

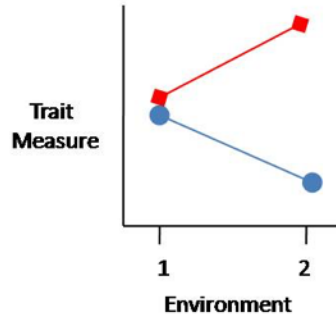
모형

- 범주형 factor(변인)가 2개인 경우
- i=요인 A, j=요인 B, k=(i, j) 요인 내 반복

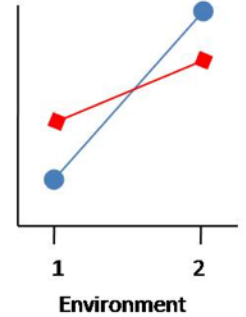
$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk}$$

- α_i - 요인 A 주 효과 main effect - β_j - 요인 B 주 효과
- $(\alpha\beta)_{ij}$ - 요인 A, B의 상호효과 (interaction effect)
- $e_{ijk} \sim N(0, \sigma^2)$

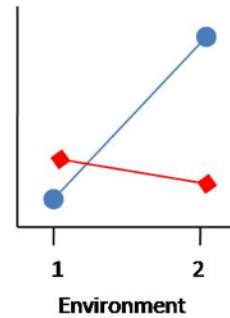
(E) Interaction and Species effect



(F) Interaction and Environment effect



(G) Interaction, Species, and Environment effect



주효과 main effect, 상호효과 interaction effect

주효과

- 개별 요인이 종속변수에 미치는 영향
- 요인 범주의 평균 차이가 주효과임
- $(\bar{y}_{i..} - \bar{y}_{i^*..})$, $(\bar{y}_{.j.} - \bar{y}_{.j^*})$

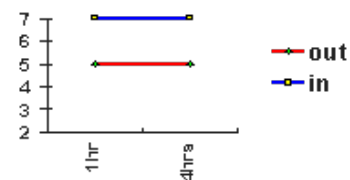
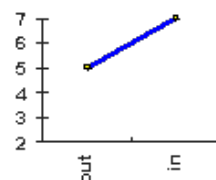
상호효과

- 두 요인의 범주의 결합 효과
- 평균도표의 경우 선이 교차되면 상호효과가 존재하고 수평이면 효과가 없음
- $(\bar{y}_{+..} - \bar{y}_{-..})$ (i, j의 곱이 2의 나머지)

Main Effects

		Time		
		1 hr	4hrs	
Setting	out	5	5	5
	in	7	7	7
		6	6	

Main Effect of Setting



변동분해 Decomposition

$$\sum (y_{ijk} - \bar{y}_{...})^2 = \sum (\bar{y}_{i..} - \bar{y}_{...})^2 + \sum (\bar{y}_{.j.} - \bar{y}_{...})^2 + \sum (\bar{y}_{ij.} - \bar{y}_{i..} - \bar{y}_{.j.} + \bar{y}_{...})^2 + \sum (y_{ijk} - \bar{y}_{i..} - \bar{y}_{.j.} - \bar{y}_{ij.})^2$$

예제  JOB.csv

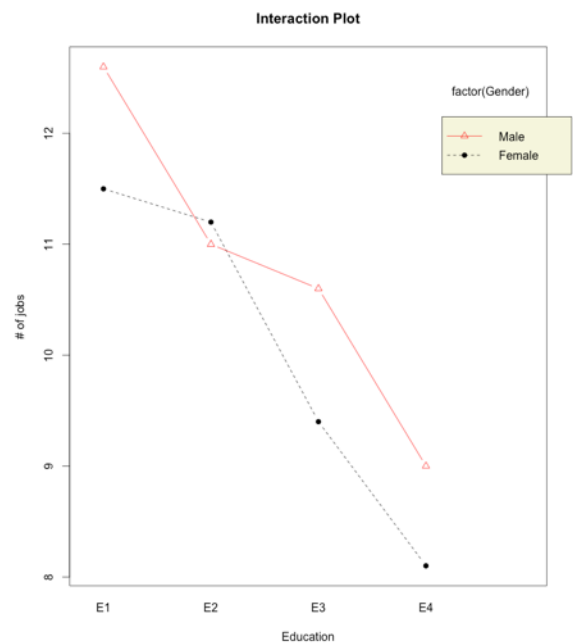
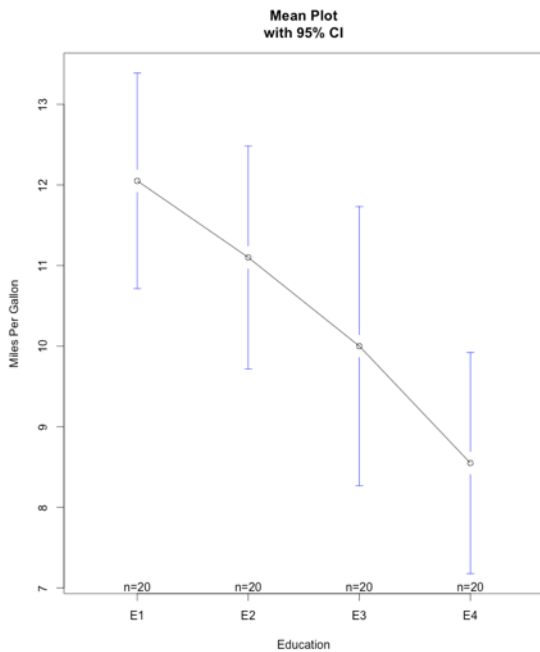
일생동안 근무하는 직장의 수가 (성별, 학력)에 따른 차이는 있는가?

```

job=read.csv("Jobs.csv")
attach(job)
fit.job=aov(Length~factor(Gender)*factor(Education))
summary(fit.job)

library(gplots)
plotmeans(Length~factor(Education),xlab="Education", ylab="Miles Per Gallon", main="Mean Plot\nwith 95% CI")

interaction.plot(factor(Education), factor(Gender), Length, type="b", col=c(1:2), leg.bty="o", leg.bg="beige",
 lwd=1, pch=c(16,24), xlab="Education", ylab="# of jobs", main="Interaction Plot")
    
```



	Df	Sum Sq	Mean Sq	F value	Pr(>F)
factor(Gender)	1	11.2	11.25	1.115	0.29444
factor(Education)	3	135.9	45.28	4.490	0.00604 **
factor(Gender):factor(Education)	3	6.2	2.08	0.207	0.89155
Residuals	72	726.2	10.09		

```
library(doBy)
summaryBy(Length ~ Education+Gender, data = job,
  FUN = function(x) { c(m = mean(x), s = sd(x)) })
TukeyHSD(aov(job$Length~factor(job$Education)))
```

	diff	lwr	upr	p adj	1	Education	Gender	Length.m	Length.s
E2-E1	-0.95	-3.548475	1.6484751	0.7722313	2	E1	Female	11.5	2.877113
E3-E1	-2.05	-4.648475	0.5484751	0.1715102	3	E1	Male	12.6	2.875181
E4-E1	-3.50	-6.098475	-0.9015249	0.0037825	4	E2	Female	11.2	3.119829
E3-E2	-1.10	-3.698475	1.4984751	0.6833087	5	E2	Male	11.0	2.943920
E4-E2	-2.55	-5.148475	0.0484751	0.0563894	6	E3	Female	9.4	4.060651
E4-E3	-1.45	-4.048475	1.1484751	0.4630436	7	E3	Male	10.6	3.405877
					8	E4	Female	8.1	3.510302
						E4	Male	9.0	2.309401

요인	변동합	자유도	평균변동	F-통계량
성별	11.2	1	11.25	1.12
학력	135.9	3	45.28	4.49**
성별*학력	6.2	3	2.08	0.207
오차	726.2	72	10.09	
총변동	879.5	79		

	남자		여자	
	M	SD	M	SD
E1 (a)	12.6	2.88	11.5	2.88
E2 (a, b)	11.0	2.94	11.2	3.11
E3 (a, b)	10.6	3.4	9.4	4.06
E4 (b)	9.0	2.31	8.1	3.51

성별 주효과, (성별, 학력)의 상호효과는 유의하지 않고 학력만 유의함.

학력이 높을수록 직장 수는 줄어들고 유의적인 차이는 대졸(E4)과 고졸미만(E1)에서 보임