#Two-way ANOVA

Table

Gains in weight (grams) for rats under six diets differing in level of protein (High or Low) and s ource of protein (Beef, Cereal, or Pork)

Level of Protein	High Protein			Low protein		
Source of Protein	Beef	Cereal	Pork	Beef	Cereal	Pork
Diet	1	2	3	4	5	6
	73	98	94	90	107	49
	102	74	79	76	95	82
	118	56	96	90	97	73
	104	111	98	64	80	86
	81	95	102	86	98	81
	107	88	102	51	74	97
	100	82	108	72	74	106
	87	77	91	90	67	70
	117	86	120	95	89	61
	111	92	105	78	58	82
Mean	100.0	85.9	99.5	79.2	83.9	78.7
Std. Dev.	15.14	15.02	10.92	13.89	15.71	16.55

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```
Data twoway;
Input Protein $ Source $ weight_gain;
Datalines;
High    Beef    73
High    Beef    102
High    Beef    118
High    Beef    104
High    Beef    81
High    Beef    107
High    Beef    100
High    Beef    87
High    Beef    117
High    Beef    111
High    Cereal  98
High    Cereal  74
High    Cereal  56
High    Cereal  111
```

High	Cereal	95
High	Cereal	88
High	Cereal	82
High	Cereal	77
High	Cereal	86
High	Cereal	92
High	Pork	94
High	Pork	79
High	Pork	96
High	Pork	98
High	Pork	102
High	Pork	102
High	Pork	108
High	Pork	91
High	Pork	120
High	Pork	105
Low	Beef	90
Low	Beef	76
Low	Beef	90
Low	Beef	64
Low	Beef	86
Low	Beef	51
Low	Beef	72
Low	Beef	90
Low	Beef	95
Low	Beef	78
Low	Cereal	107
Low	Cereal	95
Low	Cereal	97
Low	Cereal	80
Low	Cereal	98
Low	Cereal	74
Low	Cereal	74
Low	Cereal	67
Low	Cereal	89
Low	Cereal	58
Low	Pork	49
Low	Pork	82
Low	Pork	73
Low	Pork	86
Low	Pork	81
Low	Pork	97
Low	Pork	106

```
Low     Pork    70
Low     Pork    61
Low     Pork    82
;
Run;
proc anova data=twoway;
class Protein Source;
model weight_gain=Protein Source Protein*Source;
run;
quit;
```

SAS Code for two-way ANOVA

To test our hypotheses, we use the following code in SAS:

```
PROC ANOVA DATA = twoway;
  class Protein Source;
  model weight_gain = Protein Source
  Protein*Source;
RUN;
QUIT;
```

- "class" tells SAS the two classification variables, which are generally going to be the effects that you are studying. In this case, the effects are "Protein" and "Source"
- "model" tells SAS the dependent variable. The general format is "model Y = X1 X2 X1*X2" where Y is the dependent variable, X1 and X2 are independent variables. X1*X2 means the interaction of X1 and X2.
- Often a "quit" statement is necessary, because SAS may continue to run a procedure until either another one has been run, or SAS has been told to quit.

SAS Output

The ANOVA Procedure

Class Level Information

Class	Levels	Values
Protein	2	High Low
Source	3	Beef Cereal Pork

Number of Observations Read	60
Number of Observations Used	60

The ANOVA Procedure

Dependent Variable: weight_gain

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	4612.93333	922.58667	4.30	0.0023
Error	54	11586.00000	214.55556		
Corrected Total	59	16198.93333			

R-Square	Coeff Var	Root MSE	weight_gain Mean
0.284768	16.67039	14.64772	87.86667

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Protein	1	3168.266667	3168.266667	14.77	0.0003
Source	2	266.533333	133.266667	0.62	0.5411
Protein*Source	2	1178.133333	589.066667	2.75	0.0732