

(k)

```
> library(knitr)
> model1=aov(effect~drug,data=data)
> kable(anova(model1),format="markdown")
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
drug	2	161.3333	80.66667	2.42	0.2367052
Residuals	3	100.0000	33.33333	NA	NA

H₀: Drugs do not significantly affect the mean blood pressure of women who take those drugs.

H₁: Drugs have significant impacts on the mean blood pressure of women who take those drugs.

By observing the table, we have:

Test Statistic is F distribution with $F_{2,3} = 2.42$

p-value = 0.2367052 > 0.05 = α (which is the significant level)

Thus, we accept null hypothesis because the test statistic greater than 2.42 is more than 5% of the time.

Thus, drugs do not significantly affect the mean blood pressure of women who take those drugs.

(i)

```
> lsm.drug=lsmeans(model1, ~drug)
> kable(summary(contrast(lsm.drug,method="pairwise",adjust="tukey"),infer=c(T,T),level=0.5,side="two-sided"))
```

contrast	estimate	SE	df	lower.CL	upper.CL	t.ratio	p.value
Control - Drug A	11	5.773503	3	3.688629	18.311371	1.905256	0.2816743
Control - Drug B	0	5.773503	3	-7.311371	7.311371	0.000000	1.0000000
Drug A - Drug B	-11	5.773503	3	-18.311371	-3.688629	-1.905256	0.2816743

H₀: $\tau_C - \tau_A = 0$

H₁: $\tau_C - \tau_A \neq 0$

Test Statistic T^* is t distribution with degree of freedom = 3 and $t = 1.905256$.

p-value = 0.2816743 > 0.05 = α

Since p-value is larger than α , which is the significant level, we accept null hypothesis.

Thus, the mean blood pressure of women getting the Control group is not significantly different from the mean blood pressure of women getting Drug A.

2.

```
> model2=aov(weightloss~type,data=experiment)
> kable(anova(model2),format="markdown")
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
type	2	16.122050	8.061025	104.4512	6e-07
Residuals	9	0.694575	0.077175	NA	NA

H₀: Soap type does not have significant effects on the mean weight loss of a soap over 24 hours.

H₁: Soap type does have significant effects on the mean weight loss of a soap over 24 hours.

Test Statistic T* is F distribution with $F_{2,9} = 104.4512$.

p-value = $6 \times 10^{-7} < 0.05 = \alpha$

Since p-value is smaller than α , which is the significant level, we reject null hypothesis.

Thus, soap type does have significant effects on the mean weight loss of a soap over 24 hours.

3.

By using one-way ANOVA model:

```
> model3=aov(time~push,data=light)
> kable(anova(model3),format="markdown")
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
push	3	0.0080471	0.0026824	0.2454844	0.8638292
Residuals	28	0.3059529	0.0109269	NA	NA

Assumption:

All variable residuals are normally distributed (ie. $\epsilon \sim N(0, \sigma)$).

All σ for each variable are the same.

All Y_{it} are iid normal random variables.

H₀: There are no differences in mean waiting time for different number of pushing the button.

H₁: Pushing the button has significant impacts on waiting time.

Test Statistic T* is F distribution with $F_{3,28} = 0.2454844$.

p-value = $0.8638292 > 0.05 = \alpha$

Since p-value is larger than α , which is the significant level, we accept null hypothesis.

Thus, the number of push does not significantly affect the mean waiting time for light change.

```
> lsm.light=lsmeans(model3, ~push)
> kable(summary(contrast(lsm.light,method="pairwise",adjust="tukey"),infer=c(T,T),level=0.5,side="two-sided"))
```

contrast	estimate	SE	df	lower.CL	upper.CL	t.ratio	p.value
0 - 1	0.0361429	0.0515138	28	-0.0368215	0.1091072	0.7016149	0.8955744
0 - 2	0.0131429	0.0515138	28	-0.0598215	0.0861072	0.2551327	0.9940396
0 - 3	-0.0048571	0.0612075	28	-0.0915517	0.0818375	-0.0793553	0.9998162
1 - 2	-0.0230000	0.0467480	28	-0.0892141	0.0432141	-0.4919994	0.9602303
1 - 3	-0.0410000	0.0572544	28	-0.1220954	0.0400954	-0.7161022	0.8898585
2 - 3	-0.0180000	0.0572544	28	-0.0990954	0.0630954	-0.3143863	0.9890012

$H_0: \tau_0 = \tau_1 = \tau_2 = \tau_3 = 0$

H_1 : At least one τ is different than others.

Test Statistic T^* is t distribution with degree of freedom = 28 and $t = 0.7016149, 0.2551327, -0.0793553, -0.4919994, -0.7161022, -0.3143863$ for contrast pair "0-1", "0-2", "0-3", "1-2", "1-3", "2-3".

By observing the chart, we have that p-value of each contrast is greater than 5%, which is the significant level. Thus, we accept the null hypothesis.

Thus, each mean waiting time for pushing the button 0, 1, 2, 3 times is not significantly different from each other.

R code:

```
#1-----  
  
drug=c(rep("Drug A",2),rep("Drug B",2),rep("Control",2))  
effect=c(-14,-4,5,-1,-2,6)  
data=data.frame(drug=as.factor(drug),effect=effect)  
data  
  
install.packages("knitr")  
library(knitr)  
model1=aov(effect~drug,data=data)  
kable(anova(model1),format="markdown")  
  
install.packages("lsmeans")  
library(lsmeans)  
lsm.drug=lsmeans(model1, ~drug)  
kable(summary(contrast(lsm.drug,method="pairwise",adjust="tukey"),infer=c(T,T),level=0.5,side="two-sided"))  
  
#2-----  
  
type=c(rep("Regular",4),rep("Deodorant",4),rep("Moisturizing",4))  
weightloss=c(-0.30,-0.10,-0.14,0.40,2.63,2.61,2.41,3.15,1.86,2.03,2.26,1.82)  
experiment=data.frame(type,weightloss)  
experiment  
  
model2=aov(weightloss~type,data=experiment)  
kable(anova(model2),format="markdown")  
  
#3-----  
  
push=c(rep("0",7),rep("1",10),rep("2",10),rep("3",5))  
time=c(38.14,38.20,38.31,38.14,38.29,38.17,38.20,38.28,38.17,38.08,38.25,38.18,38.03,37.95,38.26,38.30,38.21,3  
8.17,38.13,38.16,38.30,38.34,38.34,38.17,38.18,38.09,38.06,38.14,38.30,38.21,38.04,38.37)  
light=data.frame(push,time)
```

```
light
```

```
model3=aov(time~push,data=light)
```

```
kable(anova(model3),format="markdown")
```

```
lsm.light=lsmeans(model3, ~push)
```

```
kable(summary(contrast(lsm.light,method="pairwise",adjust="tukey"),infer=c(T,T),level=0.5,side="two-sided"))
```