

```

1      **EXAMPLE 1*****;
2      *** Example of unbalanced CRD with experimental error      ***;
3      *** From Snedecor & Cochran, 1967 (pg 278)                ***;
4      *****;
5      OPTIONS PS=256 LS=78 NOCENTER NODATE PAGENO=1;
6      dm 'log;clear;output;clear';
7      DATA MICE onebyone; INFILE CARDS MISSOEVER;
8          INPUT STRAIN $ 1-4 DAYS NUMBER;
9          TITLE1 'EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS';
10         TITLE2 'UNEQUAL NUMBER OF MICE IN EACH TREATMENT';
11         do i = 1 to number by 1; output onebyone; end;
12         output mice;
13     CARDS;

```

NOTE: The data set WORK.MICE has 31 observations and 4 variables.

NOTE: The data set WORK.ONEBYONE has 224 observations and 4 variables.

NOTE: DATA statement used:

```

real time      0.07 seconds
cpu time       0.07 seconds

```

```
13     !           RUN;
```

```
45     ;
```

```
46     PROC PRINT data=mice; TITLE3 'RAW DATA LISTING'; RUN;
```

NOTE: There were 31 observations read from the data set WORK.MICE.

NOTE: The PROCEDURE PRINT printed page 1.

NOTE: PROCEDURE PRINT used:

```

real time      0.04 seconds
cpu time       0.04 seconds

```

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

1

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

RAW DATA LISTING

Obs	STRAIN	DAYS	NUMBER	i	16	11C	11	2	3
1	9D	2	6	7	17	11C	12	3	4
2	9D	3	4	5	18	11C	13	1	2
3	9D	4	9	10	19	DSC1	2	3	4
4	9D	5	8	9	20	DSC1	3	5	6
5	9D	6	3	4	21	DSC1	4	5	6
6	9D	7	1	2	22	DSC1	5	8	9
7	11C	2	1	2	23	DSC1	6	19	20
8	11C	3	3	4	24	DSC1	7	23	24
9	11C	4	3	4	25	DSC1	8	22	23
10	11C	5	6	7	26	DSC1	9	14	15
11	11C	6	6	7	27	DSC1	10	14	15
12	11C	7	14	15	28	DSC1	11	7	8
13	11C	8	11	12	29	DSC1	12	8	9
14	11C	9	4	5	30	DSC1	13	4	5
15	11C	10	6	7	31	DSC1	14	1	2

```
47     PROC MIXED DATA=OnebyOne cl covtest; CLASSES STRAIN;
```

```
48     TITLE3 'ANALYSIS OF VARIANCE';
```

```
49     MODEL DAYS = STRAIN / htype=3 DDFM=Satterthwaite
```

```
outp=ResidDataP;
```

```
50     repeated / group=strain;
```

```
51     run;
```

NOTE: Convergence criteria met.

NOTE: The data set WORK.RESIDDATAP has 224 observations and 11 variables.

NOTE: The PROCEDURE MIXED printed page 2.

NOTE: PROCEDURE MIXED used:

```

real time      0.14 seconds
cpu time       0.13 seconds

```

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

2

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

ANALYSIS OF VARIANCE

The Mixed Procedure

## Model Information

Data Set	WORK.ONEBYONE
Dependent Variable	DAYS
Covariance Structure	Variance Components
Group Effect	STRAIN
Estimation Method	REML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

## Class Level Information

Class	Levels	Values
STRAIN	3	11C 9D DSC1

## Dimensions

Covariance Parameters	3
Columns in X	4
Columns in Z	0
Subjects	224
Max Obs Per Subject	1
Observations Used	224
Observations Not Used	0
Total Observations	224

## Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	1027.49256195	
1	1	1012.92789611	0.00000000

Convergence criteria met.

## Covariance Parameter Estimates

Cov Parm	Group	Estimate	Standard Error	Z Value	Pr > Z	Alpha	Lower	Upper
Residual	STRAIN 11C	5.8633	1.0795	5.43	<.0001	0.05	4.2127	8.7221
Residual	STRAIN 9D	1.8989	0.4903	3.87	<.0001	0.05	1.2126	3.3928
Residual	STRAIN DSC1	6.6327	0.8164	8.12	<.0001	0.05	5.2839	8.5761

## Fit Statistics

-2 Res Log Likelihood	1012.9
AIC (smaller is better)	1018.9
AICC (smaller is better)	1019.0
BIC (smaller is better)	1029.2

## Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
2	14.56	0.0007

## Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
STRAIN	2	114	70.10	<.0001

```

53          PROC UNIVARIATE DATA=ResidDataP PLOT NORMAL; VAR resid; RUN;
NOTE: The PROCEDURE UNIVARIATE printed page 3.
NOTE: PROCEDURE UNIVARIATE used:
      real time          0.02 seconds
      cpu time           0.02 seconds
53          !                                                    QUIT;

```

```

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS
3
UNEQUAL NUMBER OF MICE IN EACH TREATMENT
ANALYSIS OF VARIANCE

```

The UNIVARIATE Procedure  
Variable: Resid

Moments			
N	224	Sum Weights	224
Mean	0	Sum Observations	0
Std Deviation	2.39433175	Variance	5.73282454
Skewness	0.06043085	Kurtosis	-0.0153611
Uncorrected SS	1278.41987	Corrected SS	1278.41987
Coeff Variation	.	Std Error Mean	0.15997802

Basic Statistical Measures			
Location		Variability	
Mean	0.00000	Std Deviation	2.39433
Median	-0.03226	Variance	5.73282
Mode	-0.79699	Range	12.00000
		Interquartile Range	3.00000

Tests for Location: Mu0=0			
Test	-Statistic-	-----p Value-----	
Student's t	t 0	Pr >  t	1.0000
Sign	M -3	Pr >=  M	0.7384
Signed Rank	S -212	Pr >=  S	0.8277

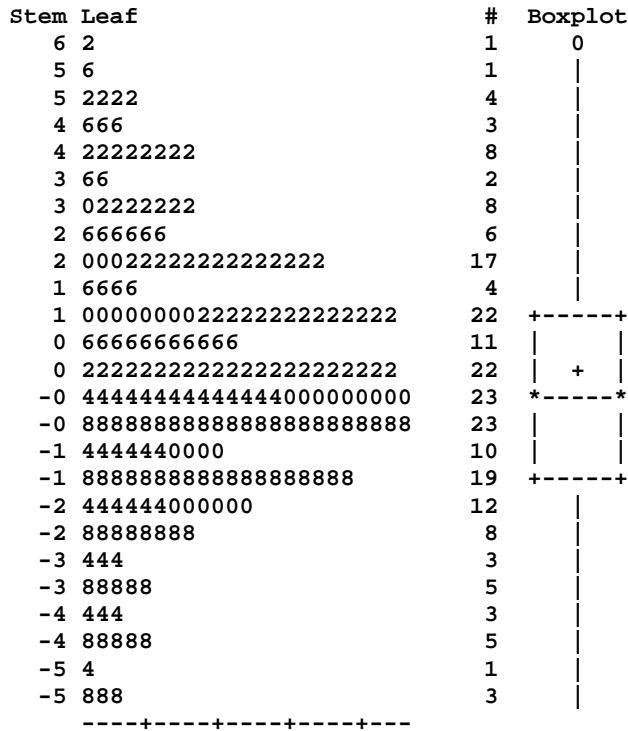
Tests for Normality			
Test	--Statistic--	-----p Value-----	
Shapiro-Wilk	W 0.988718	Pr < W	0.0758
Kolmogorov-Smirnov	D 0.077823	Pr > D	<0.0100
Cramer-von Mises	W-Sq 0.148439	Pr > W-Sq	0.0246
Anderson-Darling	A-Sq 0.857552	Pr > A-Sq	0.0276

Quantiles (Definition 5)

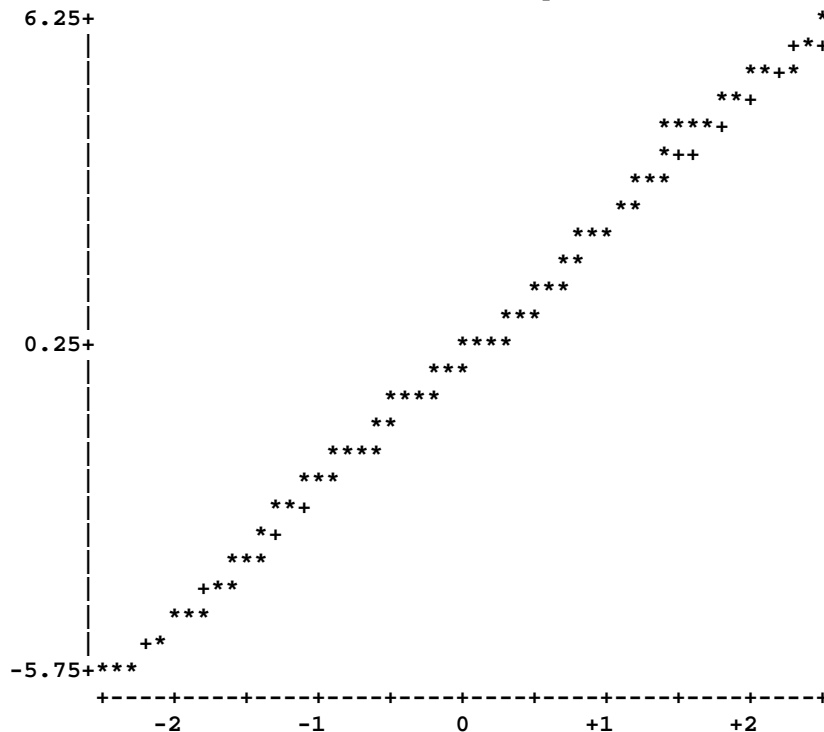
Quantile	Estimate
100% Max	6.2030075
99%	5.2030075
95%	4.2030075
90%	3.2030075
75% Q3	1.2030075
50% Median	-0.0322581
25% Q1	-1.7969925
10%	-2.7969925
5%	-4.3666667
1%	-5.7969925
0% Min	-5.7969925

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
-5.79699	94	5.20301	221
-5.79699	93	5.20301	222
-5.79699	92	5.20301	223
-5.36667	32	5.63333	91
-4.79699	99	6.20301	224



Normal Probability Plot



```

55      PROC GLM DATA=MICE; CLASSES STRAIN; FREQ NUMBER;
56          TITLE3 'ANALYSIS OF VARIANCE WITH TESTS OF HOMOGENIETY';
57      MODEL DAYS = STRAIN;
58          MEANS STRAIN / HOVTEST=BARTLETT HOVTEST=BF
HOVTEST=LEVENE(TYPE=ABS)
59          HOVTEST=LEVENE(TYPE=SQUARE) HOVTEST=OBRIEN
WELCH;
60          OUTPUT OUT=MICERES PREDICTED=P RESIDUAL=E; RUN;
60      !
60          QUIT;
NOTE: The data set WORK.MICERES has 31 observations and 6 variables.
NOTE: The PROCEDURE GLM printed pages 4-7.
NOTE: PROCEDURE GLM used:
      real time          0.11 seconds
      cpu time           0.11 seconds

```

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

4

UNEQUAL NUMBER OF MICE IN EACH TREATMENT  
ANALYSIS OF VARIANCE WITH TESTS OF HOMOGENIETY

The GLM Procedure

Class Level Information

Class	Levels	Values
STRAIN	3	11C 9D DSC1

Number of observations 224

The GLM Procedure

Dependent Variable: DAYS

Frequency: NUMBER

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	359.794413	179.897207	31.10	<.0001
Error	221	1278.419872	5.784705		
Corrected Total	223	1638.214286			

R-Square	Coeff Var	Root MSE	DAYS Mean
0.219626	33.58801	2.405141	7.160714

Source	DF	Type I SS	Mean Square	F Value	Pr > F
STRAIN	2	359.7944135	179.8972067	31.10	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
STRAIN	2	359.7944135	179.8972067	31.10	<.0001

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

6

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

ANALYSIS OF VARIANCE WITH TESTS OF HOMOGENIETY

The GLM Procedure

Levene's Test for Homogeneity of DAYS Variance

ANOVA of Squared Deviations from Group Means

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
STRAIN	2	566.4	283.2	4.56	0.0115
Error	221	13722.0	62.0903		

O'Brien's Test for Homogeneity of DAYS Variance

ANOVA of O'Brien's Spread Variable, W = 0.5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
STRAIN	2	564.1	282.0	4.40	0.0133
Error	221	14152.2	64.0370		

Brown and Forsythe's Test for Homogeneity of DAYS Variance

ANOVA of Absolute Deviations from Group Medians

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
STRAIN	2	23.0777	11.5388	4.99	0.0076
Error	221	511.1	2.3128		

Bartlett's Test for Homogeneity of DAYS Variance

Source	DF	Chi-Square	Pr > ChiSq
STRAIN	2	14.4363	0.0007

Welch's ANOVA for DAYS

Source	DF	F Value	Pr > F
STRAIN	2.0000	69.64	<.0001
Error	99.2945		

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

7

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

ANALYSIS OF VARIANCE WITH TESTS OF HOMOGENIETY

The GLM Procedure

Level of STRAIN	N	Mean	Std Dev
11C	60	7.36666667	2.42142042
9D	31	4.03225806	1.37801478
DSC1	133	7.79699248	2.57540641

61 OPTIONS PS=35 LS=80;

62

63 PROC CHART DATA=MICE;

64 TITLE3 'Histogram of mouse mortality with typhoid strain';

65 VBAR STRAIN / SUMVAR=DAYS TYPE=MEAN FREQ=NUMBER; RUN;

NOTE: The PROCEDURE CHART printed page 8.

NOTE: PROCEDURE CHART used:

real time 0.01 seconds

cpu time 0.01 seconds

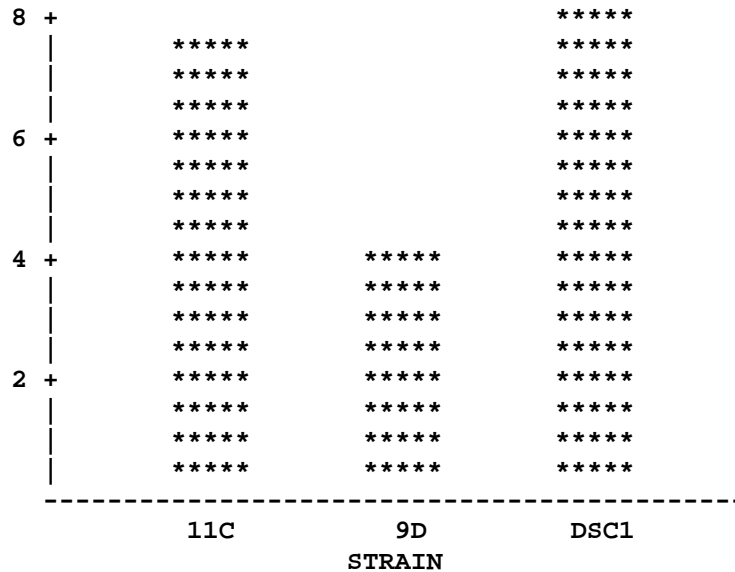
EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

8

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

Histogram of mouse mortality with typhoid strain

DAYS Mean



66        OPTIONS PS=256 LS=80;

67

68        PROC NPAR1WAY DATA=MICE; FREQ NUMBER; CLASSES STRAIN;

69            TITLE3 'Nonparametric ANALYSIS OF VARIANCE';

70        \* MODEL DAYS = STRAIN / htype=3 DDFM=Satterthwaite;

71        run;

NOTE: There were 31 observations read from the data set WORK.MICE.

NOTE: The PROCEDURE NPAR1WAY printed pages 9-20.

NOTE: PROCEDURE NPAR1WAY used:

real time            0.05 seconds

cpu time             0.05 seconds

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

9

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

Nonparametric ANALYSIS OF VARIANCE

The NPAR1WAY Procedure

Analysis of Variance for Variable DAYS

Classified by Variable STRAIN

STRAIN	N	Mean
9D	31	4.032258
11C	60	7.366667
DSC1	133	7.796992

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Among	2	359.794413	179.897207	31.0988	<.0001
Within	221	1278.419872	5.784705		

Average scores were used for ties.

## EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS

10

UNEQUAL NUMBER OF MICE IN EACH TREATMENT

Nonparametric ANALYSIS OF VARIANCE

## The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable DAYS

Classified by Variable STRAIN

STRAIN	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
9D	31	1117.0	3487.50	332.739483	36.032258
11C	60	7082.0	6750.00	426.719398	118.033333
DSC1	133	17001.0	14962.50	473.250796	127.827068

Average scores were used for ties.

## Kruskal-Wallis Test

Chi-Square	51.7109
DF	2
Pr > Chi-Square	<.0001

Median Scores (Number of Points Above Median) for Variable DAYS

Classified by Variable STRAIN

STRAIN	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
9D	31	0.394737	15.50	2.370647	0.012733
11C	60	32.526316	30.00	3.040220	0.542105
DSC1	133	79.078947	66.50	3.371739	0.594579

Average scores were used for ties.

## Median One-Way Analysis

Chi-Square	41.1408
DF	2
Pr > Chi-Square	<.0001

Van der Waerden Scores (Normal) for Variable DAYS

Classified by Variable STRAIN

STRAIN	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
9D	31	-35.335930	0.0	5.033882	-1.139869
11C	60	4.805868	0.0	6.455667	0.080098
DSC1	133	30.530063	0.0	7.159622	0.229549

Average scores were used for ties.

## Van der Waerden One-Way Analysis

Chi-Square	50.2485
DF	2
Pr > Chi-Square	<.0001

Savage Scores (Exponential) for Variable DAYS

Classified by Variable STRAIN

STRAIN	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
9D	31	-25.261616	0.0	5.066124	-0.814891
11C	60	0.066414	0.0	6.497015	0.001107
DSC1	133	25.195202	0.0	7.205478	0.189438

Average scores were used for ties.



Savage One-Way Analysis  
Chi-Square 26.3902  
DF 2  
Pr > Chi-Square <.0001

Kolmogorov-Smirnov Test for Variable DAYS  
Classified by Variable STRAIN

STRAIN	N	EDF at Maximum	Deviation from Mean at Maximum
9D	31	0.870968	3.333122
11C	60	0.216667	-0.431100
DSC1	133	0.157895	-1.319633
Total	224	0.272321	

Maximum Deviation Occurred at Observation 22  
Value of DAYS at Maximum = 5.0

Kolmogorov-Smirnov Statistics (Asymptotic)  
KS 0.241248 KSa 3.610676

Cramer-von Mises Test for Variable DAYS  
Classified by Variable STRAIN

STRAIN	N	Summed Deviation from Mean
9D	31	4.428843
11C	60	0.095553
DSC1	133	0.749578

Cramer-von Mises Statistics (Asymptotic)  
CM 0.023545 CMa 5.273974