14 Answers to exercises

Chapter 1

Dioecious trees

The question is whether the number of flowers produced depends upon the sex of the tree. The variable SEX is categorical with two levels. The commands to execute the ANOVA are as before.

MINITAB COMMANDS FOR BOX 15.1 Analysis for dioecious trees

Commands	`anova FLOWERS = SEX.`
Menu route	Stat > ANOVA > Balanced ANOVA FLOWERS → Response SEX → Model

This would produce the following output:

MINITAB OUTPUT FOR BOX 15.1 Analysis for dioecious trees

ANOVA: FLOWERS versus SEX

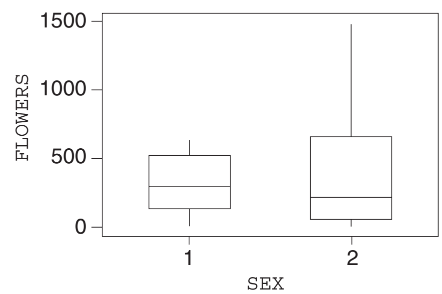
```
Factor         Type Levels Values
SEX           fixed      2  1  2

Analysis of Variance for FLOWERS

Source            DF            SS           MS          F          P
SEX                1        171841       171841       1.18      0.284
Error             48       7017255       146193
Total             49       7189097
```

There are a number of ways in which these results could be illustrated graphically, one of which is a boxplot.

MINITAB COMMANDS FOR FIGURE 15.1 Box plot for dioecious trees

Commands	`boxplot FLOWERS*SEX`
Menu route	Graph > Boxplot `FLOWERS` → Graph variables, Y `SEX` → Graph variables, X

This would produce the following graph:



Minitab Output for Fig. 15.1 Boxplot for dioecious trees

Chapter 2

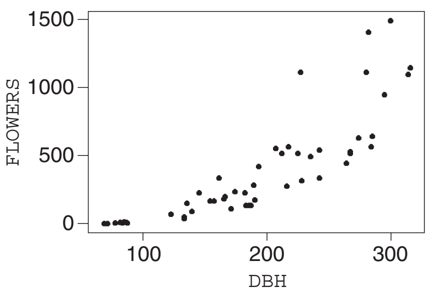
Dioecious trees

The variables `FLOWERS` and `DBH` are both continuous, so the best illustration of the relationship between them would be a scatter plot.

MINITAB COMMANDS FOR FIGURE 15.2 Graph of `FLOWERS` versus `DBH`

Commands	`plot FLOWERS*DBH`
Menu route	Graph > Plot `FLOWERS` → Graph variable, Y `DBH` → Graph variable, X

This would produce the following graph:



Minitab output for Fig 15.2 Graph of FLOWERS versus DBH.

The regression analysis would be executed using the following commands:

MINITAB COMMANDS FOR BOX 15.2 Analysis for dioecious trees

Commands	`regress FLOWERS 1 DBH`
Menu route	Stat > Regression > Regression FLOWERS → Response DBH → Predictors

which would give the following output:

MINITAB OUTPUT FOR BOX 15.2 Analysis for dioecious trees

Regression Analysis: FLOWERS **versus** DBH

```
The regression equation is
FLOWERS = - 481 + 4.51 DBH

Predictor            Coef      SE Coef          T          P
Constant          -481.16        86.24      -5.58      0.000
DBH                4.5128       0.4224      10.68      0.000

S = 210.6         R-Sq = 70.4%         R-Sq(adj) = 69.8%

Analysis of Variance

Source               DF           SS           MS          F           P
Regression            1      5060723      5060723     114.13       0.000
Residual Error       48      2128374        44341
Total                49      7189097
```

Unusual Observations

Obs	DBH	FLOWERS	Fit	SE Fit	Residual	St Resid
5	227	1107.0	543.3	33.3	563.7	2.71R
28	300	1482.0	872.7	54.6	609.3	3.00R
50	282	1398.0	791.5	48.4	606.5	2.96R

R denotes an observation with a large standardized residual

Chapter 3

How variability in the population will influence our analysis

To create datasets for this exercise, just follow the procedure outlined in Box 3.3a 'Creating your own datasets', but alter the standard deviation specified when you draw the random numbers from the Normal distribution (third step in Minitab commands 3.3a). One advantage of using the command line method is that you can copy-and-paste the whole set of commands, edit the number you want to change, and then execute the whole lot by pressing the return key.

Each of the four created data sets can be analysed using the commands shown below:

MINITAB COMMANDS TO ANALYSE SIMULTATED DATA SETS

Commands

```
brief 3.
glm Y = F.
```

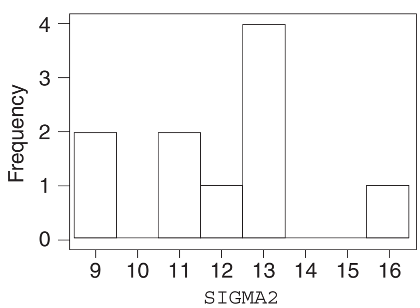
Menu route

Stat > ANOVA > General Linear Model
Y → Response
F → Model
[Results...]
⦿ In addition, coefficients for all terms

Each analysis will produce one estimate of the grand mean, which may then be entered into a new column in the worksheet. When ten estimates have been obtained, a histogram may be drawn for the column SIGMA2 (for example) using the commands:

MINITAB COMMANDS TO PLOT HISTOGRAMS OF SIMULATED DATA	
Commands	`histogram SIGMA2`
Menu route	Graph > Histogram SIGMA2 → Graph variables

This would produce a graph similar to the one below:



Minitab output for Fig 15.3 Variation of parameter estimates.

Comparison of the four graphs with the error standard deviation set at 2, 4, 8, and 16 will illustrate how the error variance will influence the reliability of the grand mean estimate.

Chapter 4

Investigating obesity

First you need to conduct two separate analyses to explain FOREARM using HT or WT.

MINITAB COMMANDS FOR BOX 15.4(a) **Explaining** FOREARM **using** HT	

Commands	`glm FOREARM = HT;`
	`covariate HT;`
	`brief 1.`

Menu route

Stat > ANOVA > General Linear Model
`FOREARM` → Response
`HT` → Model
[Covariates…]
`HT` → Covariates
[Results…]
⊙ Analysis of variance table

MINITAB OUTPUT FOR BOX 15.4(a) `FOREARM = HT`

General Linear Model: `FOREARM` **versus**

```
Factor         Type Levels Values

Analysis of Variance for FOREARM, using Adjusted SS for Tests

Source          DF       Seq SS      Adj SS     Adj MS       F         P
HT               1        0.944       0.944      0.944    0.18     0.678
Error           37      199.094     199.094      5.381
Total           38      200.038
```

MINITAB COMMANDS FOR BOX 15.4(b) **Explaining** `FOREARM` **using** `WT`

Commands

```
glm FOREARM = WT;
covariate WT;
brief 1.
```

Menu route

Stat > ANOVA > General Linear Model
`FOREARM` → Response
`WT` → Model
[Covariates…]
`WT` → Covariates
[Results…]
⊙ Analysis of variance table

MINITAB OUTPUT FOR BOX 15.4(b) FOREARM = WT

General Linear Model: FOREARM **versus**

```
Factor         Type Levels Values

Analysis of Variance for FOREARM, using Adjusted SS for Tests

Source          DF        Seq SS       Adj SS      Adj MS        F          P
WT               1        59.137       59.137      59.137    15.53      0.000
Error           37       140.901      140.901       3.808
Total           38       200.038
```

Then the joint analysis has to be conducted using both explanatory variables.

MINITAB COMMANDS FOR BOX 15.5 **Using both** HT **and** WT **to explain** FOREARM

Commands

```
glm FOREARM = HT + WT;
covariate HT WT;
brief 3.
```

Menu route

Stat > ANOVA > General Linear Model
FOREARM → Response
HT WT → Model
[Covariates...]
HT WT → Covariates
[Results...]
⊙ In addition, coefficients for all terms.

MINITAB OUTPUT FOR BOX 15.5 FOREARM = HT + WT

General Linear Model: FOREARM **versus**

```
Factor          Type Levels Values

Analysis of Variance for FOREARM, using Adjusted SS for Tests

Source          DF       Seq SS       Adj SS      Adj MS        F         P
HT               1        0.944       24.777      24.777     7.68     0.009
WT               1       82.970       82.970      82.970    25.72     0.000
Error           36      116.124      116.124       3.226
Total           38      200.038

Term                 Coef        SE Coef          T          P
Constant           17.452          8.274       2.11      0.042
HT               -0.17173        0.06196      -2.77      0.009
WT                0.23317        0.04598       5.07      0.000
```

```
Unusual Observations for FOREARM

Obs      FOREARM       Fit     SE Fit    Residual    St Resid
  7      7.74100   3.66338    0.48987     4.07762       2.36R
  9      0.23200   2.20161    0.89018    -1.96961      -1.26  X
 10      9.81100   9.79442    1.12860     0.01658       0.01  X
 37      8.58200   3.67800    0.48285     4.90400       2.83R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large influence.
```

Chapter 5

The dorsal crest of the male smooth newt

In the first analysis you are asked to investigate the relationship between LCREST and the body size of the newt. The response variable you are given is logged, therefore, the body size variable should also be logged. The commands and menus are given below.

MINITAB COMMANDS FOR BOX 15.6 Dorsal crest analysis

Commands

```
glm LCREST = LSVL;
covariate LSVL;
brief 3.
```

Menu route

Stat > ANOVA > General Linear Model
LCREST → Response
LSVL → Model
[Covariates...]
LSVL → Covariates
[Results...]
⊙ In addition, coefficients for all terms.

This would result in the following output:

MINITAB OUTPUT FOR BOX 15.6 Dorsal crest analysis

General Linear Model: LCREST versus

```
Factor          Type Levels Values

Analysis of Variance for LCREST, using Adjusted SS for Tests

Source          DF       Seq SS      Adj SS      Adj MS         F         P
LSVL             1       2.3894      2.3894      2.3894     45.81     0.000
Error           85       4.4337      4.4337      0.0522
Total           86       6.8231

Term                 Coef        SE Coef          T           P
Constant           -9.381          1.501      -6.25       0.000
LSVL               5.0870         0.7516       6.77       0.000

Unusual Observations for LCREST

Obs          LCREST          Fit         SE Fit        Residual       St Resid
 27         0.45700      0.92565        0.03267        -0.46865         -2.07R
 29         0.49800      1.04774        0.04662        -0.54974         -2.46R
 41         0.97200      0.51361        0.04626         0.45839          2.05R
 46         1.38800      0.90531        0.03077         0.48269          2.13R
 67         1.25400      0.73235        0.02545         0.52165          2.30R
 86         0.12000      0.59500        0.03661        -0.47500         -2.11R

R denotes an observation with a large standardized residual.
```

In the second analysis, POND is also included.

MINITAB COMMANDS FOR BOX 15.7 Further dorsal crest analysis

Commands

```
glm LCREST = POND + LSVL;
covariate LSVL;
brief 3.
```

Menu route

Stat > ANOVA > General Linear Model
LCREST → Response
POND + LSVL → Model
[Covariates...]
LSVL → Covariates
[Results...]
⦿ Analysis of variance table

MINITAB OUTPUT FOR BOX 15.7 Further dorsal crest analysis

General Linear Model: LCREST versus POND

```
Factor         Type Levels Values
POND           fixed    10  1  2  3  4  5  6  7  8  9  10

Analysis of Variance for LCREST, using Adjusted SS for Tests

Source        DF      Seq SS       Adj SS       Adj MS        F         P
POND           9     0.32519      0.24063      0.02674      0.48     0.881
LSVL           1     2.30483      2.30483      2.30483     41.78     0.000
Error         76     4.19310      4.19310      0.05517
Total         86     6.82312
```

Chapter 6

Determinants of the Grade Point Average

This exercise uses the *grades* dataset.

MINITAB COMMANDS FOR BOX 15.8 Analysis of the *grades* dataset

Commands

```
glm GPA = YEAR + VERBAL + MATH;
covariate VERBAL MATH;
brief 3.
```

Menu route

Stat > ANOVA > General Linear Model
  GPA → Response
  YEAR + VERBAL + MATH → Model
  Covariates...
    VERBAL MATH → Covariates
  Results...
    ⊙ In addition, coefficients for all terms

MINITAB OUTPUT FOR BOX 15.8 Analysis of the *grades* dataset

General Linear Model: GPA versus YEAR

```
Factor          Type Levels Values
YEAR            fixed     2 1 2

Analysis of Variance for GPA, using Adjusted SS for Tests

Source          DF     Seq SS      Adj SS      Adj MS         F         P
YEAR             1     1.1552      0.8460      0.8460      2.84     0.094
VERBAL           1     6.7595      5.1600      5.1600     17.32     0.000
MATH             1     0.7092      0.7092      0.7092      2.38     0.124
Error          196    58.3961     58.3961      0.2979
Total          199    67.0200

Term                  Coef        SE Coef         T            P
Constant            0.6582         0.4404      1.49        0.137
YEAR
1                  0.06521        0.03870      1.69        0.094
VERBAL            0.002288       0.000550      4.16        0.000
MATH              0.000937       0.000608      1.54        0.124

Unusual Observations for GPA

Obs            GPA           Fit         SE Fit        Residual       St Resid
40         1.20000       2.50174       0.09097       -1.30174         -2.42R
54         2.40000       2.49136       0.13968       -0.09136         -0.17 X
89         2.40000       2.11378       0.13702        0.28622          0.54 X
121        1.30000       3.02639       0.11306       -1.72639         -3.23R
131        0.30000       2.48641       0.05853       -2.18641         -4.03R
136        1.10000       2.99751       0.10492       -1.89751         -3.54R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large influence.
```

Chapter 7

Weight, fat, and sex

This question requires a factorial analysis, with an interaction between a categorical and continuous explanatory variable.

MINITAB COMMANDS FOR BOX 15.9 Analysis for weight, fat, and sex

Commands

```
glm FAT = SEX|WEIGHT;
covariate WEIGHT;
brief 3.
```

Menu route

Stat > ANOVA > General Linear Model
FAT → Response
SEX|WEIGHT → Model
[Covariates...]
WEIGHT → Covariates
[Results...]
⦿ In addition, coefficients for all terms.

MINITAB OUTPUT FOR BOX 15.9 Analysis for weight, fat, and sex

General Linear Model: FAT versus SEX

```
Factor          Type Levels Values
SEX             fixed     2 1 2

Analysis of Variance for FAT, using Adjusted SS for Tests

Source           DF      Seq SS      Adj SS      Adj MS        F        P
SEX               1      90.321       2.108       2.108     1.05    0.322
WEIGHT            1      87.105      79.542      79.542    39.59    0.000
SEX*WEIGHT        1      10.857      10.857      10.857     5.40    0.035
Error            15      30.138      30.138       2.009
Total            18     218.421

Term                   Coef       SE Coef          T          P
Constant              8.405         3.091       2.72      0.016
SEX
1                    -3.166         3.091      -1.02      0.322
WEIGHT              0.29420       0.04676       6.29      0.000
WEIGHT*SEX
       1            0.10869       0.04676       2.32      0.035

Unusual Observations for FAT

Obs           GPA          Fit         SE Fit       Residual       St Resid
16        26.0000      29.0103         0.5912        -3.0103         -2.34R

R denotes an observation with a large standardized residual.
```

Chapter 8

Combining data from different experiments

MINITAB COMMANDS FOR BOX 15.11 Bird data combined

Commands

```
glm YOUNG = YEAR + SONGDAY;
covariate SONGDAY;
brief 3.
```

Menu route

Stat > ANOVA > General Linear Model
YOUNG → Response
YEAR + SONGDAY → Model
[Covariates...]
SONGDAY → Covariates
[Results...]
⊙ In addition, coefficients for all terms

MINITAB OUTPUT FOR BOX 15.11 Bird data combined

General Linear Model: YOUNG versus YEAR

```
Factor          Type Levels Values
YEAR            fixed     5 1 2 3 4 5

Analysis of Variance for YOUNG, using Adjusted SS for Tests

Source          DF      Seq SS       Adj SS       Adj MS         F          P
YEAR             4      10.698       19.782        4.945      4.06      0.008
SONGDAY          1      12.202       12.202       12.202     10.02      0.003
Error           38      46.282       46.282        1.218
Total           43      69.182

Term                 Coef         SE Coef           T           P
Constant           5.4922          0.8637        6.36       0.000
YEAR
1                  0.1776          0.3746        0.47       0.638
2                  1.4089          0.3772        3.73       0.001
3                 -0.4916          0.4761       -1.03       0.308
4                  0.4453          0.3998        1.11       0.272
SONGDAY          -0.10913         0.03448       -3.17       0.003
```

```
Unusual Observations for YOUNG

Obs        YOUNG         Fit      SE Fit     Residual     St Resid
20       7.00000     3.84557     0.33677      3.15443        3.00R
22       5.00000     2.92715     0.43223      2.07285        2.04R
28       1.00000     3.14541     0.41947     -2.14541       -2.10R

R denotes an observation with a large standardized residual.
```

Chapter 9

Stabilising the variance in a blocked experiment

The commands required for the first part of this exercise (a) transform the data; (b) perform the analysis on the transformed data, storing the residuals and plotting the residuals against the fitted values; (c) display descriptive statistics for the residuals by treatment.

MINITAB COMMANDS FOR BOXES 15.12 AND 15.13, AND FIG. 15.6

Commands

```
name C4 = 'SQRTNCOT'
let SQRTNCOT = SQRT(NCOT)

name c5 = 'SRES1'

glm SQRTNCOT = BLOCK + TRTMNT;
brief 1;
sresiduals SRES1;
gfits;
rtype 2.

describe SRES1;
by TRTMNT.
```

Menu route

Calc > Calculator
 `SQRTNCOT` → Store result in variable
 `SQRT(NCOT)` → Expression

Stat > ANOVA > General Linear Model
 `SQRTNCOT` → Responses
 `BLOCK + TRTMNT` → Model

 Results...

 ⊙ Analysis of variance table.

 Graphs...

 ⊙ In addition, coefficients for all terms.

 ☑ Residuals versus fits

Storage...

☑ Standardised residuals

Stat > Basic Statistics > Display Descriptive Statistics
SRES1 → Variables
☑ By variable:
TRTMNT → By variable

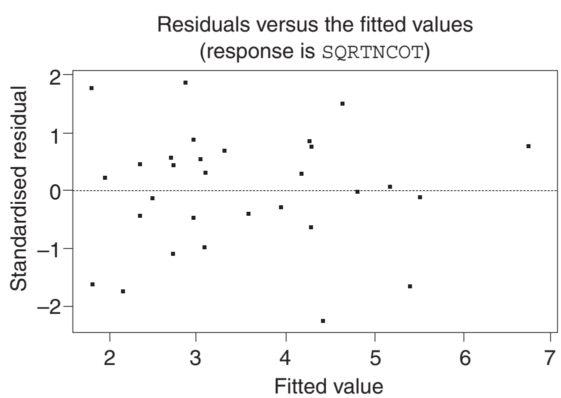
MINITAB OUTPUT FOR BOX 15.12 Analysis of blocked experiment

General Linear Model: SQRTNCOT versus BLOCK, TRTMNT

Factor	Type	Levels	Values
BLOCK	fixed	6	1 2 3 4 5 6
TRTMNT	fixed	5	1 2 3 4 5

Analysis of Variance for SQRTNCOT, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
BLOCK	5	23.9098	23.9098	4.7820	53.45	0.000
TRTMNT	4	20.5340	20.5340	5.1335	57.37	0.000
Error	20	1.7895	1.7895	0.0895		
Total	29	46.2333				



Minitab output for Fig. 15.6.

MINITAB OUTPUT FOR BOX 15.13: Examining residuals of the square root transform analysis

Descriptive Statistics: SRES1 by TRTMNT

Variable	TRTMNT	N	Mean	Median	TrMean	StDev
SRES1	1	6	-0.000	0.297	-0.000	0.936
	2	6	0.000	-0.108	0.000	1.091
	3	6	-0.000	-0.075	-0.000	0.425
	4	6	0.000	0.376	0.000	1.402
	5	6	0.000	0.319	0.000	1.336

Variable	TRTMNT	SE Mean	Minimum	Maximum	Q1	Q3
SRES1	1	0.382	-1.663	0.868	-0.774	0.726
	2	0.446	-1.096	1.869	-1.017	0.793
	3	0.173	-0.443	0.557	-0.422	0.479
	4	0.573	-1.744	1.767	-1.651	1.076
	5	0.545	-2.255	1.498	-1.048	0.947

These commands can then be repeated for the log and inverse transformation.

Checking the 'perfect' model

The commands to produce the histograms of the original and transformed data are reproduced below. We specify 'MidPoints' so that Minitab will use the same scale on the x-axes, making the histograms easier to compare by eye.

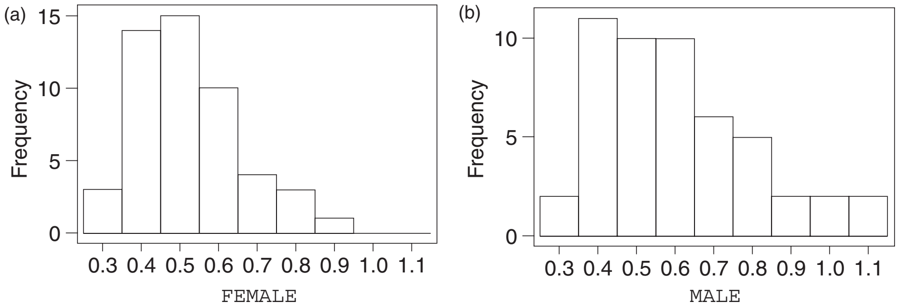
MINITAB COMMANDS TO PRODUCE FIG. 15.9a AND b

Commands

```
histogram MALE FEMALE;
midpoint 0.3:1.1/0.1.
```

Menu route

Graph > Histogram
MALE → Graph variables, X row 1
FEMALE → Graph variables, X row 2
Options...
⊙ Midpoint/cutpoint positions:
0.3:1.1/0.1 → Midpoint/cutpoint positions



Minitab output for Fig. 15.9a and b.

MINITAB COMMANDS TO PRODUCE FIG. 15.9c AND d

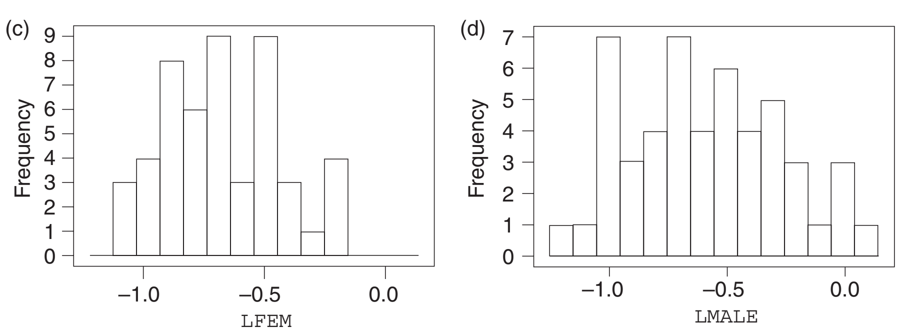
Commands

```
name C3 = 'LMALE'
let LMALE = LOGE(MALE)
name C4 = 'LFEM'
let LFEM = LOGE(FEMALE)
histogram LMALE LFEM;
midpoint −1.2:0.1/0.1.
```

Menu route

Calc > Calculator
`LMALE` → Store result in variable
`LOGE(MALE)` → Expression
`LFEM` → Store result in variable
`LOGE(FEMALE)` → Expression

Graph > Histogram
`LMALE` → Graph variables, X row 1
`LFEM` → Graph variables, X row 2
Options...
⊙ Midpoint/cutpoint positions.
–1.2:0.1/0.1. → Midpoint/cutpoint positions



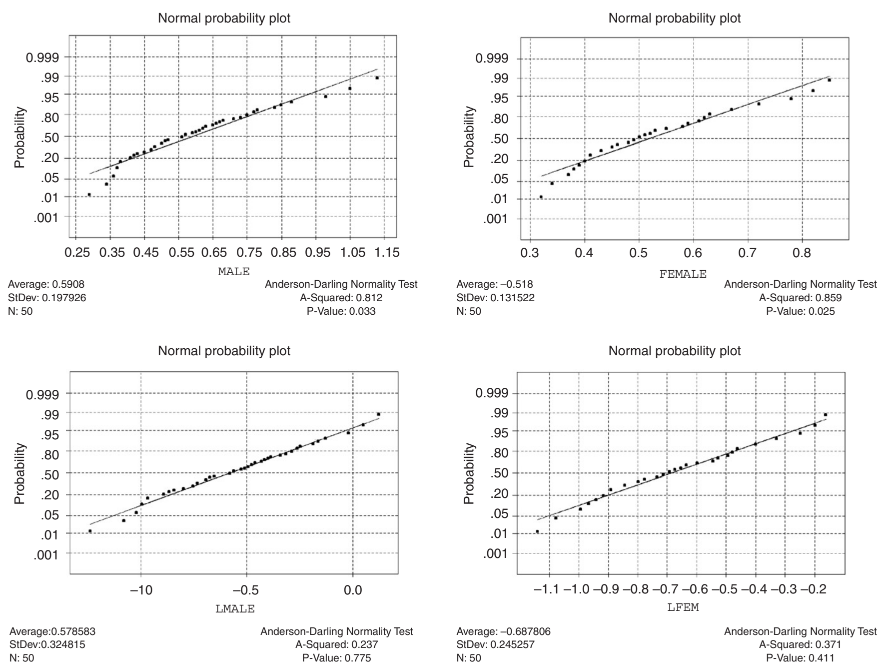
Minitab output for Fig. 15.9c and d.

The Normal probability plot may not only be performed as part of a GLM analysis (see earlier this chapter), but may also be performed on raw data using a different set of commands, for example:

MINITAB COMMANDS FOR FIG. 15.10: Normal Probability Plots

Commands	`%normplot 'MALE'.`
Menu route	Graph > Probability plot > Normality Test `MALE` → Variables

This may be repeated for the other three variables, producing the graphs below.



Minitab output for Fig. 15.10 Normal probability plots

Minitab provides a *p*-value associated with the Anderson–Darling Normality test (this is the test chosen by default), which can provide us with a criterion for rejecting the assumption of Normality. The *p*-value is below 0.05 for the raw data, but not for the transformed data.

The following commands allow you to create the null datasets designed to follow a Normal distribution, with a mean and standard deviation equal to that of the female squirrel weights (which can be obtained using the describe command, as used earlier).

MINITAB COMMANDS TO CREATE NORMALLY DISTRIBUTED NULL DATASETS

Commands

```
name c5 = 'SIMFEM1'
random 50 SIMFEM1;
normal 0.518 0.1315.
```

Menu route

Calc > Random Data > Normal
50 → Generate ... rows of data
SIMFEM1 → store in columns
0.518 → mean
0.1315 → standard deviation

This can be repeated to create as many columns of simulated female (or male) data as you require. This is particularly easy using the written commands in the session window, as one can copy-and-paste the relevant commands. These may then be examined using the histogram and Normal probability plot commands used earlier.

Chapter 10

Partitioning a sum of squares into polynomial components

The following commands are required for this exercise. Note that in the command language the analysis is conducted in two parts. In the first part, the 'interaction means' are stored at the same time as conducting the ANOVA and printing out a table of means. In the second part, a Minitab macro is called upon to draw the interaction diagram.

MINITAB COMMANDS FOR BOX 15.18 AND FIG. 10.8 Analysis for barley yield

Commands

```
glm BYIELD = BBLOCK + BSPACE|BVARIETY;
brief 1;
means BSPACE*BVARIETY;
smeans c4000;
interact BVARIETY BSPACE.

%gfint 'BVARIETY' 'BSPACE';
responses 'BYIELD';
lsmeans c4000.
```

Menu route Stat > ANOVA > General Linear Model
BYIELD → Response
BBLOCK + BSPACE|BVARIETY → Model

Results...

⦿ Analysis of variance table
BSPACE*BVARIETY → Display least squares means corresponding to the terms

Factor Plots...

BVARIETY BSPACE → Interactions Plot, Factors:

MINITAB OUTPUT FOR BOX 15.18 **Analysis for barley yield**

General Linear Model: BYIELD versus BBLOCK, BSPACE, BVARIETY

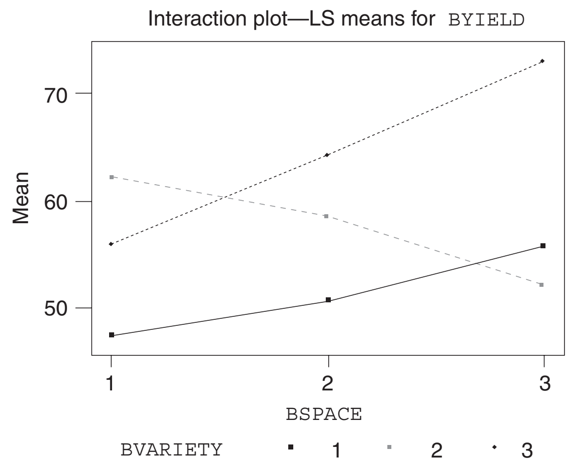
Factor	Type	Levels	Values
BBLOCK	fixed	4	1 2 3 4
BSPACE	fixed	3	1 2 3
BVARIETY	fixed	3	1 2 3

Analysis of Variance for BYIELD, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
BBLOCK	3	255.64	255.64	85.21	4.82	0.009
BSPACE	2	155.06	155.06	77.53	4.39	0.024
BVARIETY	2	1027.39	1027.39	513.69	29.07	0.000
BSPACE*BVARIETY	4	765.44	765.44	191.36	10.83	0.000
Error	24	424.11	424.11	17.67		
Total	35	2627.64				

p[Least Squares Means for BYIELD

BSPACE*BVARIETY		Mean	SE Mean
1	1	47.50	2.102
1	2	62.25	2.102
1	3	56.00	2.102
2	1	50.75	2.102
2	2	58.50	2.102
2	3	64.25	2.102
3	1	55.75	2.102
3	2	52.25	2.102
3	3	73.00	2.102



Minitab output for Fig. 10.8 Interaction diagram from the *barley* dataset.

A second analysis is then conducted on the *barley* dataset, involving a polynomial decomposition. We choose to include the interaction of BVARIETY with the quadratic term BSPACE*BSPACE so that the polynomial analysis is a decomposition of the non-polynomial analysis. This means that the error SS, MS, and DF will be the same in the two analyses, allowing us to compare them more easily. It also allows us to investigate whether the response of yield to spacing is curvilinear for some varieties but not others.

MINITAB COMMANDS FOR BOX 15.19 Second analysis for barley yield

Commands

```
glm BYIELD = BBLOCK + BVARIETY|BSPACE|BSPACE;
covariate BSPACE;
brief 1;
ssquares 1.
```

Menu route

Stat > ANOVA > General Linear Model
BYIELD → Response
BBLOCK + BVARIETY|BSPACE|BSPACE → Model
Covariates...
BSPACE → Covariates
Results...
⊙ Analysis of variance table
Options...
⊙ Sequential (Type I)

MINITAB OUTPUT FOR BOX 15.19 Second analysis for barley yield

General Linear Model: BYIELD versus BBLOCK, BVARIETY

```
Factor             Type Levels Values
BBLOCK             fixed     4 1 2 3 4
BVARIETY           fixed     3 1 2 3

Analysis of Variance for SQRTNCOT, using Adjusted SS for Tests

Source                   DF   Seq SS   Adj SS   Adj MS      F       P
BBLOCK                    3   255.64   255.64    85.21   4.82   0.009
BVARIETY                  2  1027.39    38.17   513.69  29.07   0.000
BSPACE                    1   155.04     3.59   155.04   8.77   0.007
BVARIETY*BSPACE           2   759.08     5.65   379.54  21.48   0.000
BSPACE*BSPACE             1     0.01     0.01     0.01   0.00   0.978
BVARIETY*BSPACE*BSPACE    2     6.36     6.36     3.18   0.18   0.836
Error                    24   424.11   424.11    17.67
Total                    35  2627.64
```

Chapter 11

Finding the best treatment for cat fleas

The final model is:

MINITAB COMMANDS FOR BOX 15.20 Analysis for cat fleas

Commands

```
glm LOGFLEAS = TRTMT + NCATS + CARPET;
covariates NCATS;
brief 1.
```

Menu route

Stat > ANOVA > General Linear Model
LOGFLEAS → Response
TRTMT + NCATS + CARPET → Model
[Results...]
⊙ Analysis of variance table
[Covariates...]
NCATS → Covariates

MINITAB OUTPUT FOR BOX 15.20 **Analysis for cat fleas**

General Linear Model: LOGFLEAS versus TRTMT, CARPET

```
Factor         Type Levels Values
TRTMT         fixed      2 1 2
CARPET        fixed      2 1 2

Analysis of Variance for LOGFLEAS, using Adjusted SS for Tests

Source        DF       Seq SS       Adj SS       Adj MS          F          P
TRTMT          1        1.612        5.750        5.750       9.09      0.003
NCATS          1       23.730       22.962       22.962      36.31      0.000
CARPET         1        6.103        6.103        6.103       9.65      0.003
Error         85       53.759       53.759        0.632
Total         88       85.203
```

Multiplicity of *p* values

To create the random dataset:

MINITAB COMMANDS TO PRODUCE THE NULL DATASET

Commands	`random 30 c1-c11;` `normal 10.5 2.4.`
Menu route	Calc > Random Data > Normal 30 → Generate … rows of data C1-C11 → Store in columns 10.5 → Mean 2.4 → Standard deviation

Using the regression menu would provide output giving the *p* value for the regression as a whole, with the *p* values for each individual *X* variable in the analysis being found in the table of coefficients. (The *p*-value resulting from the *t* test for the slope against zero for a particular variable is the same as the *p*-value for the *F* ratio test for the same explanatory variable in the analysis of variance table. This arises from the fact that $t^2 = F$; see Appendix 3.)

MINITAB COMMANDS TO PRODUCE OUTPUT FOR TABLE 15.6

Commands

```
regress C1 10 C2-C11;
brief 1.
```

Menu route

Stat > Regression > Regression
`C1` → Response
`C2-C11` → Predictors
Predictors...
⦿ Regression equation, table of coefficients, s, R-squared and basic analysis of variance.

EXAMPLE MINITAB OUTPUT FOR TABLE 15.6

Regression Analysis: `C1` **versus** `C2, C3, C4, C5, C6, C7, C8, C9, C10, C11`

```
The regression equation is
C1 = 8.48 + 0.006 C2 + 0.333 C3 - 0.016 C4 - 0.219 C5 - 0.063 C6 - 0.038 C7 +
0.206 C8 - 0.152 C9 + 0.217 C10 - 0.078 C11

Predictor            Coef      SE Coef        T         P
Constant            8.478        6.481     1.31     0.206
C2                 0.0064       0.1739     0.04     0.971
C3                 0.3328       0.1750     1.90     0.072
C4                -0.0164       0.1604    -0.10     0.919
C5                -0.2187       0.1401    -1.56     0.135
C6                -0.0627       0.1383    -0.45     0.655
C7                -0.0377       0.1950    -0.19     0.849
C8                 0.2061       0.1291     1.60     0.127
C9                -0.1520       0.1611    -0.94     0.357
C10                0.2167       0.2086     1.04     0.312
C11               -0.0784       0.1847    -0.42     0.676

S = 1.813              R-Sq = 41.6%          R-Sq(adj) = 10.9%

Analysis of Variance

Source               DF          SS         MS         F         P
Regression           10      44.587      4.459      1.36     0.272
Residual Error       19      62.467      3.288
Total                29     107.054
```

Chapter 12

How a nested analysis can solve problems of non-independence

These commands first calculate the variable LUPRATE, and then conduct a nested analysis.

MINITAB COMMANDS FOR BOX 15.21 Nested analysis of *sheep* dataset

Commands

```
name C6 = 'LUPRATE'.
let LUPRATE = NLOOKUPS / DURATION.
glm LUPRATE = SEX + SHEEP( SEX);
random SHEEP;
brief 1;
ems.
```

Menu route

Calc > Calculator
LUPRATE → Store result in variable
NLOOKUPS / DURATION → Expression:

Stat > ANOVA > General Linear Model
LUPRATE → Response
SEX + SHEEP(SEX) → Model
SHEEP → Random Factors

Results…

⊙ Analysis of variance table
☑ Display expected mean squares and variance components

MINITAB OUTPUT FOR BOX 15.21 Nested analysis of *sheep* dataset

General Linear Model: LUPRATE versus SEX, SHEEP

```
Factor                    Type Levels Values
SEX                        fixed    2  1  2
SHEEP(SEX)                ramdom    6  1  2  3  1  2  3


Analysis of Variance for LUPRATE, using Adjusted SS for Tests
Source              DF       Seq SS       Adj SS       Adj MS        F          P
SEX                  1     0.132816     0.132816     0.132816     1.80      0.251
SHEEP(SEX)           4     0.294774     0.294774     0.073693    26.89      0.000
Error              114     0.312387     0.312387     0.002740
Total              119     0.739977
```

```
Expected Mean Squares, using Adjusted SS

Source                    Expected Mean       Square for Each Term
 1 SEX                    (3) + 20.0000       (2) + Q[1]
 2 SHEEP(SEX)             (3) + 20.0000       (2)
 3 Error                  (3)

Error Terms for Tests, using Adjusted SS

Source                 Error DF     Error MS     Synthesis of Error MS
 1 SEX                     4.00     0.073693     (2)
 2 SHEEP(SEX)            114.00     0.002740     (3)

Variance Components, using Adjusted SS

Source                           Estimated Value
SHEEP(SEX)                               0.00355
Error                                    0.00274
```

Chapter 13

Fig trees in Costa Rica

MINITAB COMMANDS FOR TABLE 15.7 Means and variances for fig tree sites

Commands

```
describe NINDIVS;
by SITE.
describe NINDIVS.
```

Menu route

Stat > Basic Statistics > Display Descriptive Statistics
    NINDIVS → Variables
    ☑ By variable
    SITE → By variable
Stat > Basic Statistics > Display Descriptive Statistics
    NINDIVS → Variables

MINITAB OUTPUT FOR TABLE 15.7 Means and variances for fig tree sites

Descriptive Statistics: `NINDIVS` by `SITE`

Variable	SITE	N	Mean	Median	TrMean	StDev
NINDIVS	1	100	9.510	9.500	9.467	3.218
	2	100	18.930	19.000	18.989	4.409
	3	100	41.430	41.000	41.422	6.261

Variable	SITE	SE Mean	Minimum	Maximum	Q1	Q3
NINDIVS	1	0.322	2.000	17.000	7.000	12.000
	2	0.441	8.000	28.000	16.000	22.000
	3	0.626	27.000	56.000	37.000	45.000

Descriptive Statistics: `NINDIVS`

Variable	N	Mean	Median	TrMean	StDev	SE Mean
NINDIVS	300	23.290	19.000	22.748	14.239	0.822

Variable	Minimum	Maximum	Q1	Q3
NINDIVS	2.000	56.000	11.000	37.000

MINITAB COMMANDS FOR BOX 15.22

Commands

```
name C6 = 'SQRTN'
let SQRTN = SQRT(NINDIVS)
glm SQRTN = SITE;
brief 1.
```

Menu route

Calc > Calculator
`SQRTN` → Store result in variable
`SQRT(NINDIVS)` → Expression

Stat > ANOVA > General Linear Model
`SQRTN` → Response
`SITE` → Model
[Results…]
⊙ Analysis of variance table

MINITAB OUTPUT FOR BOX 15.22

General Linear Model: SQRTN versus SITE

Factor	Type	Levels	Values
SITE	fixed	3	1 2 3

Analysis of Variance for SQRTN, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
SITE	2	582.63	582.63	291.31	1091.99	0.000
Error	297	79.23	79.23	0.27		
Total	299	661.86				