Power calculations in SAS

PROC Power

PROC GLMPower

PROC Mixed

Simulations (Data Step)

Syntax (a peek at things to come)

1)The Power and Sample Size Application

2)

```
PROC POWER< just print options>;
LOGISTIC<options>;
MULTREG<options>;
ONECORR<options>;
ONESAMPLEFREQ<options>;
ONESAMPLEMEANS<options>;
ONEWAYANOVA <options>;
PAIREDFREQ<options>;
PAIREDMEANS<options>;
TWOSAMPLEFREQ<options>;
TWOSAMPLEMEANS<options>;
TWOSAMPLESURVIVAL<options>;
TWOSAMPLEWILCOXON<options>;

PLOT<plot-options> </ graph-options>;
Run;
```

3) First, you create the exemplary data set to specify means and weights;

```
Data Exemplary;
Input datalines;
input Pressure $ Fluid $ Y_bar  CellWt;
datalines;
High Water 36.9 4
High EZD1 35.0 2
Low Water 34.3 6
Low EZD1 32.4 3 ;  Run;
```

```
PROC GLMPOWER data=exemplary
options > ;
BY variables ;
CLASS variables ;
CONTRAST 'label' effect values
< . . . effect values > < / options > ;
MODEL   dependents = independents ;
PLOT < plot-options >< / graph-options > ;
POWER < options > ;
Run;
```

4)Simulations

How to save typing when asking for multiple analysis

Keyword-Lists: Keywords separated by spaces e.g. SIDES = 2 U

Number-Lists: Can be TWO things

1) Valued: NTOTAL = 30 50 70 100

or NTOTAL = 30 to 70 by 20 100

or 2) Missing NTOTAL = .

Grouped-Number-Lists:
Values for each group are “crossed” with the values from the other group

GROUPNS = 20 25 | 30 40 50

→ (20,30)(20,40)(20,50) (25,30)(25,40)(25,50)

Options for plotting

PLOT <plot-options> </ graph-options>

INTERPOL=JOIN | NONE
KEY=BYCURVE <(bycurve-options)>
KEY=BYFEATURE <(byfeature-options)>
KEY=ONCURVES
NUMBERS=OFF | ON
POS=BOTTOM | INSET
POS=BOTTOM | INSET
POS= INSET
MARKERS=ANALYSIS | COMPUTED | NICE | NONE
MAX=number | DATAMAX
MIN=number | DATAMIN
NPOINTS=number
NPTS=number
STEP=number
VARY (feature <BY parameter-list> <, ..., feature <BY parameter-list>>)
X=EFFECT | N | POWER
XOPTS=(x-options)
CROSSREF=NO | YES
REF=number-list
Y=EFFECT | N | POWER
YOPTS=(y-options)
CROSSREF=NO | YES
REF=number-list
DESCRIPTION='string '

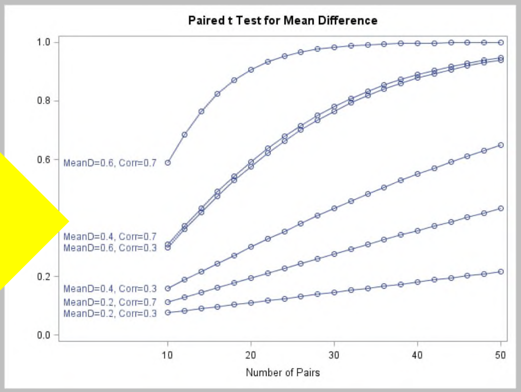
The plot option alone has over twenty options and, inside SAS Power Procs, is not unusual in that characteristic

Options for plotting

PLOT <plot-options> </ graph-options>

```
PROC POWER;
PAIREDMEANS MeanDiff= .2 .4 .6 Stddev=1
Corr= .3 .7
Alpha=.05 Npairs=25 Power=.;
PLOT X=N Min=10 Max=50 Key=OnCurves ;
RUN;
```

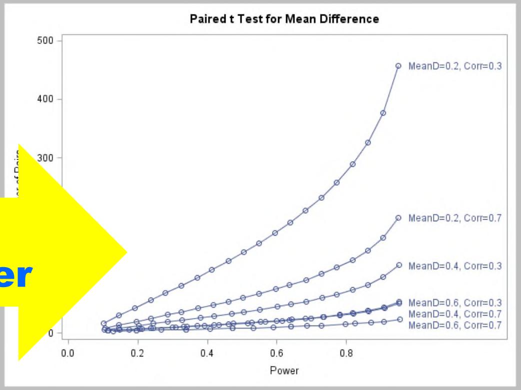
Y is Power
X is N



Yu can plot Power, N or Effect Size
and you can control Y and X axis

```
PROC POWER;
PAIREDMEANS MeanDiff= .2 .4 .6 Stddev=1
Corr= .3 .7
Alpha=.05 Npairs=. Power=.9;
PLOT X=power Min=.1 Max=.95 Key=OnCurves;
RUN;
```

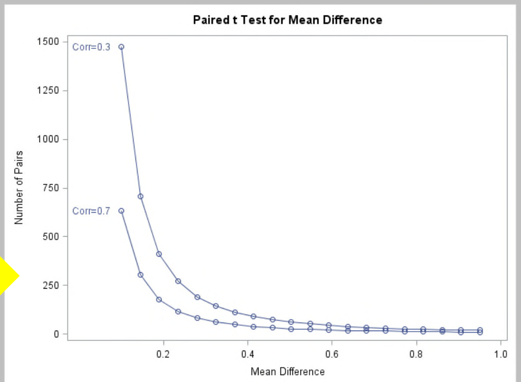
Y is N
X is Power



☹ NOT explored at all ☹
Y=EFFECT | N | POWER

```
PROC POWER;
PAIREDMEANS MeanDiff= .2 .4 .6 Stddev=1
Corr= .3 .7
Alpha=.05 Npairs=. Power=.9;
PLOT X=EFFECT Min=.1 Max=.95
Key=OnCurves; RUN;
```

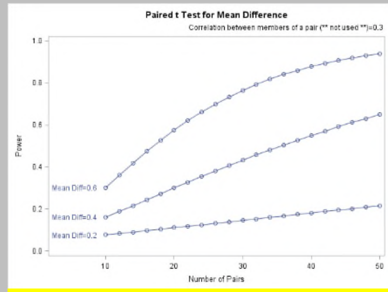
Y is N
X Mean Difference

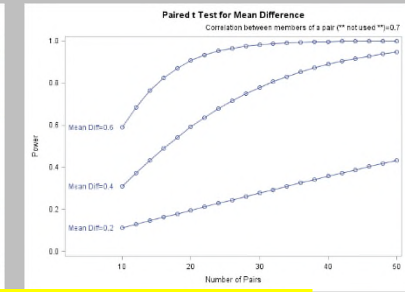


Options for plotting

PLOT <plot-options> </ graph-options>

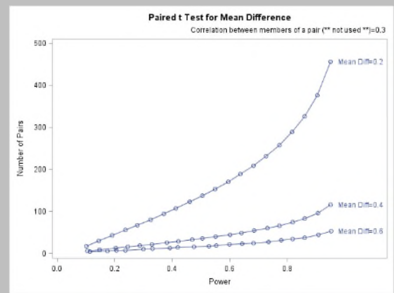
```
PROC POWER;
PAIREDMEANS MeanDiff= .2 .4 .6 Stddev=1
Corr= .3 .7
Alpha=.05 Npairs=25 Power=.;
PLOT X=N Min=10 Max=50 Key=OnCurves ;
VarY(Panel BY Corr); RUN;
```

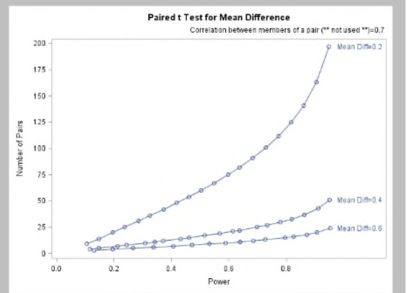




Y is Power X is N

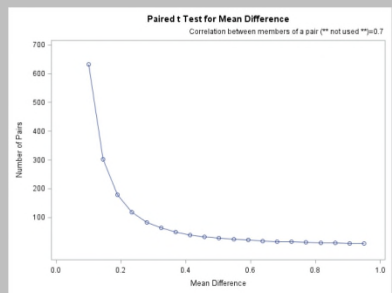
```
PROC POWER;
PAIREDMEANS MeanDiff= .2 .4 .6 Stddev=1
Corr= .3 .7
Alpha=.05 Npairs=. Power=.9;
PLOT X=power Min=.1 Max=.95
Key=OnCurves VarY(Panel BY Corr); RUN;
```

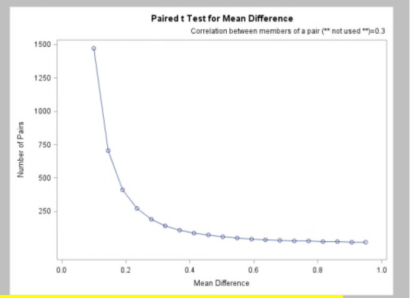




Y is N X is Power

```
PROC POWER;
PAIREDMEANS MeanDiff= .2 .4 .6 Stddev=1
Corr= .3 .7
Alpha=.05 Npairs=. Power=.9;
PLOT X=EFFECT Min=.1 Max=.95
Key=OnCurves VarY(Panel BY Corr); RUN;
```





Y is N X Mean Difference

Proc Power:
Code from SAS Documentation

PROC Power

LOGISTIC Statement
MULTREG Statement
ONECORR Statement
ONESAMPLEFREQ Statement
ONESAMPLEMEANS Statement
ONEWAYANOVA Statement
PAIREDFREQ Statement
PAIREDMEANS Statement
TWOSAMPLEFREQ Statement
TWOSAMPLEMEANS Statement
TWOSAMPLESURVIVAL Statement
TWOSAMPLEWILCOXON Statement

Proc Power: Logistic page 23 - 6320

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

LOGISTIC Statement Options

TEST= Specifies the statistical analysis
ALPHA= Specifies the significance level
COVARIATES= distrib. of predictor variables
TESTPREDICTOR= distrib. of predictor var. being tested
VARDIST= Distribution for predictor var.

Specify effects

CORR= multiple corr. between the predictor & covariates
COVODDSRATIOS= odds ratios for the covariates
COVREGCOEFFS= regression coeff. for the covariates
DEFAULTUNIT= Default change in the predictor variables
INTERCEPT= Specifies the intercept
RESPONSEPROB= Specifies response prob.
TESTODDSRATIO= Specifies the odds ratio being tested
TESTREGCOEFF= Regress. Coeff. 4 predictor variable
UNITS= Specifies the changes in the predictor variables
NFRACTIONAL allows fractional input/output for N
NTOTAL= Specifies the sample size
POWER= Specifies the desired power
DEFAULTNBINS= default # of categories 4 each X var.
NBINS= Specifies the # of categories for predictor vars
OUTPUTORDER= output order of paramaters

LOGISTIC: power and N calculations for a likelihood ratio chi-square test allowing for 1

Show results

```
proc power;
logistic
vardist("x1a") = normal(0, 2)
vardist("x1b") = normal(0, 3)
vardist("x2") = poisson(7)
vardist("x3a") =
  ordinal((-5 0 5) : (.3 .4 .3))
vardist("x3b") =
   ordinal((-5 0 5) : (.4 .3 .3))
testpredictor = "x1a" "x1b"
covariates = "x2" | "x3a" "x3b"
responseprob = 0.15
testoddsratio = 1.75
covoddsratios = (2.1 1.4)
ntotal = 100 ;
power = .;
plot x=n min=100 max=200;
run;
```

Proc Power: Logistic page 23 - 6320

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

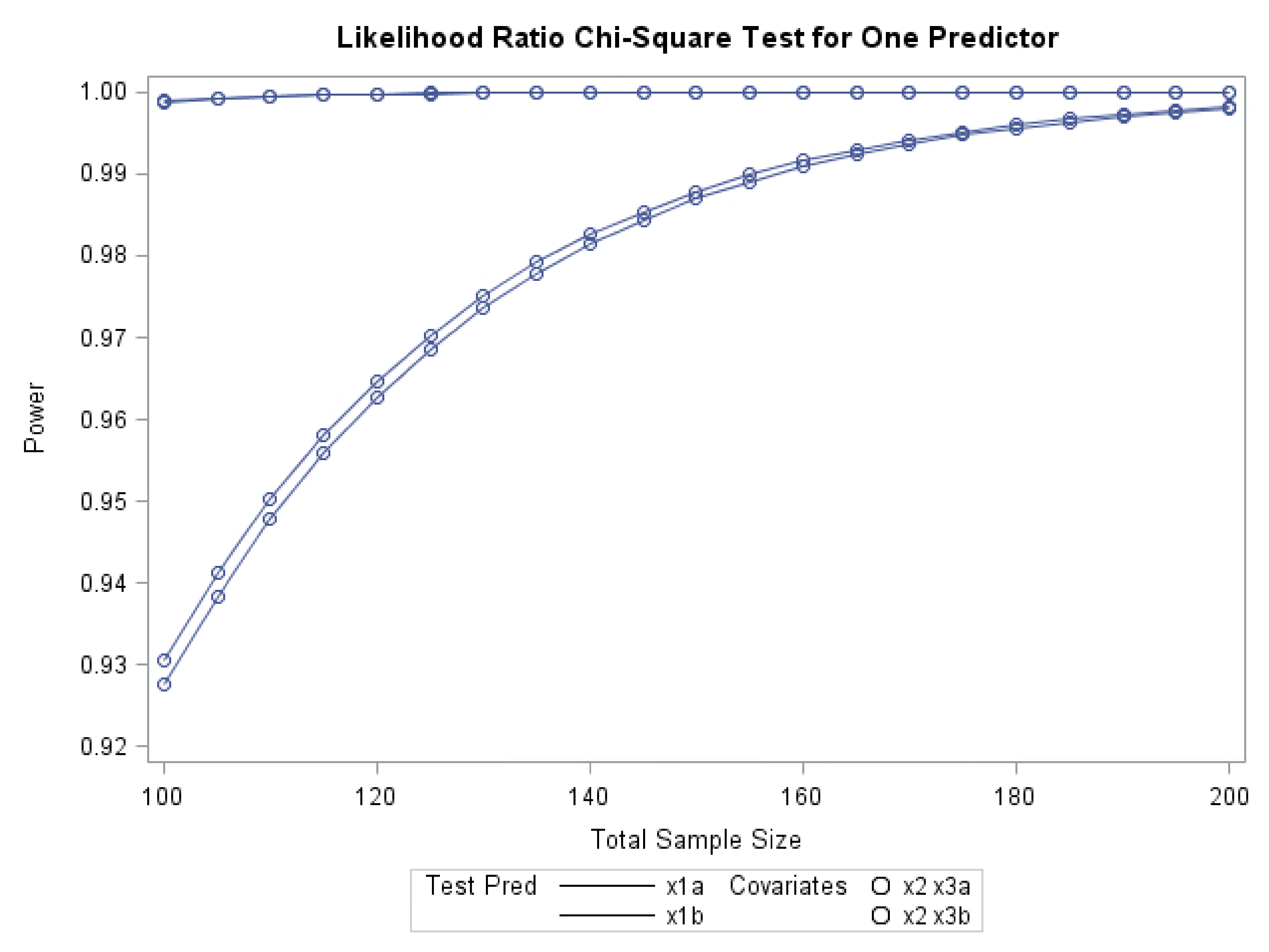
Fixed Scenario Elements	
Method	Shieh-O'Brien approximation
Response Probability	0.15
Odds Ratio for Test Predictor	1.75
Covariate Odds Ratios	2.1 1.4
Total Sample Size	100
Alpha	0.05

Computed Power

Index	Test Pred	Covariates		Test Pred Unit	Cov Units		Total N Bins	Power
1	x1a	x2	x3a	1	1	1	300	0.931
2	x1a	x2	x3b	1	1	1	300	0.927
3	x1b	x2	x3a	1	1	1	300	0.999
4	x1b	x2	x3b	1	1	1	300	0.999

Proc Power: Logistic page 23 - 6320

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf



Proc Power: Multreg
page 29 - 6325

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
proc power; Multreg
model = random
nfullpredictors = 7
ntestpredictors = 3
partialcorr = 0.35
ntotal = 100
power = .;  run;
```

Model = FIXED for categorical predictors, Model = RANDOM for MVN continuous predictors

You can also express effects in terms of R2:

```
proc power; Multreg
model = fixed
nfullpredictors = 7
ntestpredictors = 3
rsquarefull = 0.9
rsquarediff = 0.1
ntotal = .
power = 0.9;  run;
```

Show Fixed results

Example of Multreg PROC Power Syntax

* Options within MULTREG for PROC POWER:

Model = FIXED for categorical predictors,
Model = RANDOM for MVN continuous predictors

Alpha = .05 is default, choose others as you wish

INCLUDE ONLY TWO OF THREE BELOW for N predictors:

NFullPredictors = # of predictors total in regression

NReducedPredictors = # of predictors in reduced alternative model

NTestPredictors = difference in # of predictors between models

SPECIFYING EFFECT SIZE: INCLUDE ONLY TWO OF THREE BELOW RSQ OPTIONS

RsqFull = one or more R2 values of full model

RsqReduced = one or more R2 values of reduced model

RsqDiff = one or more diff in R2 between full and reduced models

OR CHOOSE PartialCorr = one or more partial correlations to be detected

NTotal = Total sample size (put . if you want it to be calculated)

Power = . if you want power to be calculated */

Restrictions on Option Combinations

To specify X use any two of these three options:

1 of 3) # of X in the full model (NFULLPREDICTORS=)

2 of 3) # of X in the reduced model (NREDUCEDPREDICTORS=)

3 of 3) # of X being tested (NTESTPREDICTORS=)

Restrictions on Option Combinations

To specify the effect, choose one of the following parameterizations:

1 of 2) partial correlation (by using the PARTIALCORR= option)

2 of 2) R2 for the full and reduced models (by using any two of)

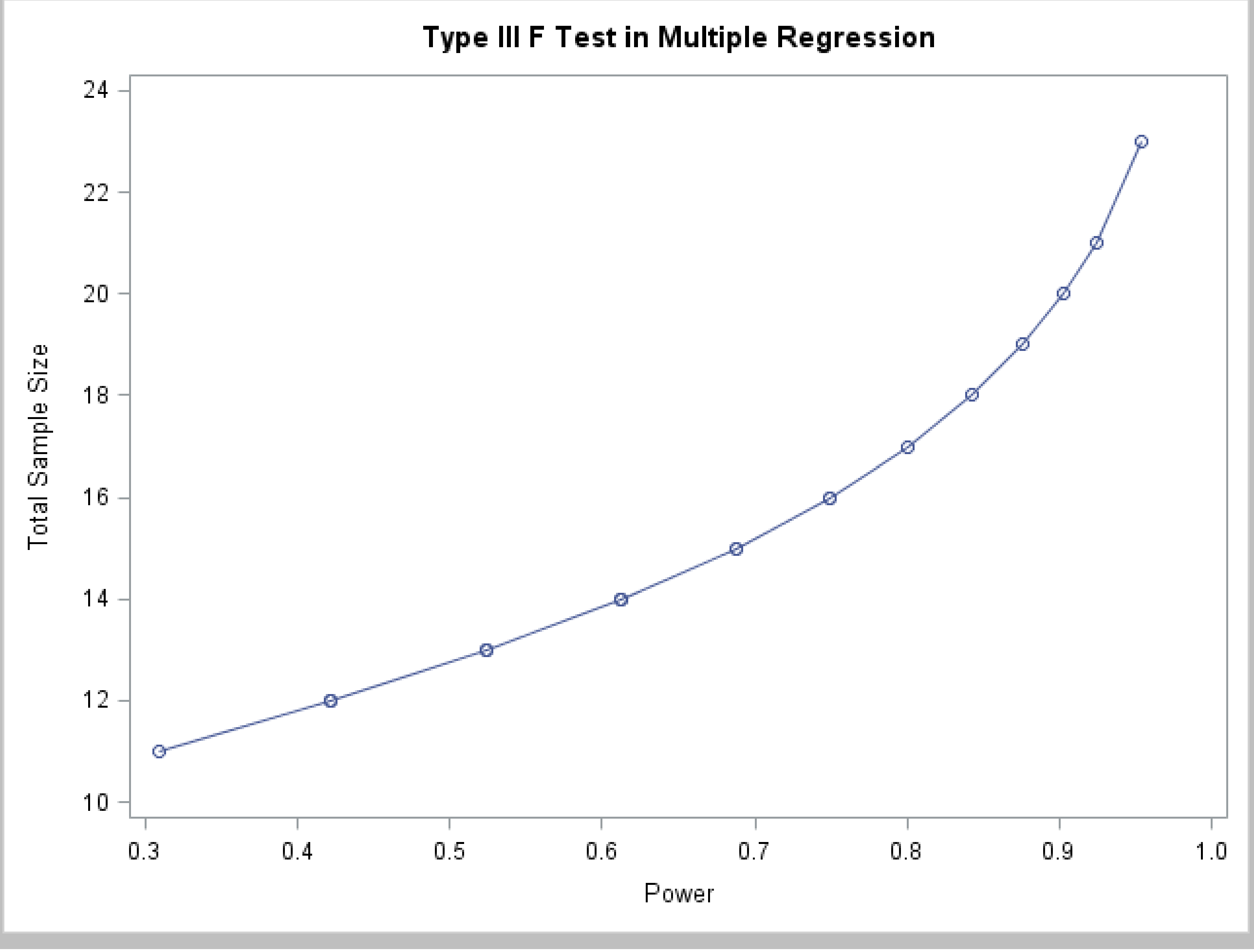
RSQUAREDIFF= ,
RSQUAREFULL= , and
RSQUAREREDUCED=)

Proc Power: Multreg page 29 - 6325

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Fixed Scenario Elements	
Method	Exact
Model	Fixed X
Number of Predictors in Full Model	7
Number of Test Predictors	3
R-square of Full Model	0.9
Difference in R-square	0.1
Nominal Power	0.9
Alpha	0.05

Computed N Total	
Actual Power	N Total
0.903	20



Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
PROC POWER;
MULTREG
Model =random
NFullPredictors = 4
NTestPredictors = 1
Alpha = .05
PartialCorr = .1  .2  .3  .4 .5
NTotal = 100
Power = . ;
PLOT X = N Min=50 Max=200
Key =OnCurves;
RUN;
```

NFullPredictors = # of predictors total in regression

NReducedPredictors = # of predictors in reduced alternative model

NTestPredictors = difference in # of predictors between models

Show results

Plot Power, N or effect size and you can control Y and X axis

Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure
Type III F Test in Multiple Regression

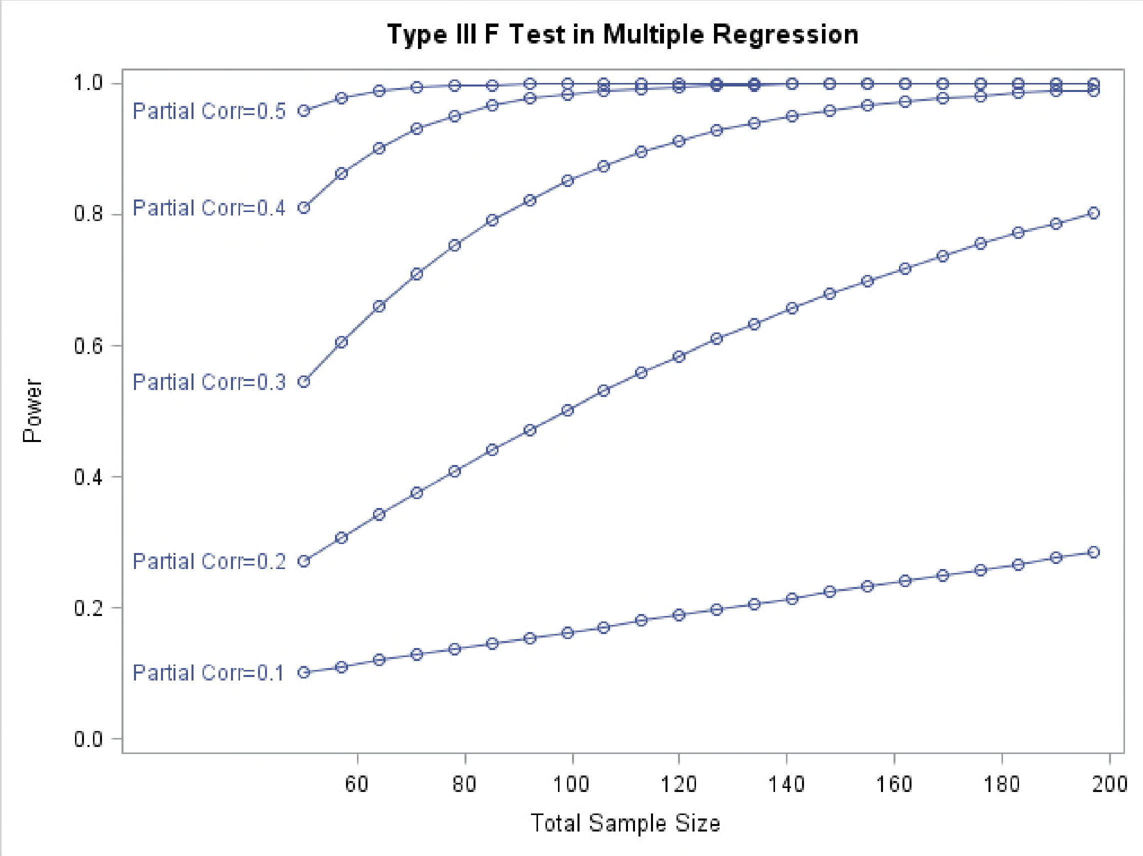
Fixed Scenario Elements	
Method	Exact
Model	Random X
# of Predictors in Full Model	4
# Test Predictors	1
Alpha	0.05
Total Sample Size	100

Computed Power

Index	Partial Corr	Power
1	0.1	0.164
2	0.2	0.506
3	0.3	0.855
4	0.4	0.985
5	0.5	>.999

Power to Detect Range of Partial Correlations

Will calculate power for sample sizes around Ntotal



Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

Show results

```
TITLE1 "Power to Detect Range of Incremental R2";
TITLE2 "Will calculate power for sample sizes around Ntotal";
PROC POWER;
MULTREG
Model=random
NFullPredictors = 3
NTestPredictors = 3
Alpha = .05
RsqReduced = 0
RsqDiff = .05 .10 .15 .20
NTotal = 100
Power = .;
PLOT X = N Min = 50 Max = 200
Key =OnCurves;
RUN;
```

NFullPredictors = # of predictors total in regression

NReducedPredictors = # of predictors in reduced alternative model

NTestPredictors = difference in # of predictors between models

RsqFull = one or more R2 values of full model

RsqReduced = one or more R2 values of reduced model

RsqDiff = one or more diff in R2 between full and reduced models

Plot Power, N or effect size and you can control Y and X axis

Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure
Type III F Test in Multiple Regression

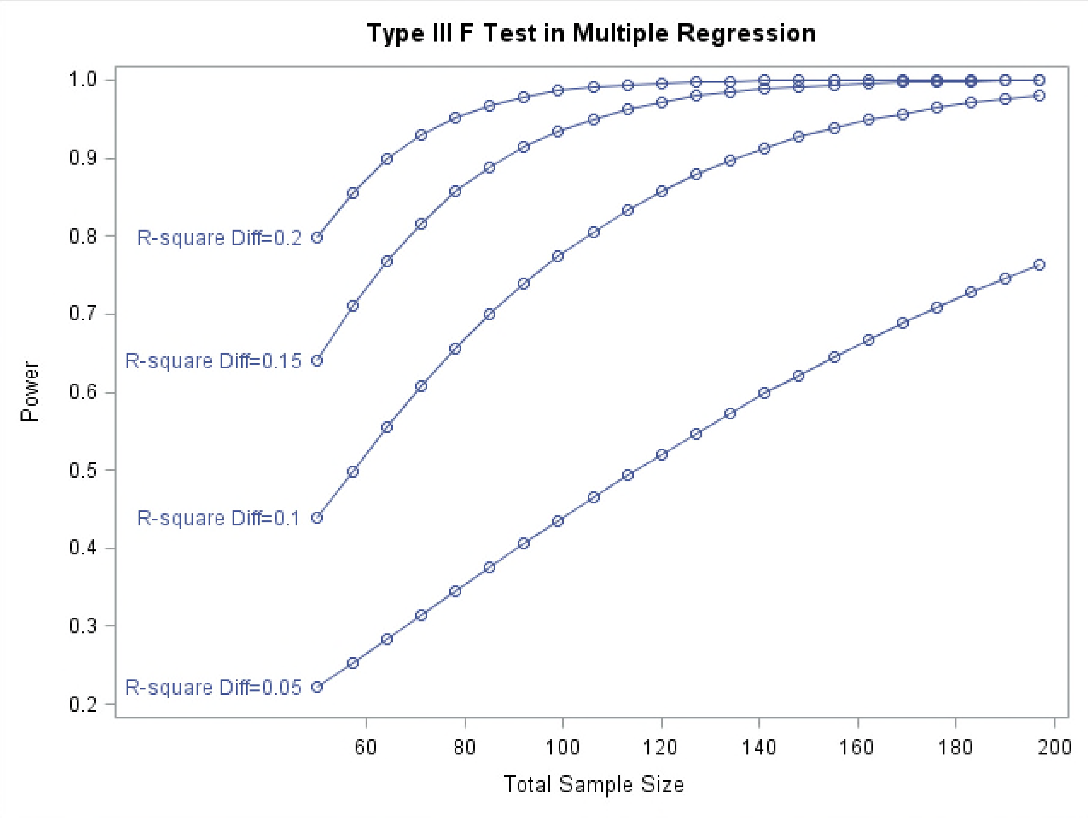
Fixed Scenario Elements	
Method	Exact
Model	Random X
# of Predictors in Full Model	3
# of Test Predictors	3
Alpha	0.05
R-square of Reduced Model	0
Total Sample Size	100

Computed Power

Index	R-square Diff	Power
1	0.05	0.440
2	0.10	0.778
3	0.15	0.937
4	0.20	0.987

Power to Detect Range of Incremental R2

Will calculate power for sample sizes around Ntotal



Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
TITLE1 "Power to Detect Range of Incremental R2";
TITLE2 "Will calculate Ntotal for 80% power at each R2";
PROC POWER;
MULTREG
Model =random
NFullPredictors = 3
NTestPredictors = 3
Alpha = .05
RsqReduced = 0
RsqDiff = .05 .10 .15 .20
NTotal = .
Power = .80;
PLOT X =Effect Min = .05 Max = .30
Key =OnCurves;
RUN ;
```

Show results

Plot Power, N or effect size and you can control Y and X axis

Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure
Type III F Test in Multiple Regression

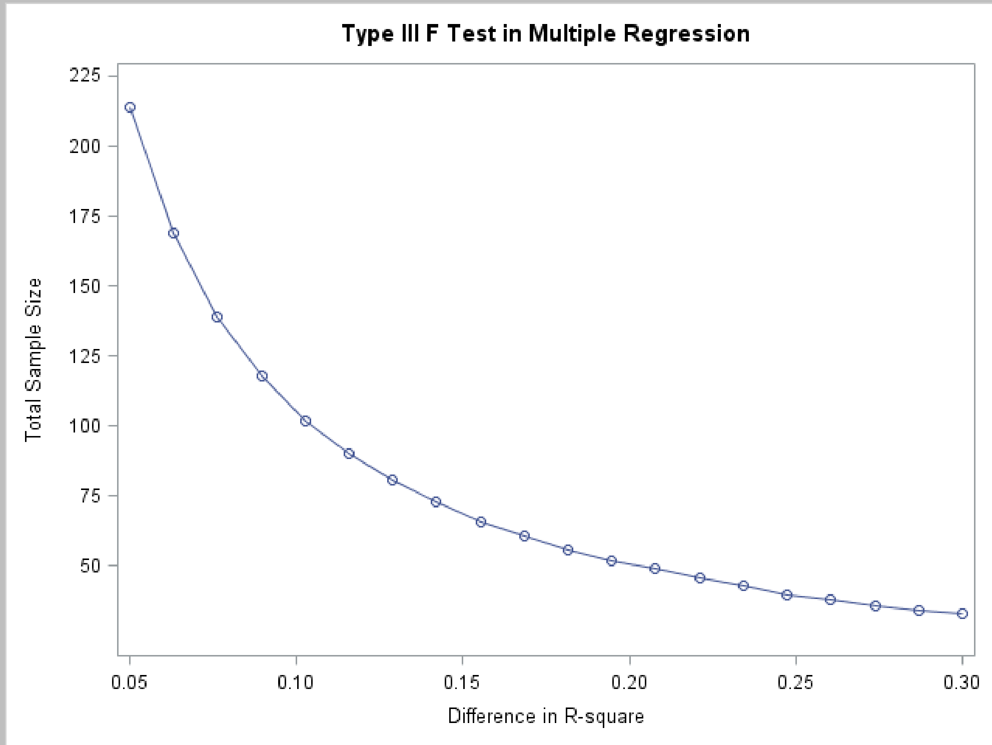
Power to Detect Range of Incremental R2

Will calculate Ntotal for 80% power at each R2

Fixed Scenario Elements	
Method	Exact
Model	Random X
# of Predictors in Full Model	3
# of Test Predictors	3
Alpha	0.05
RSQ: Reduced Model	0
Nominal Power	0.8

Computed N Total

Index	R-Sq Diff	Actual Power	N Total
1	0.05	0.800	214
2	0.10	0.801	105
3	0.15	0.804	69
4	0.20	0.807	51



X is effect size: Difference in r-square

RsqReduced = 0

RsqDiff = .05 .10 .15 .20

Proc Power: OneCorr
page 32 - 6328

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
/*Fisher's z Test for Pearson Correlation*/
PROC Power;  onecorr
dist=fisherz
nullcorr = 0.15
corr = 0.35
ntotal = 180
power = .;
run;

/*T Test for Pearson Correlation*/
PROC Power; onecorr
dist=t
npartialvars = 4
corr = 0.45
ntotal = .
power = 0.85;
run
```

Example of One Corr PROC Power Syntax

ONECORR

power and N for simple and partial Pearson correlation between two variables. Supports Fisher's Z & the T test

Summary of Options

Option	Description
Define analysis	
DIST=	Underlying distrib. assumed for the test statistic
TEST=	Specifies the statistical analysis
Specify analysis information	
ALPHA=	Specifies the significance level
MODEL=	Assumed distribution of the variables
NPARTIALVARS=	# of var. adjusted for in the correlation
NULLCORR=	Specifies the null value of the correlation
SIDES=	One-Two tails and direction of test
CORR=	Specifies t
Specify sample size	
NFRACTIONAL	Allows fractional N
NTOTAL=	Specifies/requests the sample size
POWER=	specifies/requests the power of the test
OUTPUTORDER=	Output order

```
proc power;
onecorr
dist=fisherz
nullcorr = 0.15
corr = 0.35
ntotal = 180
power = .;
plot x=n min=100
max=200;
run;
```

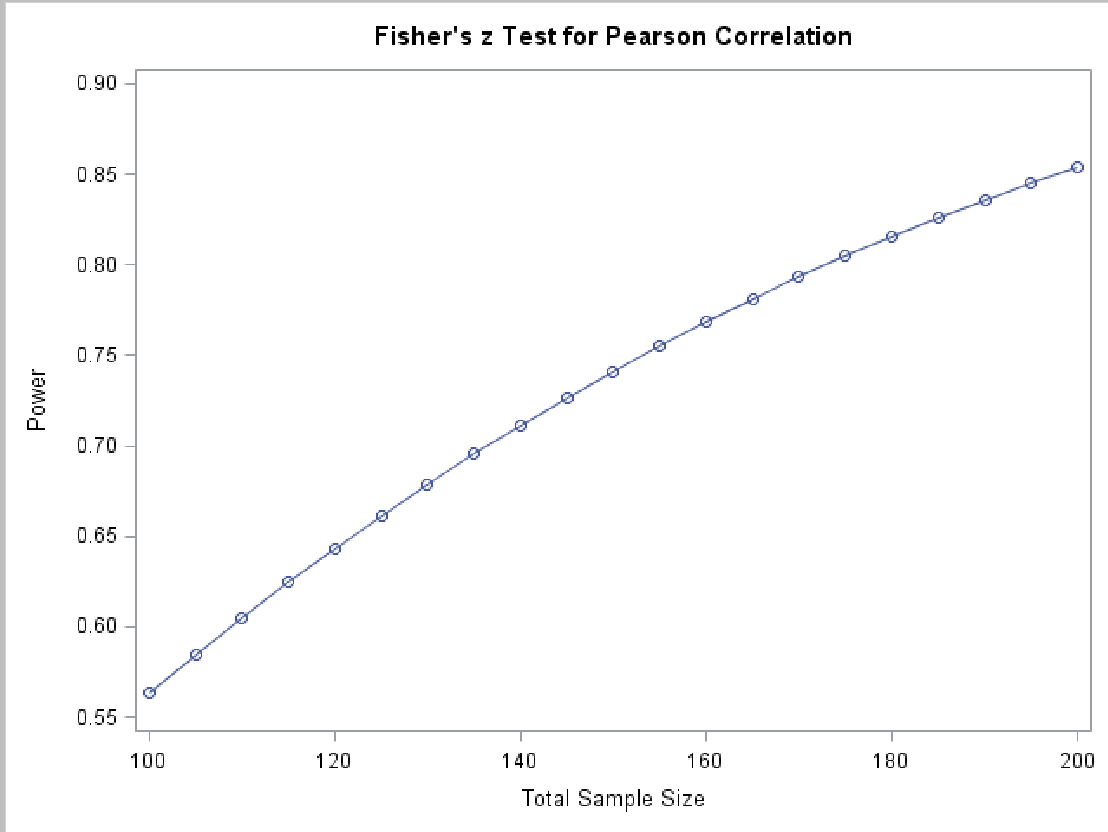
Show results

The POWER Procedure

Fisher's z Test for Pearson Correlation

Fixed Scenario Elements	
Distribution	Fisher's z transformation of r
Method	Normal approximation
Null Correlation	0.15
Correlation	0.35
Total Sample Size	180
Number of Sides	2
Nominal Alpha	0.05
Number of Variables Partialled Out	0

Computed Power	
Actual Alpha	Power
0.05	0.816



Proc Power: OneSampleFreq page 32 - 6328

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Exact Test of a Binomial Proportion

```
PROC Power; onesamplefreq
 test=exact
nullproportion = 0.2
proportion = 0.3
ntotal = 100
power = .;  run;
```

the z test of a binomial proportion.

```
PROC Power; onesamplefreq
test=z method=normal
nullproportion = 0.8
proportion = 0.85
sides = u    ntotal = .
power = .9;  run;
```

ztest of a binomial proportion with a continuity adjustment.

```
PROC Power;  onesamplefreq
test=adjz method=normal
nullproportion = 0.15
proportion = 0.1
sides = l  ntotal = .
power = .9; run;
```

Proc Power: OneSampleFreq
page 39 - 6335

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Exact Equivalence Test for a Binomial Proportion

specify equivalence bounds by EQUIVBOUNDS=

```
proc power; OneSampleFreq
test=equiv_exact
proportion = 0.35   equivbounds = (0.2 0.4)
ntotal = 50  power = .;   run;
```

With NULLPROPORTION= and MARGIN=

```
proc power; OneSampleFreq
 test=equiv_exact
proportion = 0.35  nullproportion = 0.3  margin = 0.1
ntotal = 50 power = .; run;
```

Use a combination of LOWER= and UPPER=

```
proc power; OneSampleFreq
test=equiv_exact
proportion = 0.35 lower = 0.2        upper = 0.4
ntotal = 50    power = .;  run;
```

Proc Power: OneSampleMeans page 45-46 ** 6342 -6342

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

One-Sample T Test

```
PROC Power; OneSampleMeans
test=t    mean = 7
stddev = 3
ntotal = 50  power = .; run;
```

Equivalence Test for Mean of Normal Data

```
PROC Power; OneSampleMeans
test=equiv
lower = 2   upper = 7  mean = 4
stddev = 3
ntotal = 100  power = .;  run;
```

Confidence interval for the mean

```
PROC Power; OneSampleMeans
ci = t     halfwidth = 14
stddev = 8
ntotal = 50 probwidth = .; run;
```

Proc Power: OneWayAnova
page 51 ** 6347

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Many Options in One way ANOVA

Overall F Test

```
PROC Power; OneWayANNOVA
test=overall
groupmeans = 3 | 7 | 8
stddev = 4
npergroup = 50
power = .;
run;
```

Contrast

```
PROC Power;
OneWayANNOVA
test=contrast
contrast = (1 0 -1)
groupmeans = 3 | 7 | 8
stddev = 4
groupns = (20 40 40)
power = .;
run;
```

Balanced Contrast

```
PROC Power;
OneWayANNOVA
test=contrast
contrast = (1 0 -1)
groupmeans = 3 | 7 | 8
stddev = 4
npergroup = 50
power = .;
run;
```

Unbalanced Contrast

```
PROC Power;
OneWayANNOVA
test=contrast
contrast = (1 0 -1)
groupmeans = 3 | 7 | 8
stddev = 4
groupweights = (1 2 2)
ntotal = .
power = 0.9;
run;
```

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
PROC POWER;
* 3 groups: Drug, Drug+Caffeine, Placebo, using means from previous research;
* SDs should have been 10.8, 12.4, and 7.1, but it only allows a common SD;
ONEWAYANOVA
GroupMeans = 11.4 | 16.7 | 4.0
Stddev = 10.0
GroupWeights = (1 1 1) (2 2 1)
/*space between numbers not (111) (221) */
Test =Overall
Alpha =.05
Ntotal =90
Power = .;
PLOT X = N Min = 30 Max = 180
Key = OnCurves;
RUN
;
```

Overall test of means

3 means

2 groupweights

No Contrasts

Show results

Power Analysis for General Linear Models in SAS (Multreg)

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure
Overall F Test for One-Way ANOVA

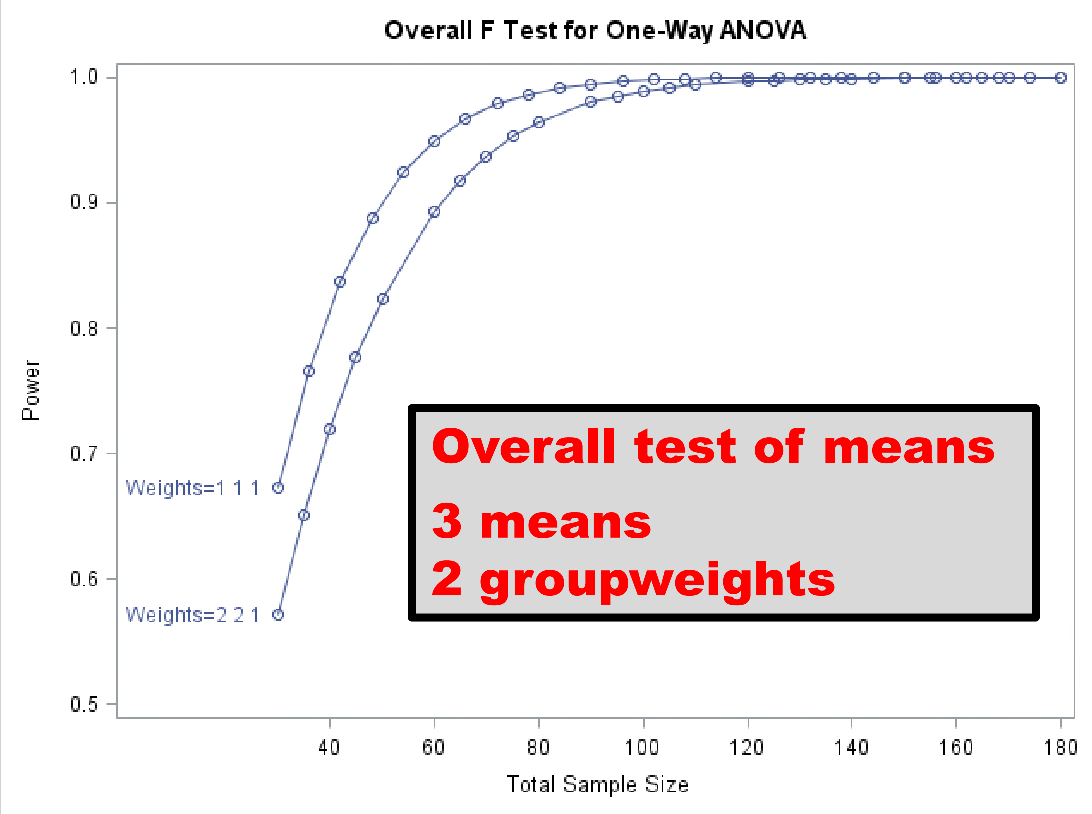
Fixed Scenario Elements	
Method	Exact
Alpha	0.05
Group Means	11.4 16.7 4
Standard Deviation	10
Total Sample Size	90

Computed Power

Index	Weights			Power
1	1	1	1	0.995
2	2	2	1	0.980

Power to Detect Range of Omnibus Between-Group Mean Differences

Will calculate power for sample sizes around Ntotal



Overall test of means

3 means
2 groupweights

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
TITLE1"Power to Detect Range of Specific Between-Group Mean Differences";
TITLE2 "Will calculate power for sample sizes around Ntotal";
PROC POWER;
* 3 groups: Drug, Drug+Caffeine, Placebo, using means from previous research;
* SDs should have been 10.8, 12.4, and 7.1, but it only allows a common SD;
OneWayANOVA
GroupMeans = 11.4 |  16.7  |  4.0
Stddev = 10.0
GroupWeights =(1 1 1)(2 2 1)
Test =Contrast
Alpha = .05
Ntotal = 90
Power = .
Contrast = (-1 -1 2 ) (-1 1 0);
PLOT X =N Min=30 Max = 180
Key =OnCurves;
RUN
;
```

3 groups with
2 possible weighting plans
(possibley cost driven?)

Test two
Contrasts

Show
results

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure

Single DF Contrast in 1-Way ANOVA

Fixed Scenario Elements

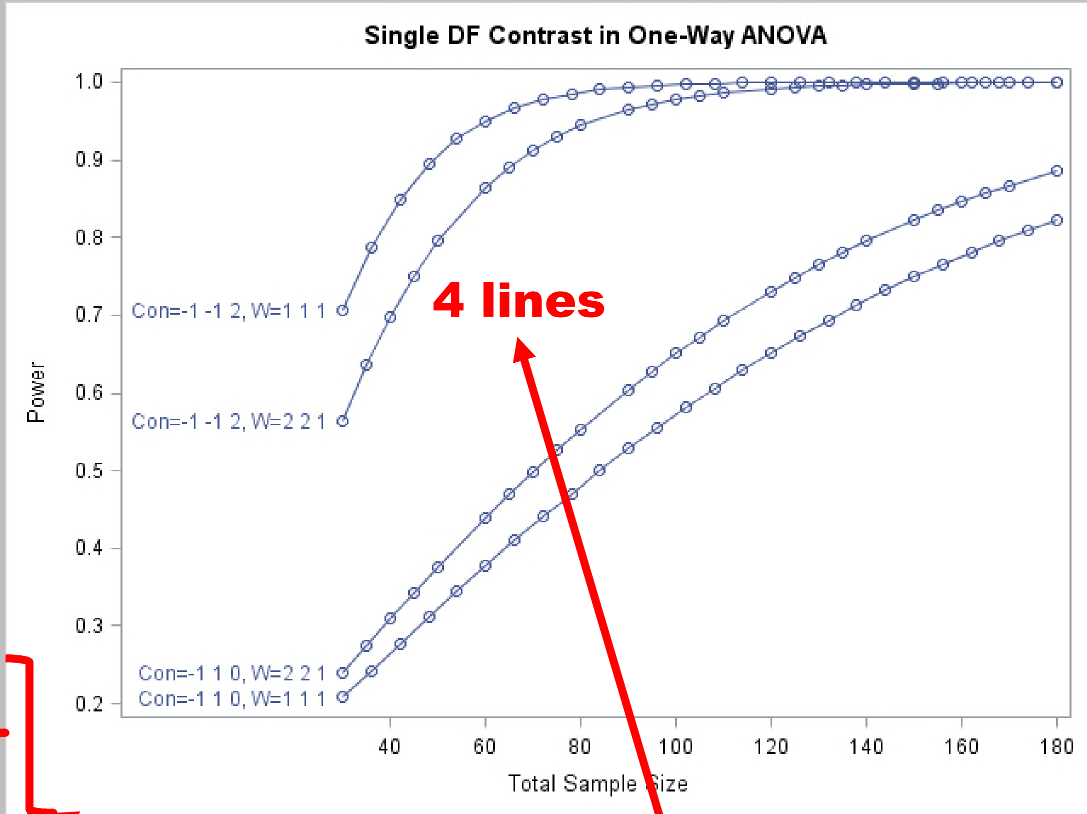
Method	Exact
Alpha	0.05
Group Means	11.4 16.7 4
Standard Dev.	10
Total Sample Size	90
Number of Sides	2
Null Contrast Value	0

Computed Power

Index	Contrast			Weights			Power
1	-1	-1	2	1	1	1	0.994
2	-1	-1	2	2	2	1	0.965
3	-1	1	0	1	1	1	0.528
4	-1	1	0	2	2	1	0.604

Power to Detect Range of Specific Between-Group Mean Differences

Will calculate power for sample sizes around Ntotal



Test two Contrasts and two weighting schemes

Examples are from Statistical Power

Analysis Using SAS and R

Shows Contrasts

(55 pages and many examples)

Proc Power: OneWayAnova

Statistical Power Analysis Using SAS and R

Contrasts 55 pages and many examples

http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1002&context=statspa

The POWER Procedure
Single DF Contrast in One-Way ANOVA

```
Proc Power;
OneWayANOVA test=contrast
contrast = ( 1 -1 0 0  0 0)
           ( 0 1 0  0 -1 0)
           ( 0 0 1 -1  0 0 )
groupmeans=(5 4 6 11 12 9 )
std= 4
npergroup= .
power= .8;
run ;
```

Fixed Scenario Elements	
Method	Exact
Group Means	5 4 6 11 12 9
Standard Deviation	4
Nominal Power	0.8
Number of Sides	2
Null Contrast Value	0
Alpha	0.05

Test three Contrasts

6 means

3 answers

Computed N Per Group

Index	Contrast						Actual Power	N Per Group
1	1	-1	0	0	0	0	0.801	252
2	0	1	0	0	-1	0	0.858	5
3	0	0	1	-1	0	0	0.822	11

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
TITLE1 "Power to Detect Range of Omnibus Between-Group Mean Differences";
TITLE2 "Will calculate power for sample sizes around Ntotal";

PROC POWER;
* 3 groups: Drug, Drug+Caffeine, Placebo, using std mean differences;
OneWayANOVA
GroupMeans = .4 | .6 | 0
Stddev =1
GroupWeights =(1 1 1 )( 2 2 1)
Test = Overall
Alpha =.05
Ntotal = 90
Power = .;
PLOT X = N Min=30 Max=180
Key =OnCurves;
RUN
;
```

OneWayANOVA

3 Means =.4 .6 0.0

Two weighting schemes

Overall test of means – No contrasts

Show results

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure

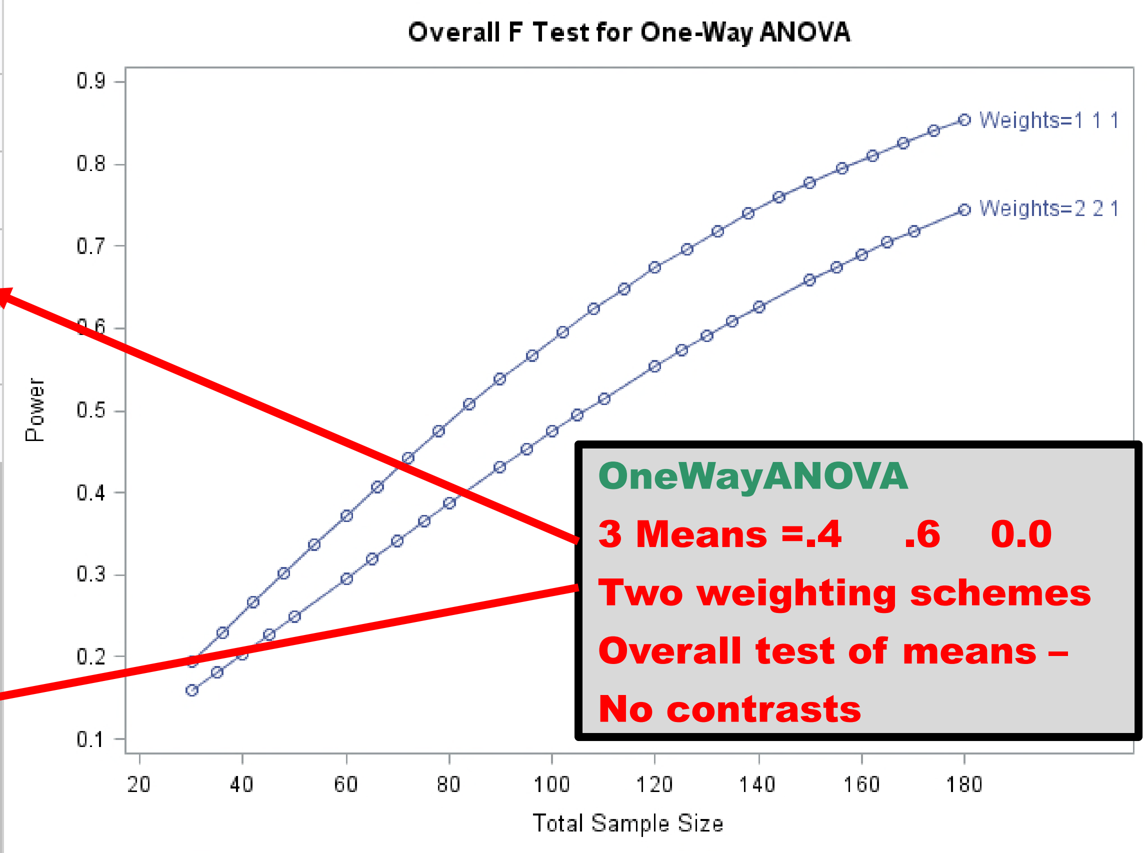
Overall F Test for One-Way ANOVA

Power to Detect Range of Omnibus Between-Group Mean Differences
Will calculate power for sample sizes around Ntotal

Fixed Scenario Elements	
Method	Exact
Alpha	0.05
Group Means	0.4 0.6 0
Standard Deviation	1
Total Sample Size	90

Computed Power

Index	Weights			Power
1	1	1	1	0.538
2	2	2	1	0.431



OneWayANOVA
3 Means =.4 .6 0.0
Two weighting schemes
Overall test of means –
No contrasts

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
TITLE1 "Power to Detect Range of Specific Between-Group Mean Differences";
TITLE2 "Will calculate power for sample sizes around Ntotal";
PROC POWER ;
* 3 groups: Drug, Drug+Caffeine, Placebo, using std mean differences;
OneWayANOVA
GroupMeans = .4  |  .6 |  0
Stddev =1
GroupWeights = ( 1 1 1 ) ( 2 2 1 )
Test =Contrast
Alpha =.05
Ntotal = 90
Power = .
Contrast =  ( -1 –1  2 ) (-1  1  0  );
PLOT X =N  Min = 30 Max = 180
Key =OnCurves;
RUN;
```

One way Anova

3 Means =.4   .6   0.0

Two weighting schemes

TWO contrasts

Show results

Proc Power: OneWayAnova

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure

Single DF Contrast in One-Way ANOVA

Fixed Scenario Elements	
Method	Exact
Alpha	0.05
Group Means	0.4 0.6 0
Standard Deviation	1
Total Sample Size	90
Number of Sides	2
Null Contrast Value	0

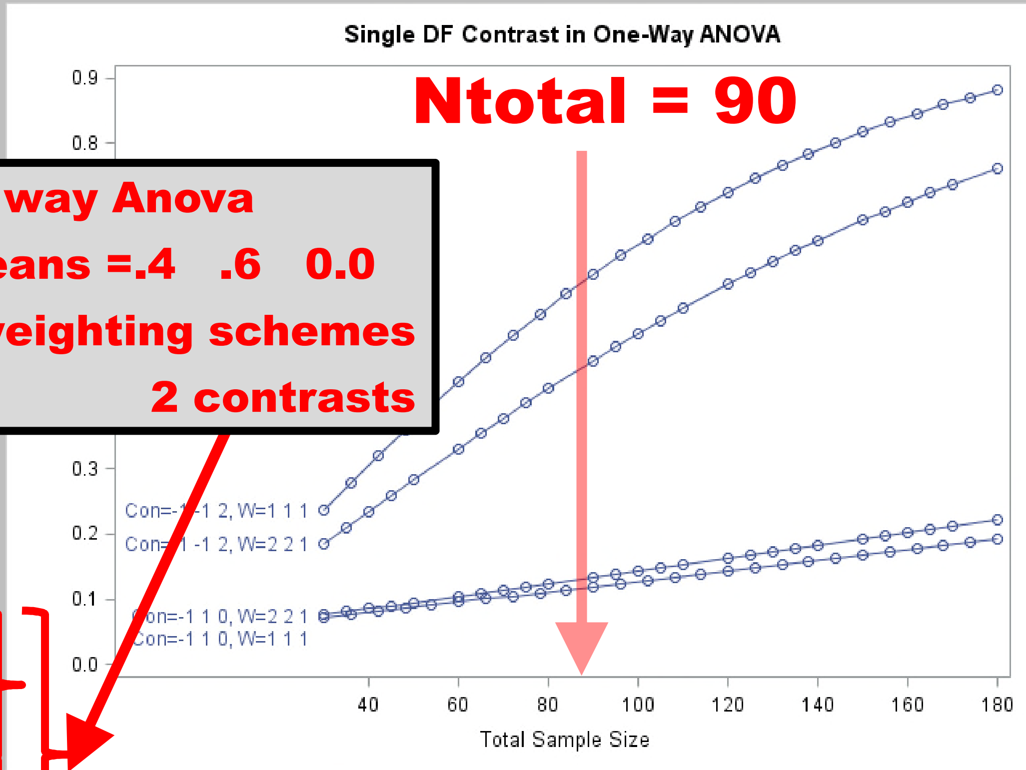
Computed Power

Index	Contrast			Weights			Power
1	-1	-1	2	1	1	1	0.599
2	-1	-1	2	2	2	1	0.467
3	-1	1	0	1	1	1	0.119
4	-1	1	0	2	2	1	0.134

Power to Detect Range of Specific Between-Group Mean Differences

Will calculate power for sample sizes around Ntotal

One way Anova
3 Means =.4 .6 0.0
2 weighting schemes
2 contrasts



Proc Power: PairedFreq
page 56-58 ** 6353-6354

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

McNemar Exact Conditional Test

```
PROC Power; PairedFreq
dist=exact_cond
discproportions = 0.15 | 0.45
npairs = 80  power = .; run;
```

difference and sum of discordant proportions

```
PROC Power; PairedFreq
dist=exact_cond
discpropdiff = 0.3
totalpropdisc = 0.6
npairs = 80  power = .;  run
```

McNemar Normal Approx. Test

```
PROC Power; PairedFreq
dist=normal method=connor
discproportions = 0.15 | 0.45
npairs = .  power = .9;  Run;
```

You can also express effects in terms of:

1) the difference of discordant proportions and the reference discordant proportion:

2) the ratio of discordant proportions and the denominator of the ratio

3) the ratio and sum of discordant proportions

4) the paired proportions and correlation

5) proportion difference, reference proportion, and correlation

6) the odds ratio, reference proportion, and correlation:

7) relative risk, reference proportion, and correlation

Proc Power: PairedMeans page 65-67** 6361-6363

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
/*Paired T test*/
PROC Power; PairedMeans
test=diff
meandiff = 7
corr = 0.4
stddev = 12
npairs = 50
power = . ;
run;

/*Additive Equivalence Test for Mean
Difference with Normal Data*/
PROC Power; PairedMeans
test=equiv_diff
lower = 2    upper = 5   meandiff = 4
corr = 0.2
stddev = 8
npairs = .
power = 0.9;
Run;
```

Proc Power: PairedMeans
page 65-67** 6361-6363

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
/*Multiplicative Equivalence Test - Mean
Ratio w/ Lognormal Data*/
PROC Power;  PairedMeans
test=equiv_ratio
lower = 3        upper = 7
meanratio = 5
cv = 1.1
corr = 0.2
npairs = 50
power = . ;  run;


/*Confidence Int. for Mean Difference*/
PROC Power; PairedMeans
ci = diff
halfwidth = 4
corr = 0.35
stddev = 8
npairs = 30
probwidth = .  ;; run;
```

Options within PairedMeans for PROC POWER:

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

TEST = Diff provides test of mean difference

PairedMeans = Means to be tested for difference

PairedStddevs = Measure-specific SD for means to be tested

Stddev = Common SD for means to be tested

MeanDiff = Mean difference to be tested

Corr = correlations between measures

```
TITLE1 "Power to Detect Range of Repeated Measures Mean Differences";
TITLE2 "Will calculate power for sample sizes around Npairs";
PROC POWER; PairedMeans
MeanDiff = .2  .4  .6
Stddev = 1
Corr = .3  .7
Alpha = .05
Npairs = 25
Power = . ;
PLOT X =N  Min = 10 Max = 50 Key=OnCurves  VarY(Panel BY Corr);
RUN ;
```

Show results

Options within PairedMeans for PROC POWER:

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure

Paired t Test for Mean Difference

Power to Detect Range of Repeated Measures Mean Differences

Will calculate power for sample sizes around Npairs

Fixed Scenario Elements	
Distribution	Normal
Method	Exact
Alpha	0.05
Standard Deviation	1
Number of Pairs	25
Number of Sides	2
Null Difference	0

Calculate power for sample sizes around Npairs

3 Mean diff

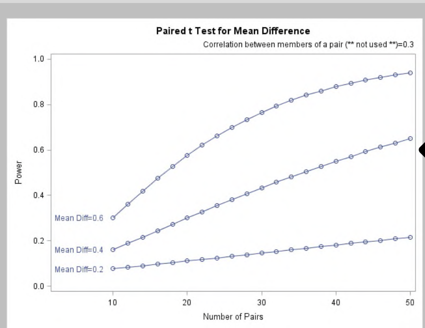
2 Correlations

Corr = .3 .7

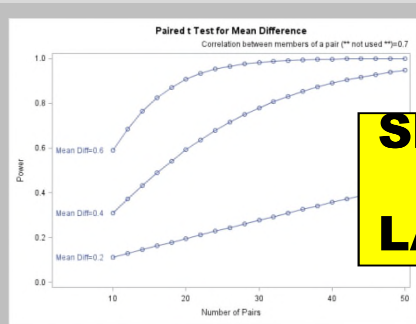
Computed Power

Index	Mean Diff	Corr	Power
1	0.2	0.3	0.128
2	0.2	0.7	0.236
3	0.4	0.3	0.368
4	0.4	0.7	0.698
5	0.6	0.3	0.682
6	0.6	0.7	0.960

PLOT X =N Min = 10 Max = 50 Key=OnCurves VarY(Panel BY Corr);



6 plots



Show LARGER

Options within PairedMeans for PROC POWER:

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The POWER Procedure

Paired t Test for Mean Difference

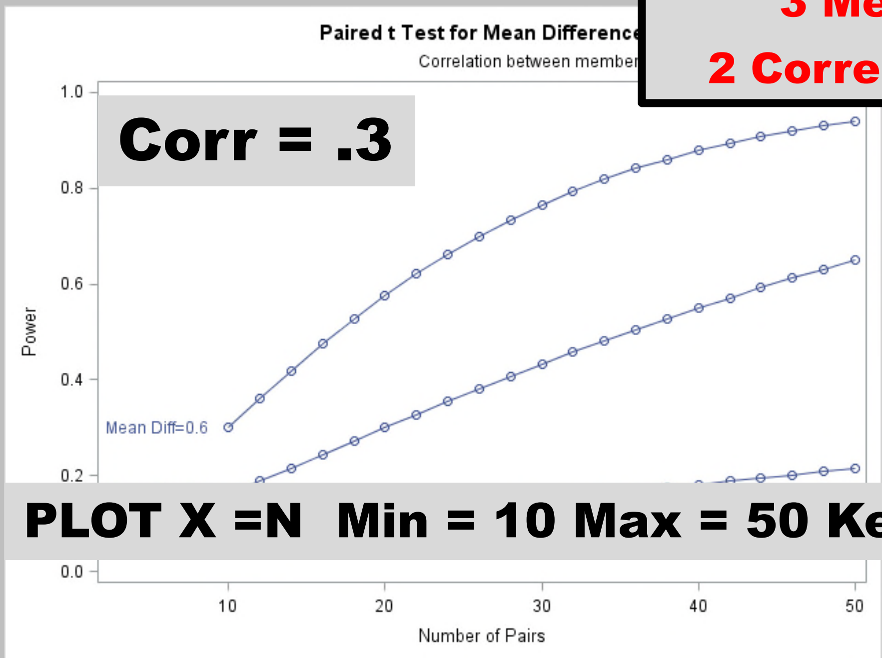
Power to Detect Range of Repeated Measures Mean Differences

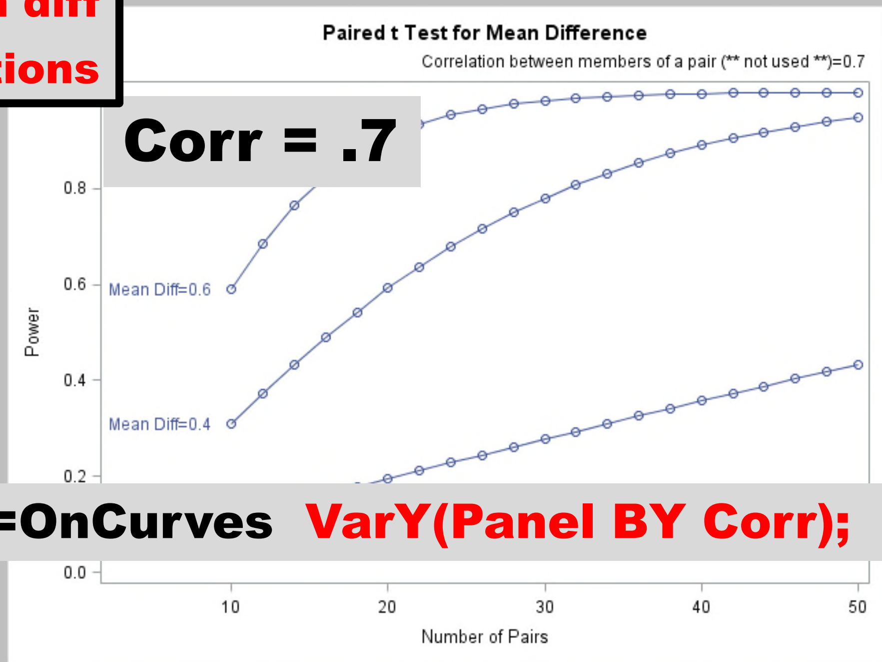
Will calculate power for sample sizes around Npairs

Calculate power for sample sizes around Npairs

3 Mean diff

2 Correlations





PLOT X =N Min = 10 Max = 50 Key=OnCurves VarY(Panel BY Corr);

Proc Power: TwoSampleFreq page 76 ** 6372-

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
/*BALANCED Pearson Chi-Square
Test for Two Proportions*/
PROC Power; TwoSampleFreq
test=pchi
groupproportions = (.15 .25)
nullproportiondiff = .03
npergroup = 50
power = .;
run;


/*UN BALANCED Pearson Chi-
Square Test for Two Proportions*/
PROC Power;TwoSampleFreq
test=pchi
oddsratio = 2.5
refproportion = 0.3
groupweights = (1 2)
ntotal = .
power = 0.8;
run;
```

Proc Power: TwoSampleFreq page 76 ** 6372-

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
/*UNBALANCED Pearson Chi-Square Test for Two Proportions Groupn and rel risk*/
PROC Power;  TwoSampleFreq
test=pchi
relativerisk = 1.5  refproportion = 0.2
groupns = 40 | 60
power = .  ;
run;


/*BALANCED Pearson Chi-Square Test for Two Proportions ProportionDiff*/
PROC Power;  TwoSampleFreq
 test=pchi
proportiondiff = 0.15   refproportion = 0.4
ntotal = 100
power = .  ;
run;
```

Proc Power: TwoSampleFreq
page 76 -77** 6372-6373

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Fisher's Exact Conditional Test for Two Proportions

```
PROC Power;  TwoSampleFreq
 test=fisher
groupproportions = (.35 .15)
npergroup = 50
power = .;
run;
```

Likelihood Ratio Chi-Square Test for Two Proportions

```
PROC Power;  TwoSampleFreq
 test=lrchi
oddsratio = 2 refproportion = 0.4
npergroup = .
power = 0.9;
run;
```

Proc Power: TwoSampleMeans page 85- 87** 6381-6383

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Balanced Two-Sample T Test Assuming Equal Variances

```
PROC Power; TwoSampleMeans
test=diff
meandiff = 7
stddev = 12
npergroup = 50
power = .  ;
run;
```

UNBALANCED Two-Sample T Test Assuming Equal Variances

```
PROC Power; TwoSampleMeans
 test=diff
groupmeans = 8 | 15
groupweights = (2 3)
stddev = 4
ntotal =  .
power = 0.9;
run;
```

Proc Power: TwoSampleMeans page 85- 87** 6381-6383

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Two-Sample Satterthwaite T Test Assuming Unequal Variances

```
PROC Power; TwoSampleMeans
test=diff_satt
meandiff = 3
groupstddevs = 5 | 8
groupweights = (1 2)
ntotal = 60
power = .  ;
run;
```

Two-Sample Pooled T Test of Mean Ratio with Lognormal Data

```
PROC Power; TwoSampleMeans
 test=ratio
meanratio = 7
cv = 0.8
groupns = 50 | 70
power = .  ;
run;
```

Proc Power: TwoSampleMeans
page 85- 87** 6381-6383

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Additive Equivalence Test for Mean Difference with Normal Data

```
PROC Power; TwoSampleMeans
test=equiv_diff
lower = 2        upper = 5    meandiff = 4
stddev = 8
ntotal = .
power = 0.9;
run;
```

Multiplicative Equivalence Test for Mean Ratio with Lognormal Data

```
PROC Power; TwoSampleMeans
test=equiv_ratio
lower = 3   upper = 7   meanratio = 5
cv = 0.75
npergroup = 50
power = .;
run;
```

Proc Power: TwoSampleMeans page 85- 87** 6381-6383

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Confidence Interval for Mean Difference

```
PROC Power; TwoSampleMeans
ci = diff
halfwidth = 4
stddev = 8
groupns = (30 35)
probwidth = .;
run;
```

Proc Power: TwoSampleSurvival page 96-99 ** 6392-6395

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Balanced Log-Rank Test Two Survival Curves

```
PROC Power; TwoSampleSurvival
test=logrank
curve("Control") = (1 2 3):(0.8 0.7 0.6)
curve("Treatment") = (5):(.6)
groupsurvival = "Control" | "Treatment“
accrualtime = 2
followuptime = 1
npergroup = 50
Power =. ;   run;
```

UNBalanced Log-Rank Test-Two Survival Curves

```
PROC Power; TwoSampleSurvival
test=logrank
curve("Control") = (1 2 3):(0.8 0.7 0.6)
refsurvival = "Control“
hazardratio = 1.5
accrualtime = 2
followuptime = 1
groupweights = (1 2)
ntotal = .
power = 0.8;    run;
```

Proc Power: TwoSampleSurvival page 96-99 ** 6392-6395

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Calc. accrual rate using ACCRUALRATETOTAL=

```
PROC Power; TwoSampleSurvival
test=logrank
curve("Control") = (1 2 3):(0.8 0.7 0.6)
refsurvival = "Control“
hazardratio = 1.5
accrualtime = 2
followuptime = 1
groupweights = (1 2)
accrualratetotal = .
power = 0.8;  run;
```

Calc. expected # of events

```
PROC Power; TwoSampleSurvival
test=logrank
curve("Control") = (1 2 3):(0.8 0.7 0.6)
refsurvival = "Control“
hazardratio = 1.5
accrualtime = 2
followuptime = 1
groupweights = (1 2)
eventstotal = .
power = 0.8;  run;
```

Proc Power: TwoSampleSurvival page 96-99 ** 6392-6395

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

specify sample n with the GROUPNS= and specify exp. survival curves in terms of median survival times

```
PROC Power; TwoSampleSurvival
test = logrank
groupmedsurvtimes = (16 22)
accrualtime = 6          totaltime = 18
groupns = 40 | 60
power = .;
```

Specify exp. survival curves using hazard ratio and reference hazard.

```
PROC Power; TwoSampleSurvival
test = logrank
hazardratio = 1.2    refsurvexphazard = 0.7
accrualtime = 2      totaltime = 4
ntotal = 100
power = .;
run;
```

Proc Power: TwoSampleSurvival page 96-99 ** 6392-6395

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

You can also specify exponential survival curves in terms of the individual hazards, as in the following statements:

```
PROC Power; TwoSampleSurvival
test = logrank
groupsurvexphazards = 0.7 | 0.84
accrualtime = 2
totaltime = 4
ntotal = .
power = 0.9;
run;
```

Proc Power: TwoSampleSurvival page 96-99 ** 6392-6395

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

Gehan Rank Test for Two Survival Curves

```
PROC Power; TwoSampleSurvival
test = Gehan
groupmedsurvtimes = 5 | 7
accrualtime = 3          totaltime = 6
npergroup = .
power = 0.8;
run;
```

Tarone-Ware Rank Test--2 Survival Curves

```
PROC Power; TwoSampleSurvival
test = TaroneWare
groupmedsurvtimes = 5 | 7
accrualtime = 3          totaltime = 6
npergroup = 100
power = .;
run;
```

Proc Power: TwoSampleWilcoxon page 103** 6399

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

```
Proc Power; TwoSampleWilcoxon
vardist("myordinal") = ordinal ((0 1 2) : (.2 .3 .5))
vardist("mybeta1") = beta (1, 2)
vardist("mybeta2") = beta (1, 2, 0, 2)
vardist("mybinomial") = binomial (.3, 3)
vardist("myexponential") = exponential (2)
vardist("mygamma") = gamma (1.5, 2)
vardist("mylaplace") = laplace (1, 2)
vardist("mylogistic") = logistic (1, 2)
vardist("mylognormal") = lognormal (1, 2)
vardist("mynormal") = normal (3, 2)
vardist("mypoisson") = poisson (2)
vardist("myuniform") = uniform (0, 2)
variables = "myordinal" | "mybeta1" "mybeta2" "mybinomial"
"myexponential" "mygamma" "mylaplace"
"mylogistic" "mylognormal" "mynormal"
"mypoisson" "myuniform"
ntotal = 40
power = . ; run;
```

Show results

Proc Power: TwoSampleWilcoxon page 103 6399**

http://support.sas.com/documentation/onlinedoc/stat/131/power.pdf

The POWER Procedure Wilcoxon-Mann-Whitney Test

Fixed Scenario Elements	
Method	O'Brien-Castelloe approximation
Total Sample Size	40
Number of Sides	2
Alpha	0.05
Group 1 Weight	1
Group 2 Weight	1
NBins Per Group	1000

Computed Power				
Index	Variables		Pooled N Bins	Power
1	myordinal	mybeta1	1003	0.887
2	myordinal	mybeta2	1002	0.718
3	myordinal	mybinomial	5	0.404
4	myordinal	myexponential	1003	0.132
5	myordinal	mygamma	1003	0.741
6	myordinal	mylaplace	1002	0.124
7	myordinal	mylogistic	1002	0.103
8	myordinal	mylognormal	1003	0.578
9	myordinal	mynormal	1003	0.894
10	myordinal	mypoisson	10	0.359
11	myordinal	myuniform	1002	0.413

PROC GLMPower

Examples from the Web
SAS Documentation
SUG papers &

Academic web pages

PROC GLMPower Syntax

The GLMPOWER procedure performs prospective power analysis for general linear models. The procedure supports:

Type III tests and contrasts of fixed class effects

continuous and categorical covariates

unbalanced designs

customized graphics.

PROC GLMPOWER requires an exemplary data set that is used to pass parameters to PROC GLMPower.

1) The Input data set will contain:

2) Population response means

3) Design weights (If unbalanced design)

multiple scenarios can be simulated in one PROC GLMPower call.

PROC GLMPOWER *<options>*;

CLASS *variables;*

MODEL *dependent-variables = classification-effects;*

WEIGHT *variable;*

CONTRAST *'label' effect values<...effectvalues></options>;*

POWER <*options*>*;*

PLOT*<plot-options></graph-options>;*

RUN;

PROC GLMPower Syntax

X variables can be categorical, continuous or a mixture of both.

Each Y variable must point to a set of cell averages in the data

Multiple Y variables can be processed in one proc

Main effects and interactions are modeled in a manner similar to GLM

You can model the effect of covariates with:

the NCOVARIATES= option and **one of** the
1) CORRXY= or
2) PROPVARREDUCTION= options

There are **other** syntax limitations/Quirks:

The class statement appears above the Model statement.
The MODEL statement appears above the POWER statement.

GLMPower

http://familymed.uthscsa.edu/research08/pcrmsc/20
h_2005/presentations/5.%20Sample%20Size%20and
%20Power,%20John%20Boltri%20MD,%20Cindy%20
Passmore%20MS,%20Robert%20L%20Vogel%20PhD
.pdf

```
Data bp;
input treat$ reduce cellwgt @@;
Datalines;
1placebo   5    1  2standard 12    1
3Newlow 10.5 1  4Newhigh 13.5  1;
run;

PROC GLMPower data=bp data=order;
class treat;
model reduce=treat;
weight cellwgt;
contrast 'placebo vs. low' treat 10-10;
contrast 'placebo vs. high' treat 100-1;
contrast 'standard vs. low' treat 01-10;
contrast 'standard vs. high' treat 010-1;
power
stddev=6 alpha=0.0125 ntotal = .
power=0.9;
PLOT X=power Min=.1 Max=.95
Key=OnCurves;  run;
```

We wish to compare the reduction in blood pressure resulting from use of a placebo, a standard drug and a new drug at both a low dose and a high dose. Previous studies with the standard drug suggest a standard deviation of about 6 mmHg.

In the past the placebo has resulted in reductions of about 5mmHg and the standard drug of about 12mmHg.

The researcher guesses the low dose new drug will result in a reduction of about 10.5 mmHg and the high dose will result in a reduction of about 13.5 mmHg.

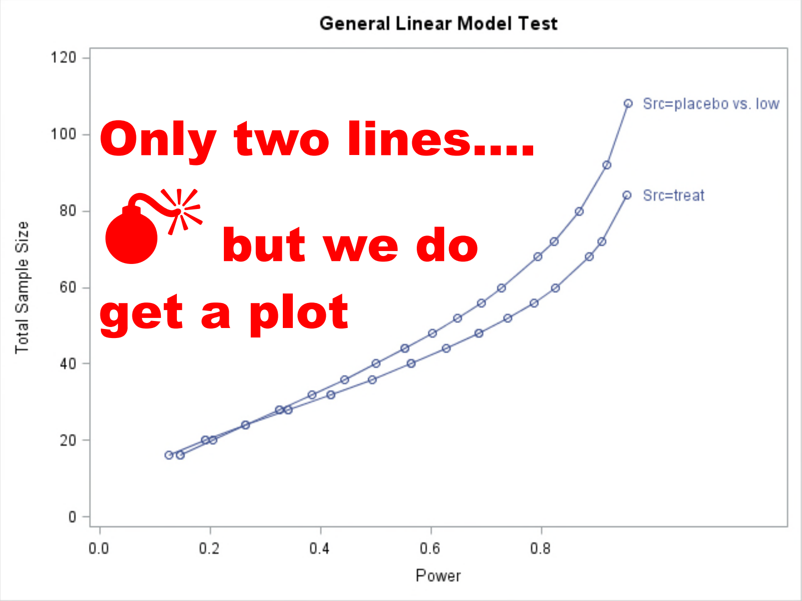
Show results

GLMPower

http://familymed.uthscsa.edu/research08/pcrmsc/2005_h_2005/presentations/5.%20Sample%20Size%20and%20Power,%20John%20Boltri%20MD,%20Cindy%20Passmore%20MS,%20Robert%20L%20Vogel%20PhD.pdf

The GLMPOWER Procedure

Fixed Scenario Elements	
Dependent Variable	reduce
Weight Variable	cellwgt
Alpha	0.0125
Error Standard Deviation	6
Nominal Power	0.9



Computed N Total

Index	Type	Source	Test DF	Error DF	Actual Power	N Total	Error
1	Effect	treat	3	68	0.909	72	
2	Contrast	placebo vs. low	1	84	0.903	88	
3	Contrast	placebo vs. high	.	.	.	.	Inestimable
4	Contrast	standard vs. low	.	.	.	.	Inestimable
5	Contrast	standard vs. high	.	.	.	.	Inestimable

Example 47.3 Repeated Measures ANOVA

http://support.sas.com/documentation/cdl/en/statug/67523/HTML/default/viewer.htm#statug_glmpower_examples03.htm

Repeated Measures

```
Data Pain;
input Treatment $
     PainMem0      PainMem1Wk
     PainMem6Mo PainMem12Mo;
datalines;
SensoryFocus    2.40  2.38  2.05   1.90
StandardOfCare 2.40  2.39  2.36   2.30;
Run;
```

```
ods graphics on;
PROC GLMPower data=Pain;
CLASS Treatment;
MODEL PainMem0 PainMem1Wk PainMem6Mo
         PainMem12Mo  = Treatment;
repeated Time contrast;
POWER mtest = hlt alpha = 0.01
  power = .9      ntotal = .
  StdDev = 0.92 1.04
  Matrix ("PainCorr") =
     lear(0.6, 0.8, 4, 0 1 26 52)
  CorrMat = "PainCorr";
PLOT y=power   min=0.05 max=0.99
       yopts=(ref=0.9) vary (linestyle by stddev,
       symbol by dependent source); run;
ods graphics off;
```

Logan, Baron, and Kohout (1995) and Guo et al. (2013) study a dental intervention on the memory of pain.

The study compare sensory focus to standard care over a period of a year, asking patients to self-report immediately after the procedure and then again at 1 week, 6 , and 12 months.

The correlation is thought to be linear exponent autoregressive (LEAR), with a correlation of about 0.6 and a decay rate of about 0.8 over one-week intervals. X has 2 levels (sensory focus versus standard care), and you allocate to a balanced design.
The within-subject factor is time, with four levels (0, 1, 26, and 52 weeks).

Show results

http://support.sas.com/documentation/cdl/en/statug/67523/HTML/default/viewer.htm#statug_glmpower_examples03.htm

Table 47.14: Conjectured Correlation Matrix

Time (week)	0	1	26	52
0	1	0.6	0.491	0.399
1	0.6	1	0.495	0.402
26	0.491	0.495	1	0.491
52	0.399	0.402	0.491	1

Example 47.3 Repeated Measures ANOVA

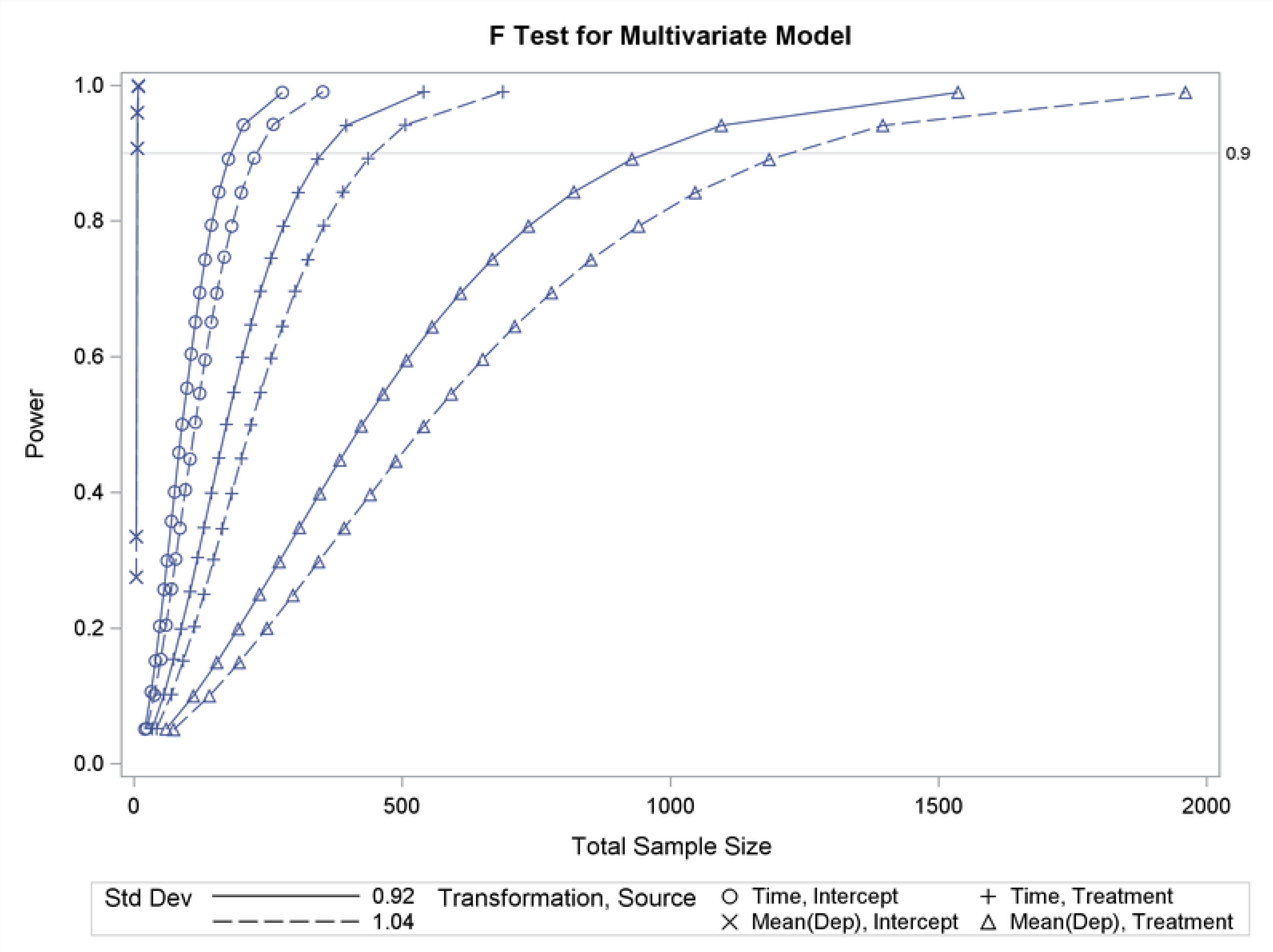
http://support.sas.com/documentation/cdl/en/statug/67523/HTML/default/viewer.htm#statug_glmpower_examples03.htm

Computed N Total

Index	Transformation	Source	Std Dev	Effect	Num DF	Den DF	Actual Power	N Total
1	Time	Intercept	0.92	Time	3	176	0.90	180
2	Time	Intercept	1.04	Time	3	226	0.90	230
3	Time	Treatment	0.92	Time*Treatment	3	346	0.90	350
4	Time	Treatment	1.04	Time*Treatment	3	442	0.90	446
5	Mean(Dep)	Intercept	0.92	Intercept	1	4	0.96	6
6	Mean(Dep)	Intercept	1.04	Intercept	1	4	0.90	6
7	Mean(Dep)	Treatment	0.92	Treatment	1	950	0.90	952
8	Mean(Dep)	Treatment	1.04	Treatment	1	1214	0.90	1216

Example 47.3 Repeated Measures ANOVA

http://support.sas.com/documentation/cdl/en/statug/67523/HTML/default/viewer.htm#statug_glmpower_examples03.htm



Stat 582

☹ Throws Error

but message is not the most helpful

STAT 582 GLMPower

http://www.stat.purdue.edu/~jennings/stat582/software/SAS.pdf

```
Data Fluids;
INFILE DATALINES FIRSTOBS=2;
input @1 Fluid $CHAR5. @7 LacticAcid1 @14 LacticAcid2 @23 CellWgt;
datalines;
123456789012345678901234567890
Water 35.6   35.6     2
A1    33.7   33.7     1
A2    30.2   30.2     1
B1    29     28       1
B2    25.9   25.9     1
;
/*Then the SAS code for the power analysis
 with standard deviation=3.75
alpha=0.025 and power=0.9 is:*/
PROC GLMPower data =Fluids;
Class Fluid;
weight CellWgt;
Model Fluid = LacticAcid1 LacticAcid2;
power stddev =3.75
     alpha=0.025
     ntotal=.
     power=0.9;
run;
quit;
```

☹ Throws Error because Fluid is character

```
16   PROC GLMPower data =Fluids;
17   Class Fluid;
18   weight CellWgt;
19   Model Fluid = LacticAcid1 LacticAcid2;
ERROR: Variable Fluid in list does not match type prescribed for this list.
NOTE: The previous statement has been deleted.
20   power stddev =3.75
21         alpha=0.025
22         ntotal=.
23         power=0.9;
24   run;
```

Cuckoo egg Power examples

Complex and Cool Examples

that compare

different methods of calculating power

and show how

Group means , in ANOVA, affect power

Cuckoo Power examples

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

/* There are 6 host species in whose nests cuckoo birds lay eggs. What sample size is needed to detect a difference between 21 and 23 mm. The standard deviation is about 1 mm. */

Compute power curves for a single factor CRD ANOVA */

Power computations will be done using three procedures –

Proc Power: suitable for simple designs –
Proc GLMPower: suitable for more complex designs with a single error term allowing for covariates etc. –
Methods of Stroup: suitable for ALL design (including those with multiple error terms)

SAS also has an interactive program to compute power - look in your SAS directory under the START button in WinDoze */ dm 'output' clear; dm 'log' clear;

Cuckoo Power examples

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

5 examples form the same research project

All are ANOVA problems with 6 Classes/Levels of X

PROC Power
with two different sets of means

PROC GLMPower
with the same two sets of means

Stroup's method

Ex #1 Means are: 21 22 22 22 22 23
Worst configuration of means – Hardest to detect

Ex #2 Means are: 21 21 21 23 23 23
Best configuration of means – Easiest to detect

Cuckoo Ex. #1

Proc Power Hard to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
options orientation=landscape; ods
pdf file=‘E:\____Proc_power\\cuckoo-power.pdf';
goptions device=pdf colors=(black) rotate=landscape;
title 'Cuckoo egg size power analysis';
options nodate noovp;
%let alpha=.05;  %let power=.80;  %let stddev= 1;
%let var =%sysevalf(&stddev*&stddev); /*←compute variance */
PROC POWER; title2 'Using a base difference of 2 mm';
  onewayanova
  groupmeans = 21 | 22 | 22 | 22 | 22 | 23 /* list group means*/
  stddev = &stddev /* what is the standard deviation */
  alpha = &alpha /* what is the alpha level */
  power = &power /* target power */
  ntotal = . /* solve for TOTAL samplesize */ ;
 /* end of the onewayanova statement - don't forget it */
plot y=power yopts=(ref=.80 crossref=yes) min=.05 max=.95;
footnote 'This configuration has the worst power and so the largest
possible sample size'; run;
```

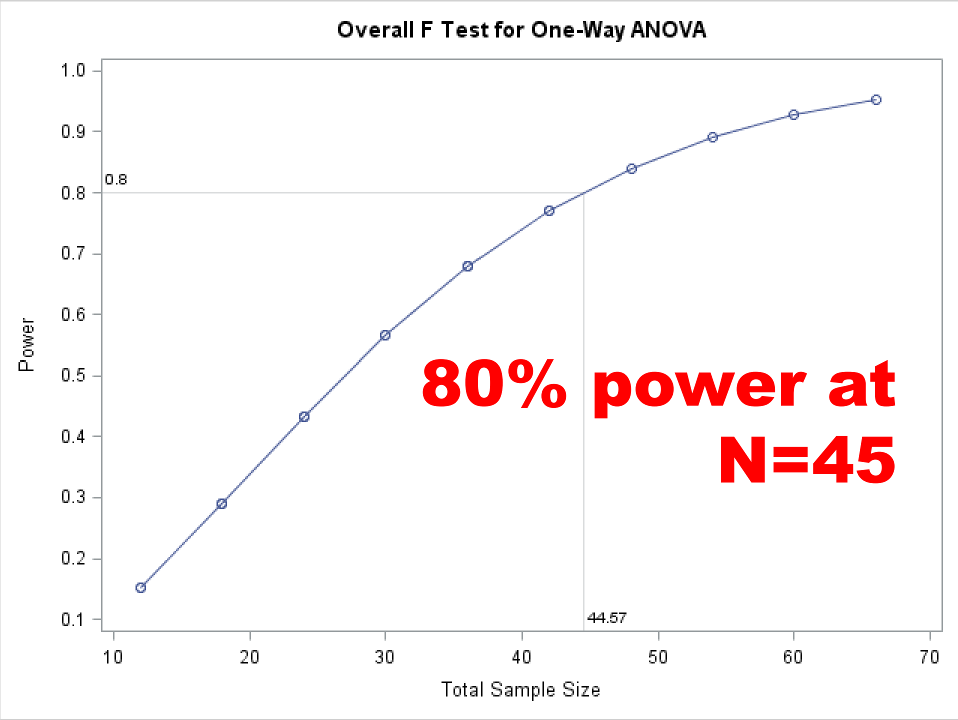
Show results

Cuckoo Ex. #1
Proc Power Hard to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

The POWER Procedure
Overall F Test for One-Way ANOVA

Fixed Scenario Elements	
Method	Exact
Alpha	0.05
Group Means	21 22 22 22 22 23
Standard Deviation	1
Nominal Power	0.8
Group Weights	1 1 1 1 1 1



Computed N Total	
Actual Power	N Total
0.840	48

Cuckoo Ex. #2

Proc Power Easy to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
proc power;
title2 'Using a base difference of 2 mm with a different configuration of means';
onewayanova groupmeans=21| 21| 21| 23| 23| 23/*list group means*/
stddev = &stddev /* what is the standard deviation */
alpha = &alpha /* what is the alpha level */
power = &power /* target power */
ntotal = . /* solve for TOTAL sample size */ ;
/* end of the onewayanova statement - don't forget it */
plot y=power yopts=(ref=.80 crossref=yes) min=.05 max=.95;;
footnote 'This configuration has the best power and so the smallest possible sample size'; run;
```

Show results

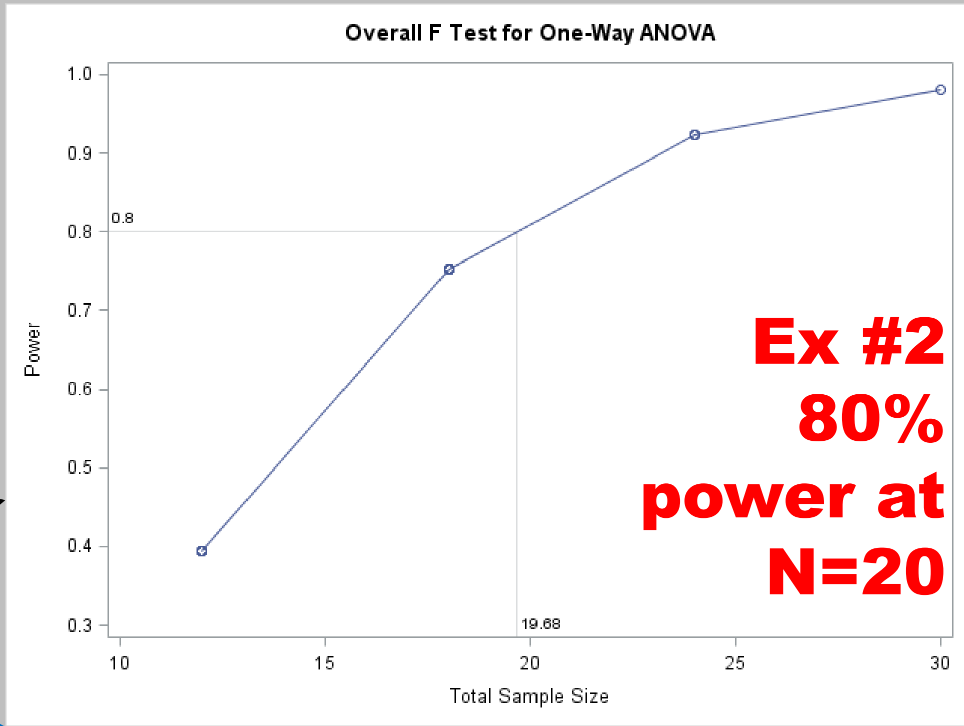
Cuckoo Ex. #2
Proc Power Easy to detect

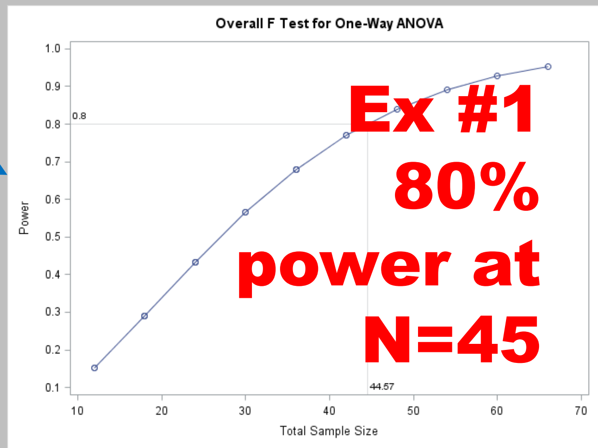
http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

The POWER Procedure
Overall F Test for One-Way ANOVA

Fixed Scenario Elements	
Method	Exact
Alpha	0.05
Group Means	21 21 21 23 23 23 **Ex #1 Means were** 21 22 22 22 22 23
Standard Deviation	1
Nominal Power	0.8
Group Weights	1 1 1 1 1 1

Computed N Total	
Actual Power	N Total
0.923	24





Cuckoo Ex. #3

Proc GLMPower Hard to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

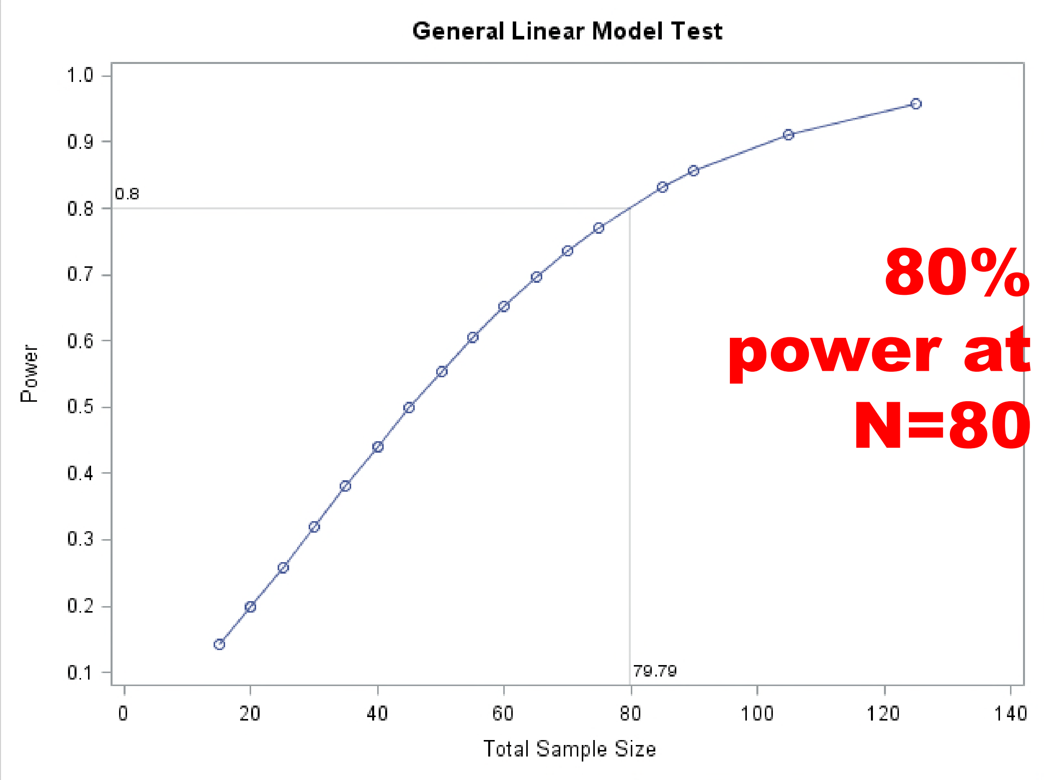
```
data means;
infile datalines ;
input species $ mean_set1 mean_set2  @@;
datalines;
s1 21 21   s2 22 21   s3 22 21  s4 22 23  s5 22 23 s6 23 23
;run;

proc glmpower data=means;
title2 'GLMPower - Worst configuration of means';
class species;
model mean_set1 = species;
power stddev = &stddev
   alpha = &alpha
   ntotal = .
   power = &power;
  plot y=power yopts=(ref=.80 crossref=yes) min=.05 max=.95;; run;
```

Show results

Cuckoo Ex. #3
Proc GLMPower Hard to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

Fixed Scenario Elements	
Dependent Variable	mean_set1
Source	species
Alpha	0.05
Error Standard Deviation	1
Nominal Power	0.8
Test Degrees of Freedom	4



Computed N Total		
Error DF	Actual Power	N Total
75	0.803	80

Cuckoo Ex. 4

Proc GLMPower Easy to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
data means;
infile datalines ;
input species $ mean_set1 mean_set2  @@;
datalines;
s1 21 21   s2 22 21   s3 22 21  s4 22 23  s5 22 23 s6 23 23
;run;
proc glmpower data=means;
title2 'GLMPower - Best configuration of means';
class species;
model mean_set2 = species;
power stddev = &stddev
   alpha = &alpha
   ntotal = .
   power = &power;
  plot y=power yopts=(ref=.80 crossref=yes) min=.05 max=.95;; run;
```

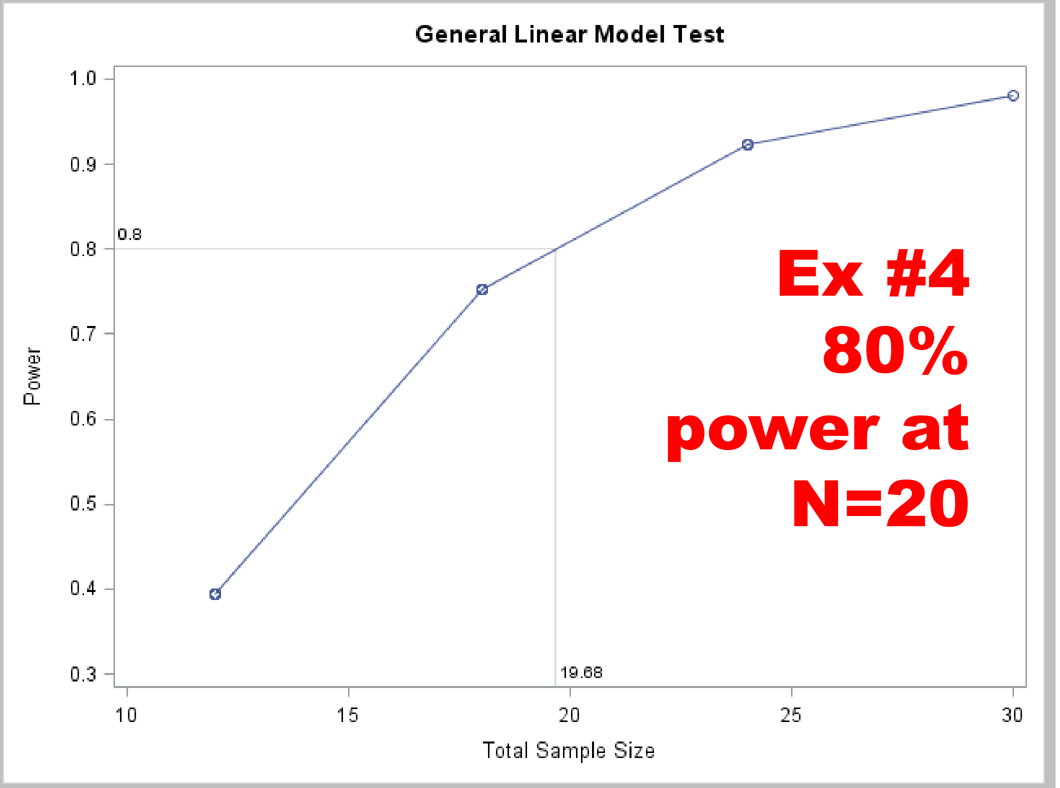
Show results

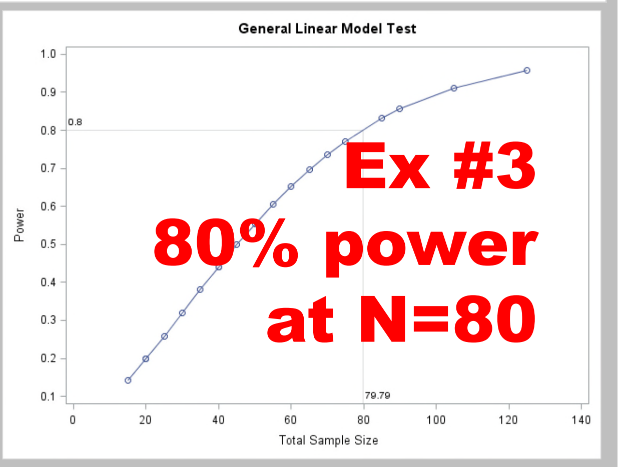
Cuckoo Ex. 4
Proc GLMPower Easy to detect

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

Fixed Scenario Elements	
Dependent Variable	mean_set2
Source	species
Alpha	0.05
Error Standard Deviation	1
Nominal Power	0.8
Test Degrees of Freedom	5

Computed N Total		
Error DF	Actual Power	N Total
18	0.923	24





Cuckoo Ex. 5
Stroup Ex #1

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

/* This will illustrate how to estimate the power based on the ideas of **Stroup, W. W.** (1999) Mixed model procedures to assess power, precision, and sample size in the design of experiments. Pages 15-24 in Proc. Biopharmaceutical Section. Am. Stat. Assoc., Baltimore, MD. The nice thing about this method is that it can be used for ANY design regardless of complexity. The idea is to

1. Create a data set with the structure of the design to be assessed. Instead of observed data, use the means that reflect the departure from H0 of interest.

2. Run PROC MIXED with the variance and covariance components set at the anticipated values. Use the NOPROFILE and NOITER options (see below) to set the (co)variance components.

3. The MODEL and CONTRAST statements in PROC MIXED compute F values which gives the non-centrality parameter.

4. Pass these to a data step that estimates the power

5. Plot (or print) the results. You can have several sets of means identified by the set number and separate power computations will be done for each set

Cuckoo Ex. 5
Stroup Ex #1

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
data effect_sizes;
   set means;
    set = 1; mu = mean_set1; output;
    set = 2; mu = mean_set2; output;
    keep set species mu; ;;
proc sort data=effect_sizes;
  by set species;    run;

proc tabulate data=effect_sizes;
title2 'Effect sizes for which power computations are done';
class set species;
var mu;
table set, species*mu*sum=' '*f=5.0 / rts=10; run;

/* Generate data sets for various sample sizes for later plotting purposes */
data trials;
set effect_sizes;
    do n_per_group = 2 to 20 by 1; /* number of replicates at level of the factor */
      /* generate data with sufficient replicates all with the same mean values */
         do rep=1 to n_per_group;
             output;
          end;
end;
attrib n_per_group label='Number of replicates at each species';
run;
```

set	species					
	s1	s2	s3	s4	s5	s6
	mu	mu	mu	mu	mu	mu
1 hard	21	22	22	22	22	23
2 Easy	21	21	21	23	23	23

More Code & Print Trials

Cuckoo Ex. 5
Stroup Ex #1

```
proc sort data=trials;
by set n_per_group;  /* group data appropriately */

proc print data=trials(obs=30);
title2 'part of the generated data';  run;
```

From loop on previous slide

Obs	species	set	mu	N /group	rep
1	s1	1	21	2	1
2	s1	1	21	2	2
3	s2	1	22	2	1
4	s2	1	22	2	2
5	s3	1	22	2	1
6	s3	1	22	2	2
7	s4	1	22	2	1
8	s4	1	22	2	2
9	s5	1	22	2	1
10	s5	1	22	2	2
11	s6	1	23	2	1
12	s6	1	23	2	2
13	s1	1	21	3	1
14	s1	1	21	3	2
15	s1	1	21	3	3
16	s2	1	22	3	1
17	s2	1	22	3	[illegible]
18	s2	1	22	[illegible]	[illegible]
19	s3	1	22	[illegible]	[illegible]
20	s3	1	22	[illegible]	[illegible]
21	s3	1	22	3	[illegible]
22	s4	1	22	3	1
23	s4	1	22	3	2
24	s4	1	22	3	3
25	s5	1	22	3	1
26	s5	1	22	3	2
27	s5	1	22	3	3
28	s6	1	23	3	1
29	s6	1	23	3	2
30	s6	1	23	3	3

More Code

Cuckoo Ex. 5
Stroup Ex #1

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
/* Show the results from ONE analysis */
proc mixed
     data=trials noprofile;
/* the noprofile options prevents trying to fit the model */
title2 'Estimate the non-centrality parameter for one set of data ';
where set=1 & n_per_group=2;
by set n_per_group;
class species;
model mu = species; parms (&var) / noiter;
/* this is where the estimated variance components are specified */
run;
```

Show 1 result

Dimensions	
Covariance Parameters	1
Columns in X	7
Columns in Z	0
Subjects	12
Max Obs Per Subject	1

Fit Statistics	
-2 Res Log Likelihood	15.2
AIC (smaller is better)	15.2
AICC (smaller is better)	15.2
BIC (smaller is better)	15.2

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
species	5	6	0.80	0.5876

Cuckoo Ex. 5
Stroup Ex #1

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
/* Estimate the non-centrality parameter
from all the combinations */
ods select none; run;
/* turn the output off as it is not needed */
proc mixed data=trials noprofile;
/* the noprofile options prevents trying
to fit the model */
title2 'Estimate the non-centrality
parameter ';
by set n_per_group;
class species;
model mu = species;
parms (&var) / noiter;
/* this is where the estimated variance
  components are specified */
/* save the results to the ods datasets */
ods output tests3=
    whole_model_power_effects;
/* extract the F-statistic */ run;
ods select all;
run; /* turn the output back on */

proc print data=whole_model_power_effects(obs=20);
title2 'Part of the output from Proc Mixed on the fake data';
```

Obs	set	n/ group	Effect	NumD F	DenD F	FValu e	ProbF
1	1	2	species	5	6	0.80	0.587
2	1	3	species	5	12	1.20	0.366
3	1	4	species	5	18	1.60	0.210
4	1	5	species	5	24	2.00	0.115
5	1	6	species	5	30	2.40	0.060
6	1	7	species	5	36	2.80	0.030
7	1	8	species	5	42	3.20	0.015
8	1	9	species	5	48	3.60	0.007
9	1	10	species	5	54	4.00	0.003
10	1	11	species	5	60	4.40	0.001
11	1	12	species	5	66	4.80	0.000
12	1	13	species	5	72	5.20	0.000
13	1	14	species	5	78	5.60	0.000
14	1	15	species	5	84	6.00	<.000
15	1	16	species	5	90	6.40	<.000
16	1	17	species	5	96	6.80	<.000
17	1	18	species	5	102	7.20	<.000
18	1	19	species	5	108	7.60	<.000
19	1	20	species	5	114	8.00	<.000
20	2	2	species	5	6	2.40	0.158

Show results

Cuckoo Ex. 5
Stroup Ex #1

http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-power.sas

```
/* now to compute approximations to the power */

data power;
   set whole_model_power_effects;
   nc = numdf*Fvalue;
   /* approximate non-centrality parameter */
   fcrit = finv(1-&alpha, numDF, denDF, 0);
  /* estimate critical value */
  power = 1 - probf(fcrit, numdf, dendf, nc);
  /* estimated power */
 attrib power label='Power' format=7.2;
 attrib nc label='Non-centrality' format=7.1;
 attrib fcrit label='F-critical value' format=7.2;
 drop probF;
 run;
```

Show results

Cuckoo Ex. 5
Stroup Ex #1

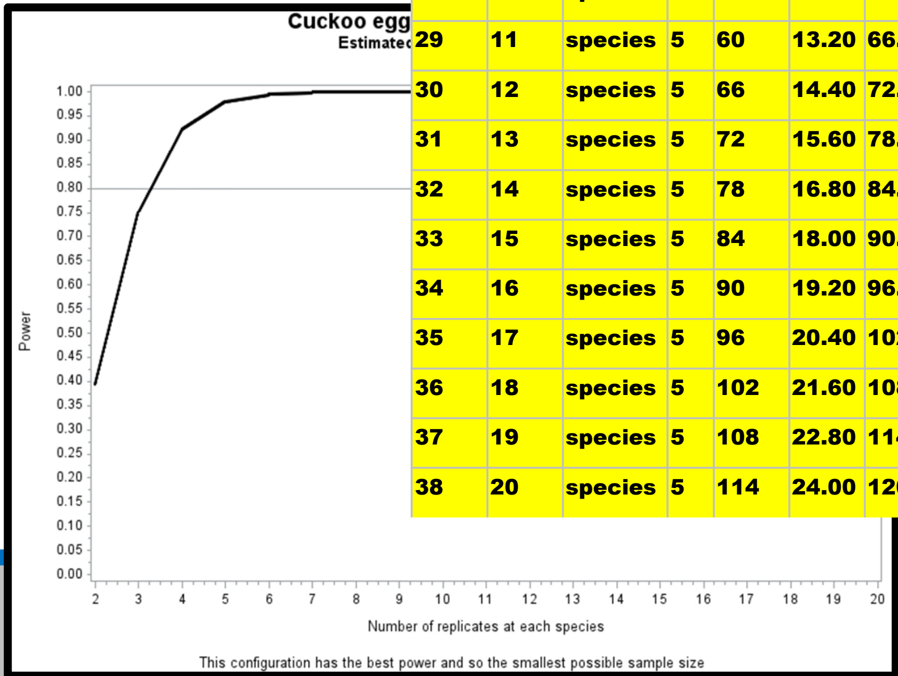
http://people.stat.sfu.ca/~cschwarz/Stat-LinearModels/Examples/CRD.fixed/cuckoo-

```
proc print data=power label split=' ';
title2 'Estimated power using Stroup method
by set; run;

PROC GPLOT data=power;
title2 "Estimated power at alpha=&alpha";
by set;
axis1 label=(a=90 r=0
 'Power') order=0 to 1 by .05;
plot power*n_per_group
   / vaxis=axis1 vref=.80;
symbol1
 v=none i=join w=2 l=1; run;
ods pdf close;
run;
```

Show results

Obs	Number of replicates at each species	Effect	Num DF	Den DF	F Value	Non-centrality	F-critical value	Power
20	2	species	5	6	2.40	12.0	4.39	0.39
21	3	species	5	12	3.60	18.0	3.11	0.75
22	4	species	5	18	4.80	24.0	2.77	0.92
23	5	species	5	24	6.00	30.0	2.62	0.98
24	6	species	5	30	7.20	36.0	2.53	1.00
25	7	species	5	36	8.40	42.0	2.48	1.00
26	8	species	5	42	9.60	48.0	2.44	1.00
27	9	species	5	48	10.80	54.0	2.41	1.00
28	10	species	5	54	12.00	60.0	2.39	1.00
29	11	species	5	60	13.20	66.0	2.37	1.00
30	12	species	5	66	14.40	72.0	2.35	1.00
31	13	species	5	72	15.60	78.0	2.34	1.00
32	14	species	5	78	16.80	84.0	2.33	1.00
33	15	species	5	84	18.00	90.0	2.32	1.00
34	16	species	5	90	19.20	96.0	2.32	1.00
35	17	species	5	96	20.40	102.0	2.31	1.00
36	18	species	5	102	21.60	108.0	2.30	1.00
37	19	species	5	108	22.80	114.0	2.30	1.00
38	20	species	5	114	24.00	120.0	2.29	1.00

Show results



Proc Mixed

An Introduction to Statistical Power Calculations for Linear Models with SAS 9.1

Robin High, University of Oregon

/*Power Computations with PROC MIXED

Studies frequently utilize more complicated designs than T-tests or independent groups ANOVAs.

Researchers may compute power for studies with these simpler designs and then run the experiment with a more complex one, assuming the power results from the former act as an "upper bound" since efficiencies are produced by the chosen design. That is, if 30 subjects are deemed necessary to meet study objectives under an independent groups design (e.g., a study will have .80 power to detect a given effect), power will likely increase if a repeated measures design is chosen.

To illustrate the flexibility of PROC MIXED, its ability to compute power for the independent groups design will be shown first.

The general process is described in Chapter 12 of "SAS for Mixed Models (Littell, et. al.). With manipulation of the inputs to PROC MIXED and specifying the variance, results

from the table of "Type3 Tests of Fixed Effects" will produce the power calculation for a two-sample t-test: */

Statistical Power Analysis Using SAS and R

Contrasts 55 pages and many examples

http://jansenlex.readyhosting.com/pnwsug/2007/Robin%20High%20-%20Statistical%20Power%20Calculations%20for%20Linear%20Models.pdf

```
DATA anv;
INPUT group $ mean count @@;
* assume equal group sizes;
CARDS;
A 10 86  B 12 86
;
ODS OUTPUT tests3=tst3;
PROC MIXED DATA=anv NOProfile;
 * add the NOProfile option;
CLASS group;
WEIGHT count;
MODEL mean = group / ddf=170;
* add the error degrees of freedom;
PARMS (16) / NOITER ;
* enter the assumed population variance;
RUN;
```

```
DATA pwr;
SET tst3; alpha = .05;
NonCen = NumDF*Fvalue;
Fcrit = FINV(1-alpha, numdf, dendf, 0);
Power =
  1- PROBF(Fcrit, NumDF, DenDF, NonCen);
run;

PROC PRINT DATA=pwr NOobs;
run;
```

Show results

Effect	NumDF	DenDF	FValue	ProbF	alpha	NonCen	Fcrit	Power
group	1	170	10.75	0.0013	0.05	10.75	3.8967	0.9032

Power for More Uncommon Design Situations

Simulations

Power for More Uncommon Design Situations

http://jansenlex.readyhosting.com/pnwsug/2007/Robin%20High%20-%20Statistical%20Power%20Calculations%20for%20Linear%20Models.pdf

```
DATA prd_t;
sigma=4;              * standard deviation of an observation = σ;
delta=2;              *  difference in means to be detected = Δ ;
crr=.25;              *  within subject correlation = ρ;
alpha=.05;            * Type I error = α;
power=.9032;          * Power of the test = 1-ß;
beta=1-power;         * Type II error = ß;
sides=2;              * 1 or 2 sided;
* compute standard deviation of a difference of correlated values;
sigma_dif = sigma*SQRT(2*(1-crr));
z_a=ABS(PROBIT(alpha/sides));
z_b=ABS(PROBIT((1-beta)));
NSubj = CEIL(((z_a + z_b)**2) * ((sigma_dif/delta)**2));
RUN; PROC PRINT NOobs; run;
```

Show Results

sigma	delta	crr	alpha	power	beta	sides	sigma_dif	z_a	z_b	NSubj
4	2	0.25	0.05	0.90	0.097	2	4.899	1.96	1.30	64

SIMULATION

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
OPTIONS nocenter Nodate nonumber
  linesize=MAX pagesize=MAX
  formdlim = '-'
  nomprint nosymbolgen nomlogic ;
TITLE ;
ODS GRAPHICS OFF;
* GENERATE DATA 4 ANOVA MODEL;
* SIMULATION SPECIFICS;
%GLOBAL n1 n2 n3
  mean1 mean2 mean3
  sd1 sd2 sd3
  ngroups nreps SeedVar;
%LET ngroups = 3;
%LET mean1 = 11.4;
%LET mean2 = 16.7;
%LET mean3 = 4.0;
%LET sd1 = 10.0;
%LET sd2 = 10.0;
%LET sd3 = 10.0;
%LET n1 = 20;
%LET n2 = 20;
%LET n3 = 20;
%LET nreps = 100;
%LET SeedVar = 7;
```

```
%MACRO simulateANOVA ;
DATA ANOVAsim;
CALL streaminit(&SeedVar.); *set random seed;
%DO replication = 1 %TO &nreps.;
  %DO group = 1 %TO &ngroups.;
    %DO n = 1 %TO &&n&group.;
      Y        =
RAND('NORMAL',%SYSEVALF(&&mean&group.),%SYSEVALF(&&sd&group.));
      mean      = &&mean&group.;
      sd        = &&sd&group.;
      group     =&group.;
      person    =&n.;
      replication=&replication.;
      OUTPUT;
    %END;
    *person loop;
  %END;*group loop;
%END; *replication loop;
RUN;
%MEND simulateANOVA;
```

More Code

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
%simulateANOVA;
* Run ANOVA per dataset, save
results;
PROC GLM DATA =ANOVAsim;
  BY replication;
  CLASS
  group;
  MODEL y = group / SS3 ;
  ODS OUTPUT FitStatistics=R2
      ModelANOVA=SumSquares
OverallANOVA=ANOVA
LSMeans=Means;
  LSMEANS group;
RUN;
```

Two Examples

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The GLM Procedure
replication=1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2744.2	1372.1	15.37	<.0001
Error	57	5088.6	89.2		
Total	59	7832.9			

The GLM Procedure
replication=2

More Code

```
DATA SumSquares;
 SET SumSquares;
IF ProbF LT .05 THEN Signif=1;
ELSE                 Signif=0;
 RUN;
```

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	669.4	334.7	2.48	0.0927
Error	57	7690.1	134.9		
Total	59	8359.5			

R-Square	Coeff Var	Root MSE	Y Mean
0.350348	92.61810	9.448551	10.20163

R-Square	Coeff Var	Root MSE	Y Mean
0.080081	92.17956	11.61525	12.60068

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
TITLE "Proportion Significant
Omnibus F-test for Group";
PROC MEANS DATA =SumSquares;
VAR Signif;
RUN ;
TITLE "Simulated Group Means" ;

PROC MEANS DATA = Means;
CLASS Group;
VAR yLSmean;
RUN;
```

Proportion Significant Omnibus F-test for Group

Analysis Variable : Signif				
N	Mean	Std Dev	Min	Max
100	0.910	0.287	0	1.000

Analysis Variable : YLSMean Y LSMEAN						
group	N Obs	N	Mean	Std Dev	Minimum	Maximum
1	100	100	11.32	2.48	4.34	17.22
2	100	100	16.17	2.18	11.13	21.43
3	100	100	4.062	2.29	-1.04	9.95

SIMULATION Unequal variances

```
%MACRO simulateANOVA ;
DATA ANOVAsim;
CALL streaminit(&SeedVar.); *set random seed;
%DO replication = 1 %TO &nreps.;
  %DO group = 1 %TO &ngroups.;
    %DO n = 1 %TO &&n&group.;
       Y        =
RAND('NORMAL',%SYSEVALF(&&mean&group.),%SYSEVALF(&&sd&group.));
       mean      = &&mean&group.;
       sd        = &&sd&group.;
       group     =&group.;
       person    =&n.;
       replication=&replication.;
       OUTPUT;
    %END;
    *person loop;
  %END;*group loop;
%END; *replication loop;
RUN;
%MEND simulateANOVA;
```

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
* SDs should have been 10.8,
12.4, and 7.1, but it only allows
a common SD;
%GLOBAL n1 n2 n3 mean1
mean2 mean3 sd1 sd2 sd3
ngroups nreps SeedVar;
%LET  ngroups = 3;
%LET  mean1 = 11.4;
%LET  mean2 = 16.7;
%LET  mean3 = 4.0;
%LET  sd1 = 10.8;
%LET  sd2 = 12.4;
%LET  sd3 = 7.1;
%LET  n1 = 20;
%LET  n2 = 20;
%LET  n3 = 20;
%LET  nreps = 100;
%LET  SeedVar = 77;
%simulateANOVA;
```

```
* FOR UNEQUAL VARIANCES;
PROC MIXED DATA =ANOVAsim
  METHOD =ML;
  BY  replication;
  CLASS  group perso
  MODEL  y = group /
  SOLUTION DDFM =KR;
  LSMEANS  group / PDIFF =ALL;
  REPEATED  / SUBJECT =person*group
  GROUP =group;
  ODS OUTPUT Diffs    = LSMEANDIFF
                Tests3 = Tests3;
RUN;
```

Two Examples

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The Mixed Procedure

replication=1

Null Model Likelihood Ratio Test		
DF	Chi-Square	Pr > ChiSq
2	22.11	<.0001

Fit Statistics	
-2 Log Likelihood	431.7
AIC (smaller ☺)	443.7
AICC (smaller ☺)	445.3
BIC (smaller ☺)	456.3

The Mixed Procedure

replication=2

Null Model Likelihood Ratio Test		
DF	Chi-Square	Pr > ChiSq
2	3.51	0.1727

Fit Statistics	
-2 Log Likelihood	443.1
AIC (smaller ☺)	455.1
AICC (smaller ☺)	456.7
BIC (smaller ☺)	467.7

Two Examples

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

The Mixed Procedure

replication=1

Solution for Fixed Effects

Effect	group	Estimate	Std Error	DF	t Value	Pr > |t|
Intercept		2.32	1.27	20	1.83	0.0827
group	1	8.90	2.14	36.7	4.15	0.0002
group	2	13.31	3.73	25.2	3.57	0.0015
group	3	0	.	.	.	.

The Mixed Procedure

replication=2

Solution for Fixed Effects

Effect	group	Estimate	Std Error	DF	T	Pr > |t|
Intercept		6.86	1.71	20	4.01	0.0007
group	1	6.54	3.11	34.5	2.10	0.0432
group	2	12.02	2.86	36.9	4.19	0.0002
group	3	0	.	.	.	.

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
DATA Tests3;
SET  Tests3;
IF  ProbF LT .05 THEN Signif=1;
ELSE                  Signif=0;
RUN;

DATA LSMEANDIFF;
SET  LSMEANDIFF;
IF  ProbT LT .05 THEN  Signif= 1;
ELSE               Signif=0;
RUN;

PROC SORT DATA=LSMEANDIFF;
BY  Group _Group;
RUN;
TITLE "Proportion Significant
Omnibus F-test for Group";
```

Show results

SIMULATION

http://jonathantemplin.com/files/multivariate/mv12psyc943/mv12psyc943_lecture21.pdf

```
PROC MEANS DATA =Tests3 MEAN;
VAR Signif; RUN ;
TITLE "Simulated Group Mean Differences";
PROC MEANS DATA =LSMEANDIFF MEAN ;
BY  Group _Group;
VAR  Signif;
RUN;
TITLE;
* To clear results viewer in between runs;
ODS HTML CLOSE; ODS HTML ;
```

Show Results

Analysis Variable : Signif
Mean
0.9900000

Show Results

Simulated Group Mean Differences

group=1 _group=2

Analysis Variable : Signif
Mean
0.3200000

group=1 _group=3

Analysis Variable : Signif
Mean
0.8100000

group=2 _group=3

Analysis Variable : Signif
Mean
0.9800000

The End

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Thanks To:
Dr. Bajgier

Russell Lavery

http://support.sas.com/documentation/cdl/en/statug/67523/HTML/default/viewer.htm#statug_glmpower_gettingstarted02.htm

Incorporating Contrasts, Unbalanced Designs, and Multiple Means Scenarios

Suppose you want to compute power for the two-way ANOVA described in the section Simple Two-Way ANOVA, but you want to additionally perform the following tasks:

- try an unbalanced sample size allocation with respect to Exposure, using twice as many samples for levels 2 and 3 as for level 1
- consider an additional, less optimistic scenario for the cell means, shown in Table 47.2
- test a contrast of Exposure comparing levels 1 and 3

```
data Exemplary; input Variety $ Exposure $ HeightOrig HeightNew Weight;
datalines; 1 1 14 15 1 1 2 16 16 2 1 3 21 20 2 2 1 10 11 1 2 2 15 14 2 2 3 16 15
2 ;
```

```
proc glmpower data=Exemplary; class Variety Exposure; model
HeightOrig HeightNew = Variety | Exposure; weight Weight; contrast
'Exposure=1 vs Exposure=3' Exposure 1 0 -1; power stddev = 5 ntotal =
60 power = .; run;
```

https://sassyfridays.wordpress.com/2014/03/18/proc-power-and-proc-glmpower/ a factorial design

We are now designing an ANOVA with 2×3 factorial design. We want to examine whether male and female dodo birds have different beek lengths when housed in a small, medium or large yard. We were able to obtain means and a standard deviation from a study conducted in Atlantis centuries ago and now we need to know how many dodo birds we need in order to obtain a power of 80%.

Based on the paper from Atlantis we have the following means:

Males in small yard: 12
Females in small yard: 8

Males in medium yard: 21
Females in medium yard: 21

Males in large yard: 46
Females in large yard: 39

Overall standard deviation reported in the paper was: 4

```
Data atlantis;
  do sex = 1 to 2;
    do housing = 1 to 3;
      input beek_length @@;
    end;
  end;
datalines;
12    21    46
8     21    39
;
Run;
```

To calculate sample size – we need PROC GLMPOWER

```
Proc glmpower data=atlantis;
  class sex housing;
  model beek_length = sex | housing;
  power
    stddev = 4
    ntotal = .
    power = 0.80;
Run;
```