

pulse

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pulse

reference:

- Cannon, et al., Stat2, chapter 07, example 7.20

data

Import the data.

```
data <- read.csv("Pulse.csv", header=TRUE)
head(data, 3)
```

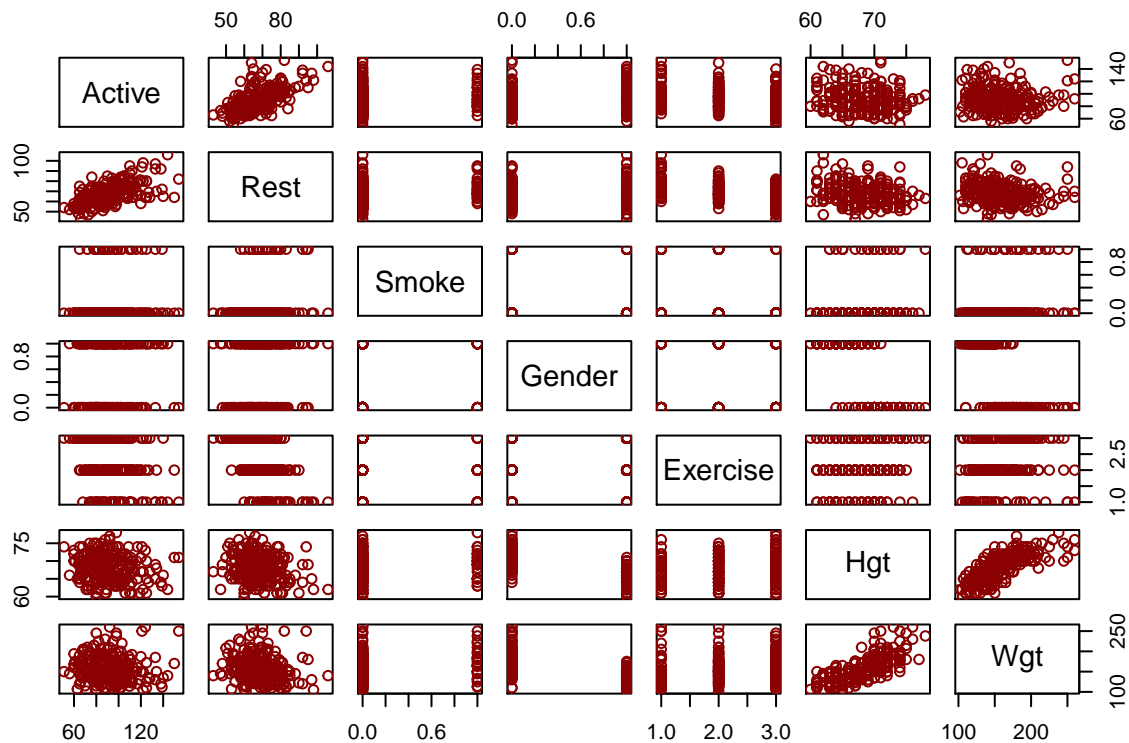
```
##   Active Rest Smoke Gender Exercise Hgt Wgt
## 1    97  78    0     1       1  63 119
## 2    82  68    1     0       3  70 225
## 3    88  62    0     0       3  72 175
```

```
dim(data)
```

```
## [1] 232  7
```

Scatterplot matrix.

```
pairs(~ Active + Rest + Smoke + Gender + Exercise + Hgt + Wgt, data=data, col="darkred")
```



ANOVA: Active ~ Exercise

ANOVA: Active ~ Exercise

```
data$Exercise <- factor(data$Exercise, levels=1:3) # Exercise is a factor with 3 levels
pulse.aov <- aov(Active ~ Exercise, data=data)
options(show.signif.stars=FALSE)
summary(pulse.aov)
```

```
##           Df Sum Sq Mean Sq F value    Pr(>F)
## Exercise    2  10523     5261   16.9 1.43e-07
## Residuals  229   71298       311
```

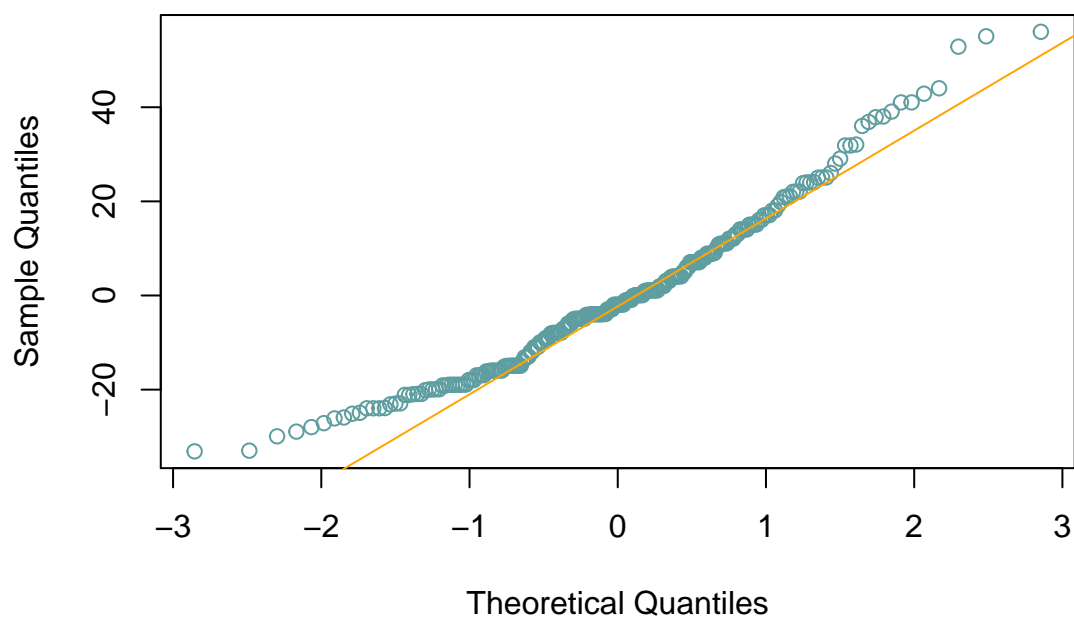
pulse.aov

```
## Call:
## aov(formula = Active ~ Exercise, data = data)
##
## Terms:
##           Exercise Residuals
## Sum of Squares  10522.72  71297.76
## Deg. of Freedom      2      229
##
## Residual standard error: 17.64494
## Estimated effects may be unbalanced
```

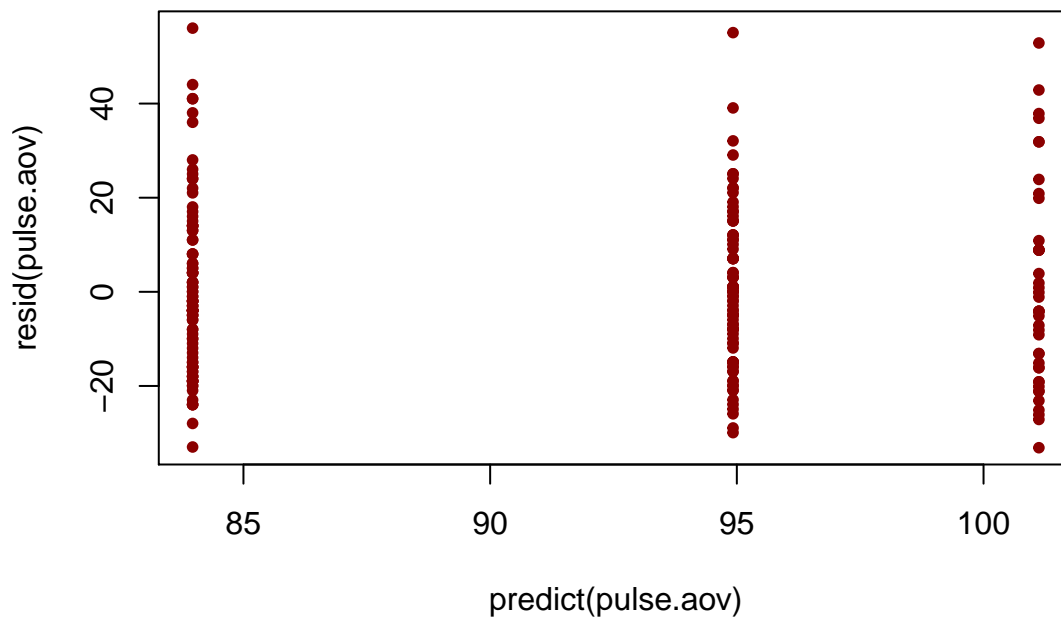
Residuals.

```
qqnorm(resid(pulse.aov), col="cadetblue")
qqline(resid(pulse.aov), col="orange")
```

Normal Q-Q Plot



```
plot(predict(pulse.aov), resid(pulse.aov),  
      pch=20, col="darkred")
```



Levene's test.

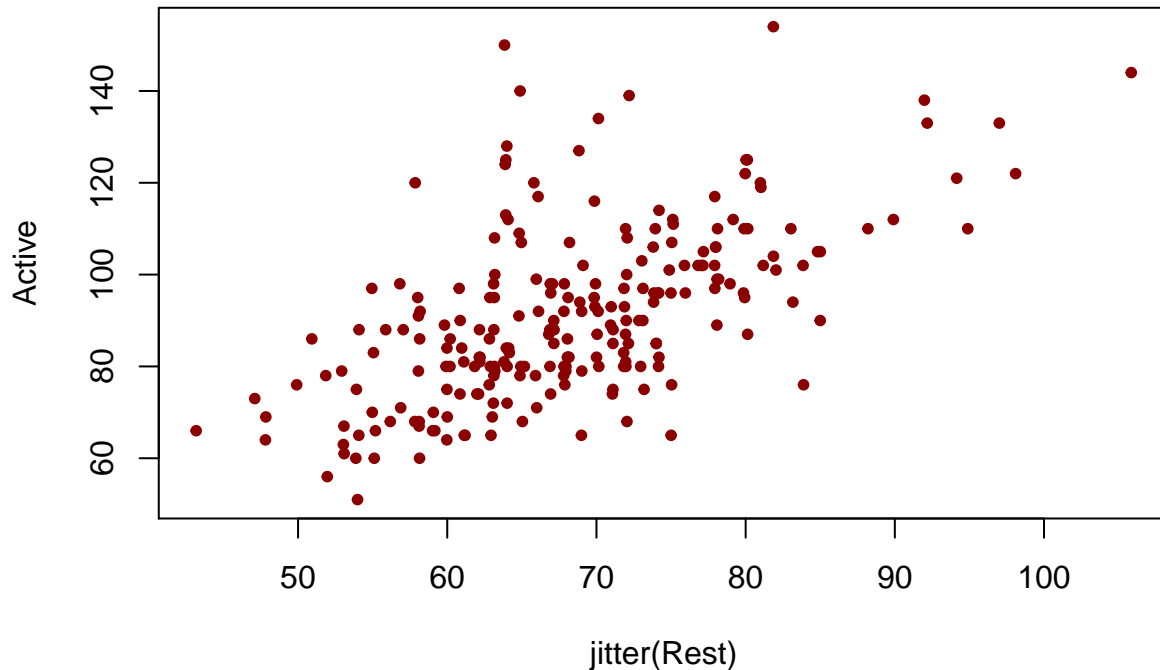
```
library(car)  
leveneTest(Active ~ Exercise, data=data)
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group  2  2.1082 0.1238  
##      229
```

ANCOVA with resting pulse rate as covariate.

Response ~ covariate

```
plot(Active ~ jitter(Rest), data=data, # jitter the points a bit  
      pch=20, col="darkred")         # to avoid overlap
```



ANCOVA with resting pulse rate as covariate.

```
pulse.lm <- lm(Active ~ Exercise + Rest, data=data)
summary(pulse.lm)
```

```
##
## Call:
## lm(formula = Active ~ Exercise + Rest, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -34.974  -9.807  -2.179   7.102  62.151
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  15.9465     9.4514   1.687  0.0929
## Exercise2     1.3529     2.9458   0.459  0.6465
## Exercise3    -1.2141     3.2755  -0.371  0.7112
## Rest          1.1023     0.1185   9.304 <2e-16
##
## Residual standard error: 15.05 on 228 degrees of freedom
## Multiple R-squared:  0.3684, Adjusted R-squared:  0.3601
## F-statistic: 44.33 on 3 and 228 DF,  p-value: < 2.2e-16
```

```
anova(pulse.lm)
```

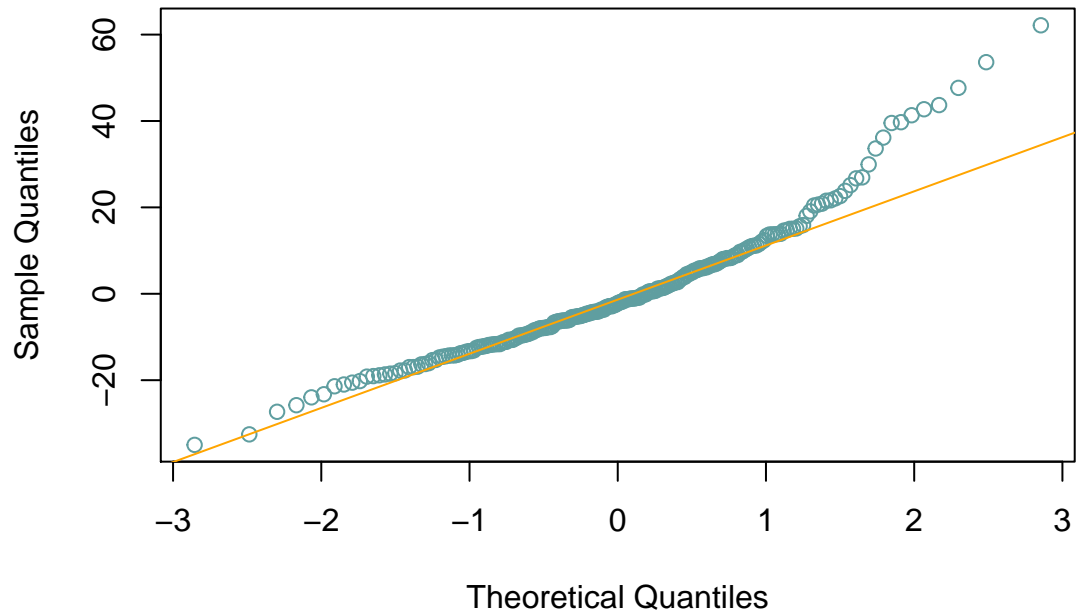
```
## Analysis of Variance Table
##
## Response: Active
##           Df Sum Sq Mean Sq F value    Pr(>F)
## Exercise   2  10523  5261.4  23.214 6.666e-10
```

```
## Rest      1  19622 19621.6  86.572 < 2.2e-16
## Residuals 228  51676   226.7
```

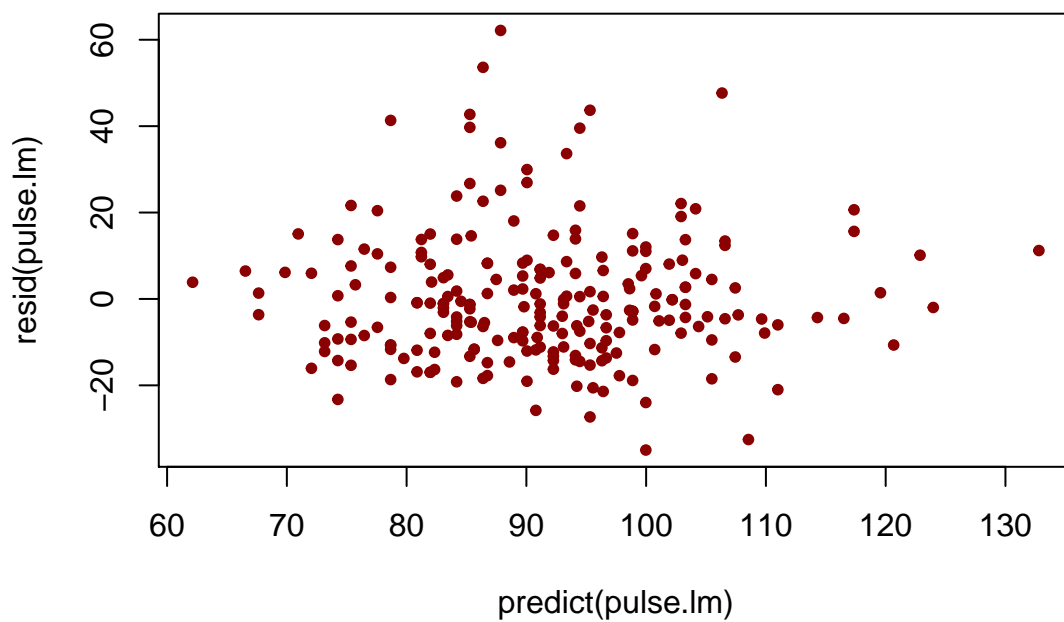
Residuals.

```
qqnorm(resid(pulse.lm), col="cadetblue")
qqline(resid(pulse.lm), col="orange")
```

Normal Q-Q Plot



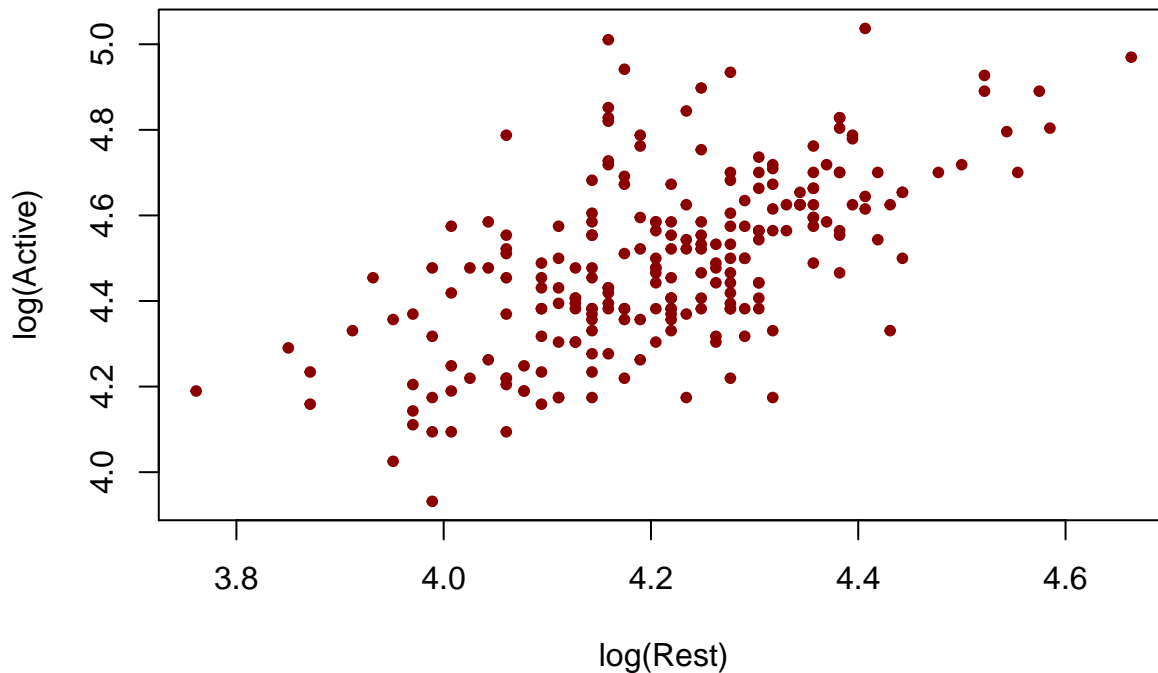
```
plot(predict(pulse.lm), resid(pulse.lm),
      pch=20, col="darkred")
```



ANOVA with log transformation: $\log(\text{Active}) \sim \text{Exercise}$

Response ~ covariate: $\log(\text{Active}) \sim \log(\text{Rest})$

```
plot(log(Active) ~ log(Rest), data=data,  
     pch=20, col="darkred")
```



ANOVA with log transformation: $\log(\text{Active}) \sim \text{Exercise}$

```
pulse.aov2 <- aov(log(Active) ~ Exercise, data=data)  
summary(pulse.aov2)
```

```
##           Df Sum Sq Mean Sq F value    Pr(>F)  
## Exercise    2  1.307  0.6535    18.4 3.87e-08  
## Residuals  229  8.132  0.0355
```

```
pulse.aov2
```

```
## Call:  
##   aov(formula = log(Active) ~ Exercise, data = data)  
##  
## Terms:  
##           Exercise Residuals  
## Sum of Squares  1.307032  8.131555  
## Deg. of Freedom      2      229  
##  
## Residual standard error: 0.1884383  
## Estimated effects may be unbalanced
```

ANCOVA with log transformation: $\log(\text{Active}) \sim \log(\text{Rest}) + \text{Exercise}$

ANCOVA with log transformation: $\log(\text{Active}) \sim \log(\text{Rest}) + \text{Exercise}$

```
pulse.lm2 <- lm(log(Active) ~ log(Rest) + Exercise, data=data)
summary(pulse.lm2)
```

```
##
## Call:
## lm(formula = log(Active) ~ log(Rest) + Exercise, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.42168 -0.10416 -0.01292  0.09752  0.54592
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.00244    0.37625   2.664  0.00827
## log(Rest)    0.82818    0.08654   9.570 < 2e-16
## Exercise2    0.01797    0.03099   0.580  0.56259
## Exercise3   -0.01391    0.03456  -0.403  0.68764
##
## Residual standard error: 0.1595 on 228 degrees of freedom
## Multiple R-squared:  0.3854, Adjusted R-squared:  0.3773
## F-statistic: 47.65 on 3 and 228 DF,  p-value: < 2.2e-16
```

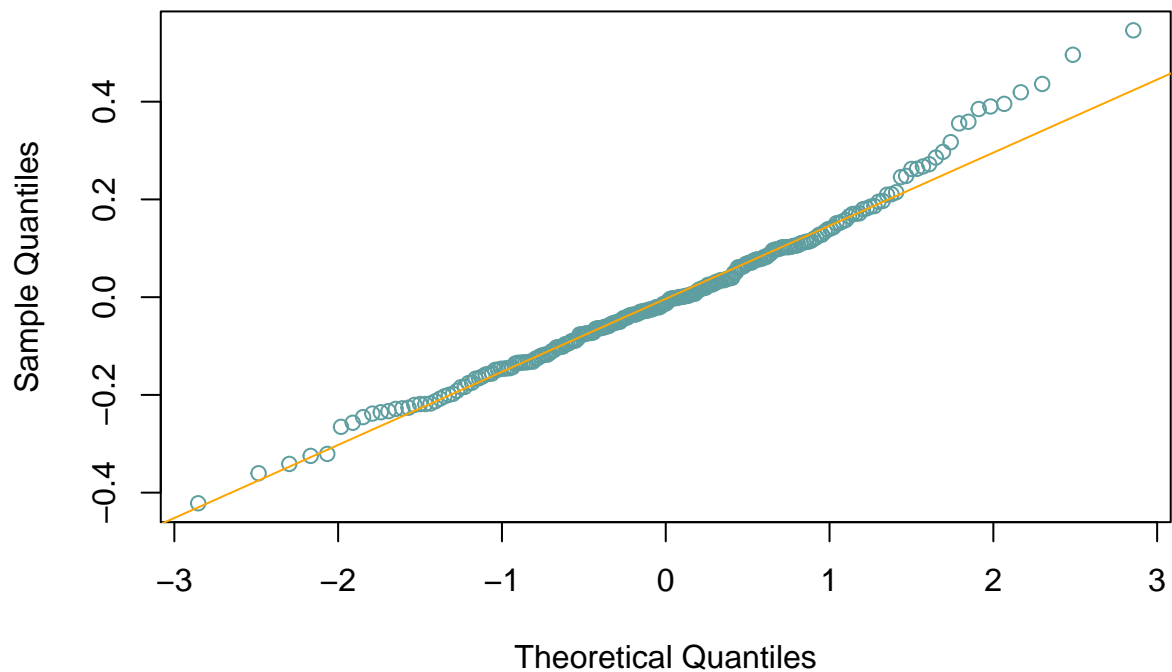
```
anova(pulse.lm2)
```

```
## Analysis of Variance Table
##
## Response: log(Active)
##           Df Sum Sq Mean Sq F value Pr(>F)
## log(Rest)  1  3.5951  3.5951 141.297 <2e-16
## Exercise  2  0.0424  0.0212   0.833  0.436
## Residuals 228  5.8011  0.0254
```

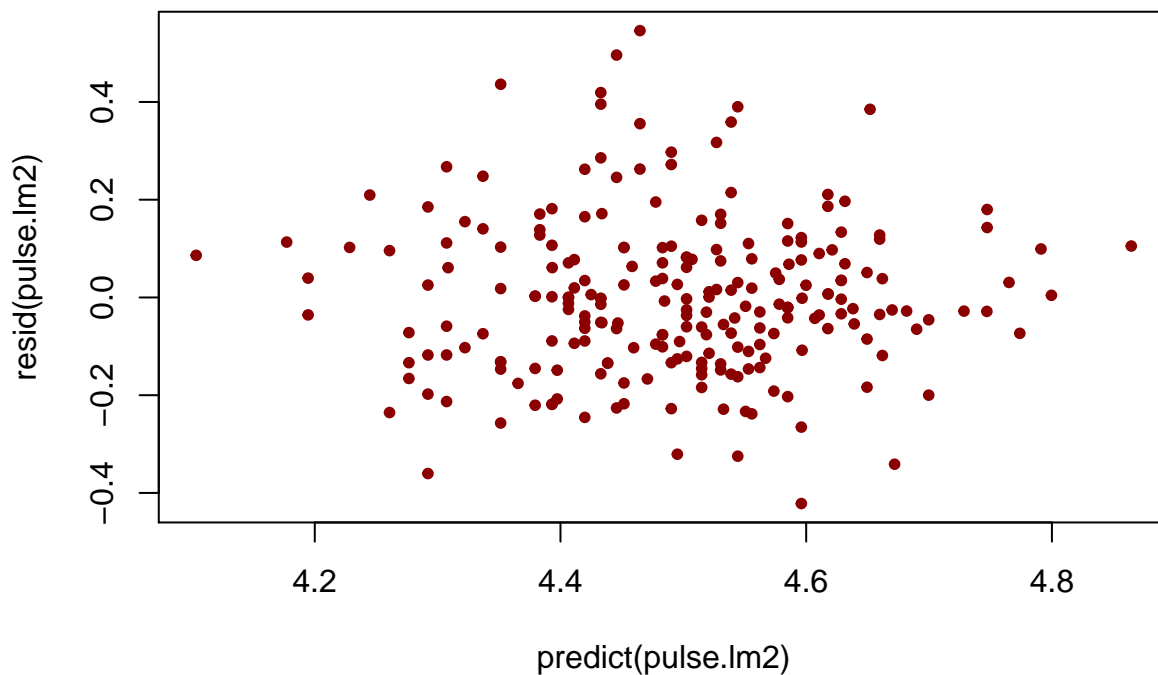
Residuals.

```
qqnorm(resid(pulse.lm2), col="cadetblue")
qqline(resid(pulse.lm2), col="orange")
```

Normal Q-Q Plot



```
plot(predict(pulse.lm2), resid(pulse.lm2),  
     pch=20, col="darkred")
```



Final model: $\log(\text{Active}) \sim \log(\text{Rest}) \mid \text{Exercise}$

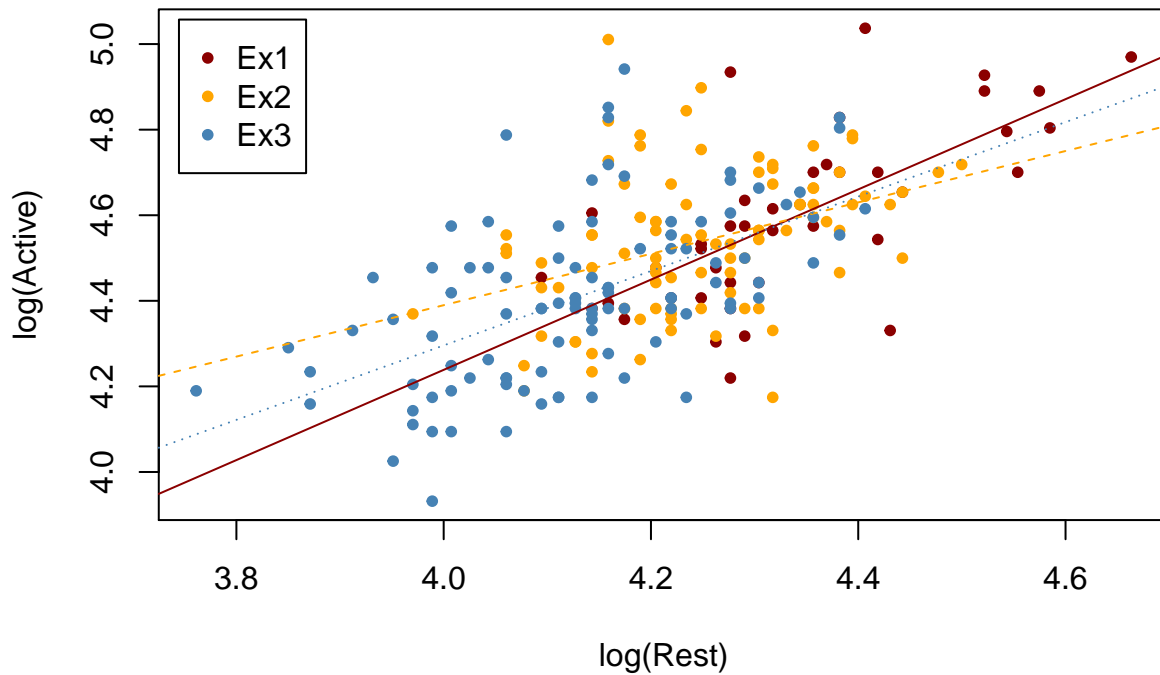
```
plot(log(Active) ~ log(Rest), data=data,  
     xlab="log(Rest)", ylab="log(Active)", type="n")
```



```

exercise1 <- data[data$Exercise==1, 2:1]
exercise2 <- data[data$Exercise==2, 2:1]
exercise3 <- data[data$Exercise==3, 2:1]
points(log(exercise1), pch=20, col="darkred")
points(log(exercise2), pch=20, col="orange")
points(log(exercise3), pch=20, col="steelblue")
legend("topleft", c("Ex1", "Ex2", "Ex3"),
      pch=20, inset=0.02, col=c("darkred", "orange", "steelblue"))
abline(lm(log(Active) ~ log(Rest), data=exercise1), lty=1, col="darkred")
abline(lm(log(Active) ~ log(Rest), data=exercise2), lty=2, col="orange")
abline(lm(log(Active) ~ log(Rest), data=exercise3), lty=3, col="steelblue")

```



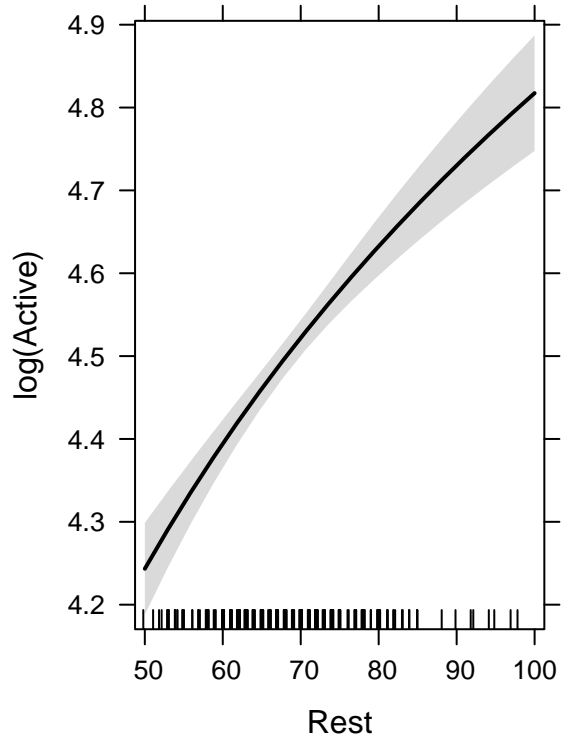
Main effects.

```

library(alr4)
plot(allEffects(pulse.lm2))

```

Rest effect plot



Exercise effect plot

