

## Two-Way ANOVA Multiple Comparisons Solvent Experiment (no interaction effect)

```
> solv=read.table("solvents.txt",header=TRUE)
> solv$Varnish=as.factor(solv$Varnish)
> solv$Solvent=as.factor(solv$Solvent)
> solv$Treatment=as.factor(solv$Treatment)
> attach(solv)
> a=aov(Time~Solvent+Varnish+Solvent:Varnish)
> anova(a) #recall these results from previous handout
Analysis of Variance Table
```

Response: Time

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Solvent	1	97.416	97.416	11.1810	0.002706 **
Varnish	2	18.636	9.318	1.0695	0.358990
Solvent:Varnish	2	7.673	3.836	0.4403	0.648930
Residuals	24	209.104	8.713		

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
> TukeyHSD(a,"Solvent",conf.level=.95) #only two levels for Solvent, so not
particularly necessary to perform this TukeyHSD comparison.
```

```
  Tukey multiple comparisons of means
    95% family-wise confidence level
```

```
Fit: aov(formula = Time ~ Solvent + Varnish + Solvent:Varnish)
```

```
$Solvent
      diff      lwr      upr      p adj
2-1 3.604 1.379498 5.828502 0.0027061
```

```
> TukeyHSD(a,"Varnish",conf.level=.95) #note - would not really do this since we
did not reject the ANOVA hypothesis that the levels of Varnish were the same. But
note that all pairwise comparisons are not rejected, as expected.
```

```
  Tukey multiple comparisons of means
    95% family-wise confidence level
```

```
Fit: aov(formula = Time ~ Solvent + Varnish + Solvent:Varnish)
```

```
$Varnish
      diff      lwr      upr      p adj
2-1 -1.890 -5.186541 1.406541 0.3410299
3-1 -0.604 -3.900541 2.692541 0.8915261
3-2  1.286 -2.010541 4.582541 0.5998133
```

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Two-Way ANOVA Multiple Comparisons

### Mouse Growth Experiment (interaction effect present)

```

> detach(solv)
> mouse=read.table("mousegrowth.txt",header=TRUE,sep=",")
> mouse$Hormone=as.factor(mouse$Hormone)
> mouse$Treatment=as.factor(mouse$Treatment)
> mouse$Treatment=as.factor(mouse$Treatment)
> attach(mouse)

> a=aov(Weight.Gain~Hormone+Diet+Hormone:Diet)
> anova(a) #recall from previous results
Analysis of Variance Table

Response: Weight.Gain
          Df Sum Sq Mean Sq F value    Pr(>F)
Hormone    2  45.501   22.751  126.392 8.664e-09 ***
Diet       1   5.227    5.227   29.040 0.000163 ***
Hormone:Diet 2   3.788    1.894   10.522 0.002294 **
Residuals 12   2.160    0.180
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> cm=aov(Weight.Gain~Treatment)
> anova(cm) #corresponding previous result from cell means model
Analysis of Variance Table

Response: Weight.Gain
          Df Sum Sq Mean Sq F value    Pr(>F)
Treatment  5  54.516   10.903   60.574 4.275e-08 ***
Residuals 12   2.160    0.180
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> TukeyHSD(a,"Diet",conf.level=.95) #compare main effects of Diet levels
Tukey multiple comparisons of means
 95% family-wise confidence level

Fit: aov(formula = Weight.Gain ~ Hormone + Diet + Hormone:Diet)

$Diet
          diff          lwr          upr      p adj
Normal-High Prot -1.077778 -1.513540 -0.6420152 0.000163

> TukeyHSD(a,"Hormone",conf.level=.95) #compare main effects of Hormone levels
Tukey multiple comparisons of means
 95% family-wise confidence level

Fit: aov(formula = Weight.Gain ~ Hormone + Diet + Hormone:Diet)

$Hormone
          diff          lwr          upr      p adj
5-0  1.416667  0.7631762  2.070157 0.0002372
10-0 3.850000  3.1965095  4.503490 0.0000000
10-5 2.433333  1.7798429  3.086824 0.0000011

```

```
> TukeyHSD(cm,"Treatment",conf.level=.95) #compare cell effects in cell-means model
Tukey multiple comparisons of means
 95% family-wise confidence level
```

```
Fit: aov(formula = Weight.Gain ~ Treatment)
```

```
$Treatment
      diff      lwr      upr    p adj
2-1  1.1333333 -0.03023099  2.2968977 0.0578489
3-1  2.7666667  1.60310235  3.9302310 0.0000440
4-1  0.1666667 -0.99689765  1.3302310 0.9959931
5-1  1.8666667  0.70310235  3.0302310 0.0017422
6-1  5.1000000  3.93643568  6.2635643 0.0000001
3-2  1.6333333  0.46976901  2.7968977 0.0051446
4-2 -0.9666667 -2.13023099  0.1968977 0.1268140
5-2  0.7333333 -0.43023099  1.8968977 0.3405820
6-2  3.9666667  2.80310235  5.1302310 0.0000010
4-3 -2.6000000 -3.76356432 -1.4364357 0.0000819
5-3 -0.9000000 -2.06356432  0.2635643 0.1711325
6-3  2.3333333  1.16976901  3.4968977 0.0002339
5-4  1.7000000  0.53643568  2.8635643 0.0037577
6-4  4.9333333  3.76976901  6.0968977 0.0000001
6-5  3.2333333  2.06976901  4.3968977 0.0000088
```

NOTE: Treatment levels 1 through 6 were defined as follows:

- 1 = 0mg Hormone, Normal Diet
- 2 = 5mg Hormone, Normal Diet
- 3 = 10mg Hormone, Normal Diet
- 4 = 0mg Hormone, High Protein Diet
- 5 = 5mg Hormone, High Protein Diet
- 6 = 10mg Hormone, High Protein Diet

Multiple comparisons Line Plot (done manually)

Treatment	Sample Mean
6	8.63
3	6.30
5	5.40
2	4.67
4	3.70
1	3.53

Conclude: Treatment level 6 (10mg hormone, high protein diet) appears to be the best of the six. Levels 3 and 5 seem about even for second place.