Balcewicz HW 3

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Univariate Assignment

Read in tree data, metadata can be found in: ./data/tree_metadata.txt

```
trees = read.csv("https://raw.githubusercontent.com/dmcglinn/quant_methods/gh-pages/data/treedata_subse
                 header = TRUE)
acer = subset(trees, species == "Acer rubrum")
abies = subset(trees, species == "Abies fraseri")
```

1. Exploratory analysis

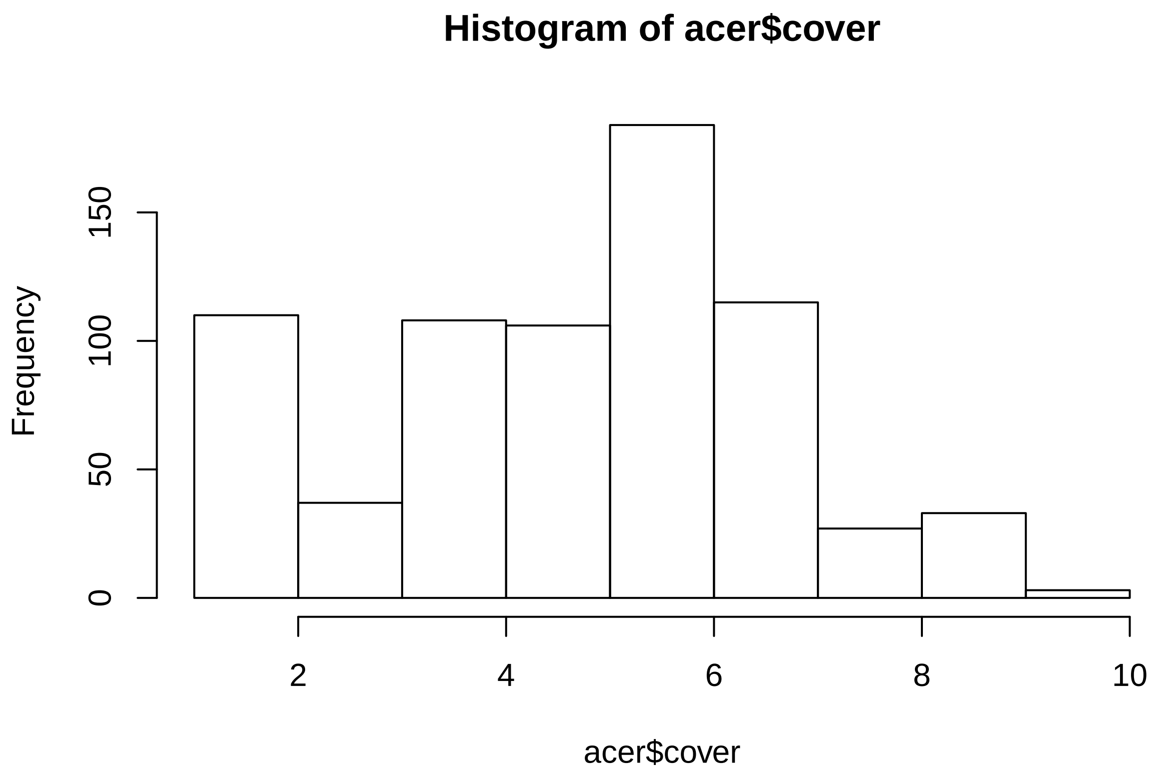
```
str(acer)
```

```
## 'data.frame':    723 obs. of  9 variables:
##  $ plotID    : Factor w/ 734 levels "ATBN-01-0303",..: 1 2 3 4 5 6 8 9 10 18 ...
##  $ spcode    : Factor w/ 52 levels "ABIEFRA","ACERNEG",..: 4 4 4 4 4 4 4 4 4 4 ...
##  $ species   : Factor w/ 51 levels "Abies fraseri",..: 4 4 4 4 4 4 4 4 4 4 ...
##  $ cover     : int  6 7 5 7 5 4 2 7 4 7 ...
##  $ elev      : num  896 947 1027 450 477 ...
##  $ tci       : num  4.71 4.45 6.15 4.13 5.59 ...
##  $ streamdist: num  197 125 175 202 134 ...
##  $ disturb   : Factor w/ 4 levels "CORPLOG","LT-SEL",..: 1 1 1 2 2 2 1 4 2 1 ...
##  $ beers     : num  1.991 0.817 0.586 0.86 0.101 ...
```

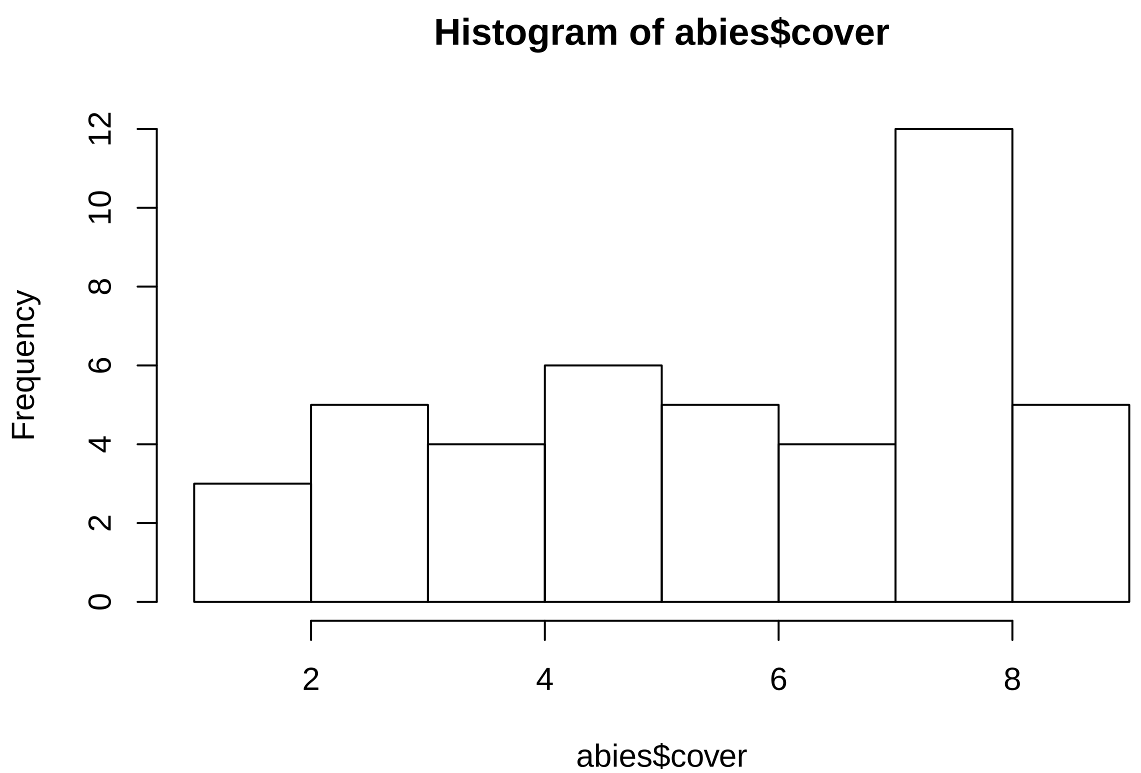
```
str(abies)
```

```
## 'data.frame':    44 obs. of  9 variables:
##  $ plotID    : Factor w/ 734 levels "ATBN-01-0303",..: 20 53 54 56 109 188 452 471 471 471 ...
##  $ spcode    : Factor w/ 52 levels "ABIEFRA","ACERNEG",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ species   : Factor w/ 51 levels "Abies fraseri",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ cover     : int  1 8 3 3 5 2 4 8 8 5 ...
##  $ elev      : num  1660 1712 1722 1754 1570 ...
##  $ tci       : num  5.7 3.82 3.89 3.15 11.85 ...
##  $ streamdist: num  491 454 453 492 0 ...
##  $ disturb   : Factor w/ 4 levels "CORPLOG","LT-SEL",..: 1 4 2 3 2 4 4 4 4 4 ...
##  $ beers     : num  0.224 0.834 1.333 1.471 0.496 ...
```

```
hist(acer$cover)
```

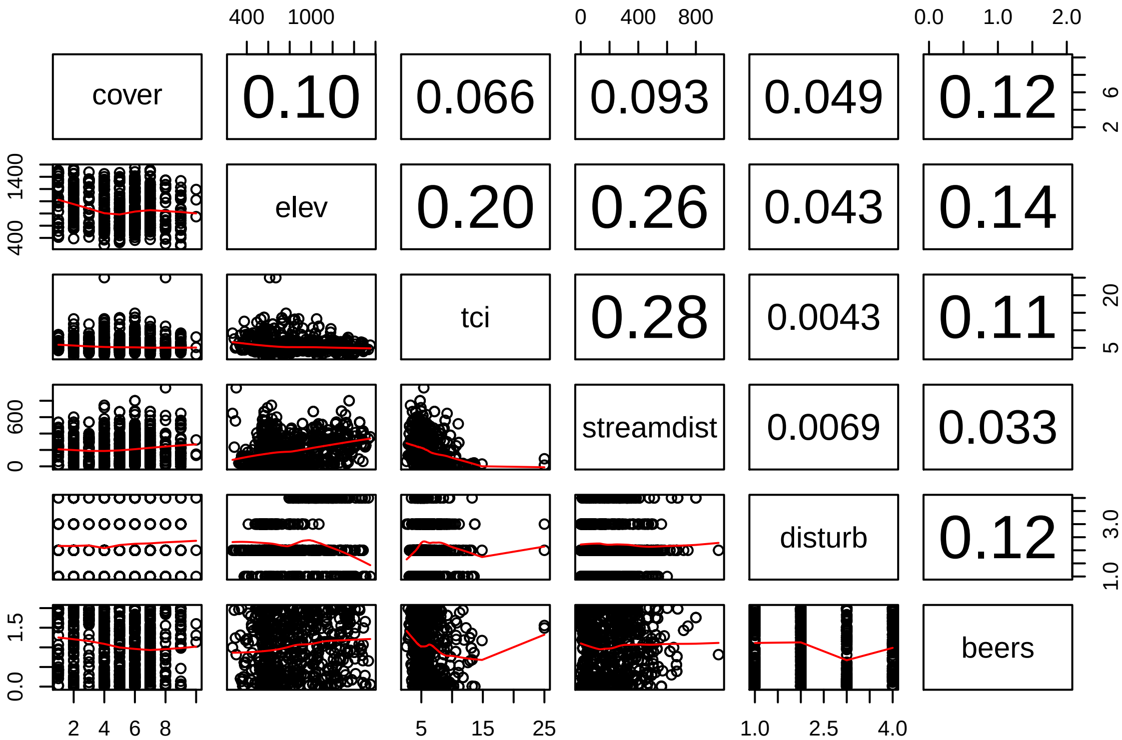



```
hist(abies$cover)
```

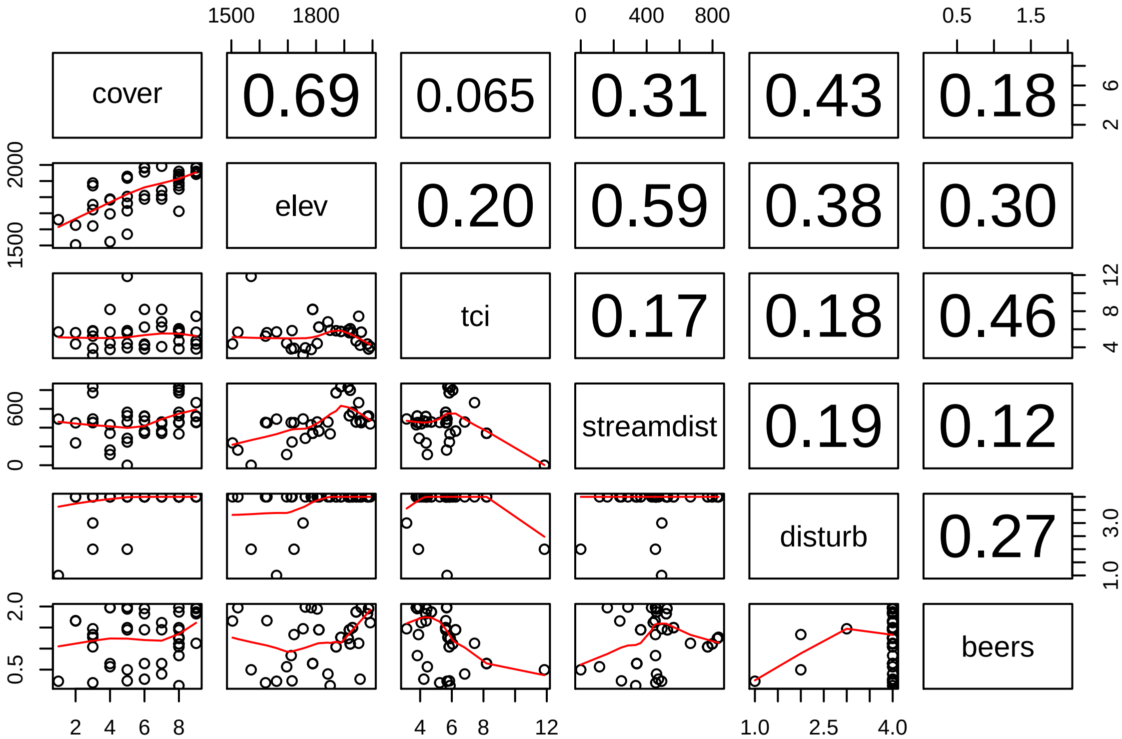



```
panel.cor <- function(x, y, digits = 2, prefix = "", cex.cor=3, ...)
{
    usr <- par("usr"); on.exit(par(usr))
```

```r
    par(usr = c(0, 1, 0, 1))
    r <- abs(cor(x, y))
    txt <- format(c(r, 0.123456789), digits = digits)[1]
    txt <- paste0(prefix, txt)
    if(missing(cex.cor))
        cex.cor <- 0.8/strwidth(txt)
    text(0.5, 0.5, txt, cex = cex.cor)
}
pairs(acer[,c("cover", "elev", "tci", "streamdist", "disturb", "beers")],
      lower.panel = panel.smooth, upper.panel = panel.cor)
```




```r
pairs(abies[,c("cover", "elev", "tci", "streamdist", "disturb", "beers")],
      lower.panel = panel.smooth, upper.panel = panel.cor)
```




```r
lm.acer = lm(cover ~ elev + tci + streamdist + disturb + beers, data = acer)
summary(lm.acer)
```

```
##
## Call:
## lm(formula = cover ~ elev + tci + streamdist + disturb + beers,
##     data = acer)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.7073 -1.2446  0.3409  1.3575  5.2732
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      6.3502303  0.4564973  13.911  < 2e-16 ***
## elev            -0.0010108  0.0003161  -3.197  0.00145 **
## tci             -0.0627613  0.0351922  -1.783  0.07495 .
## streamdist       0.0012895  0.0004756   2.712  0.00686 **
## disturbLT-SEL    0.0829610  0.2166747   0.383  0.70192
## disturbSETTLE   -0.1044556  0.2804213  -0.372  0.70963
## disturbVIRGIN    0.3088364  0.2518161   1.226  0.22044
## beers           -0.3269597  0.1089662  -3.001  0.00279 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.989 on 715 degrees of freedom
## Multiple R-squared:  0.04493,    Adjusted R-squared:  0.03558
## F-statistic: 4.805 on 7 and 715 DF,  p-value: 2.669e-05
```

```r
lm.abies = lm(cover ~ elev + tci + streamdist + disturb + beers, data = abies)
summary(lm.abies)
```

```
##
## Call:
## lm(formula = cover ~ elev + tci + streamdist + disturb + beers,
##     data = abies)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.4630 -0.6472  0.0788  1.0872  3.8017
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -20.561173   4.271449  -4.814 2.65e-05 ***
## elev            0.012370   0.002523   4.903 2.02e-05 ***
## tci             0.287641   0.193467   1.487   0.1458
## streamdist     -0.001266   0.001585  -0.799   0.4296
## disturbLT-SEL   2.188367   2.097905   1.043   0.3038
## disturbSETTLE   1.527604   2.341471   0.652   0.5183
## disturbVIRGIN   3.025596   1.735921   1.743   0.0899 .
## beers           0.037551   0.500269   0.075   0.9406
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.601 on 36 degrees of freedom
## Multiple R-squared:  0.5824, Adjusted R-squared:  0.5011
## F-statistic: 7.171 on 7 and 36 DF,  p-value: 2.215e-05
```

```r
library(car)
```

```
## Warning: package 'car' was built under R version 3.4.3
```

```r
Anova(lm.acer, type = 3)
```

```
## Anova Table (Type III tests)
##
## Response: cover
##              Sum Sq  Df  F value    Pr(>F)
## (Intercept)  765.43   1 193.5096 < 2.2e-16 ***
## elev          40.44   1  10.2233  0.001448 **
## tci           12.58   1   3.1805  0.074947 .
## streamdist    29.09   1   7.3531  0.006856 **
## disturb        9.45   3   0.7962  0.496166
## beers         35.61   1   9.0034  0.002789 **
## Residuals   2828.21 715
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
Anova(lm.abies, type = 3)
```

```
## Anova Table (Type III tests)
##
## Response: cover
##             Sum Sq Df F value    Pr(>F)
## (Intercept) 59.401  1 23.1710 2.652e-05 ***
## elev        61.618  1 24.0358 2.022e-05 ***
## tci          5.667  1  2.2105    0.1458
## streamdist   1.636  1  0.6382    0.4296
```

```
## disturb     10.089  3  1.3118    0.2855
## beers        0.014  1  0.0056    0.9406
## Residuals   92.289 36
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The p-values generate by the Anova function are the same as those generated by the lm function.

```r
library(MASS)
step.acer =  stepAIC(lm.acer)
```

```
## Start:  AIC=1002.17
## cover ~ elev + tci + streamdist + disturb + beers
##
##              Df Sum of Sq    RSS     AIC
## - disturb     3     9.449 2837.7  998.58
## <none>                    2828.2 1002.17
## - tci         1    12.581 2840.8 1003.37
## - streamdist  1    29.085 2857.3 1007.56
## - beers       1    35.613 2863.8 1009.21
## - elev        1    40.439 2868.7 1010.43
##
## Step:  AIC=998.58
## cover ~ elev + tci + streamdist + beers
##
##              Df Sum of Sq    RSS     AIC
## <none>                    2837.7  998.58
## - tci         1    14.370 2852.0 1000.23
## - streamdist  1    31.491 2869.2 1004.56
## - beers       1    35.515 2873.2 1005.57
## - elev        1    45.778 2883.4 1008.15
```

```r
step.abies = stepAIC(lm.abies)
```

```
## Start:  AIC=48.59
## cover ~ elev + tci + streamdist + disturb + beers
##
##              Df Sum of Sq     RSS    AIC
## - beers       1     0.014  92.304 46.599
## - disturb     3    10.089 102.379 47.157
## - streamdist  1     1.636  93.926 47.366
## <none>                     92.289 48.593
## - tci         1     5.667  97.956 49.215
## - elev        1    61.618 153.908 69.095
##
## Step:  AIC=46.6
## cover ~ elev + tci + streamdist + disturb
##
##              Df Sum of Sq     RSS    AIC
## - streamdist  1     1.665  93.969 45.386
## - disturb     3    10.679 102.983 45.417
## <none>                     92.304 46.599
## - tci         1     6.745  99.049 47.703
## - elev        1    64.662 156.966 67.961
##
## Step:  AIC=45.39
```

```
## cover ~ elev + tci + disturb
##
##            Df Sum of Sq     RSS    AIC
## - disturb  3    12.021 105.990 44.683
## <none>                  93.969 45.386
## - tci      1     6.807 100.776 46.463
## - elev     1    78.687 172.656 70.153
##
## Step:  AIC=44.68
## cover ~ elev + tci
##
##        Df Sum of Sq    RSS    AIC
## <none>              105.99 44.683
## - tci   1     9.239 115.23 46.360
## - elev  1   114.046 220.04 74.822
```

```r
summary(step.acer)
```

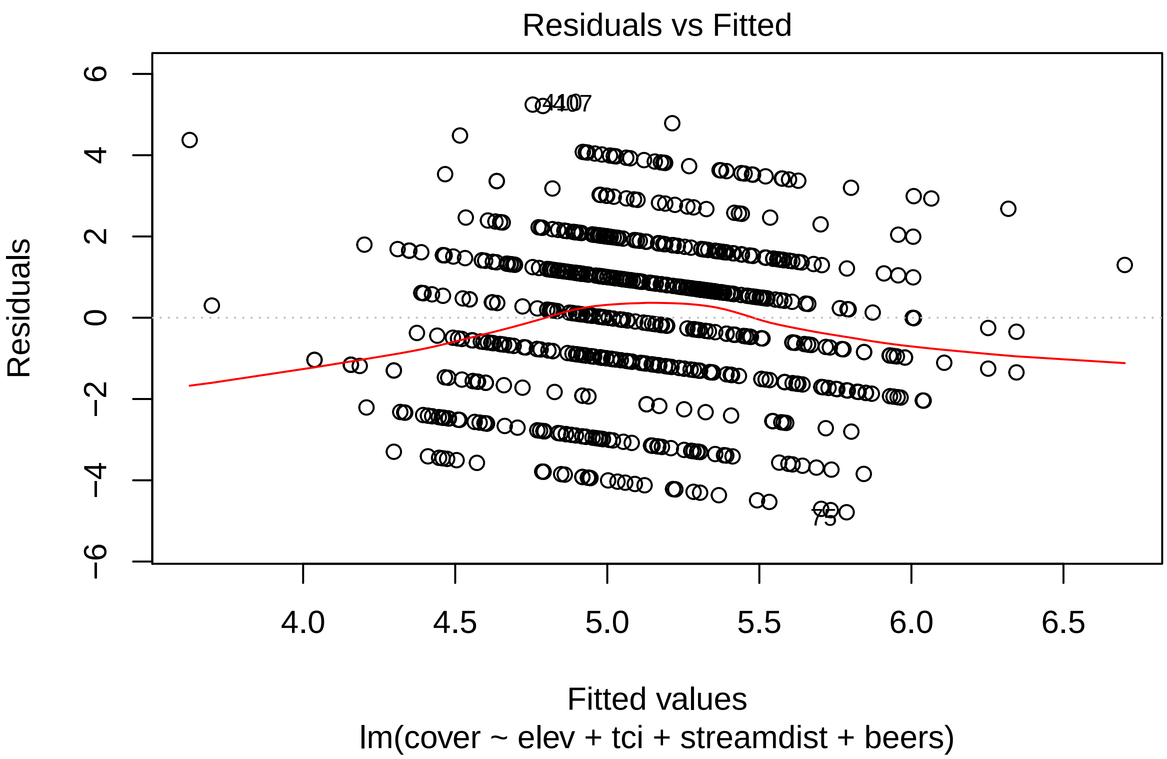
```
##
## Call:
## lm(formula = cover ~ elev + tci + streamdist + beers, data = acer)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.7869 -1.2983  0.3618  1.4014  5.2451
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.3218898  0.3604346  17.540  < 2e-16 ***
## elev        -0.0008868  0.0002606  -3.403 0.000703 ***
## tci         -0.0668631  0.0350647  -1.907 0.056939 .
## streamdist   0.0013256  0.0004696   2.823 0.004893 **
## beers       -0.3204370  0.1068951  -2.998 0.002814 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.988 on 718 degrees of freedom
## Multiple R-squared:  0.04174,    Adjusted R-squared:  0.0364
## F-statistic: 7.818 on 4 and 718 DF,  p-value: 3.603e-06
```

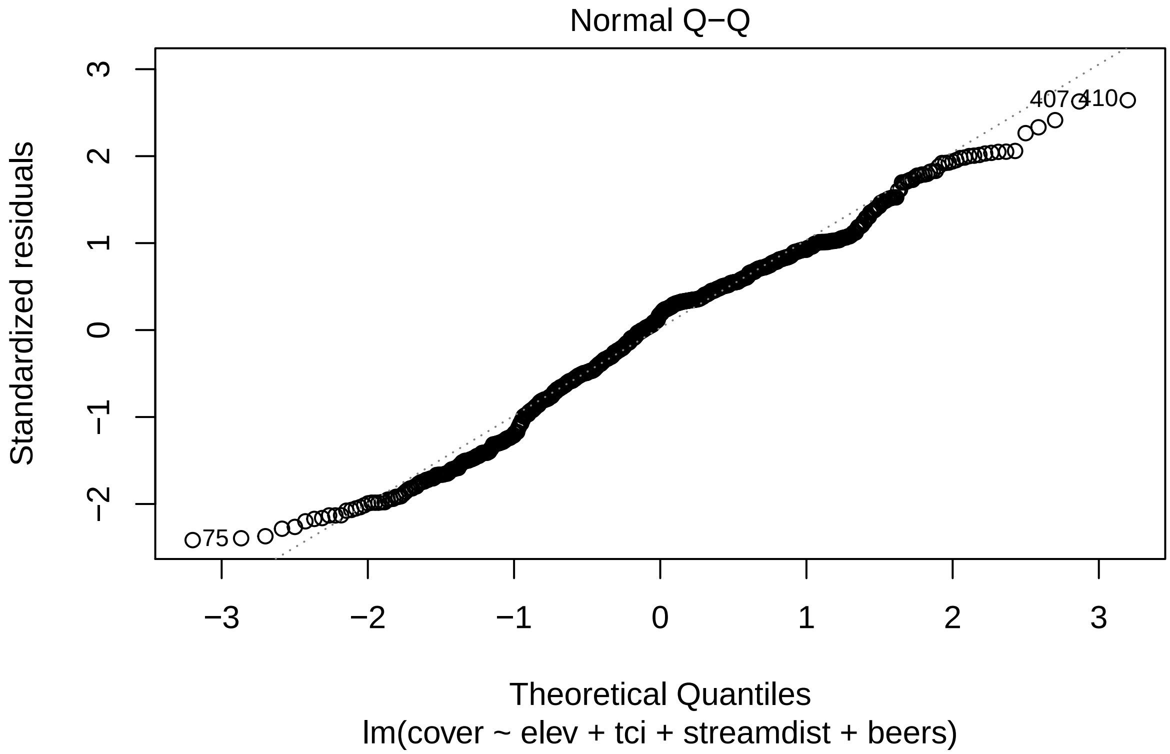
```r
summary(step.abies)
```

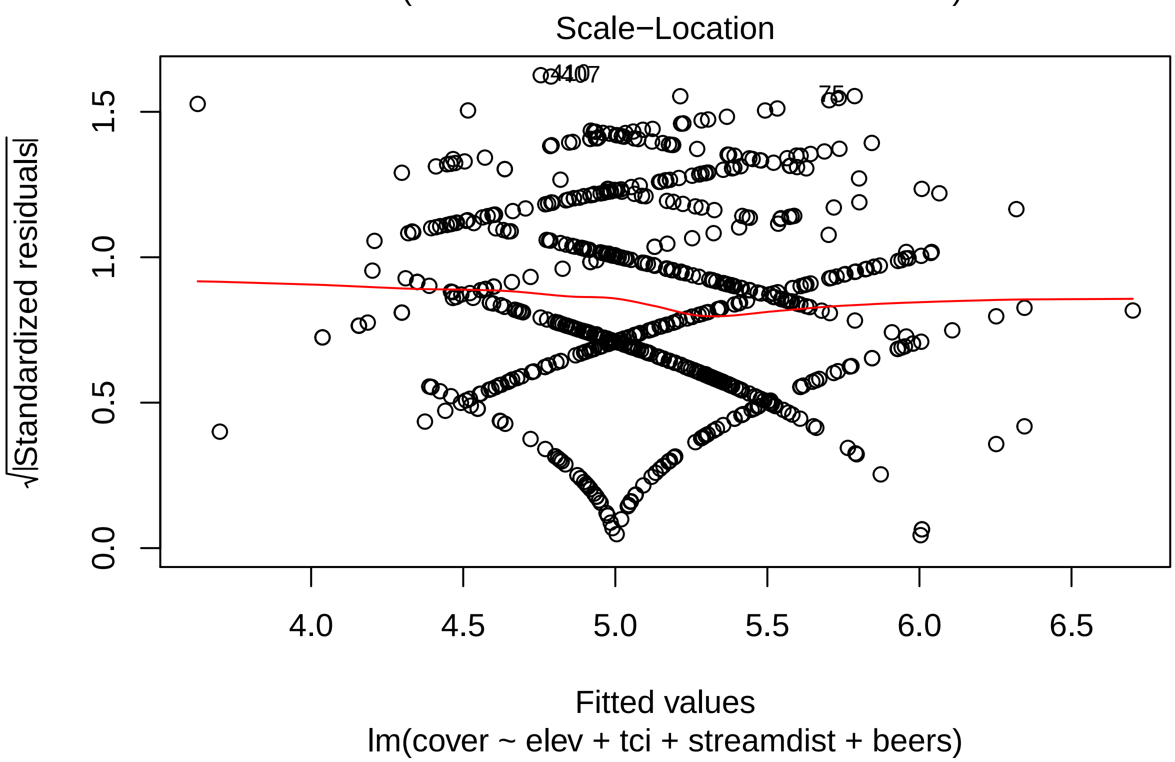
```
##
## Call:
## lm(formula = cover ~ elev + tci, data = abies)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.7819 -1.1346  0.3731  0.8880  4.0268
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -18.789840   3.767380  -4.988 1.17e-05 ***
## elev          0.012616   0.001899   6.642 5.29e-08 ***
## tci           0.304539   0.161094   1.890   0.0658 .
```

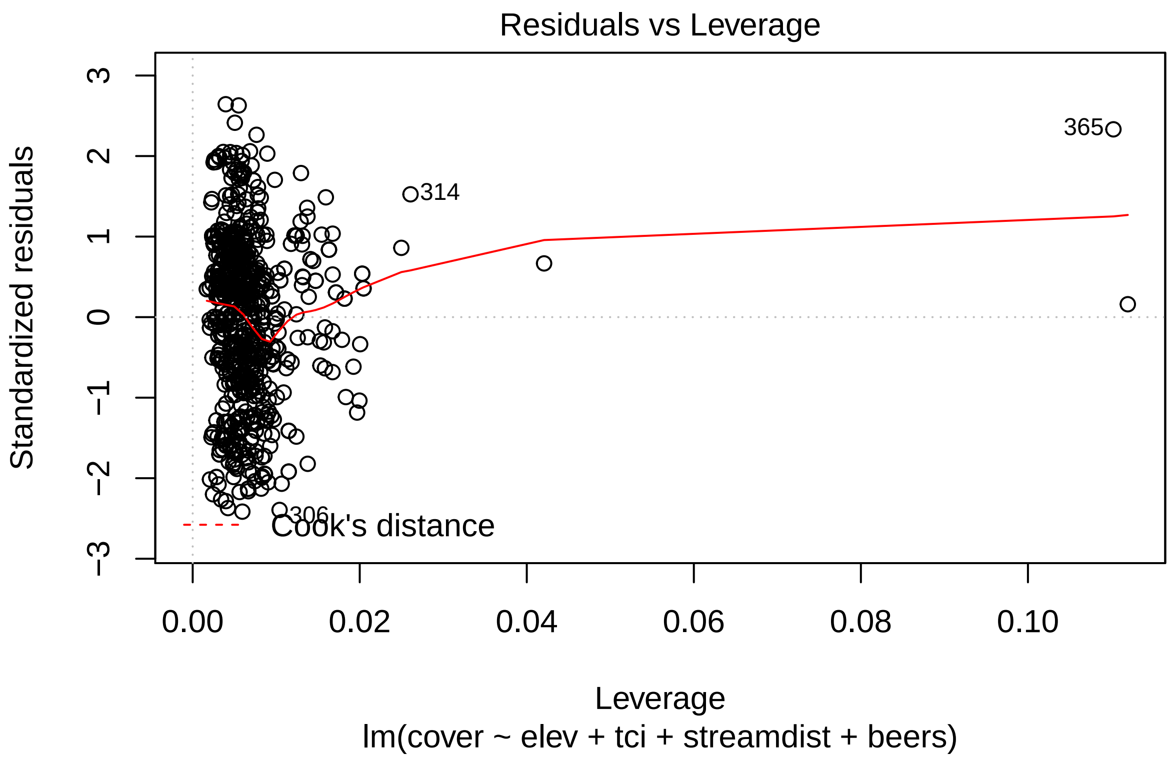
```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.608 on 41 degrees of freedom
## Multiple R-squared:  0.5204, Adjusted R-squared:  0.497
## F-statistic: 22.24 on 2 and 41 DF,  p-value: 2.876e-07
```

```r
plot(step.acer)
```

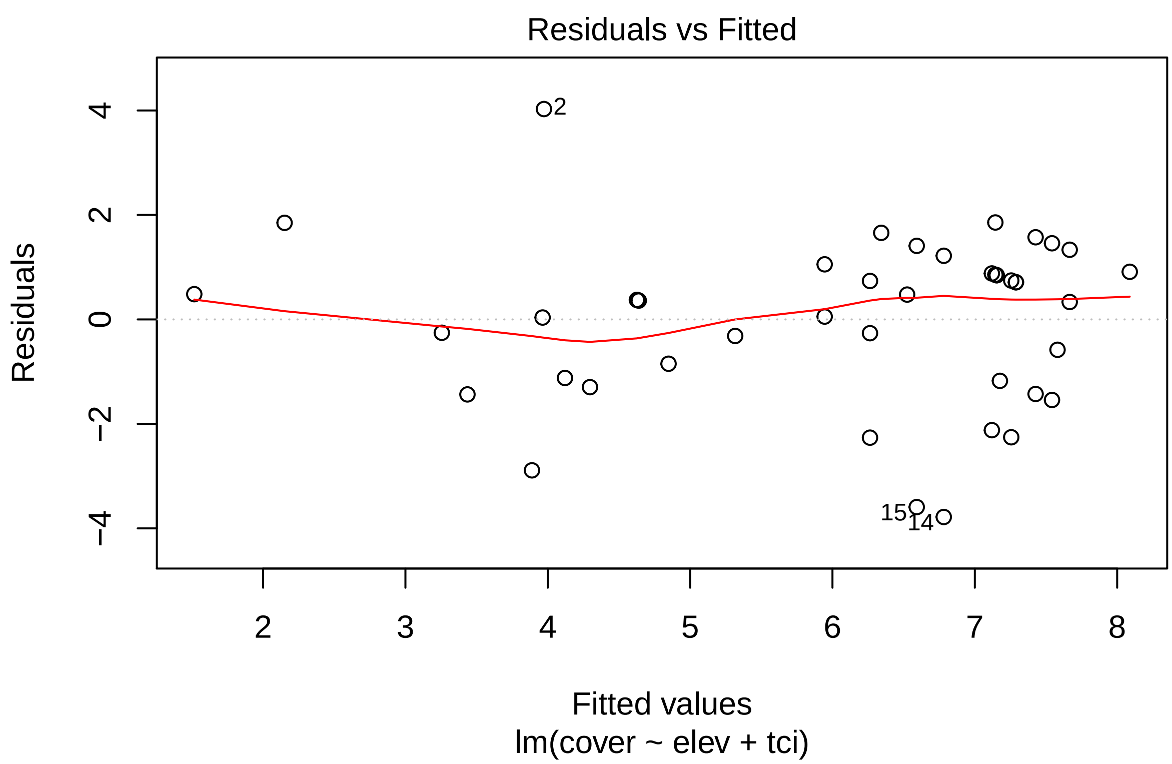


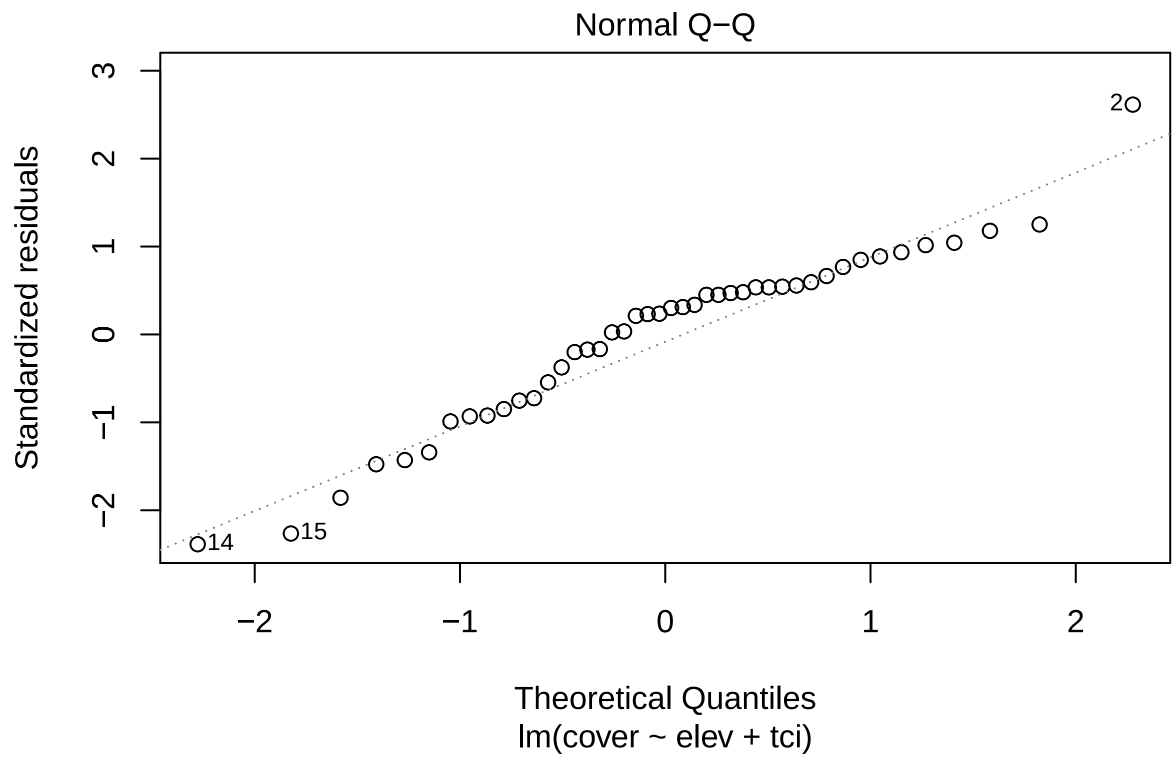

Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(cover ~ elev + tci + streamdist + beers)
75
407
410

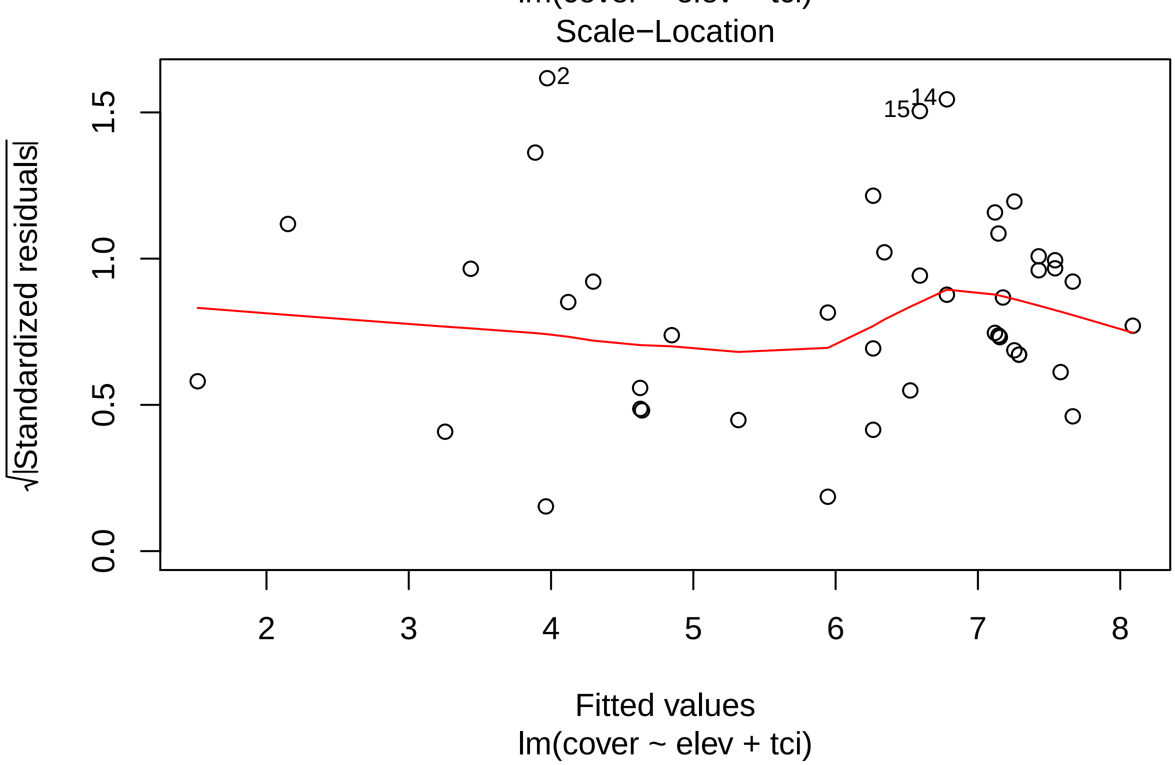

Scale−Location
√|Standardized residuals|
Fitted values
lm(cover ~ elev + tci + streamdist + beers)
410
407
75

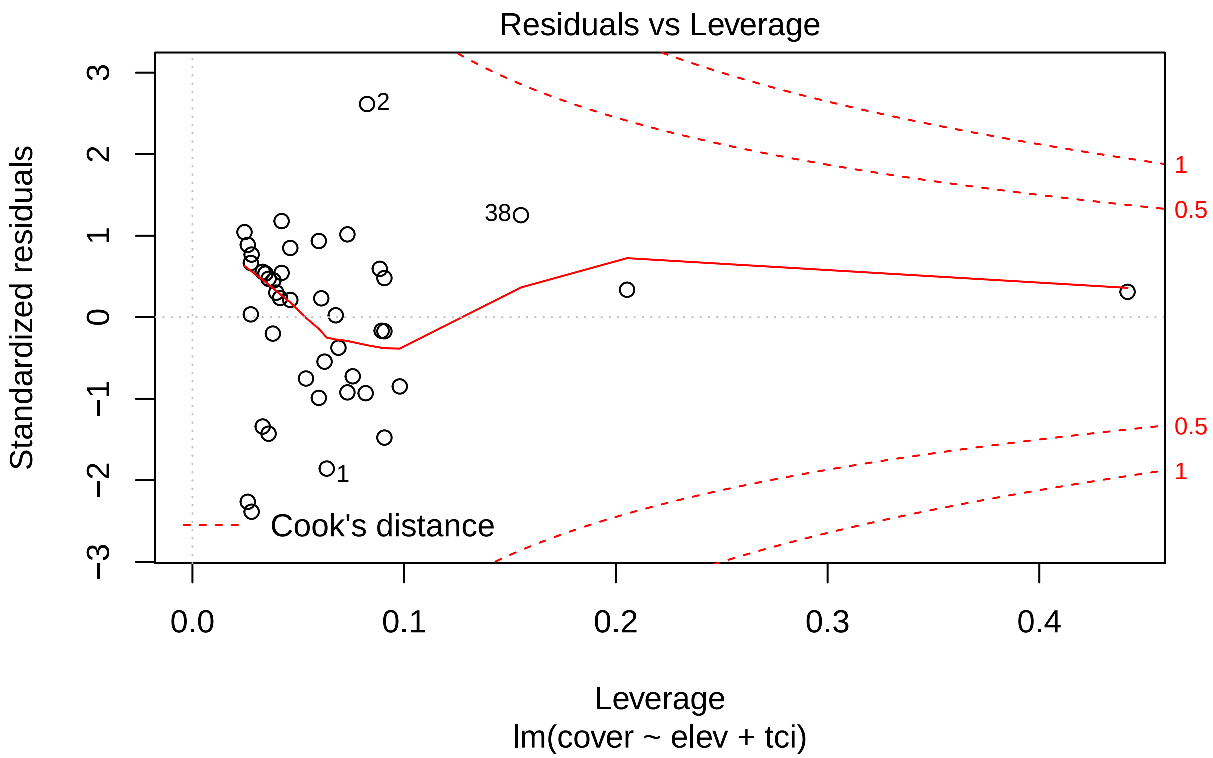



```
plot(step.abies)
```




Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(cover ~ elev + tci)
2
14
15


Scale−Location
√|Standardized residuals|
Fitted values
lm(cover ~ elev + tci)
2
15
14




```
The Acer rubrum model has a multiple r-squared value of 0.04174, indicating that only 4.174% of the vari
The Abies fraseri model has a multiple r-squared value of 0.5204, indicating that 52.04% of the variatio
Between the two models, the variance in Abies fraseri cover is much better explained by the data. This i
```

2. General Linear Model (GLM) with a Poisson error term

```r
acer_glm = glm(cover ~ elev + tci + streamdist + beers , data = acer,
               family = 'poisson')
abies_glm = glm(cover ~ elev + tci, data = abies, family = 'poisson')

pseudo_r2 = function(glm_mod) {
     1 -  glm_mod$deviance / glm_mod$null.deviance
}

acer_r2 = pseudo_r2(acer_glm)
acer_r2
```

```
## [1] 0.03704802
```

```r
abies_r2 = pseudo_r2(abies_glm)
abies_r2
```

```
## [1] 0.5140995
```

```r
anova(step.acer, acer_glm)
```

```
## Analysis of Variance Table
##
## Model 1: cover ~ elev + tci + streamdist + beers
## Model 2: cover ~ elev + tci + streamdist + beers
```

```
##   Res.Df     RSS Df Sum of Sq F Pr(>F)
## 1    718 2837.66
## 2    718  625.28  0    2212.4
```

```r
anova(step.abies, abies_glm)
```

```
## Analysis of Variance Table
##
## Model 1: cover ~ elev + tci
## Model 2: cover ~ elev + tci
##   Res.Df     RSS Df Sum of Sq F Pr(>F)
## 1     41 105.990
## 2     41  20.055  0    85.935
```

Changing the error distribution greatly reduced the residual sum of squares errors for both models. For the Acer model, it reduded from 2837.66 to 625.28, a difference of 2212.4. For the Abies model, it reduced from 105.99 to 20.055, a reduction of 85.935.

3. Plain english summary

```
The cover of Acer rubrum and Abies fraseri trees can be predicted using orinary least squares regressio
```