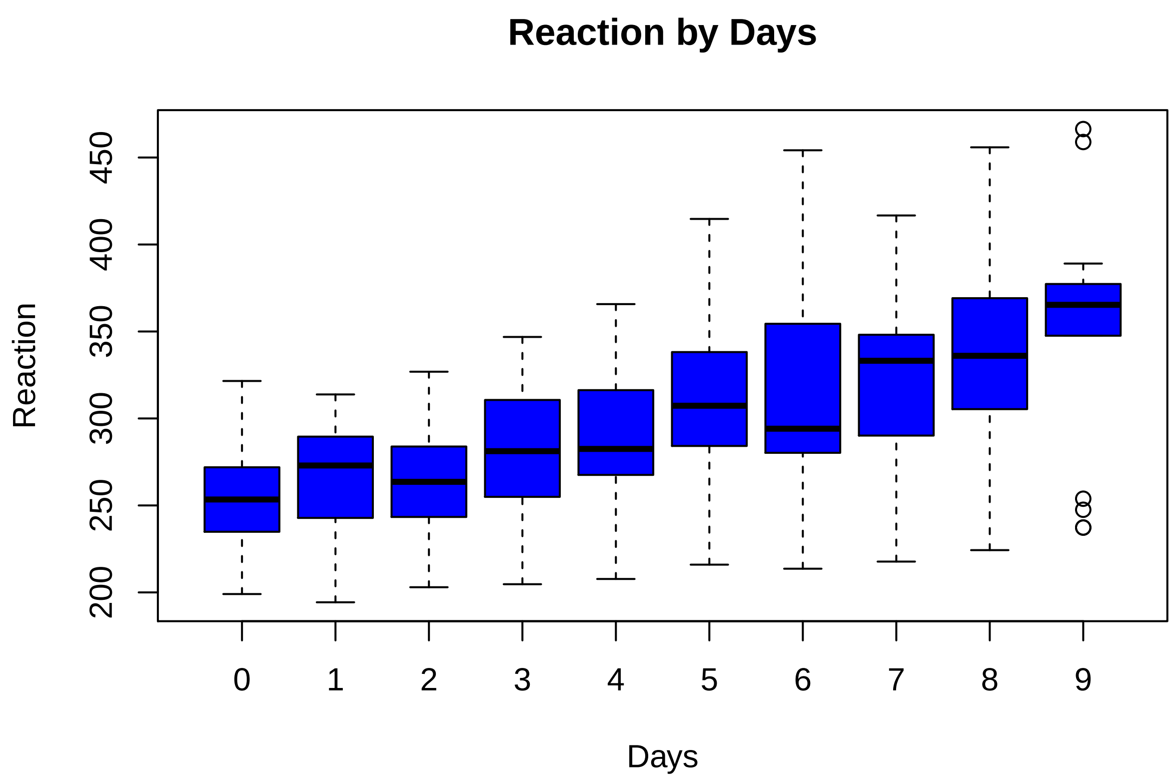
Comparison of P values from linear and linear mixed models

This is illustrated with the documentation example.

```
require(lme4)
boxplot(Reaction~Days, data=sleepstudy, main="Reaction by Days",
        xlab="Days", ylab="Reaction", col="blue", border="black")
```



We see a trend of `Reaction` by `Days`, so it is reasonable to fit a simple linear regression,

```
l <- lm(Reaction ~ Days, sleepstudy)
s <- summary(l)
s
```

```
##
## Call:
## lm(formula = Reaction ~ Days, data = sleepstudy)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -110.848  -27.483    1.546   26.142  139.953
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  251.405      6.610  38.033  < 2e-16 ***
## Days          10.467      1.238   8.454 9.89e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 47.71 on 178 degrees of freedom
## Multiple R-squared:  0.2865, Adjusted R-squared:  0.2825
## F-statistic: 71.46 on 1 and 178 DF,  p-value: 9.894e-15
```

```r
names(s)
```

```
##  [1] "call"          "terms"         "residuals"     "coefficients"
##  [5] "aliased"       "sigma"         "df"            "r.squared"
##  [9] "adj.r.squared" "fstatistic"    "cov.unscaled"
```

```r
class(s)
```

```
## [1] "summary.lm"
```

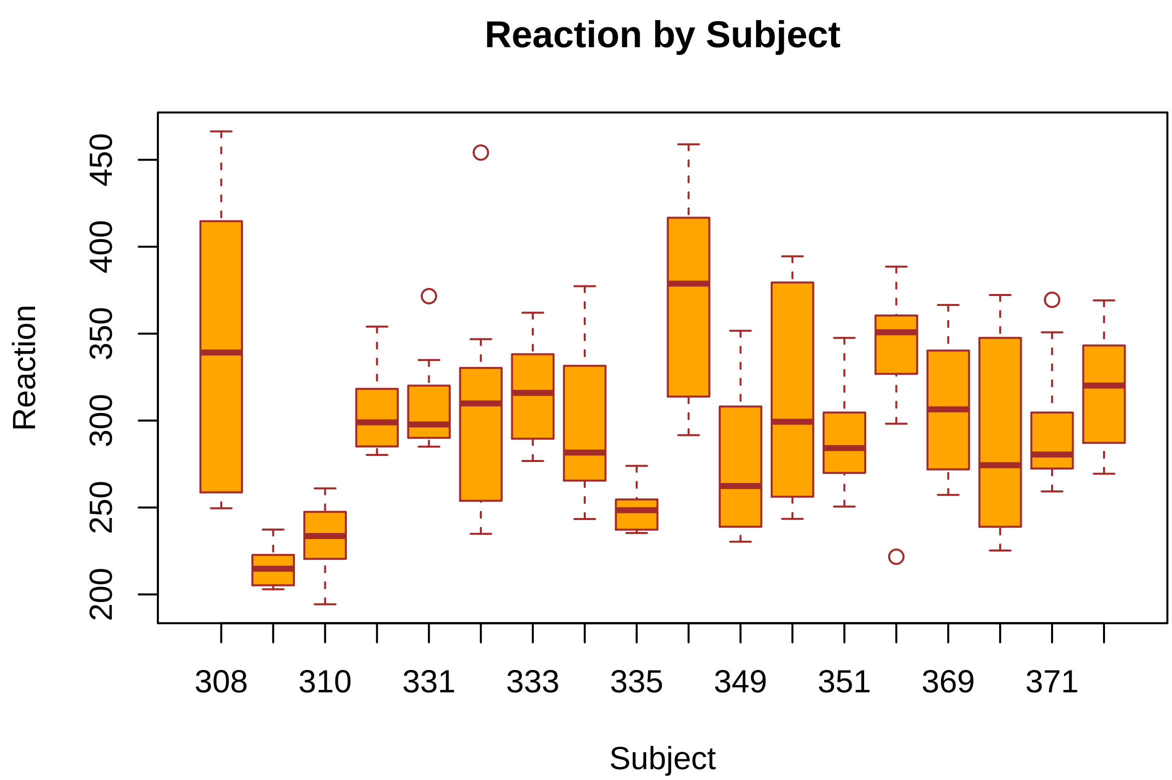
```r
round(sqrt(s$fstatistic[1]),3)
```

```
## value
## 8.454
```

```r
df <- with(s,df)
```

the F statistics is simply t^2. Maybe it is worthwhile to examine the effect of `Subject` as well; from

```r
boxplot(Reaction~Subject, data=sleepstudy, main="Reaction by Subject",
        xlab="Subject", ylab="Reaction", col="orange", border="brown")
```



it is more approriate to fit a random effect model

```r
f <- lmer(Reaction ~ Days + (Days | Subject), sleepstudy)
s <- summary(f)
```

```
s
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Reaction ~ Days + (Days | Subject)
##    Data: sleepstudy
##
## REML criterion at convergence: 1743.6
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.9536 -0.4634  0.0231  0.4633  5.1793
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  Subject  (Intercept) 611.90   24.737
##           Days         35.08    5.923   0.07
##  Residual             654.94   25.592
## Number of obs: 180, groups:  Subject, 18
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept)  251.405      6.824  36.843
## Days          10.467      1.546   6.771
##
## Correlation of Fixed Effects:
##      (Intr)
## Days -0.138
```

```
names(s)
```

```
##  [1] "methTitle"    "objClass"     "devcomp"      "isLmer"
##  [5] "useScale"     "logLik"       "family"       "link"
##  [9] "ngrps"        "coefficients" "sigma"        "vcov"
## [13] "varcor"       "AICtab"       "call"         "residuals"
## [17] "fitMsgs"      "optinfo"
```

```
class(with(s,coefficients))
```

```
## [1] "matrix"
```

```
t <- with(s,coefficients)[,3]
p <- 2*(pnorm(-abs(t)))
p
```

```
##   (Intercept)          Days
## 3.851313e-297  1.281214e-11
```

Consequently, the effect of `Days` on `Reaction` became less pronounced after accounting for individual differences – as we saw the same estimate of effect but a larger standard error for `Days` in the linear mixed model compared to that in the linear regression model.

The significane levels seemed strikingly different for the Intercept between the two models though, making us derive P values from *t*-statistics

```
df
```

```
## [1]   2 178   2
```

```r
pt <-2*(pt(-abs(t),df[2]))
pt
```

```
##  (Intercept)         Days
## 3.287918e-85 1.794531e-10
```