calcium

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reference:
- Cannon, et al., Stat2, chapter 07, example 8.6, 8.10

Import the data.

```
data <- read.csv("CalciumBP.csv", header=TRUE)
data[20, 2] <- -1     # data file does not match text figure, p.404
head(data, 4)
```

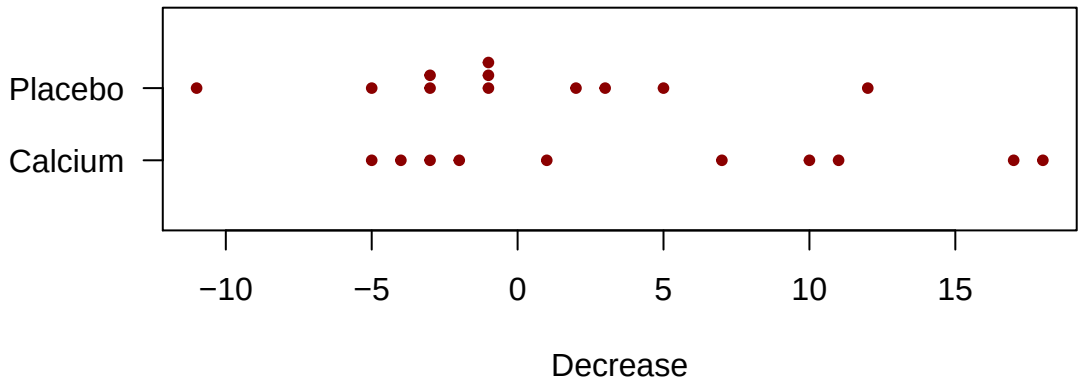
```
##   Treatment Decrease
## 1   Calcium        7
## 2   Calcium       -4
## 3   Calcium       18
## 4   Calcium       17
```

```
dim(data)
```

```
## [1] 21  2
```

View the data.

```
stripchart(Decrease ~ Treatment, data=data,
           ylim=1:2, at=c(1.3, 1.65), pch=20,
           las=1, method="stack", col="darkred")
```




```
calcium.mean.bloodPressure <- with(data, tapply(Decrease, Treatment, mean))
calcium.mean.bloodPressure
```

```
##    Calcium    Placebo
##  5.0000000 -0.2727273
```

ANOVA.

```
calcium.aov <- aov(Decrease ~ Treatment, data=data)
options(show.signif.stars=FALSE)
summary(calcium.aov)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## Treatment    1  145.6  145.63    2.67  0.119
## Residuals   19 1036.2   54.54
```

```
calcium.lm <- lm(Decrease ~ Treatment, data=data)
F.observed <- summary(calcium.lm)$fstatistic[1]
F.observed
```

```
##   value
## 2.67031
```

Randomize the data and test again.

```
new.data <- data
new.data$Decrease <- sample(new.data$Decrease)      # randomize
new.calcium.aov <- aov(Decrease ~ Treatment, data=new.data)
summary(new.calcium.aov)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## Treatment    1   35.4   35.41   0.587  0.453
## Residuals   19 1146.4   60.34
```

```
new.calcium.lm <- lm(Decrease ~ Treatment, data=new.data)
summary(new.calcium.lm)
```

```
##
## Call:
## lm(formula = Decrease ~ Treatment, data = new.data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -12.0   -4.6   -2.0    4.0   14.4
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)         3.600      2.456   1.466    0.159
## TreatmentPlacebo   -2.600      3.394  -0.766    0.453
##
## Residual standard error: 7.768 on 19 degrees of freedom
## Multiple R-squared:  0.02996,    Adjusted R-squared:  -0.02109
## F-statistic: 0.5869 on 1 and 19 DF,  p-value: 0.453
```

```
summary(new.calcium.lm)$fstatistic
```

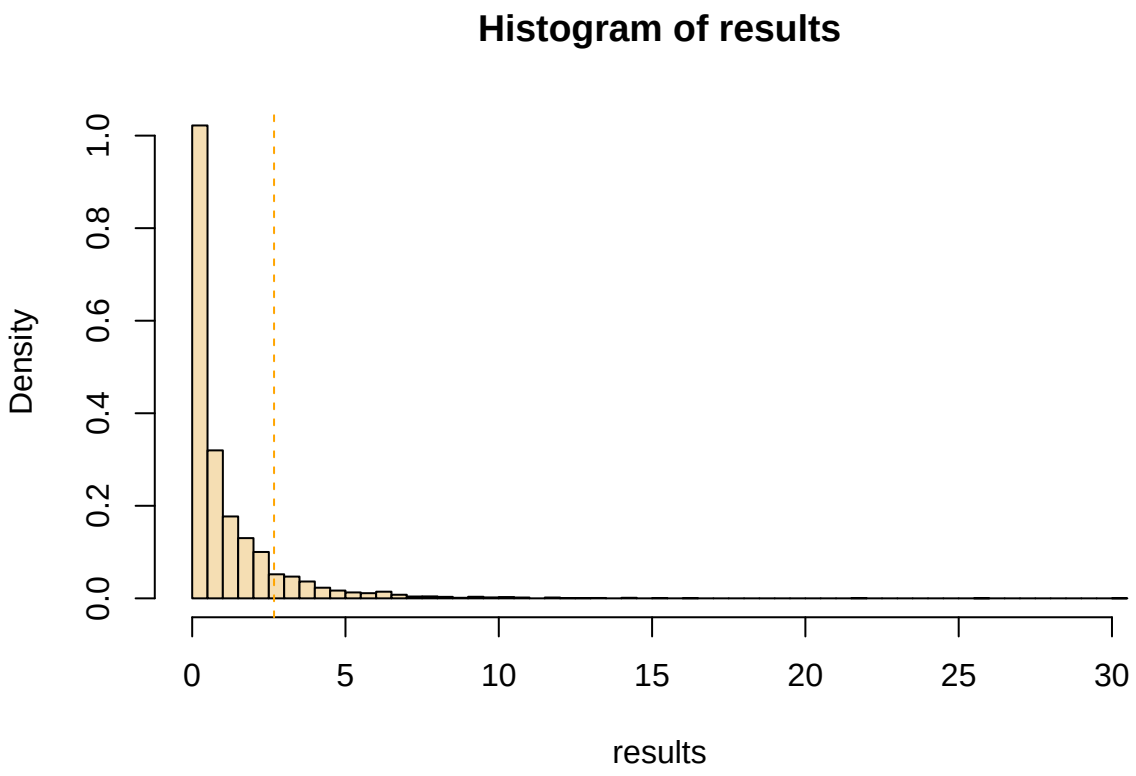
```
##      value      numdf      dendf
##  0.5868641  1.0000000 19.0000000
```

```
F.rand <- summary(new.calcium.lm)$fstatistic[1]
F.rand                                              # new F
```

```
##     value
## 0.5868641
```

Randomization F-test.

```
n.experiments <- 10000
results <- rep(NA, n.experiments)
for (i in 1:n.experiments){
  new.data <- data
  new.data$Decrease <- sample(new.data$Decrease)      # randomize
  new.calcium.lm <- lm(Decrease ~ Treatment, data=new.data)
  F.rand <- summary(new.calcium.lm)$fstatistic[1]
  results[i] <- F.rand                                # new F
}
hist(results,
     freq=FALSE, breaks=2 * 31, col="wheat")
abline(v=F.observed, lty=2, col="orange")
```




```
p.value <- sum(results >= F.observed) / n.experiments
p.value
```

```
## [1] 0.1147
```

Comparison with F distribution.

```r
hist(results,
     freq=FALSE, breaks=2 * 31, col="wheat")
curve(df(x, df1=1, df2=19), col="darkred", add=TRUE)
```