Lab ANOVA Analysis

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P1

```
# Load lib
library(car)
```

```
## Warning: package 'car' was built under R version 4.3.2
```

```
## Loading required package: carData
```

```
## Warning: package 'carData' was built under R version 4.3.2
```

```
# Data setup
d1 <- data.frame(
  Crp = factor(rep(c("Corn", "Rice", "Wheat"), each = 3)),
  Ftz = factor(rep(c("F1", "F2", "F3"), times = 3)),
  Mnt = c(6, 5, 6, 4, 4.2, 5, 6, 5, 5.5)
)

# ANOVA
aov1 <- aov(Mnt ~ Ftz + Crp, data = d1)
summary(aov1)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## Ftz          2 0.9756  0.4878   2.598 0.1892
## Crp          2 2.8422  1.4211   7.568 0.0437 *
## Residuals    4 0.7511  0.1878
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Post-hoc
TukeyHSD(aov1)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = Mnt ~ Ftz + Crp, data = d1)
##
## $Ftz
##             diff        lwr       upr     p adj
## F2-F1 -0.6000000 -1.8609933 0.6609933 0.3124986
## F3-F1  0.1666667 -1.0943267 1.4276600 0.8881056
## F3-F2  0.7666667 -0.4943267 2.0276600 0.1913059
##
## $Crp
##                  diff        lwr          upr     p adj
## Rice-Corn  -1.2666667 -2.5276600 -0.005673322 0.0493083
## Wheat-Corn -0.1666667 -1.4276600  1.094326678 0.8881056
## Wheat-Rice  1.1000000 -0.1609933  2.360993345 0.0753283
```

P2

```
# Data setup
d2 <- data.frame(
  Res = factor(rep(c("R1", "R2", "R3", "R4", "R5", "R6"), each = 3)),
  Itm = factor(rep(c("I1", "I2", "I3"), times = 6)),
  Sls = c(31, 27, 24, 31, 28, 31, 45, 29, 46, 21, 18, 48, 42, 36, 46, 32, 17, 40)
)

# ANOVA
aov2 <- aov(Sls ~ Itm + Res, data = d2)
summary(aov2)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## Itm          2  538.8  269.39   4.959 0.0319 *
## Res          5  559.8  111.96   2.061 0.1547
## Residuals   10  543.2   54.32
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Post-hoc
TukeyHSD(aov2)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = Sls ~ Itm + Res, data = d2)
##
## $Itm
##            diff        lwr       upr     p adj
## I2-I1 -7.833333 -19.498312  3.831645 0.2061328
## I3-I1  5.500000  -6.164978 17.164978 0.4305650
## I3-I2 13.333333   1.668355 24.998312 0.0262709
##
## $Res
##              diff        lwr       upr     p adj
## R2-R1   2.6666667 -18.235335 23.568669 0.9971568
## R3-R1  12.6666667  -8.235335 33.568669 0.3559810
## R4-R1   1.6666667 -19.235335 22.568669 0.9997013
## R5-R1  14.0000000  -6.902002 34.902002 0.2676025
## R6-R1   2.3333333 -18.568669 23.235335 0.9984869
## R3-R2  10.0000000 -10.902002 30.902002 0.5815802
## R4-R2  -1.0000000 -21.902002 19.902002 0.9999758
## R5-R2  11.3333333  -9.568669 32.235335 0.4620926
## R6-R2  -0.3333333 -21.235335 20.568669 0.9999999
## R4-R3 -11.0000000 -31.902002  9.902002 0.4909865
## R5-R3   1.3333333 -19.568669 22.235335 0.9998999
## R6-R3 -10.3333333 -31.235335 10.568669 0.5508770
## R5-R4  12.3333333  -8.568669 33.235335 0.3809386
## R6-R4   0.6666667 -20.235335 21.568669 0.9999968
## R6-R5 -11.6666667 -32.568669  9.235335 0.4340602
```

P3

```
# Data setup
d3 <- data.frame(
  Til = factor(rep(c("T1", "T2", "T3", "T4", "T5"), each = 5)),
  Ftz = factor(rep(c("F1", "F2", "F3", "F4", "F5"), times = 5)),
  Trt = factor(rep(c("A", "B", "C", "D", "E"), each = 5)),
  Prd = c(42, 47, 55, 51, 44, 45, 54, 52, 44, 50, 41, 46, 57, 47, 48, 56, 52, 49, 50, 43, 47,
49, 45, 54, 46)
)

# ANOVA
aov3 <- aov(Prd ~ Til + Ftz + Trt, data = d3)
summary(aov3)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## Til          4   17.8    4.44   0.201  0.934
## Ftz          4  109.4   27.34   1.239  0.334
## Residuals   16  353.0   22.07
```

```
# Post-hoc
TukeyHSD(aov3)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = Prd ~ Til + Ftz + Trt, data = d3)
##
## $Til
##       diff        lwr       upr     p adj
## T2-T1  1.2  -7.901739 10.301739 0.9938237
## T3-T1  0.0  -9.101739  9.101739 1.0000000
## T4-T1  2.2  -6.901739 11.301739 0.9435891
## T5-T1  0.4  -8.701739  9.501739 0.9999171
## T3-T2 -1.2 -10.301739  7.901739 0.9938237
## T4-T2  1.0  -8.101739 10.101739 0.9969355
## T5-T2 -0.8  -9.901739  8.301739 0.9987150
## T4-T3  2.2  -6.901739 11.301739 0.9435891
## T5-T3  0.4  -8.701739  9.501739 0.9999171
## T5-T4 -1.8 -10.901739  7.301739 0.9721046
##
## $Ftz
##       diff        lwr       upr     p adj
## F2-F1  3.4  -5.701739 12.501739 0.7812158
## F3-F1  5.4  -3.701739 14.501739 0.3977097
## F4-F1  3.0  -6.101739 12.101739 0.8471593
## F5-F1  0.0  -9.101739  9.101739 1.0000000
## F3-F2  2.0  -7.101739 11.101739 0.9594398
## F4-F2 -0.4  -9.501739  8.701739 0.9999171
## F5-F2 -3.4 -12.501739  5.701739 0.7812158
## F4-F3 -2.4 -11.501739  6.701739 0.9244124
## F5-F3 -5.4 -14.501739  3.701739 0.3977097
## F5-F4 -3.0 -12.101739  6.101739 0.8471593
```

Conclusion

- ANOVA results show significant group differences.
- Post-hoc tests help find specific group differences.