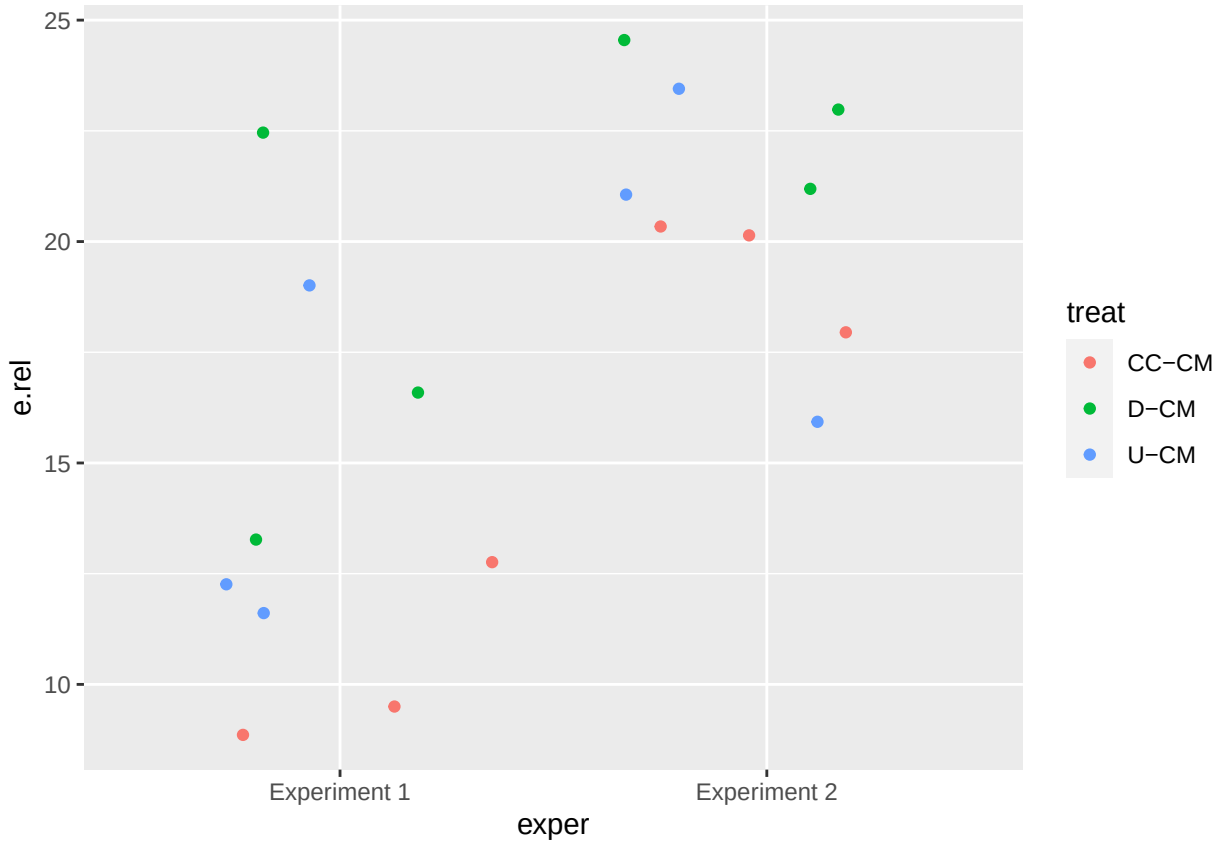
Data analysis for digestate experiments

Sasha D. Hafner

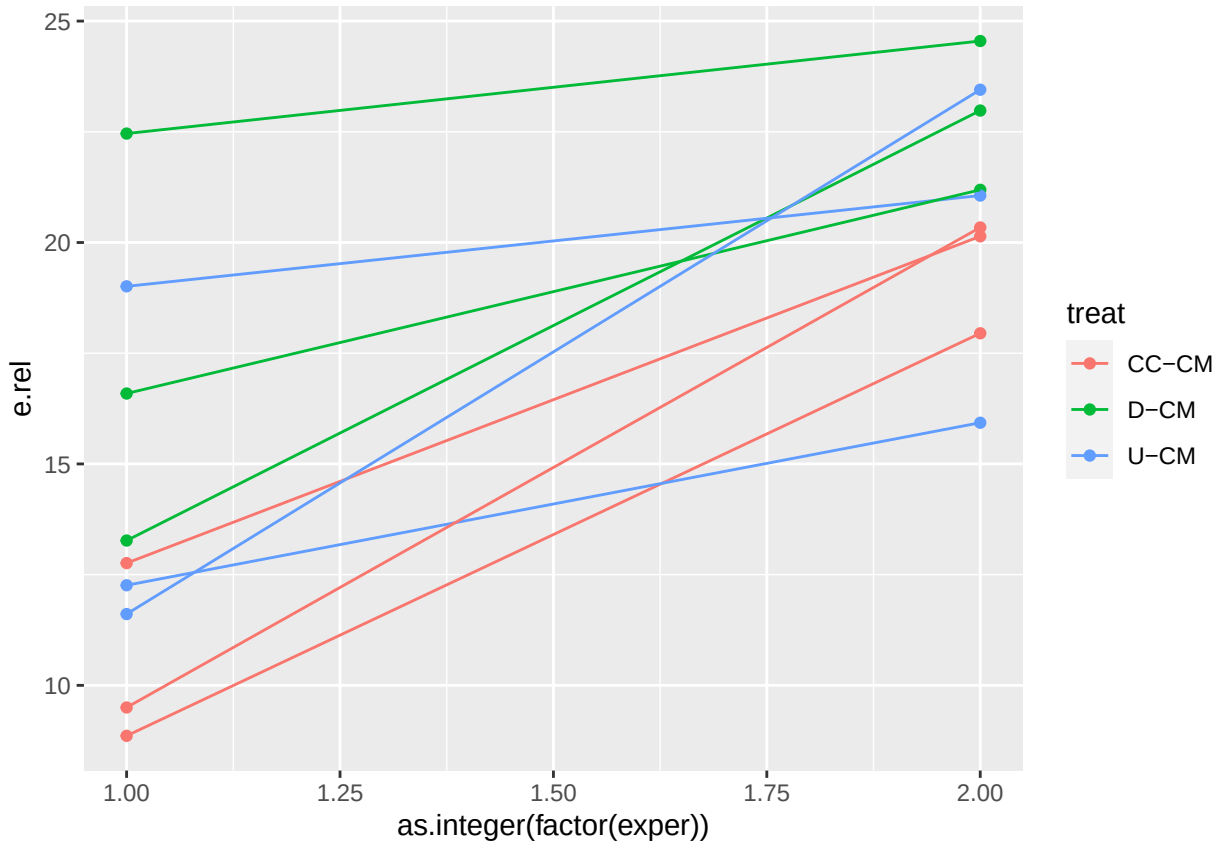
21 November, 2022

NH3 plots

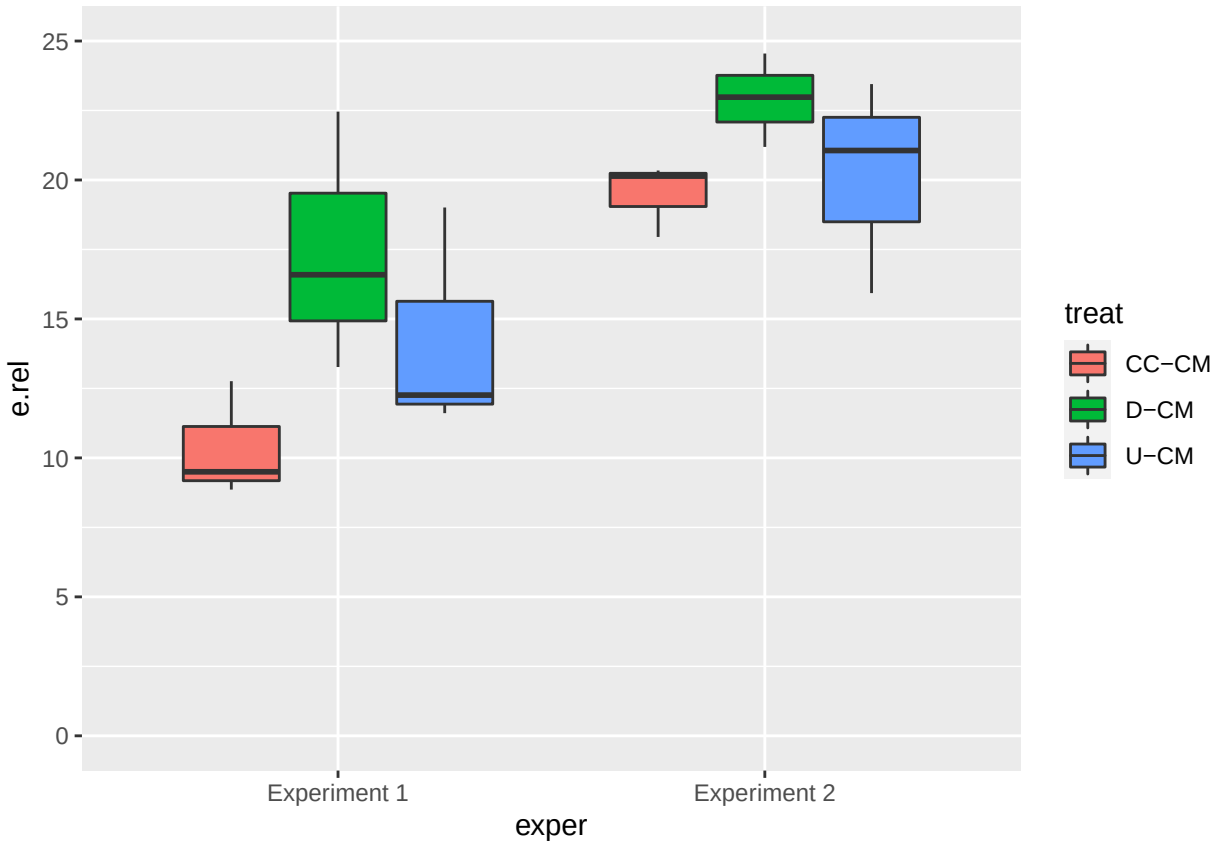
```
ggplot(dat, aes(exper, e.rel, colour = treat)) +
  geom_jitter(height = 0)
```




```
ggplot(dat, aes(as.integer(factor(exper)), e.rel, colour = treat, group = interaction(treat, rep))) +
  geom_point() +
  geom_line()
```




```
ggplot(dat, aes(exper, e.rel, fill = treat)) +
  geom_boxplot() +
  ylim(0, 25)
```



NH3 stats

Set reference to untreated cattle manure.

```
dat$treat <- factor(dat$treat, levels = c('U-CM', 'CC-CM', 'D-CM'))
```

```
m1 <- aov(e.rel ~ treat + exper, data = dat)
summary(m1)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## treat        2  83.07   41.53   4.266 0.035753 *
## exper        1 208.56  208.56  21.421 0.000391 ***
## Residuals   14 136.31    9.74
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary.lm(m1)
```

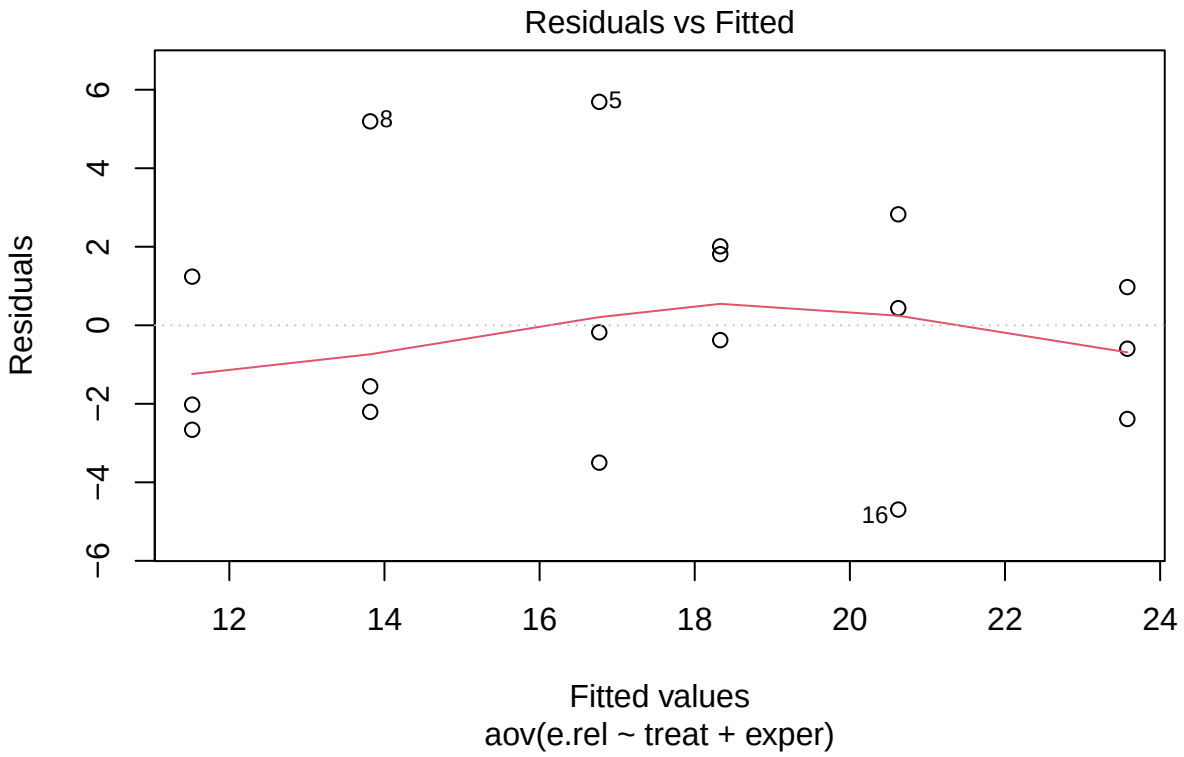
```
##
## Call:
## aov(formula = e.rel ~ treat + exper, data = dat)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.6939 -2.1599 -0.2792  1.6681  5.6906
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
```

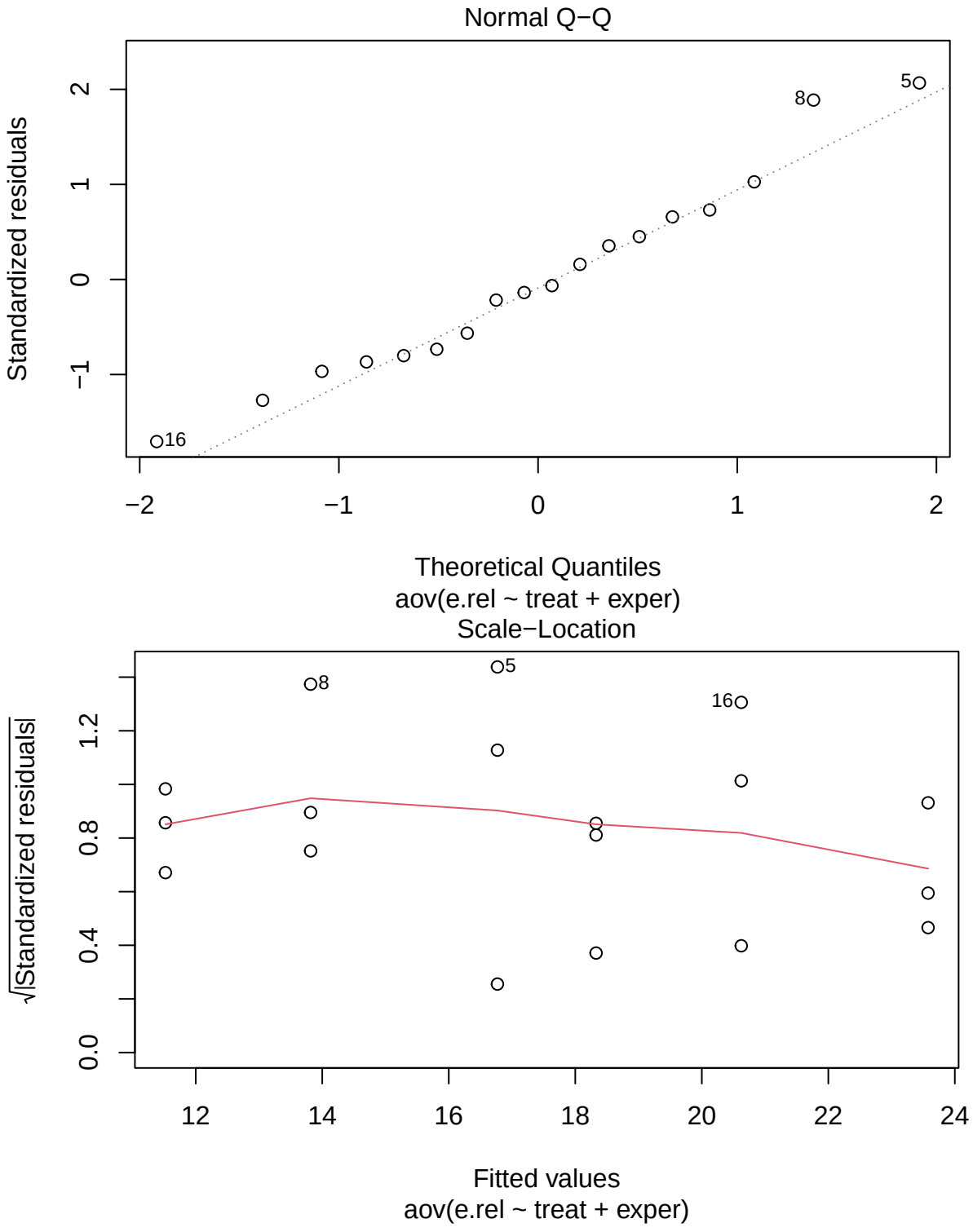
```
## (Intercept)         13.816      1.471   9.393 2.02e-07 ***
## treatCC-CM          -2.295      1.801  -1.274 0.223428
## treatD-CM            2.953      1.801   1.639 0.123404
## experExperiment 2    6.808      1.471   4.628 0.000391 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.12 on 14 degrees of freedom
## Multiple R-squared:  0.6815, Adjusted R-squared:  0.6132
## F-statistic: 9.984 on 3 and 14 DF,  p-value: 0.0008875
```

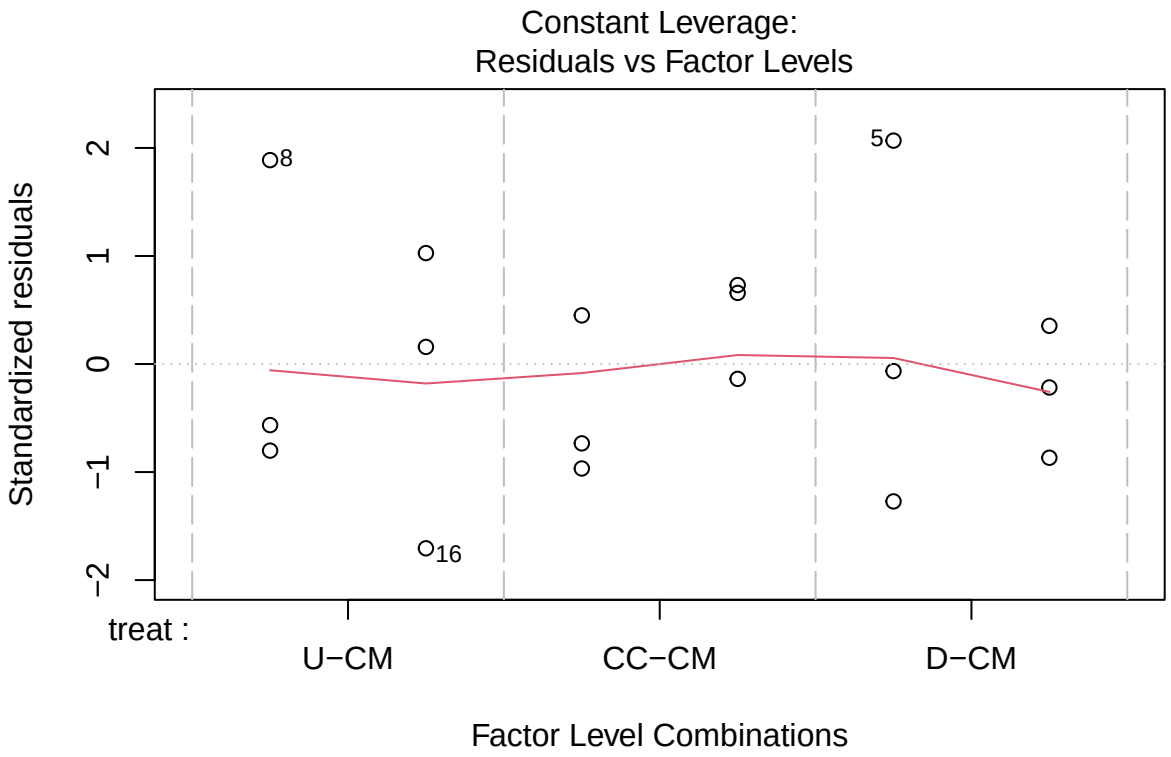
CC-CM and D-CM are clearly different. But neither is clearly different from the reference. Makes interpretation just a bit tricky. Some evidence of a difference but presumably digestion pH effect is moderated by low DM, and variability was high, so power is low.

Check residuals.

```
plot(m1, ask = FALSE)
```



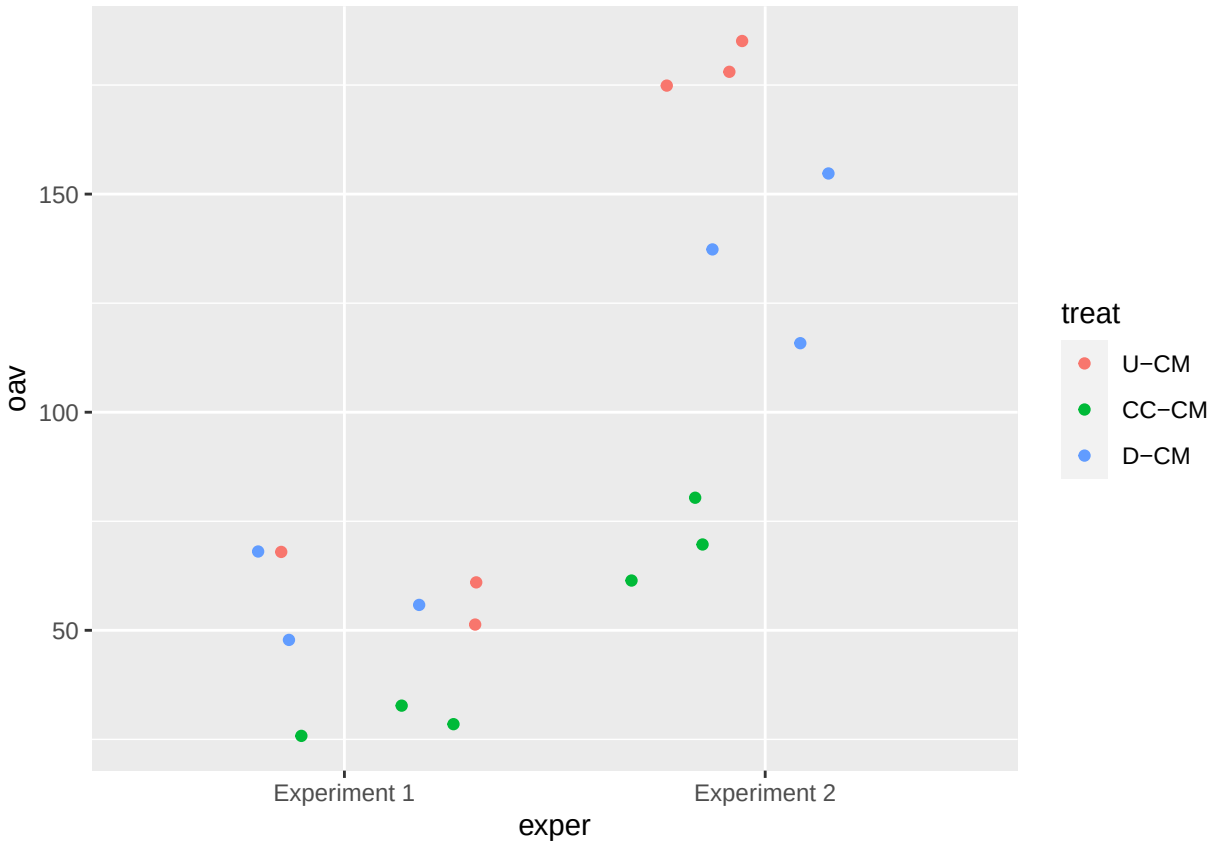

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(e.rel ~ treat + exper)
Scale−Location
√|Standardized residuals|
Fitted values
aov(e.rel ~ treat + exper)



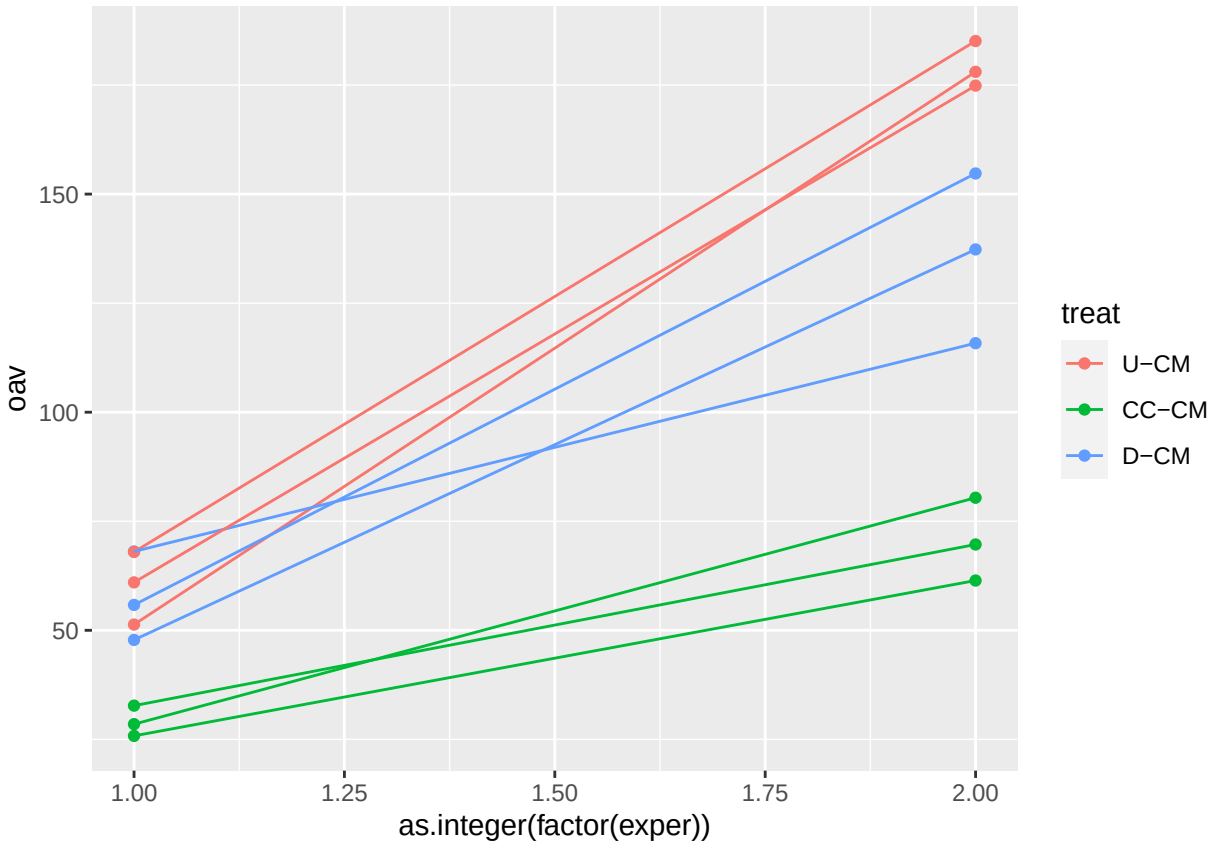
Looks fine, no need to transform.

OAV plots

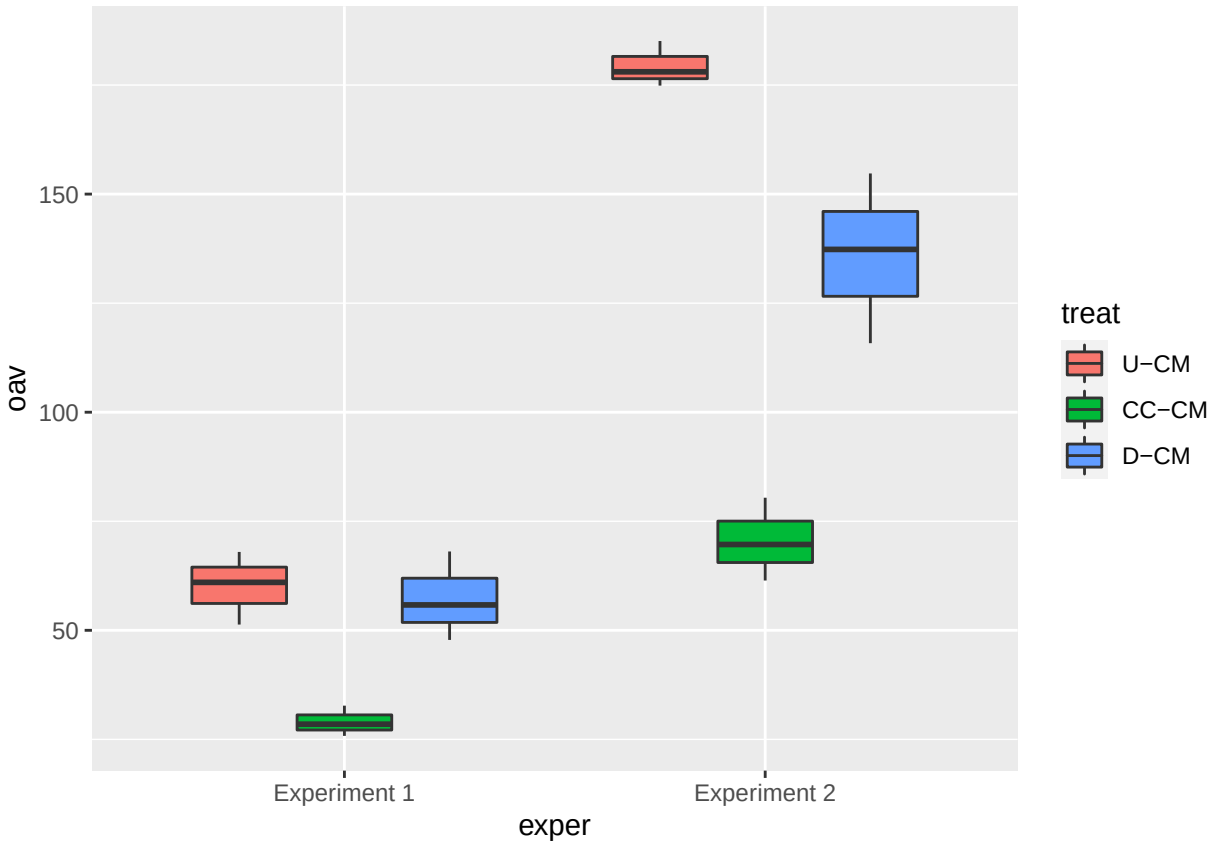
```
ggplot(dat, aes(exper, oav, colour = treat)) +
  geom_jitter(height = 0)
```




```
ggplot(dat, aes(as.integer(factor(exper)), oav, colour = treat, group = interaction(treat, rep))) +
  geom_point() +
  geom_line()
```




```
ggplot(dat, aes(exper, oav, fill = treat)) +
  geom_boxplot()
```



OAV stats

```
m1 <- aov(oav ~ treat + exper, data = dat)
summary(m1)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## treat        2  15249    7625   18.08 0.000132 ***
## exper        1  28672   28672   67.97 9.63e-07 ***
## Residuals   14   5905     422
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

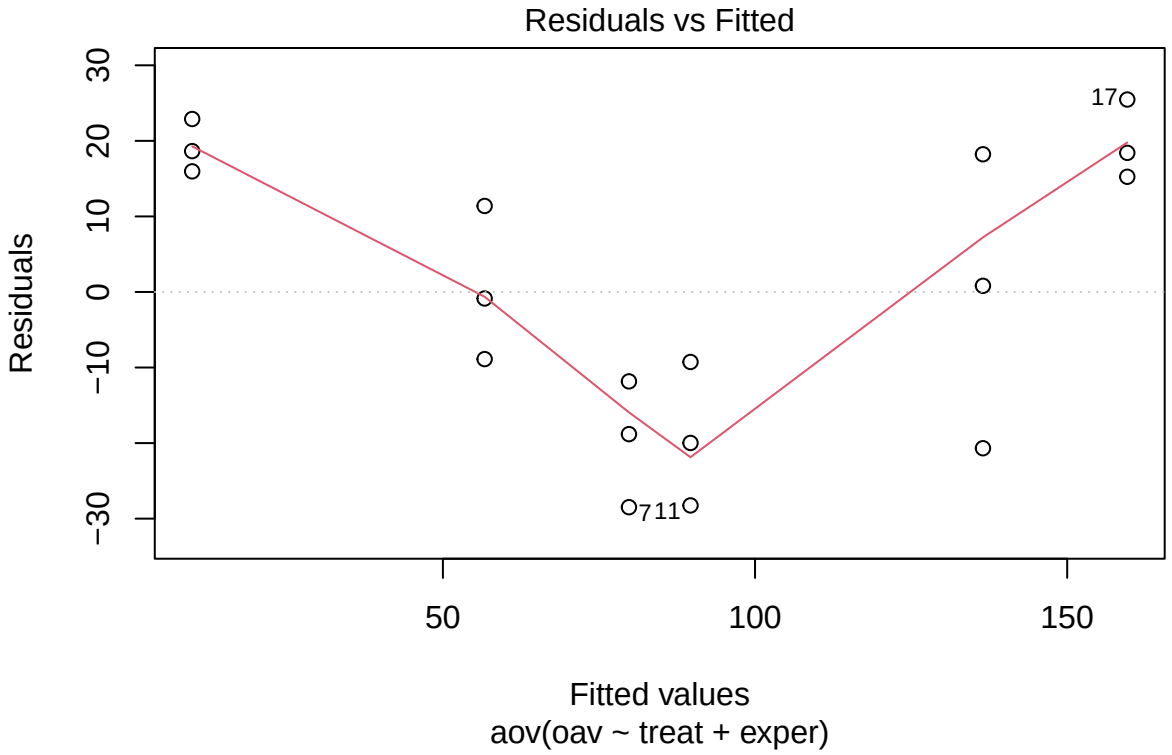
```
summary.lm(m1)
```

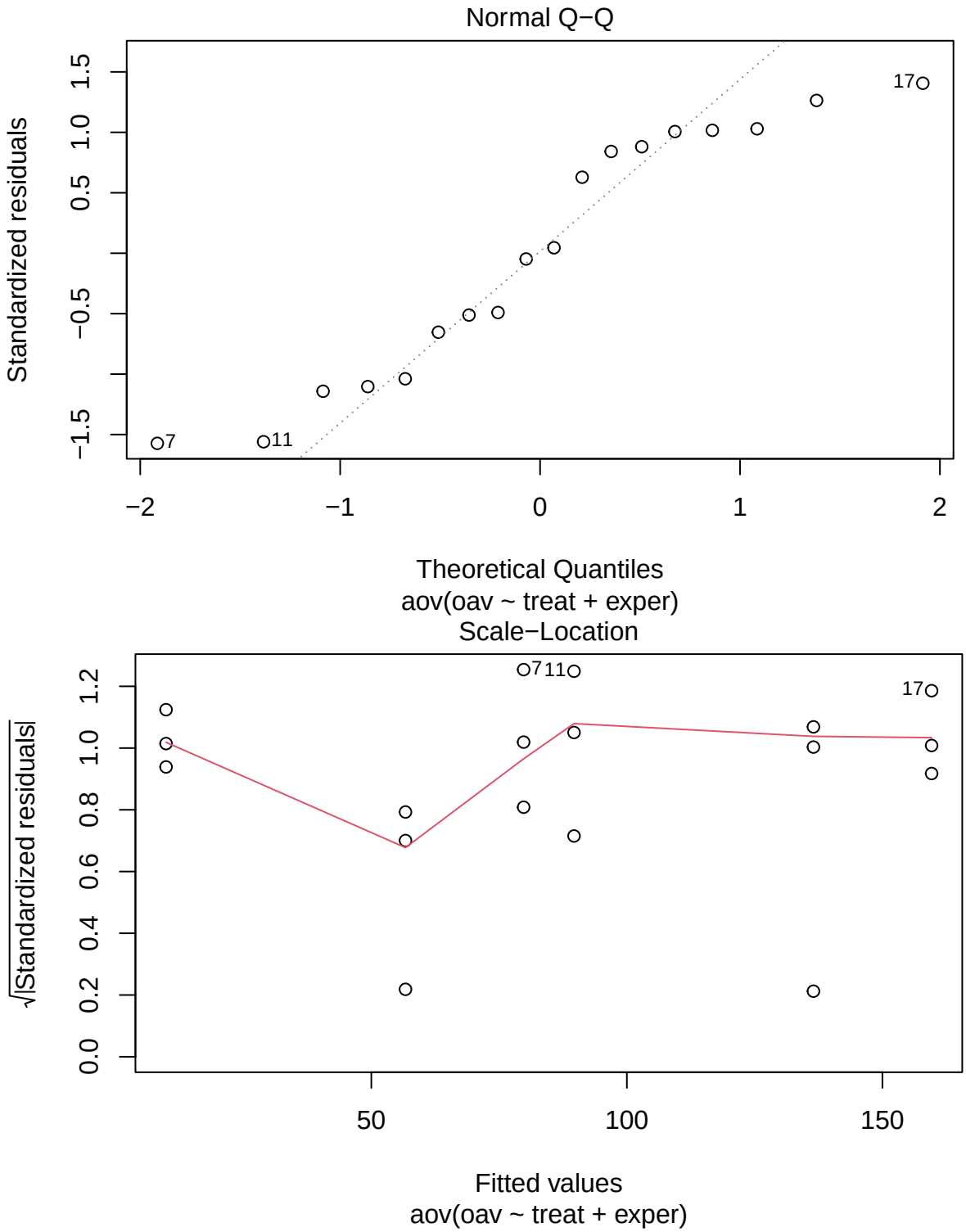
```
##
## Call:
## aov(formula = oav ~ treat + exper, data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -28.4848 -17.0698  -0.0237  17.6607  25.4712
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)        79.805      9.682   8.243 9.65e-07 ***
## treatCC-CM        -69.967     11.858  -5.901 3.86e-05 ***
```

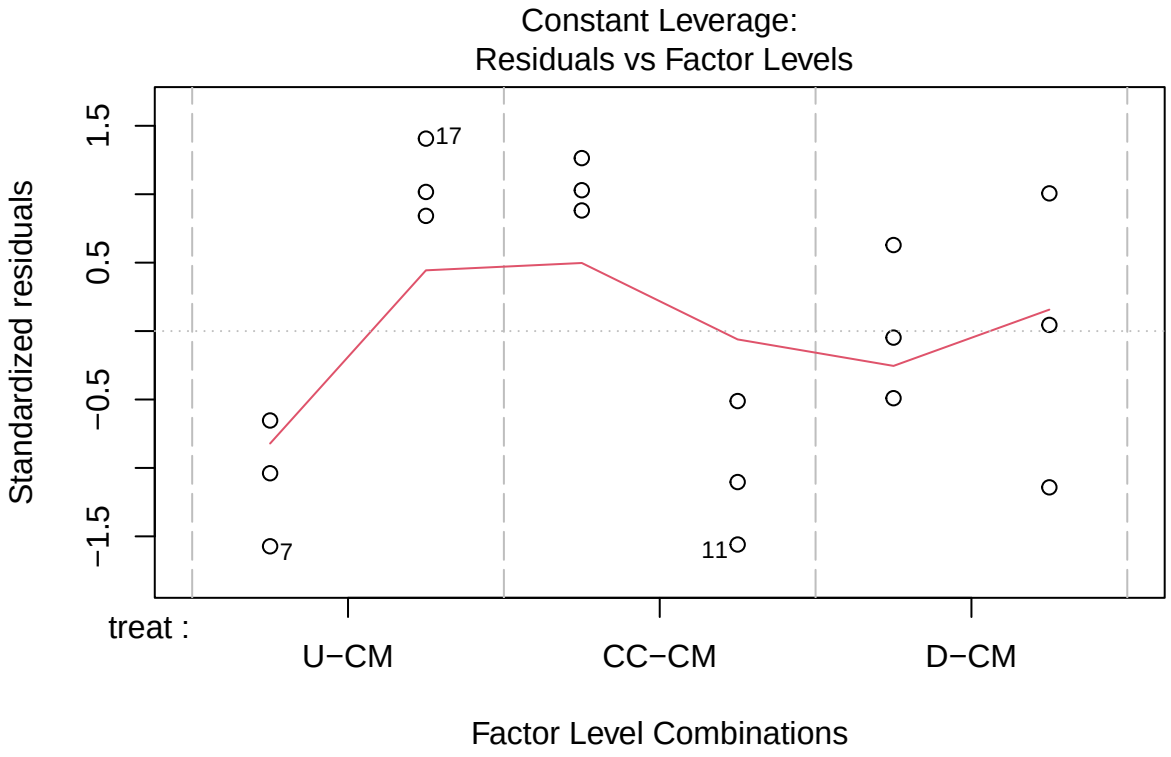
```
## treatD-CM          -23.121     11.858  -1.950   0.0715 .
## experExperiment 2   79.822      9.682   8.245 9.63e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 20.54 on 14 degrees of freedom
## Multiple R-squared:  0.8815, Adjusted R-squared:  0.8561
## F-statistic: 34.71 on 3 and 14 DF,  p-value: 9.771e-07
```

Check residuals.

```
plot(m1, ask = FALSE)
```

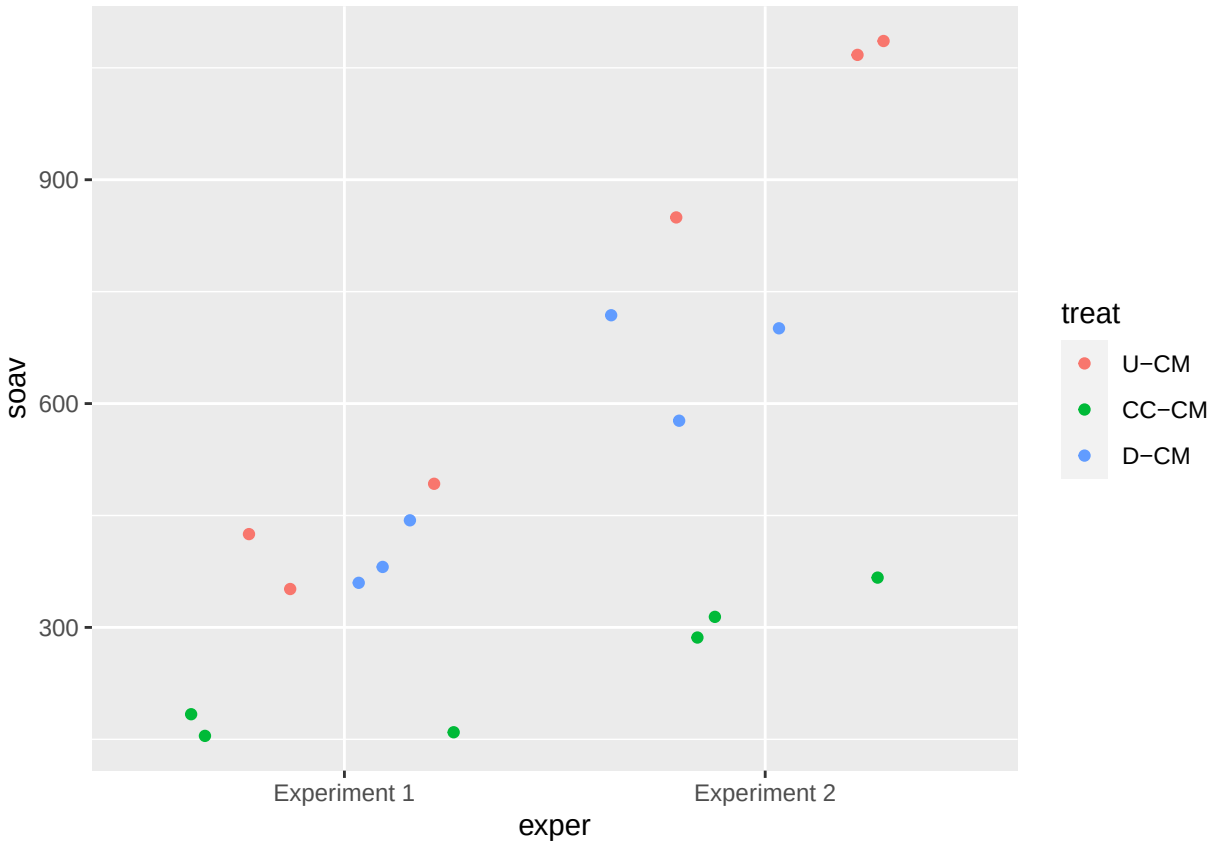



Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(oav ~ treat + exper)
Scale−Location
√|Standardized residuals|
Fitted values
aov(oav ~ treat + exper)

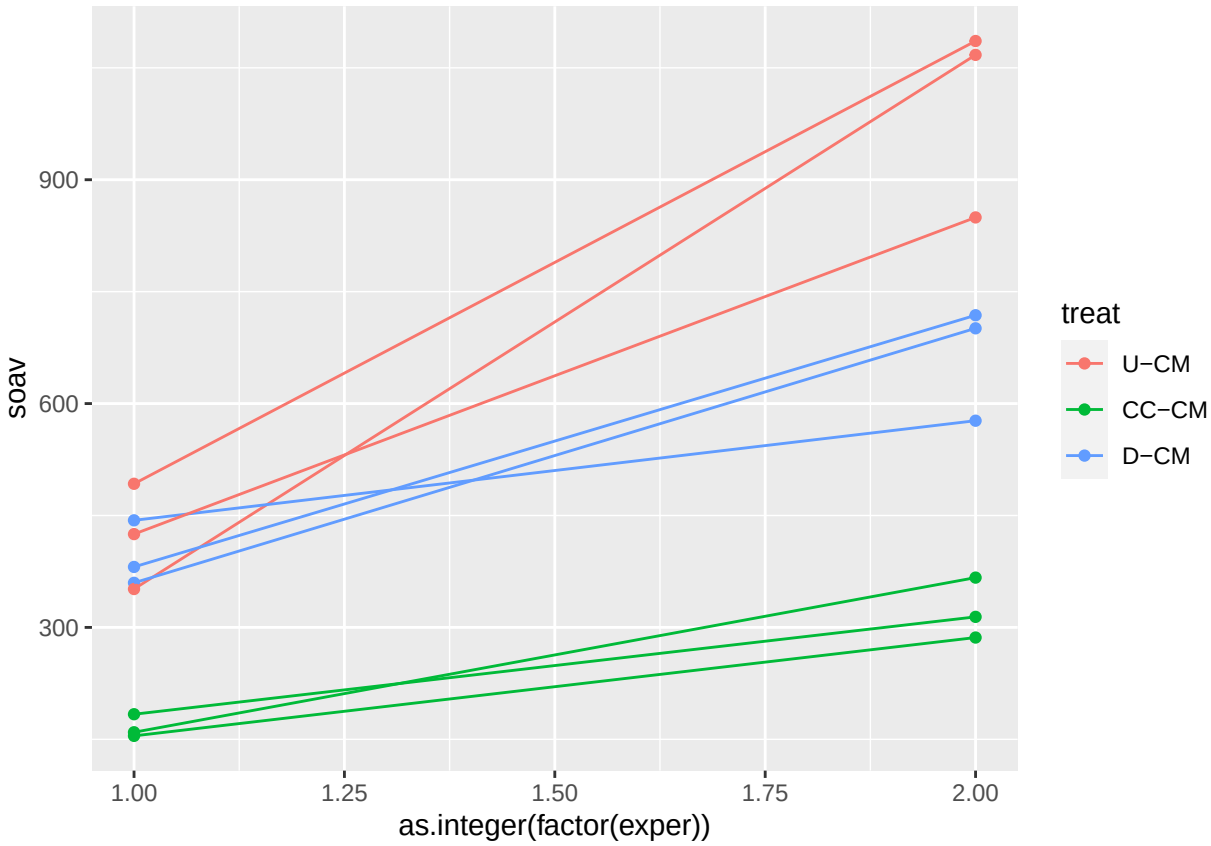


SOAV plots

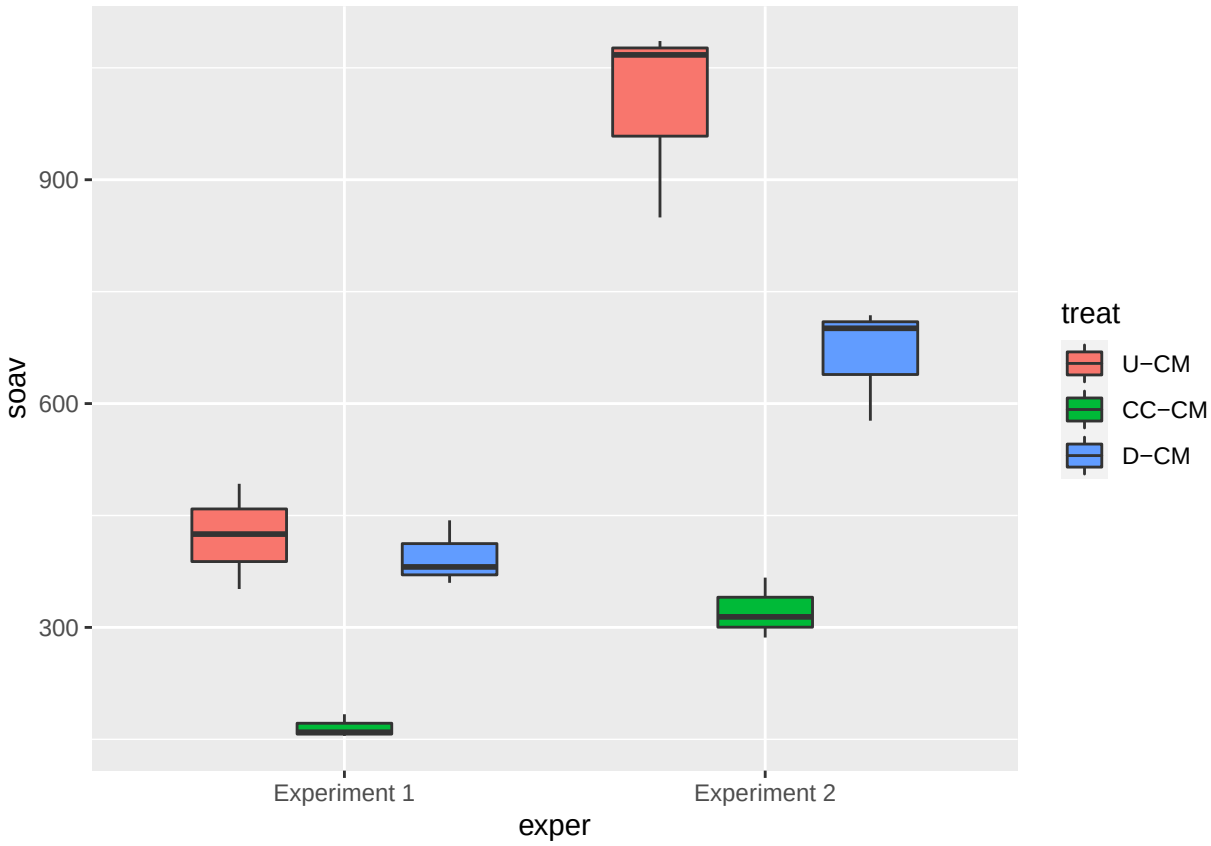
```
ggplot(dat, aes(exper, soav, colour = treat)) +
  geom_jitter(height = 0)
```




```
ggplot(dat, aes(as.integer(factor(exper)), soav, colour = treat, group = interaction(treat, rep))) +
  geom_point() +
  geom_line()
```




```
ggplot(dat, aes(exper, soav, fill = treat)) +
  geom_boxplot()
```



SOAV stats

```
m1 <- aov(soav ~ treat + exper, data = dat)
summary(m1)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## treat        2 667283  333641   22.62 4.12e-05 ***
## exper        1 505073  505073   34.24 4.20e-05 ***
## Residuals   14 206485   14749
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

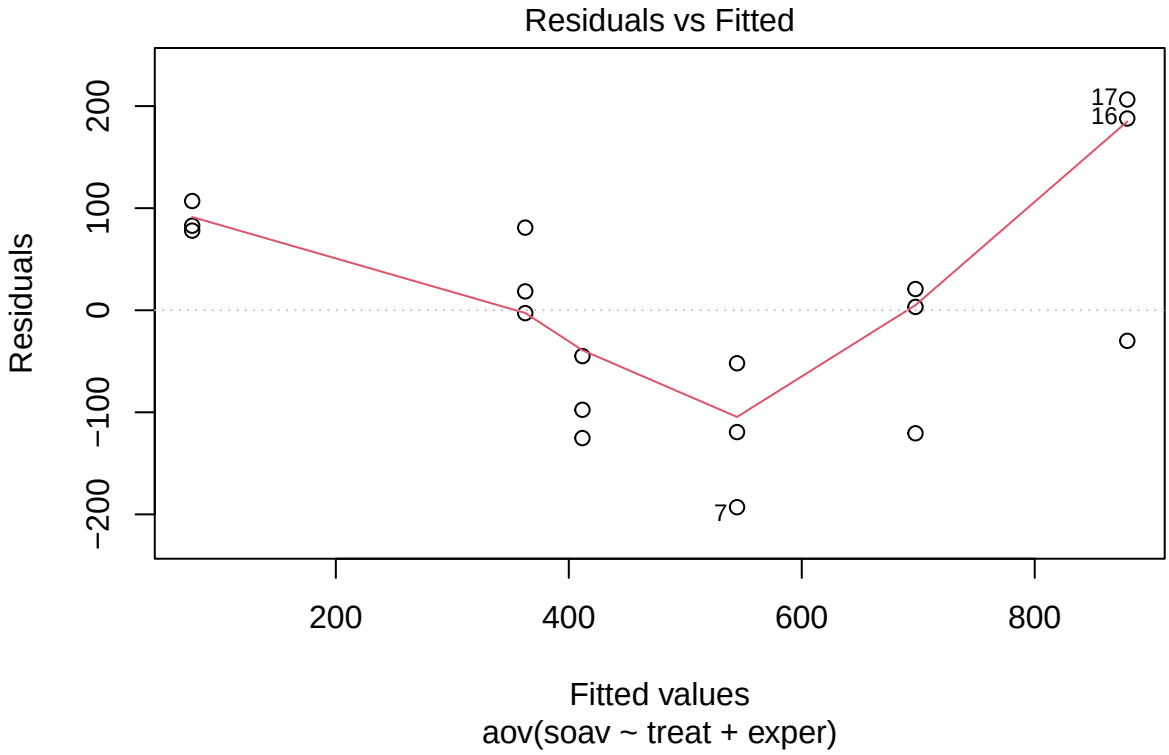
```
summary.lm(m1)
```

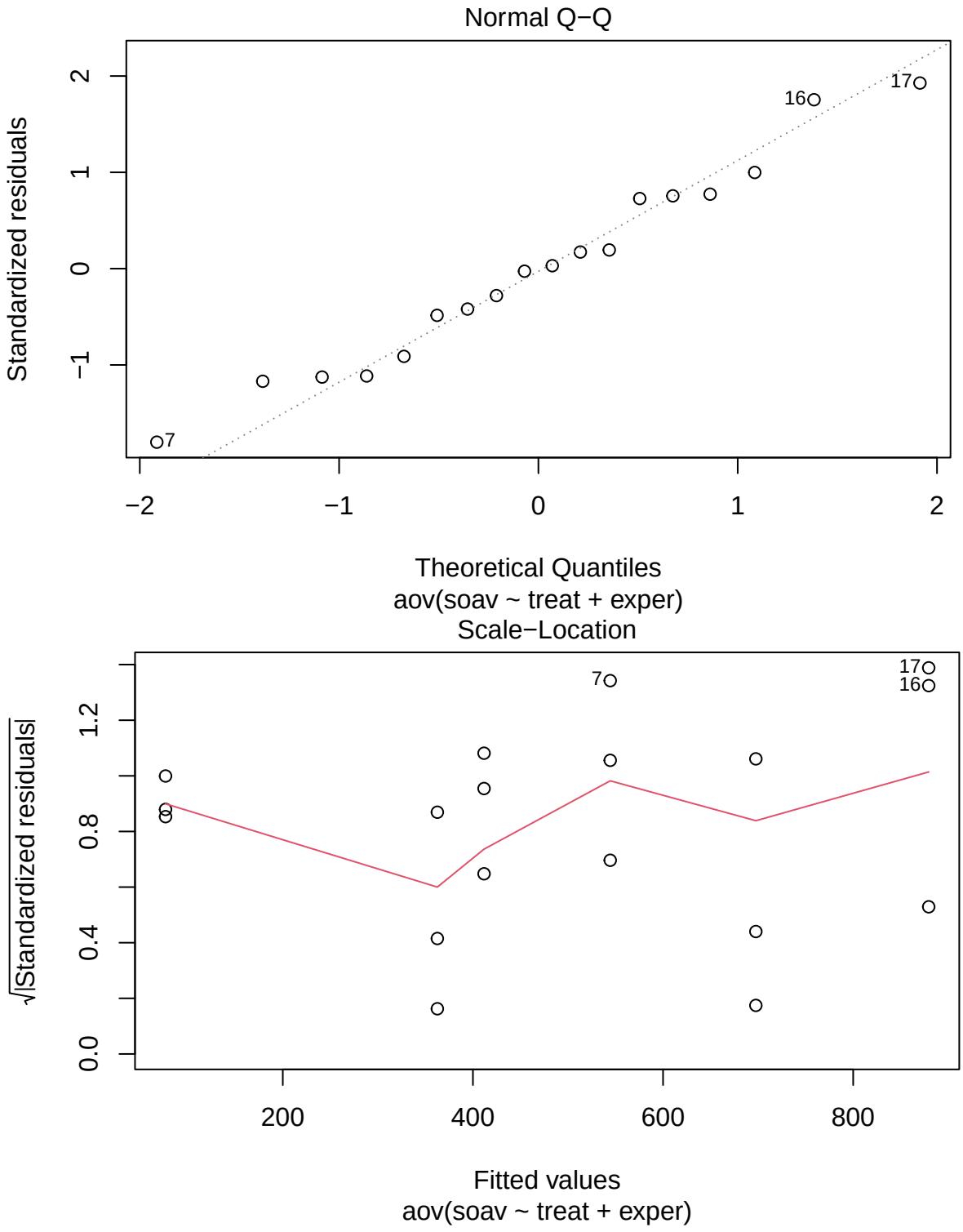
```
##
## Call:
## aov(formula = soav ~ treat + exper, data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -192.976  -86.153    0.217   80.188  206.442
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)        544.45      57.25   9.510 1.73e-07 ***
## treatCC-CM        -467.78      70.12  -6.671 1.06e-05 ***
```

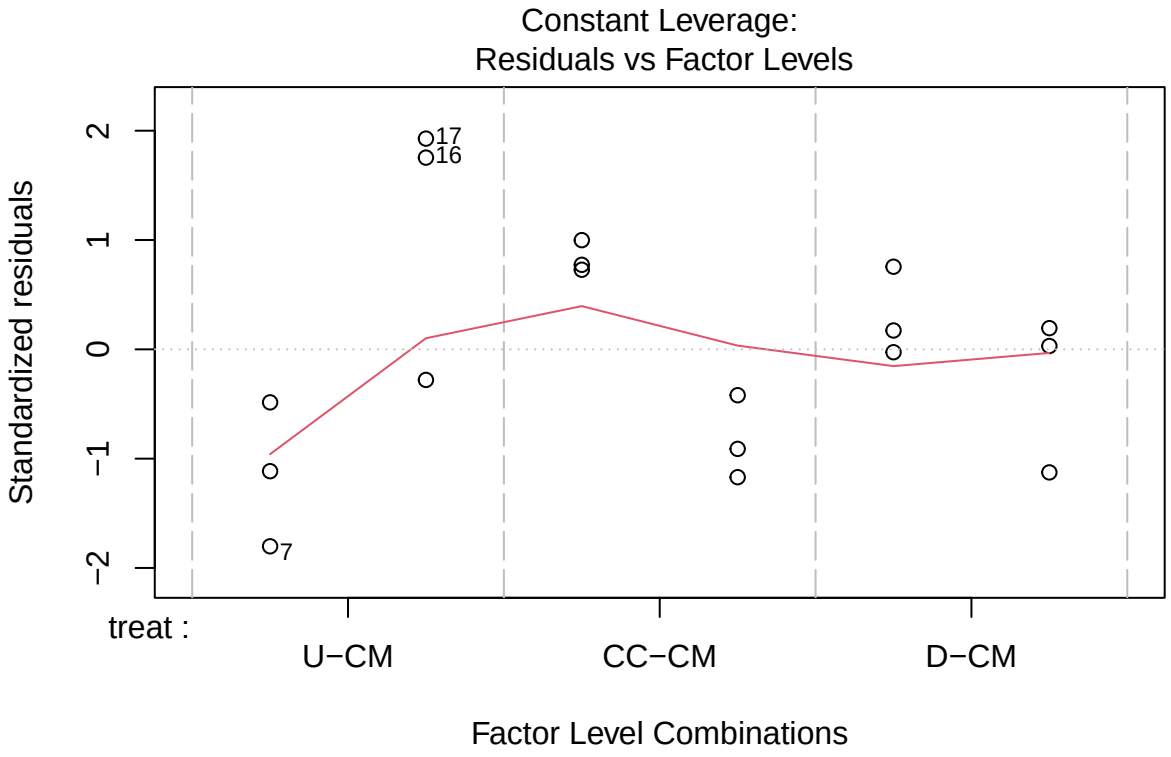
```
## treatD-CM          -181.85      70.12  -2.594   0.0212 *
## experExperiment 2   335.02      57.25   5.852 4.20e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 121.4 on 14 degrees of freedom
## Multiple R-squared:  0.8502, Adjusted R-squared:  0.8182
## F-statistic:  26.5 on 3 and 14 DF,  p-value: 4.947e-06
```

Check residuals.

```
plot(m1, ask = FALSE)
```




Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(soav ~ treat + exper)
Scale−Location
√|Standardized residuals|
Fitted values
aov(soav ~ treat + exper)


Constant Leverage:
Residuals vs Factor Levels
Standardized residuals
2
1
0
−1
−2
17
16
7
treat :
U−CM
CC−CM
D−CM
Factor Level Combinations