Red and Black 2015.1

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Randomization Stage

이번 학기에는 smart campus를 이용하는 관계로 n.accesses 를 구할 수 없었고 대신 전공과 학년으로 구분. 자료 읽어들이는 과정, header를 지우고 읽어들인 후 설정하는 방식으로 작업.

```
class.roll.1501<-read.table("class_roll1501.txt", header=F, sep="")
str(class.roll.1501)
```

```
## 'data.frame':    58 obs. of  4 variables:
##  $ V1: int  20071750 20081501 20085108 20091450 20092236 20095210 20102229 2
0102819 20103227 20103232 ...
##  $ V2: chr  "정재훈" "김수호" "김덕현" "최선호" ...
##  $ V3: chr  "사학과" "러시아학과" "컴퓨터공학과" "사학과" ...
##  $ V4: int  3 3 4 3 4 2 4 2 3 4 ...
```

```
dimnames(class.roll.1501)[[2]]<-c("ID", "Name", "Major", "Year")
```

랜덤화 과정은 각자 실험해 보고, 추출한 값을 불러서 사용.

```
red.id<-sample(1:58, size=29)
```

저장해 놓은 랜덤화 id 불러오기

```
load("random_id_1501.rda")
ls()
```

```
## [1] "black.id"        "class.roll.1501" "red.id"
```

```
red.id
```

```
##  [1]  3  6  9 12 14 15 16 18 19 20 21 22 23 25 29 31 33 36 38 39 45 47 49
## [24] 50 52 55 56 57 58
```

```
class.roll.1501$group<-factor(ifelse((1:58) %in% red.id, "red", "black"), level
s=c("red", "black"))
black.id<-(1:58)[-red.id]
```

랜덤화 효과 확인 1. 13학번을 기준으로

```
ID.13<-factor(ifelse(substr(class.roll.1501$ID, 1, 4) >= 2013, "younger.13", "o
lder.13"), levels=c("younger.13", "older.13"))
table(ID.13)
```

```
## ID.13
## younger.13   older.13
##         31         27
```

```
table(ID.13[red.id])
```

```
##
## younger.13   older.13
##         15         14
```

```
table(ID.13[black.id])
```

```
##
## younger.13   older.13
##         16         13
```

```
table(class.roll.1501$group, ID.13)
```

```
##        ID.13
##         younger.13 older.13
##   red           15       14
##   black         16       13
```

랜덤화 효과 확인 2. 12학번을 기준으로

```
ID.12<-factor(ifelse(substr(class.roll.1501$ID, 1, 4) >= 2012, "younger.12", "o
lder.12"), levels=c("younger.12", "older.12"))
table(ID.12[red.id])
```

```
##
## younger.12   older.12
##         18         11
```

```
table(ID.12[black.id])
```

```
##
## younger.12   older.12
##         19         10
```

```
table(class.roll.1501$group, ID.12)
```

```
##        ID.12
##         younger.12 older.12
##   red            18       11
##   black          19       10
```

본인 확인용 게시물 만들기

```
class.roll.1501[red.id, "ID"]
```

```
##  [1] 20085108 20095210 20103227 20111414 20112102 20112401 20112761
##  [8] 20112852 20112904 20113165 20118008 20122206 20122207 20123149
## [15] 20132103 20132135 20132920 20141427 20142107 20142524 20152128
## [22] 20152140 20152579 20152580 20152614 20152761 20153164 20155257
## [29] 20158369
```

```
class.roll.1501[black.id, "ID"]
```

```
##  [1] 20071750 20081501 20091450 20092236 20102229 20102819 20103232
##  [8] 20111325 20111423 20112781 20122954 20123167 20123210 20131245
## [15] 20132131 20132315 20138005 20141410 20141529 20142911 20144332
## [22] 20146289 20151225 20152104 20152133 20152523 20152582 20152654
## [29] 20152750
```

```
cbind(class.roll.1501[red.id, "ID"], class.roll.1501[black.id, "ID"])
```

```
##           [,1]     [,2]
##  [1,] 20085108 20071750
##  [2,] 20095210 20081501
##  [3,] 20103227 20091450
##  [4,] 20111414 20092236
##  [5,] 20112102 20102229
##  [6,] 20112401 20102819
##  [7,] 20112761 20103232
##  [8,] 20112852 20111325
##  [9,] 20112904 20111423
## [10,] 20113165 20112781
## [11,] 20118008 20122954
## [12,] 20122206 20123167
## [13,] 20122207 20123210
## [14,] 20123149 20131245
## [15,] 20132103 20132131
## [16,] 20132135 20132315
## [17,] 20132920 20138005
## [18,] 20141427 20141410
## [19,] 20142107 20141529
## [20,] 20142524 20142911
## [21,] 20152128 20144332
## [22,] 20152140 20146289
## [23,] 20152579 20151225
## [24,] 20152580 20152104
## [25,] 20152614 20152133
## [26,] 20152761 20152523
## [27,] 20153164 20152582
## [28,] 20155257 20152654
## [29,] 20158369 20152750
```

```
red.black.ID<-cbind(class.roll.1501[red.id, "ID"], class.roll.1501[black.id, "I
D"])
dimnames(red.black.ID)[[2]]<-c("red", "black")
red.black.ID
```

```
##            red    black
##  [1,] 20085108 20071750
##  [2,] 20095210 20081501
##  [3,] 20103227 20091450
##  [4,] 20111414 20092236
##  [5,] 20112102 20102229
##  [6,] 20112401 20102819
##  [7,] 20112761 20103232
##  [8,] 20112852 20111325
##  [9,] 20112904 20111423
## [10,] 20113165 20112781
## [11,] 20118008 20122954
## [12,] 20122206 20123167
## [13,] 20122207 20123210
## [14,] 20123149 20131245
## [15,] 20132103 20132131
## [16,] 20132135 20132315
## [17,] 20132920 20138005
## [18,] 20141427 20141410
## [19,] 20142107 20141529
## [20,] 20142524 20142911
## [21,] 20152128 20144332
## [22,] 20152140 20146289
## [23,] 20152579 20151225
## [24,] 20152580 20152104
## [25,] 20152614 20152133
## [26,] 20152761 20152523
## [27,] 20153164 20152582
## [28,] 20155257 20152654
## [29,] 20158369 20152750
```

Red and Black Experiment

Data 읽어들이기. 원시자료의 구조를 감안하여

```
red.black.1501<-read.table("red_black1501.txt", header=T, row.names=3)
str(red.black.1501)
```

```
## 'data.frame':    51 obs. of  27 variables:
##  $ row.names: chr  "BLACK" "BLACK" "BLACK" "BLACK" ...
##  $ X.카드색 : int  20102229 20152523 20132315 20111325 20071750 20122954 20131
245 20141529 20141410 20141911 ...
##  $ Q1       : int  5 3 4 4 5 3 4 NA 4 3 ...
##  $ Q2_1     : int  4 4 4 5 5 4 4 5 4 4 ...
##  $ Q2_2     : int  4 4 4 5 5 5 4 4 4 3 ...
##  $ Q2_3     : int  4 3 4 5 5 4 4 4 4 4 ...
##  $ Q2_4     : int  5 5 3 5 5 4 3 4 4 5 ...
##  $ Q2_5     : int  5 5 4 5 5 5 4 4 4 5 ...
##  $ Q2_6     : int  5 4 4 5 5 5 4 5 4 5 ...
##  $ Q3_1     : int  4 4 5 5 4 3 5 4 1 3 ...
##  $ Q3_2     : int  4 3 3 4 4 3 4 4 1 2 ...
##  $ Q3_3     : int  4 3 3 3 3 3 4 5 1 2 ...
##  $ Q3_4     : int  4 4 3 5 4 3 4 4 1 3 ...
##  $ Q3_5     : int  3 4 3 4 3 2 3 4 1 3 ...
##  $ Q4_1     : int  5 4 4 5 5 4 5 5 3 4 ...
##  $ Q4_2     : int  5 3 4 3 5 4 4 4 1 1 ...
##  $ Q4_3     : int  5 4 3 4 5 4 5 4 3 2 ...
##  $ Q4_4     : int  5 3 3 3 4 4 5 5 1 3 ...
##  $ Q4_5     : int  3 2 3 2 3 3 3 4 3 4 ...
##  $ Q5_1     : int  4 4 4 4 4 3 4 4 1 3 ...
##  $ Q5_2     : int  4 4 4 4 5 3 5 3 3 1 ...
##  $ Q5_3     : int  5 5 3 5 5 3 5 4 1 1 ...
##  $ Q5_4     : int  4 5 4 5 5 4 5 4 4 4 ...
##  $ Q5_5     : int  3 5 4 4 5 4 4 5 4 3 ...
##  $ Q6_1     : chr  "가" "나" "나" "가" ...
##  $ Q6_2     : chr  "가" "가" "나" "나" ...
##  $ Q6_3     : chr  "다" "다" "나" "가" ...
```

이상한 이름을 고치고,

```
dimnames(red.black.1501)[[2]][1:2]<-c("Color", "ID")
```

백업용 파일을 만든 후, 변수 순서 조정.

```
red.black.1501.2<-red.black.1501
red.black.1501.2<-red.black.1501[, c(2,1, 3:27)]
str(red.black.1501.2)
```

```
## 'data.frame':    51 obs. of  27 variables:
##  $ ID   : int  20102229 20152523 20132315 20111325 20071750 20122954 2013124
5 20141529 20141410 20141911 ...
##  $ Color: chr  "BLACK" "BLACK" "BLACK" "BLACK" ...
##  $ Q1   : int  5 3 4 4 5 3 4 NA 4 3 ...
##  $ Q2_1 : int  4 4 4 5 5 4 4 5 4 4 ...
##  $ Q2_2 : int  4 4 4 5 5 5 4 4 4 3 ...
##  $ Q2_3 : int  4 3 4 5 5 4 4 4 4 4 ...
##  $ Q2_4 : int  5 5 3 5 5 4 3 4 4 5 ...
##  $ Q2_5 : int  5 5 4 5 5 5 4 4 4 5 ...
##  $ Q2_6 : int  5 4 4 5 5 5 4 5 4 5 ...
##  $ Q3_1 : int  4 4 5 5 4 3 5 4 1 3 ...
##  $ Q3_2 : int  4 3 3 4 4 3 4 4 1 2 ...
##  $ Q3_3 : int  4 3 3 3 3 3 4 5 1 2 ...
##  $ Q3_4 : int  4 4 3 5 4 3 4 4 1 3 ...
##  $ Q3_5 : int  3 4 3 4 3 2 3 4 1 3 ...
##  $ Q4_1 : int  5 4 4 5 5 4 5 5 3 4 ...
##  $ Q4_2 : int  5 3 4 3 5 4 4 4 1 1 ...
##  $ Q4_3 : int  5 4 3 4 5 4 5 4 3 2 ...
##  $ Q4_4 : int  5 3 3 3 4 4 5 5 1 3 ...
##  $ Q4_5 : int  3 2 3 2 3 3 3 4 3 4 ...
##  $ Q5_1 : int  4 4 4 4 4 3 4 4 1 3 ...
##  $ Q5_2 : int  4 4 4 4 5 3 5 3 3 1 ...
##  $ Q5_3 : int  5 5 3 5 5 3 5 4 1 1 ...
##  $ Q5_4 : int  4 5 4 5 5 4 5 4 4 4 ...
##  $ Q5_5 : int  3 5 4 4 5 4 4 5 4 3 ...
##  $ Q6_1 : chr  "가" "나" "나" "가" ...
##  $ Q6_2 : chr  "가" "가" "나" "나" ...
##  $ Q6_3 : chr  "다" "다" "나" "가" ...
```

한글 포함 chr을 factor로, 출신지역을 잘못 입력하여 (나)가 두번 나온 관계로 경기와 강원을 합침.

```
red.black.1501.2$Color<-factor(red.black.1501.2$Color, levels=c("RED", "BLAC
K"), labels=c("Red", "Black"))
str(red.black.1501.2)
```

```
## 'data.frame':    51 obs. of  27 variables:
##  $ ID   : int  20102229 20152523 20132315 20111325 20071750 20122954 2013124
5 20141529 20141410 20141911 ...
##  $ Color: Factor w/ 2 levels "Red","Black": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Q1   : int  5 3 4 4 5 3 4 NA 4 3 ...
##  $ Q2_1 : int  4 4 4 5 5 4 4 5 4 4 ...
##  $ Q2_2 : int  4 4 4 5 5 5 4 4 4 3 ...
##  $ Q2_3 : int  4 3 4 5 5 4 4 4 4 4 ...
##  $ Q2_4 : int  5 5 3 5 5 4 3 4 4 5 ...
##  $ Q2_5 : int  5 5 4 5 5 5 4 4 4 5 ...
##  $ Q2_6 : int  5 4 4 5 5 5 4 5 4 5 ...
##  $ Q3_1 : int  4 4 5 5 4 3 5 4 1 3 ...
##  $ Q3_2 : int  4 3 3 4 4 3 4 4 1 2 ...
##  $ Q3_3 : int  4 3 3 3 3 3 4 5 1 2 ...
##  $ Q3_4 : int  4 4 3 5 4 3 4 4 1 3 ...
##  $ Q3_5 : int  3 4 3 4 3 2 3 4 1 3 ...
##  $ Q4_1 : int  5 4 4 5 5 4 5 5 3 4 ...
##  $ Q4_2 : int  5 3 4 3 5 4 4 4 1 1 ...
##  $ Q4_3 : int  5 4 3 4 5 4 5 4 3 2 ...
##  $ Q4_4 : int  5 3 3 3 4 4 5 5 1 3 ...
##  $ Q4_5 : int  3 2 3 2 3 3 3 4 3 4 ...
##  $ Q5_1 : int  4 4 4 4 4 3 4 4 1 3 ...
##  $ Q5_2 : int  4 4 4 4 5 3 5 3 3 1 ...
##  $ Q5_3 : int  5 5 3 5 5 3 5 4 1 1 ...
##  $ Q5_4 : int  4 5 4 5 5 4 5 4 4 4 ...
##  $ Q5_5 : int  3 5 4 4 5 4 4 5 4 3 ...
##  $ Q6_1 : chr  "가" "나" "나" "가" ...
##  $ Q6_2 : chr  "가" "가" "나" "나" ...
##  $ Q6_3 : chr  "다" "다" "나" "가" ...
```

```
red.black.1501.2$Q6_1<-factor(red.black.1501.2$Q6_1, levels=c("가", "나"), label
s=c("Male", "Female"))
red.black.1501.2$Q6_2<-factor(red.black.1501.2$Q6_2, levels=c("가", "나"), label
s=c("Glasses", "None"))
red.black.1501.2$Q6_3<-factor(red.black.1501.2$Q6_3, levels=c("가", "나", "다"),
labels=c("Seoul", "GyungGang", "Other"))
str(red.black.1501.2)
```

```
## 'data.frame':    51 obs. of  27 variables:
##  $ ID   : int  20102229 20152523 20132315 20111325 20071750 20122954 2013124
5 20141529 20141410 20141911 ...
##  $ Color: Factor w/ 2 levels "Red","Black": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Q1   : int  5 3 4 4 5 3 4 NA 4 3 ...
##  $ Q2_1 : int  4 4 4 5 5 4 4 5 4 4 ...
##  $ Q2_2 : int  4 4 4 5 5 5 4 4 4 3 ...
##  $ Q2_3 : int  4 3 4 5 5 4 4 4 4 4 ...
##  $ Q2_4 : int  5 5 3 5 5 4 3 4 4 5 ...
##  $ Q2_5 : int  5 5 4 5 5 5 4 4 4 5 ...
##  $ Q2_6 : int  5 4 4 5 5 5 4 5 4 5 ...
##  $ Q3_1 : int  4 4 5 5 4 3 5 4 1 3 ...
##  $ Q3_2 : int  4 3 3 4 4 3 4 4 1 2 ...
##  $ Q3_3 : int  4 3 3 3 3 3 4 5 1 2 ...
##  $ Q3_4 : int  4 4 3 5 4 3 4 4 1 3 ...
##  $ Q3_5 : int  3 4 3 4 3 2 3 4 1 3 ...
##  $ Q4_1 : int  5 4 4 5 5 4 5 5 3 4 ...
##  $ Q4_2 : int  5 3 4 3 5 4 4 4 1 1 ...
##  $ Q4_3 : int  5 4 3 4 5 4 5 4 3 2 ...
##  $ Q4_4 : int  5 3 3 3 4 4 5 5 1 3 ...
##  $ Q4_5 : int  3 2 3 2 3 3 3 4 3 4 ...
##  $ Q5_1 : int  4 4 4 4 4 3 4 4 1 3 ...
##  $ Q5_2 : int  4 4 4 4 5 3 5 3 3 1 ...
##  $ Q5_3 : int  5 5 3 5 5 3 5 4 1 1 ...
##  $ Q5_4 : int  4 5 4 5 5 4 5 4 4 4 ...
##  $ Q5_5 : int  3 5 4 4 5 4 4 5 4 3 ...
##  $ Q6_1 : Factor w/ 2 levels "Male","Female": 1 2 2 1 1 2 2 1 1 1 ...
##  $ Q6_2 : Factor w/ 2 levels "Glasses","None": 1 1 2 2 2 1 1 1 1 1 ...
##  $ Q6_3 : Factor w/ 3 levels "Seoul","GyungGang",..: 3 3 2 1 2 1 1 1 2 1 ...
```

평균 비교

```
options(digits=3)
aggregate(red.black.1501.2[,-c(1:2, 25:27)], by=list(red.black.1501.2$Color), m
ean, na.rm=T)
```

```
##   Group.1   Q1 Q2_1 Q2_2 Q2_3 Q2_4 Q2_5 Q2_6 Q3_1 Q3_2 Q3_3 Q3_4 Q3_5 Q4_1
## 1     Red 3.58 4.15 4.35  4.0 4.15 4.08 4.31  3.5 3.42 3.19 3.23 3.58 4.12
## 2   Black 3.52 4.08 4.08  3.8 4.12 4.48 4.24  3.6 3.20 3.20 3.32 3.00 4.20
##   Q4_2 Q4_3 Q4_4 Q4_5 Q5_1 Q5_2 Q5_3 Q5_4 Q5_5
## 1 3.46 3.58 3.65 3.38 3.35 3.46 3.38 3.73 4.12
## 2 3.32 3.68 3.36 3.36 3.28 3.64 3.40 4.12 3.72
```

Group.1 이라는 변수명이 보기 싫으면

```
aggregate(red.black.1501.2[,-c(1:2, 25:27)], by=list(Color=red.black.1501.2$Col
or), mean, na.rm=T)
```

```
##    Color   Q1 Q2_1 Q2_2 Q2_3 Q2_4 Q2_5 Q2_6 Q3_1 Q3_2 Q3_3 Q3_4 Q3_5 Q4_1
## 1   Red 3.58 4.15 4.35  4.0 4.15 4.08 4.31  3.5 3.42 3.19 3.23 3.58 4.12
## 2 Black 3.52 4.08 4.08  3.8 4.12 4.48 4.24  3.6 3.20 3.20 3.32 3.00 4.20
##   Q4_2 Q4_3 Q4_4 Q4_5 Q5_1 Q5_2 Q5_3 Q5_4 Q5_5
## 1 3.46 3.58 3.65 3.38 3.35 3.46 3.38 3.73 4.12
## 2 3.32 3.68 3.36 3.36 3.28 3.64 3.40 4.12 3.72
```

two-sample t-test를 수행하기 전에 과연 각각의 variance 는 차이가 있을까? R의 var.test, bartlett.test, fligner.test 는 두 표본의 분산에 대하여 차이를 검정. fligner.test 가 가장 robust하다고 알려져 있음.

```
apply(red.black.1501.2[, 3:24], 2, function(x) {var.test(x~red.black.1501.2$Col
or)})
```

```
## $Q1
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.18, num df = 25, denom df = 22, p-value = 0.7066
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.507 2.666
## sample estimates:
## ratio of variances
##               1.18
##
##
## $Q2_1
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.11, num df = 25, denom df = 24, p-value = 0.7993
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.492 2.490
## sample estimates:
## ratio of variances
##               1.11
##
##
## $Q2_2
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.801, num df = 25, denom df = 24, p-value = 0.586
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.355 1.797
## sample estimates:
## ratio of variances
```

```
##              0.801
##
##
## $Q2_3
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.96, num df = 25, denom df = 24, p-value = 0.9182
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.425 2.153
## sample estimates:
## ratio of variances
##               0.96
##
##
## $Q2_4
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.975, num df = 25, denom df = 23, p-value = 0.9473
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.426 2.199
## sample estimates:
## ratio of variances
##              0.975
##
##
## $Q2_5
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.923, num df = 25, denom df = 24, p-value = 0.8424
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.409 2.070
## sample estimates:
## ratio of variances
##              0.923
##
##
## $Q2_6
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.746, num df = 25, denom df = 24, p-value = 0.4722
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.331 1.673
```

```
## sample estimates:
## ratio of variances
##             0.746
##
##
## $Q3_1
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.06, num df = 25, denom df = 24, p-value = 0.8887
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.47 2.38
## sample estimates:
## ratio of variances
##              1.06
##
##
## $Q3_2
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.621, num df = 25, denom df = 24, p-value = 0.2432
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.275 1.392
## sample estimates:
## ratio of variances
##             0.621
##
##
## $Q3_3
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.65, num df = 25, denom df = 24, p-value = 0.2251
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.73 3.70
## sample estimates:
## ratio of variances
##              1.65
##
##
## $Q3_4
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.703, num df = 25, denom df = 24, p-value = 0.3862
## alternative hypothesis: true ratio of variances is not equal to 1
```

```
## 95 percent confidence interval:
##  0.311 1.575
## sample estimates:
## ratio of variances
##              0.702
##
##
## $Q3_5
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.881, num df = 25, denom df = 24, p-value = 0.7534
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.39 1.97
## sample estimates:
## ratio of variances
##              0.881
##
##
## $Q4_1
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 2.29, num df = 25, denom df = 24, p-value = 0.04595
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  1.02 5.14
## sample estimates:
## ratio of variances
##               2.29
##
##
## $Q4_2
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.686, num df = 25, denom df = 24, p-value = 0.355
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.304 1.538
## sample estimates:
## ratio of variances
##              0.686
##
##
## $Q4_3
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
```

```
## F = 1.07, num df = 25, denom df = 24, p-value = 0.8712
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.474 2.398
## sample estimates:
## ratio of variances
##               1.07
##
##
## $Q4_4
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.869, num df = 25, denom df = 24, p-value = 0.7286
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.385 1.948
## sample estimates:
## ratio of variances
##              0.869
##
##
## $Q4_5
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.27, num df = 25, denom df = 24, p-value = 0.5601
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.563 2.849
## sample estimates:
## ratio of variances
##               1.27
##
##
## $Q5_1
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.71, num df = 25, denom df = 24, p-value = 0.1939
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.757 3.831
## sample estimates:
## ratio of variances
##               1.71
##
##
## $Q5_2
##
##  F test to compare two variances
```

```
##
## data:  x by red.black.1501.2$Color
## F = 0.342, num df = 25, denom df = 24, p-value = 0.009833
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.151 0.767
## sample estimates:
## ratio of variances
##              0.342
##
##
## $Q5_3
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 0.725, num df = 25, denom df = 24, p-value = 0.429
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.321 1.625
## sample estimates:
## ratio of variances
##              0.725
##
##
## $Q5_4
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1, num df = 25, denom df = 24, p-value = 0.9966
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.444 2.249
## sample estimates:
## ratio of variances
##                  1
##
##
## $Q5_5
##
##  F test to compare two variances
##
## data:  x by red.black.1501.2$Color
## F = 1.03, num df = 25, denom df = 24, p-value = 0.9497
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.455 2.303
## sample estimates:
## ratio of variances
##               1.03
```

```r
apply(red.black.1501.2[, 3:24], 2, function(x) {bartlett.test(x~red.black.150
1.2$Color)})
```

```
## $Q1
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.148, df = 1, p-value = 0.7
##
##
## $Q2_1
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.0661, df = 1, p-value = 0.7972
##
##
## $Q2_2
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.294, df = 1, p-value = 0.5878
##
##
## $Q2_3
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.01, df = 1, p-value = 0.9203
##
##
## $Q2_4
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.0037, df = 1, p-value = 0.9518
##
##
## $Q2_5
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.0385, df = 1, p-value = 0.8445
##
##
## $Q2_6
##
```

```
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.513, df = 1, p-value = 0.4739
##
##
## $Q3_1
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.0204, df = 1, p-value = 0.8865
##
##
## $Q3_2
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 1.36, df = 1, p-value = 0.2443
##
##
## $Q3_3
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 1.48, df = 1, p-value = 0.224
##
##
## $Q3_4
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.746, df = 1, p-value = 0.3877
##
##
## $Q3_5
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.097, df = 1, p-value = 0.7555
##
##
## $Q4_1
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 3.99, df = 1, p-value = 0.04566
##
##
```

```
## $Q4_2
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.85, df = 1, p-value = 0.3564
##
##
## $Q4_3
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.0272, df = 1, p-value = 0.869
##
##
## $Q4_4
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.118, df = 1, p-value = 0.7306
##
##
## $Q4_5
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.343, df = 1, p-value = 0.5582
##
##
## $Q5_1
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 1.69, df = 1, p-value = 0.193
##
##
## $Q5_2
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 6.65, df = 1, p-value = 0.009921
##
##
## $Q5_3
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.621, df = 1, p-value = 0.4306
```

```
##
##
## $Q5_4
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 1e-04, df = 1, p-value = 0.9944
##
##
## $Q5_5
##
##  Bartlett test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Bartlett's K-squared = 0.0043, df = 1, p-value = 0.9475
```

```
apply(red.black.1501.2[, 3:24], 2, function(x) {fligner.test(x~red.black.150
1.2$Color)})
```

```
## $Q1
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.0131, df = 1, p-value = 0.9089
##
##
## $Q2_1
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.193, df = 1, p-value = 0.6605
##
##
## $Q2_2
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.02, df = 1, p-value = 0.8875
##
##
## $Q2_3
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.0106, df = 1, p-value = 0.918
##
##
## $Q2_4
```

```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.141, df = 1, p-value = 0.7073
##
##
## $Q2_5
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 1.57, df = 1, p-value = 0.2107
##
##
## $Q2_6
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.501, df = 1, p-value = 0.4789
##
##
## $Q3_1
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.0203, df = 1, p-value = 0.8868
##
##
## $Q3_2
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.33, df = 1, p-value = 0.5657
##
##
## $Q3_3
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 2.22, df = 1, p-value = 0.1361
##
##
## $Q3_4
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 1.02, df = 1, p-value = 0.3129
##
```

```
##
## $Q3_5
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.699, df = 1, p-value = 0.4031
##
##
## $Q4_1
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 2.86, df = 1, p-value = 0.09081
##
##
## $Q4_2
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.485, df = 1, p-value = 0.486
##
##
## $Q4_3
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.0017, df = 1, p-value = 0.9667
##
##
## $Q4_4
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.0294, df = 1, p-value = 0.8639
##
##
## $Q4_5
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.0679, df = 1, p-value = 0.7944
##
##
## $Q5_1
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
```

```
## Fligner-Killeen:med chi-squared = 0.387, df = 1, p-value = 0.5339
##
##
## $Q5_2
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 1.18, df = 1, p-value = 0.2779
##
##
## $Q5_3
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.691, df = 1, p-value = 0.4057
##
##
## $Q5_4
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 0.181, df = 1, p-value = 0.6709
##
##
## $Q5_5
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  x by red.black.1501.2$Color
## Fligner-Killeen:med chi-squared = 1.11, df = 1, p-value = 0.292
```

two-sample t-test 수행. 앞의 등분산 검정을 토대로 var.equal=TRUE 로 하거나 Welch’s Approximation 사용하여 비교.

```
apply(red.black.1501.2[, 3:24], 2, function(x) {t.test(x~red.black.1501.2$Colo
r, var.equal=TRUE)})
```

```
## $Q1
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.233, df = 47, p-value = 0.8165
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.421  0.531
## sample estimates:
##   mean in group Red mean in group Black
##                3.58                3.52
##
```

```
##
## $Q2_1
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.401, df = 49, p-value = 0.6905
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.297  0.444
## sample estimates:
##   mean in group Red mean in group Black
##                4.15                4.08
##
##
## $Q2_2
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.43, df = 49, p-value = 0.1599
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.109  0.641
## sample estimates:
##   mean in group Red mean in group Black
##                4.35                4.08
##
##
## $Q2_3
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.945, df = 49, p-value = 0.3495
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.226  0.626
## sample estimates:
##   mean in group Red mean in group Black
##                 4.0                 3.8
##
##
## $Q2_4
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.138, df = 48, p-value = 0.8905
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.390  0.448
## sample estimates:
##   mean in group Red mean in group Black
```

```
##                 4.15                4.12
##
##
## $Q2_5
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -2.25, df = 49, p-value = 0.02914
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.7635 -0.0427
## sample estimates:
##   mean in group Red mean in group Black
##                 4.08                4.48
##
##
## $Q2_6
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.267, df = 49, p-value = 0.7905
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.442  0.577
## sample estimates:
##   mean in group Red mean in group Black
##                 4.31                4.24
##
##
## $Q3_1
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.352, df = 49, p-value = 0.7266
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.671  0.471
## sample estimates:
##   mean in group Red mean in group Black
##                  3.5                 3.6
##
##
## $Q3_2
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.09, df = 49, p-value = 0.2828
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.190  0.636
```

```
## sample estimates:
##   mean in group Red mean in group Black
##               3.42               3.20
##
##
## $Q3_3
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.0312, df = 49, p-value = 0.9753
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.504  0.488
## sample estimates:
##   mean in group Red mean in group Black
##               3.19               3.20
##
##
## $Q3_4
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.336, df = 49, p-value = 0.7383
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.623  0.445
## sample estimates:
##   mean in group Red mean in group Black
##               3.23               3.32
##
##
## $Q3_5
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 2.33, df = 49, p-value = 0.02407
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.079 1.075
## sample estimates:
##   mean in group Red mean in group Black
##               3.58               3.00
##
##
## $Q4_1
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.332, df = 49, p-value = 0.7416
## alternative hypothesis: true difference in means is not equal to 0
```

```
## 95 percent confidence interval:
##  -0.597  0.428
## sample estimates:
##   mean in group Red mean in group Black
##                4.12                4.20
##
##
## $Q4_2
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.482, df = 49, p-value = 0.6321
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.449  0.732
## sample estimates:
##   mean in group Red mean in group Black
##                3.46                3.32
##
##
## $Q4_3
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.351, df = 49, p-value = 0.7269
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.693  0.487
## sample estimates:
##   mean in group Red mean in group Black
##                3.58                3.68
##
##
## $Q4_4
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.2, df = 49, p-value = 0.2371
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.200  0.787
## sample estimates:
##   mean in group Red mean in group Black
##                3.65                3.36
##
##
## $Q4_5
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
```

```
## t = 0.0908, df = 49, p-value = 0.928
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.52  0.57
## sample estimates:
##   mean in group Red mean in group Black
##                3.38                3.36
##
##
## $Q5_1
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.227, df = 49, p-value = 0.8212
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.519  0.651
## sample estimates:
##   mean in group Red mean in group Black
##                3.35                3.28
##
##
## $Q5_2
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.786, df = 49, p-value = 0.4358
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.635  0.278
## sample estimates:
##   mean in group Red mean in group Black
##                3.46                3.64
##
##
## $Q5_3
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.0513, df = 49, p-value = 0.9593
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.618  0.587
## sample estimates:
##   mean in group Red mean in group Black
##                3.38                3.40
##
##
## $Q5_4
##
##  Two Sample t-test
```

```
##
## data:  x by red.black.1501.2$Color
## t = -2.09, df = 49, p-value = 0.04226
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.7643 -0.0142
## sample estimates:
##   mean in group Red mean in group Black
##                3.73                4.12
##
##
## $Q5_5
##
##  Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.43, df = 49, p-value = 0.1589
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.160  0.951
## sample estimates:
##   mean in group Red mean in group Black
##                4.12                3.72
```

```
apply(red.black.1501.2[, 3:24], 2, function(x) {t.test(x~red.black.1501.2$Colo
r)})
```

```
## $Q1
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.234, df = 46.9, p-value = 0.8156
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.418  0.529
## sample estimates:
##   mean in group Red mean in group Black
##                3.58                3.52
##
##
## $Q2_1
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.401, df = 49, p-value = 0.6902
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.296  0.444
## sample estimates:
##   mean in group Red mean in group Black
##                4.15                4.08
```

```
##
##
## $Q2_2
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.42, df = 47.9, p-value = 0.161
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.110  0.642
## sample estimates:
##   mean in group Red mean in group Black
##                4.35                4.08
##
##
## $Q2_3
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.944, df = 48.8, p-value = 0.3497
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.226  0.626
## sample estimates:
##   mean in group Red mean in group Black
##                 4.0                 3.8
##
##
## $Q2_4
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.138, df = 47.6, p-value = 0.8905
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.390  0.448
## sample estimates:
##   mean in group Red mean in group Black
##                4.15                4.12
##
##
## $Q2_5
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -2.25, df = 48.7, p-value = 0.02929
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.7638 -0.0423
## sample estimates:
```

```
##   mean in group Red mean in group Black
##                4.08                4.48
##
##
## $Q2_6
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.266, df = 47.4, p-value = 0.7911
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.443  0.579
## sample estimates:
##   mean in group Red mean in group Black
##                4.31                4.24
##
##
## $Q3_1
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.352, df = 49, p-value = 0.7264
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.671  0.471
## sample estimates:
##   mean in group Red mean in group Black
##                 3.5                 3.6
##
##
## $Q3_2
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.08, df = 45.6, p-value = 0.2854
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.192  0.639
## sample estimates:
##   mean in group Red mean in group Black
##                3.42                3.20
##
##
## $Q3_3
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.0313, df = 47, p-value = 0.9751
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
```

```
##  -0.502  0.486
## sample estimates:
##   mean in group Red mean in group Black
##                3.19                3.20
##
##
## $Q3_4
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.335, df = 46.9, p-value = 0.7393
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.625  0.447
## sample estimates:
##   mean in group Red mean in group Black
##                3.23                3.32
##
##
## $Q3_5
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 2.33, df = 48.5, p-value = 0.02429
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.0782 1.0757
## sample estimates:
##   mean in group Red mean in group Black
##                3.58                3.00
##
##
## $Q4_1
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.334, df = 43.5, p-value = 0.7398
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.595  0.426
## sample estimates:
##   mean in group Red mean in group Black
##                4.12                4.20
##
##
## $Q4_2
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.48, df = 46.6, p-value = 0.6335
```

```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.452  0.735
## sample estimates:
##   mean in group Red mean in group Black
##                3.46                3.32
##
##
## $Q4_3
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.351, df = 49, p-value = 0.7267
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.692  0.486
## sample estimates:
##   mean in group Red mean in group Black
##                3.58                3.68
##
##
## $Q4_4
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.2, df = 48.4, p-value = 0.2378
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.200  0.788
## sample estimates:
##   mean in group Red mean in group Black
##                3.65                3.36
##
##
## $Q4_5
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 0.091, df = 48.7, p-value = 0.9279
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.519  0.568
## sample estimates:
##   mean in group Red mean in group Black
##                3.38                3.36
##
##
## $Q5_1
##
##  Welch Two Sample t-test
##
```

```
## data:  x by red.black.1501.2$Color
## t = 0.228, df = 46.7, p-value = 0.8203
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.517  0.649
## sample estimates:
##   mean in group Red mean in group Black
##                3.35                3.28
##
##
## $Q5_2
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.778, df = 38.4, p-value = 0.4413
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.643  0.286
## sample estimates:
##   mean in group Red mean in group Black
##                3.46                3.64
##
##
## $Q5_3
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -0.0511, df = 47.1, p-value = 0.9594
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.621  0.590
## sample estimates:
##   mean in group Red mean in group Black
##                3.38                3.40
##
##
## $Q5_4
##
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = -2.09, df = 48.9, p-value = 0.04226
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.7643 -0.0142
## sample estimates:
##   mean in group Red mean in group Black
##                3.73                4.12
##
##
## $Q5_5
##
```

```
##  Welch Two Sample t-test
##
## data:  x by red.black.1501.2$Color
## t = 1.43, df = 49, p-value = 0.1587
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.160  0.951
## sample estimates:
##   mean in group Red mean in group Black
##                4.12                3.72
```

Wilcoxon Rank Sum test 수행(tie가 많다고 warning이 나와도 무시)

```
apply(red.black.1501.2[, 3:24], 2, function(x) {wilcox.test(x~red.black.150
1.2$Color)})
```

```
## Warning in wilcox.test.default(x = structure(c(3L, 2L, 3L, 3L, 4L, 4L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 4L, 5L, 4L, 4L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(5L, 4L, 4L, 5L, 5L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 2L, 4L, 5L, 4L, 4L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 4L, 4L, 4L, 4L, 4L, 5L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 4L, 4L, 4L, 4L, 4L, 5L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 4L, 5L, 5L, 5L, 5L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 3L, 5L, 4L, 3L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 3L, 3L, 3L, 3L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 2L, 3L, 3L, 5L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 3L, 3L, 5L, 4L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 5L, 3L, 5L, 5L, 3L, 3L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 5L, 3L, 5L, 5L, 3L, 3L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 3L, 3L, 3L, 3L, 3L, 3L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(3L, 4L, 2L, 5L, 3L, 5L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(3L, 5L, 2L, 4L, 5L, 4L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(3L, 4L, 1L, 3L, 5L, 3L, 3L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(2L, 4L, 1L, 4L, 5L, 4L, 3L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(3L, 4L, 3L, 3L, 4L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(3L, 4L, 1L, 3L, 5L, 3L, 4L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(4L, 4L, 3L, 4L, 5L, 4L, 5L,
## : cannot compute exact p-value with ties
```

```
## Warning in wilcox.test.default(x = structure(c(5L, 5L, 3L, 5L, 3L, 4L, 5L,
## : cannot compute exact p-value with ties
```

```
## $Q1
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 306, p-value = 0.8976
## alternative hypothesis: true location shift is not equal to 0
##
##
```

```
## $Q2_1
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 345, p-value = 0.6797
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q2_2
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 391, p-value = 0.1732
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q2_3
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 368, p-value = 0.3603
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q2_4
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 322, p-value = 0.8306
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q2_5
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 214, p-value = 0.01916
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q2_6
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 332, p-value = 0.8935
## alternative hypothesis: true location shift is not equal to 0
##
##
```

```
## $Q3_1
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 311, p-value = 0.7893
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q3_2
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 360, p-value = 0.4669
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q3_3
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 340, p-value = 0.7651
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q3_4
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 309, p-value = 0.7569
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q3_5
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 430, p-value = 0.03288
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q4_1
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 334, p-value = 0.8634
## alternative hypothesis: true location shift is not equal to 0
##
##
```

```
## $Q4_2
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 336, p-value = 0.8365
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q4_3
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 310, p-value = 0.7757
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q4_4
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 387, p-value = 0.2138
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q4_5
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 328, p-value = 0.9526
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q5_1
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 346, p-value = 0.6867
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q5_2
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 263, p-value = 0.2086
## alternative hypothesis: true location shift is not equal to 0
##
##
```

```
## $Q5_3
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 316, p-value = 0.8651
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q5_4
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 228, p-value = 0.04403
## alternative hypothesis: true location shift is not equal to 0
##
##
## $Q5_5
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  x by red.black.1501.2$Color
## W = 396, p-value = 0.1627
## alternative hypothesis: true location shift is not equal to 0
```

- 기대대로 나온 것이 하나도 없음. 엉뚱한 데서 유의한 결과가 ... OTL.

유형 비교

```
table(red.black.1501.2[,c(2,25)])
```

```
##        Q6_1
## Color   Male Female
##   Red     18      8
##   Black   18      7
```

```
table(red.black.1501.2[,c(2,26)])
```

```
##        Q6_2
## Color   Glasses None
##   Red        16   10
##   Black      15   10
```

```
table(red.black.1501.2[,c(2,27)])
```

```
##        Q6_3
## Color   Seoul GyungGang Other
##   Red       9        11     6
##   Black    11        10     4
```

χ^2 테스트.

```
chisq.test(table(red.black.1501.2[,c(2,25)]))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(red.black.1501.2[, c(2, 25)])
## X-squared = 0, df = 1, p-value = 1
```

```
chisq.test(table(red.black.1501.2[,c(2,26)]))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(red.black.1501.2[, c(2, 26)])
## X-squared = 0, df = 1, p-value = 1
```

```
chisq.test(table(red.black.1501.2[,c(2,27)]))
```

```
## Warning in chisq.test(table(red.black.1501.2[, c(2, 27)])): Chi-squared
## approximation may be incorrect
```

```
##
##  Pearson's Chi-squared test
##
## data:  table(red.black.1501.2[, c(2, 27)])
## X-squared = 0.628, df = 2, p-value = 0.7304
```

마지막에 경고 메시지가 나온 이유 파악.

```
chisq.test(table(red.black.1501.2[,c(2,27)]))$expected
```

```
## Warning in chisq.test(table(red.black.1501.2[, c(2, 27)])): Chi-squared
## approximation may be incorrect
```

```
##        Q6_3
## Color   Seoul GyungGang Other
##   Red    10.2      10.7   5.1
##   Black   9.8      10.3   4.9
```

p-value 를 bootstrap 방식으로 계산 요구

```
chisq.test(table(red.black.1501.2[,c(2,27)]), simulate.p.value=T)
```

```
##
##  Pearson's Chi-squared test with simulated p-value (based on 2000
##  replicates)
##
## data:  table(red.black.1501.2[, c(2, 27)])
## X-squared = 0.628, df = NA, p-value = 0.7586
```

결석자 분석

학번을 기준으로 출결 구분. logical 변수 임에 유의

```
present<-class.roll.1501$ID %in% red.black.1501.2$ID
mode(present)
```

```
## [1] "logical"
```

출석자 명단

```
class.roll.1501$Name[present]
```

```
##  [1] "정재훈"                 "김수호"
##  [3] "김덕현"                 "최선호"
##  [5] "이필용"                 "김범진"
##  [7] "이성학"                 "이재우"
##  [9] "안경혁"                 "곽태인"
## [11] "강신화"                 "이병호"
## [13] "전준구"                 "박원"
## [15] "이동현"                 "최정우"
## [17] "리우페이란"             "김영주"
## [19] "김정동"                 "김서현"
## [21] "이동하"                 "조광현"
## [23] "남기성"                 "홍재원"
## [25] "김도경"                 "이찬리"
## [27] "장승호"                 "김지연"
## [29] "장은선"                 "김승재"
## [31] "서현숙"                 "이지우"
## [33] "김세한"                 "김서정"
## [35] "정재민"                 "김미정"
## [37] "장하림"                 "진선민"
## [39] "한도언"                 "김지유"
## [41] "임소미"                 "임찬우"
## [43] "임채원"                 "황선우"
## [45] "김연지"                 "오규민"
## [47] "이창범"                 "조익준"
## [49] "진재형"                 "Baljinnyam_Nasanjargal"
```

결석자 학번

```
class.roll.1501$ID[!present]
```

```
## [1] 20092236 20095210 20103227 20111414 20138005 20142911 20144332 20151225
```

출결 여부를 factor로 저장하기 위하여

```
presence<-factor(ifelse(present, "present", "absent"), levels=c("present", "abs
ent"))
```

Cross table 로 랜덤화 효과 확인

```
 table(class.roll.1501$group, presence)
```

```
##        presence
##         present absent
##   red        26      3
##   black      24      5
```