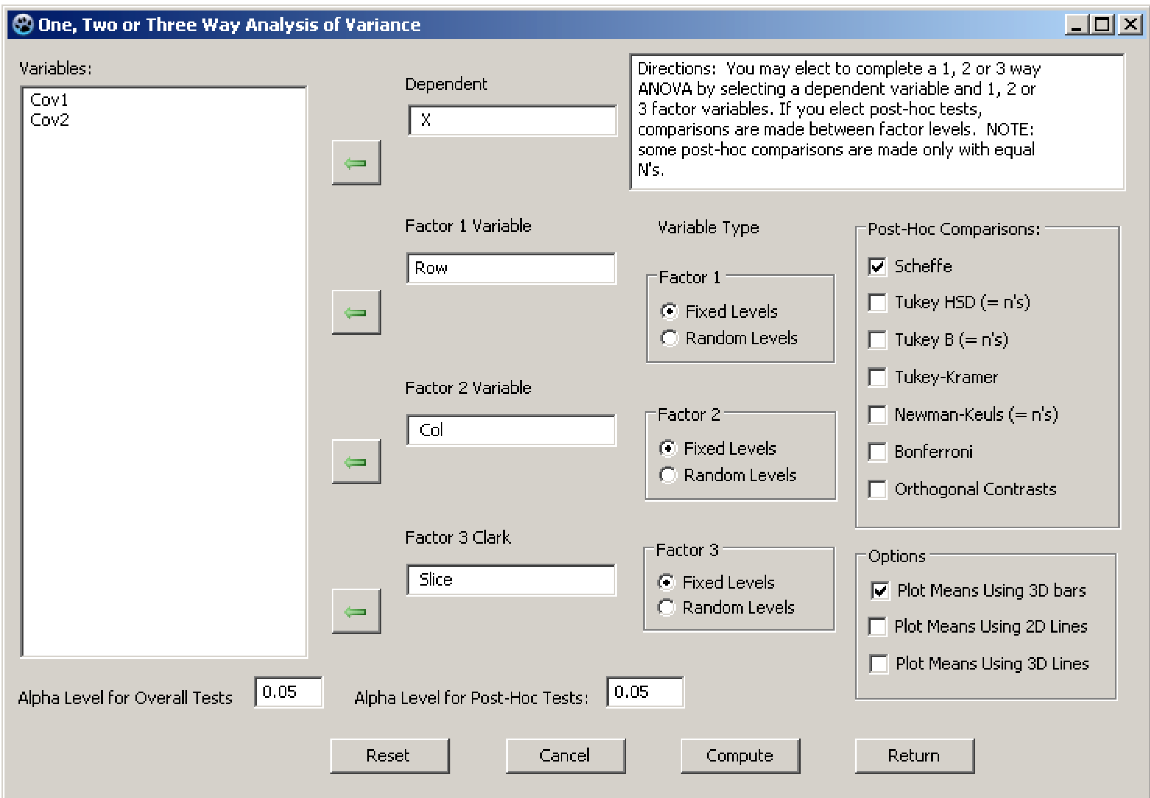
One, Two or Three Way Analyses of Variance

Analysis of Variance is one of the most commonly used methods for testing hypotheses of differences among means of samples collected from one or more populations. Typically there is a dependent variable and one to three "treatments" consisting of two or more "levels". To demonstrate this procedure, we will use a file labeled Anova2.LAZ. This file contains a dependent variable and three independent variables. The dependent variable X is a "floating point" type of variable. The three independent variables are row, column and slice and are coded as integer types of variables. We start our analysis by selecting this option and entering the variables to be analyzed. We will ignore the two "covariate" measures at this time.



Notice that each of the independent variables may be one of two types – fixed or random levels. We have also selected a "post-hoc" test as well as the option to plot means using three dimension bars. When we click the Compute button, we receive the output shown below.

Three Way Analysis of Variance

Variable analyzed: X

Factor A (rows) variable: Row (Fixed Levels)
Factor B (columns) variable: Col (Fixed Levels)
Factor C (slices) variable: Slice (Fixed Levels)

SOURCE	D.F.	SS	MS	F	PROB.> F	Omega Squared
Among Rows	1	12.250	12.250	12.250	0.002	0.083
Among Columns	1	42.250	42.250	42.250	0.000	0.304

Among Slices	2	6.500	3.250	3.250	0.056	0.033
A x B Inter.	1	12.250	12.250	12.250	0.002	0.083
A x C Inter.	2	6.500	3.250	3.250	0.056	0.033
B x C Inter.	2	6.500	3.250	3.250	0.056	0.033
AxBxC Inter.	2	24.500	12.250	12.250	0.000	0.166
Within Groups	24	24.000	1.000			
Total	35	134.750	3.850			

Omega squared for combined effects = 0.735

Note: MSErr denominator for all F ratios.

Descriptive Statistics

GROUP				N	MEAN	VARIANCE	STD.DEV.
Cell	1	1	1	3	2.000	1.000	1.000
Cell	1	1	2	3	3.000	1.000	1.000
Cell	1	1	3	3	4.000	1.000	1.000
Cell	1	2	1	3	5.000	1.000	1.000
Cell	1	2	2	3	4.000	1.000	1.000
Cell	1	2	3	3	3.000	1.000	1.000
Cell	2	1	1	3	2.000	1.000	1.000
Cell	2	1	2	3	5.000	1.000	1.000
Cell	2	1	3	3	2.000	1.000	1.000
Cell	2	2	1	3	5.000	1.000	1.000
Cell	2	2	2	3	6.000	1.000	1.000
Cell	2	2	3	3	8.000	1.000	1.000
Row	1			18	3.500	1.676	1.295
Row	2			18	4.667	5.529	2.351
Col	1			18	3.000	2.118	1.455
Col	2			18	5.167	3.324	1.823
Slice	1			12	3.500	3.182	1.784
Slice	2			12	4.500	2.091	1.446
Slice	3			12	4.250	6.386	2.527
TOTAL				36	4.083	3.850	1.962

TESTS FOR HOMOGENEITY OF VARIANCE

Hartley Fmax test statistic = 1.00 with deg.s freedom: 4 and 2.
Cochran C statistic = 0.08 with deg.s freedom: 4 and 2.
Bartlett Chi-square statistic = 0.00 with 3 D.F. Prob. larger = 1.000

COMPARISONS AMONG COLUMNS WITHIN EACH ROW

ROW 1 COMPARISONS

Scheffe contrasts among pairs of means.
alpha selected = 0.05

Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	1.00	1.22	2.093	NO

ROW 2 COMPARISONS

Scheffe contrasts among pairs of means.
alpha selected = 0.05

Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	-6.00	7.35	2.093	YES

COMPARISONS AMONG ROWS WITHIN EACH COLUMN

COLUMN 1 COMPARISONS

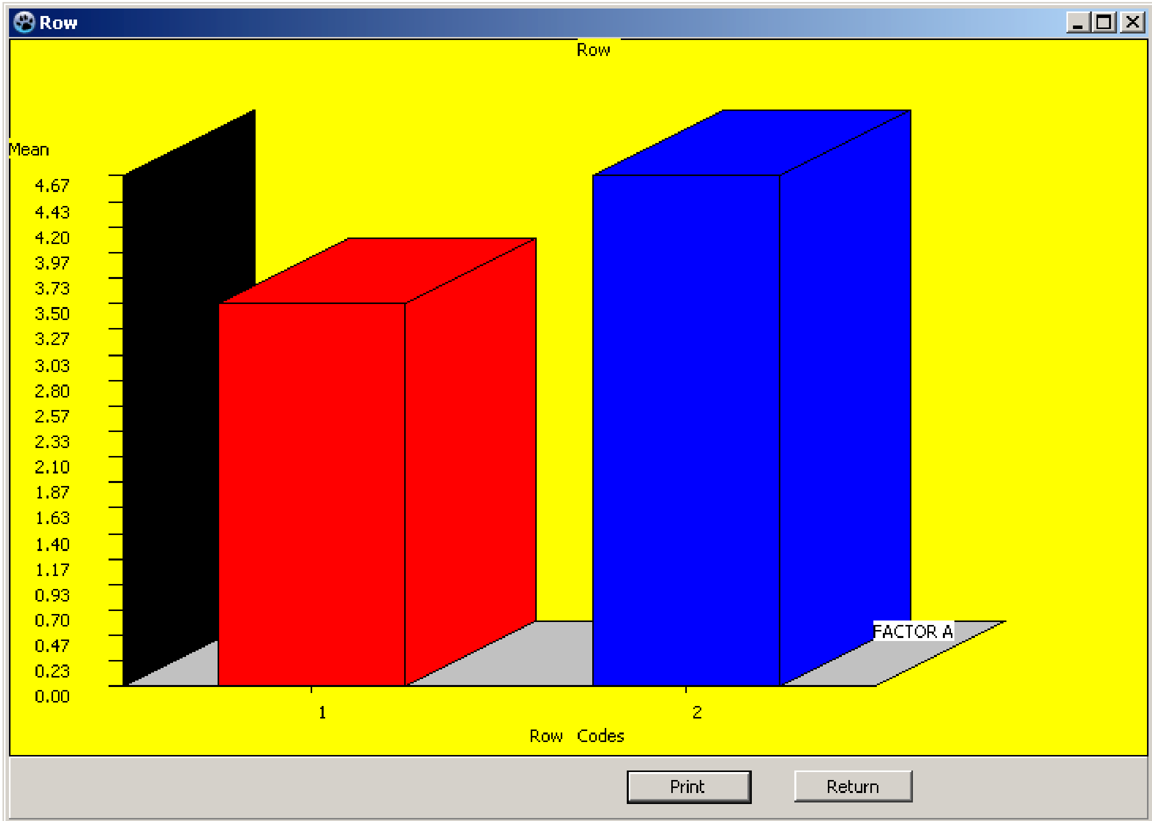
Scheffe contrasts among pairs of means.
alpha selected = 0.05

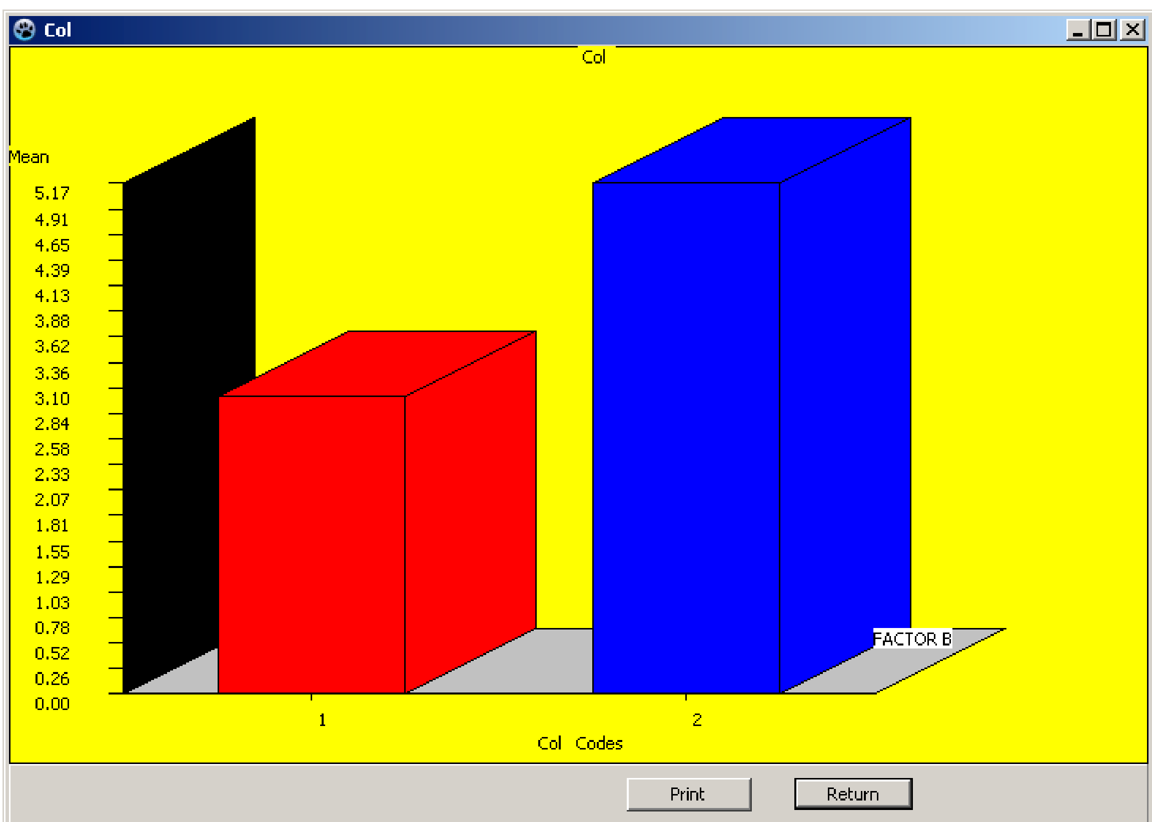
Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	2.00	2.45	2.093	YES

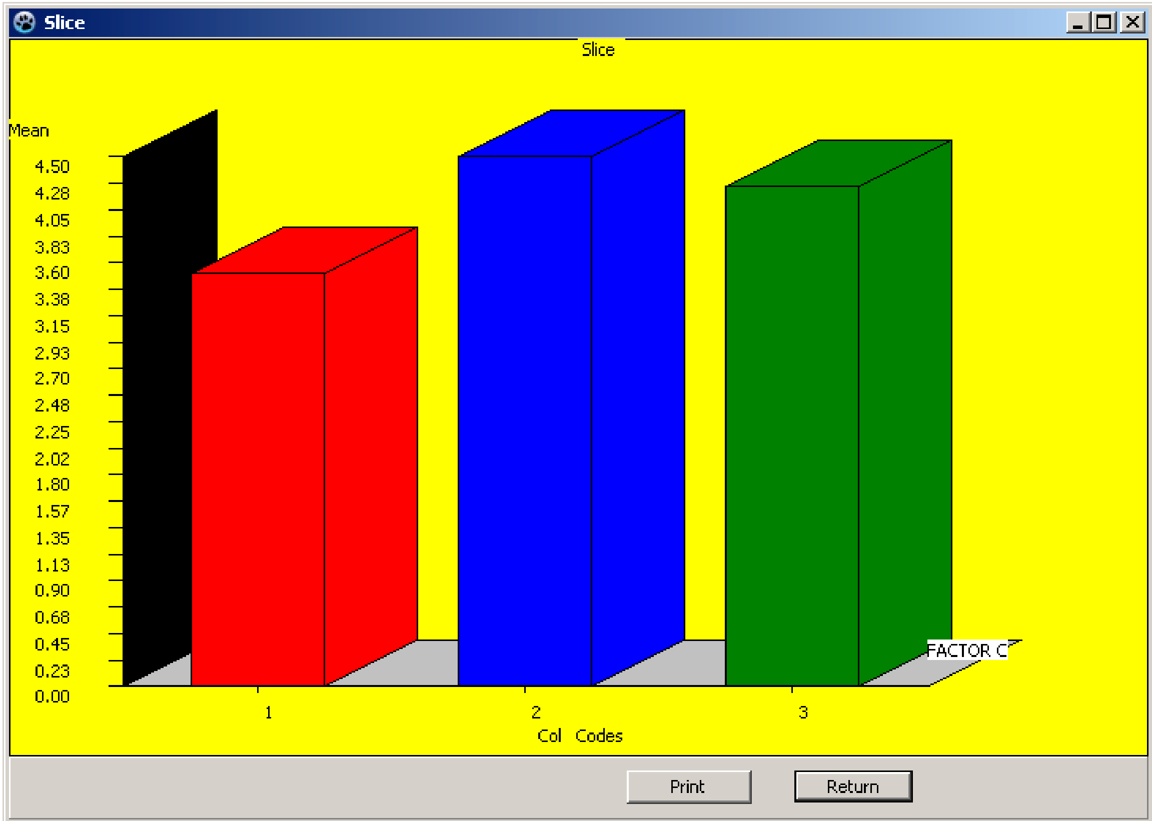
COLUMN 2 COMPARISONS

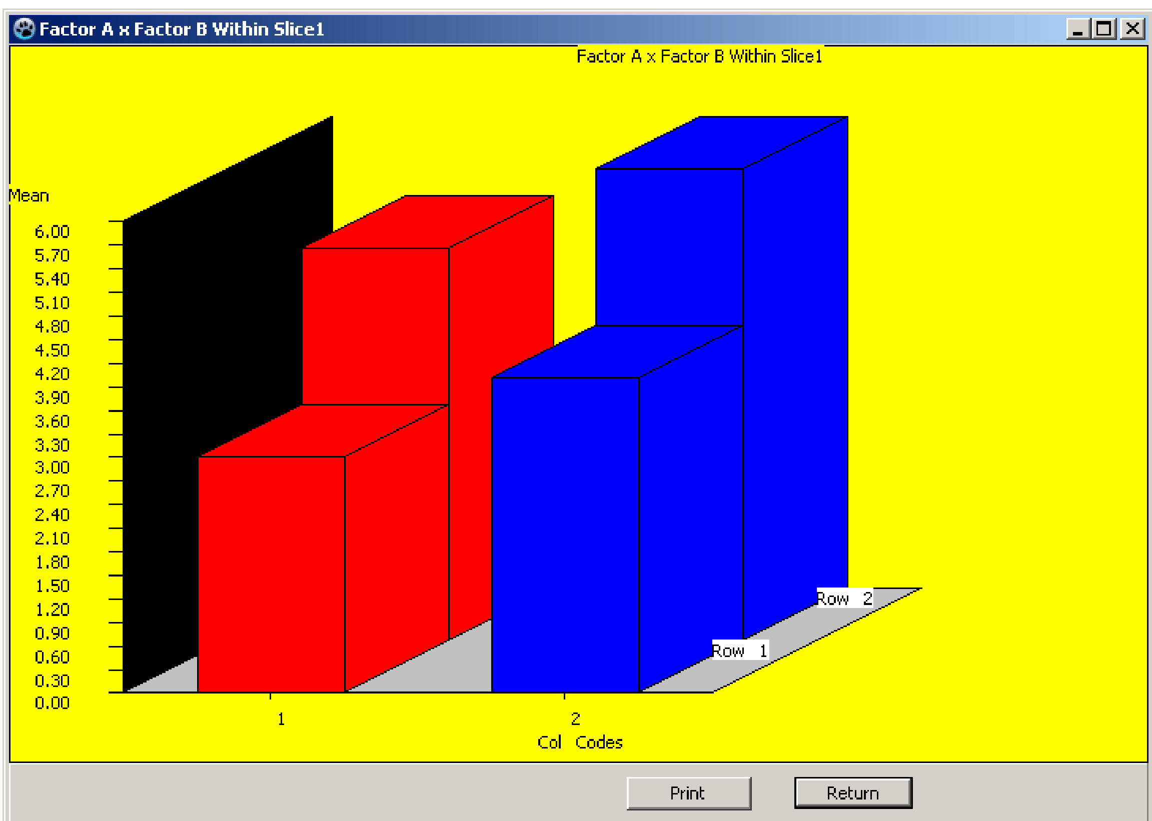
Scheffe contrasts among pairs of means.
alpha selected = 0.05

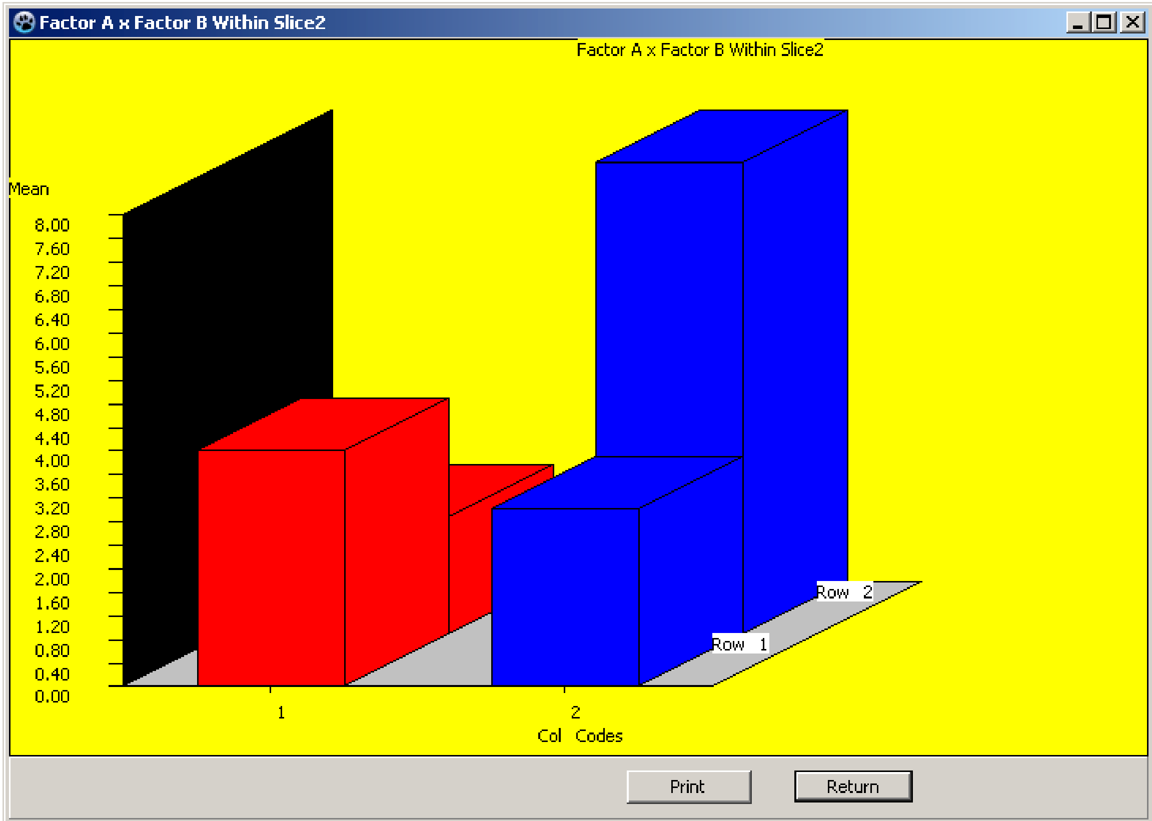
Group vs Group		Difference	Scheffe Statistic	Critical Value	Significant?
1	2	-5.00	6.12	2.093	YES


Row
Row
Mean
4.67
4.43
4.20
3.97
3.73
3.50
3.27
3.03
2.80
2.57
2.33
2.10
1.87
1.63
1.40
1.17
0.93
0.70
0.47
0.23
0.00
FACTOR A
1
2
Row Codes
Print
Return

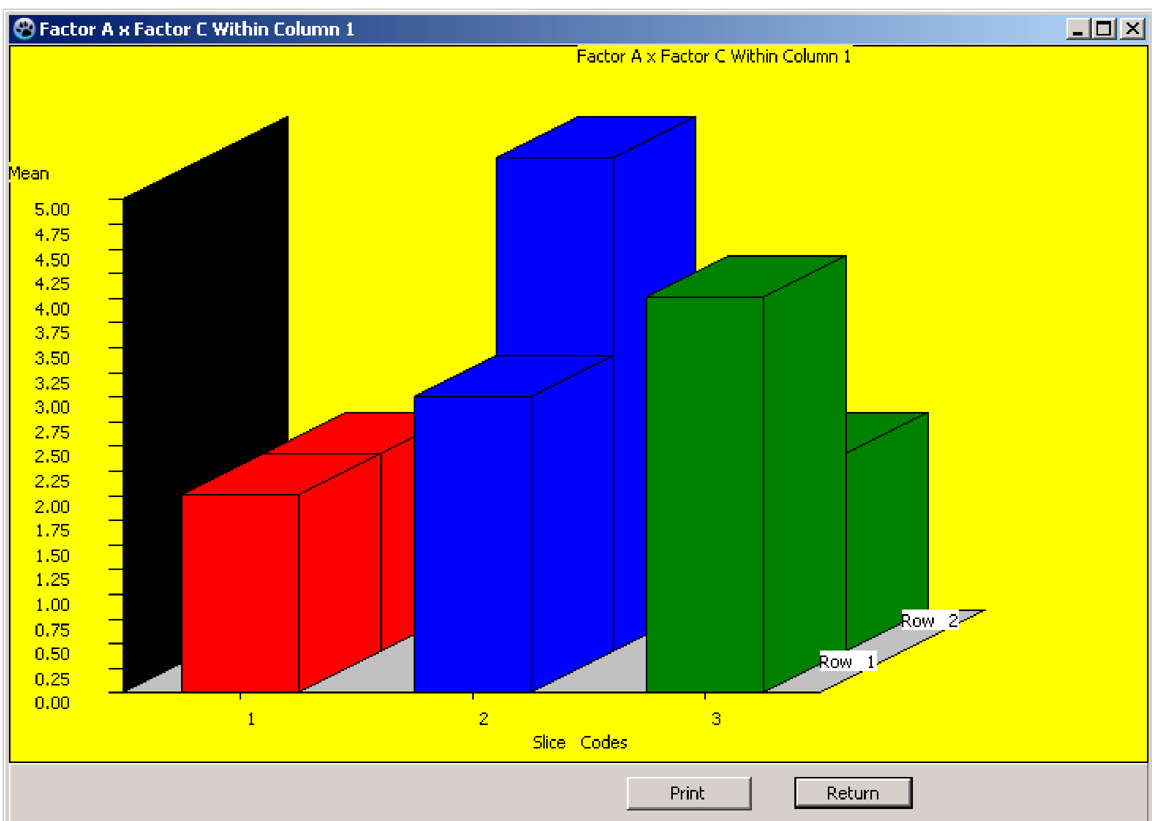

Col
Col
Mean
5.17
4.91
4.65
4.39
4.13
3.88
3.62
3.36
3.10
2.84
2.58
2.33
2.07
1.81
1.55
1.29
1.03
0.78
0.52
0.26
0.00
FACTOR B
1
2
Col Codes
Print
Return


Slice
Slice
Mean
4.50
4.28
4.05
3.83
3.60
3.38
3.15
2.93
2.70
2.48
2.25
2.02
1.80
1.57
1.35
1.13
0.90
0.68
0.45
0.23
0.00
FACTOR C
1
2
3
Col Codes
Print
Return

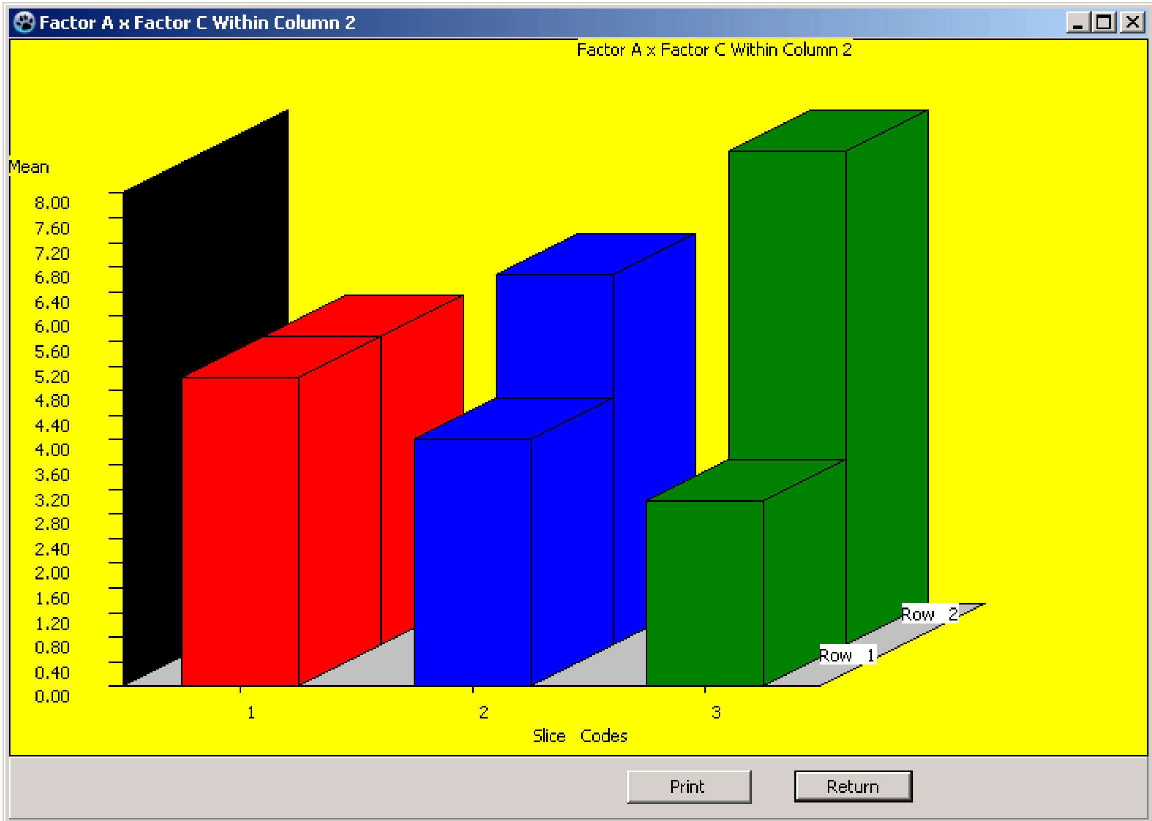

Factor A x Factor B Within Slice1
Factor A x Factor B Within Slice1
Mean
6.00
5.70
5.40
5.10
4.80
4.50
4.20
3.90
3.60
3.30
3.00
2.70
2.40
2.10
1.80
1.50
1.20
0.90
0.60
0.30
0.00
Row 2
Row 1
1
2
Col Codes
Print
Return



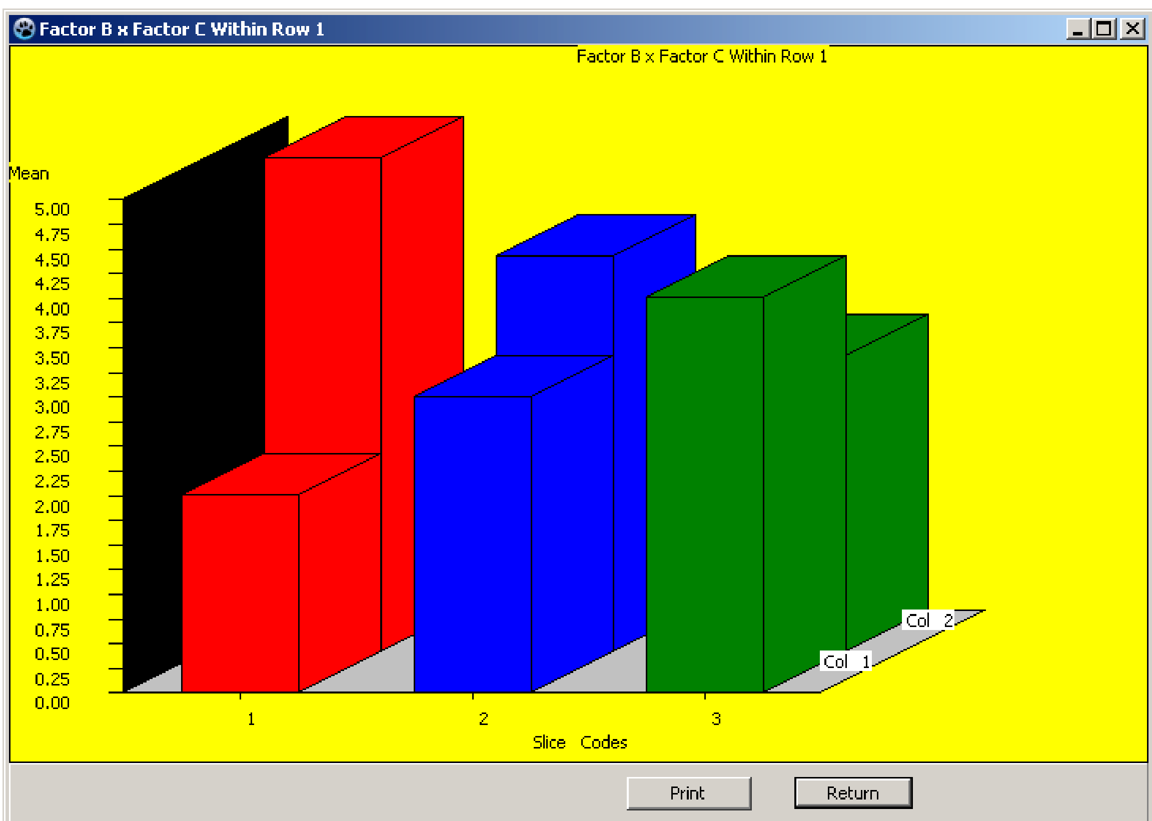
Factor A x Factor B Within Slice2
Factor A x Factor B Within Slice2
Mean
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
Row 2
Row 1
1
2
Col Codes
Print
Return



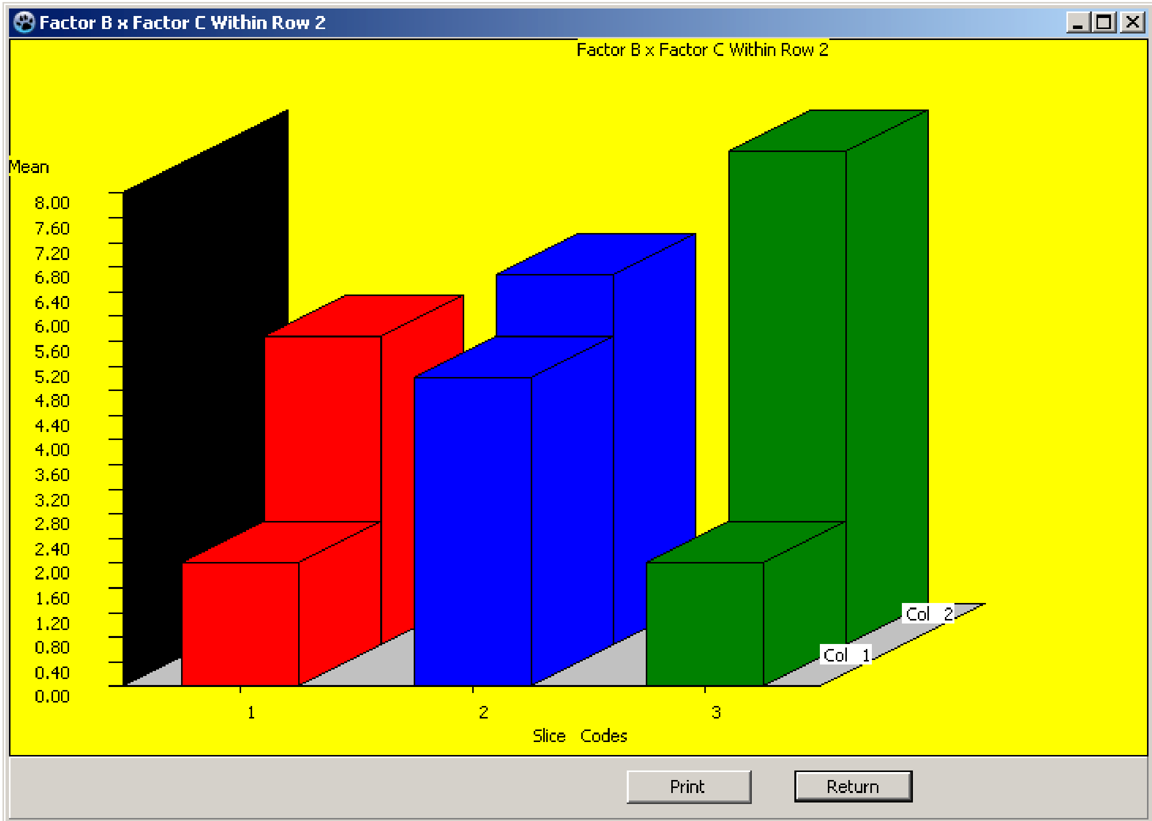
Factor A x Factor C Within Column 1
Factor A x Factor C Within Column 1
Mean
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Row 2
Row 1
1
2
3
Slice Codes
Print
Return



Factor A x Factor C Within Column 2
Factor A x Factor C Within Column 2
Mean
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
Row 2
Row 1
1
2
3
Slice Codes
Print
Return



Factor B x Factor C Within Row 1
Factor B x Factor C Within Row 1
Mean
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Col 2
Col 1
1
2
3
Slice Codes
Print
Return



Factor B x Factor C Within Row 2
Factor B x Factor C Within Row 2
Mean
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
1
2
3
Slice Codes
Col 2
Col 1
Print
Return