Homework 2

Xinyi Lin

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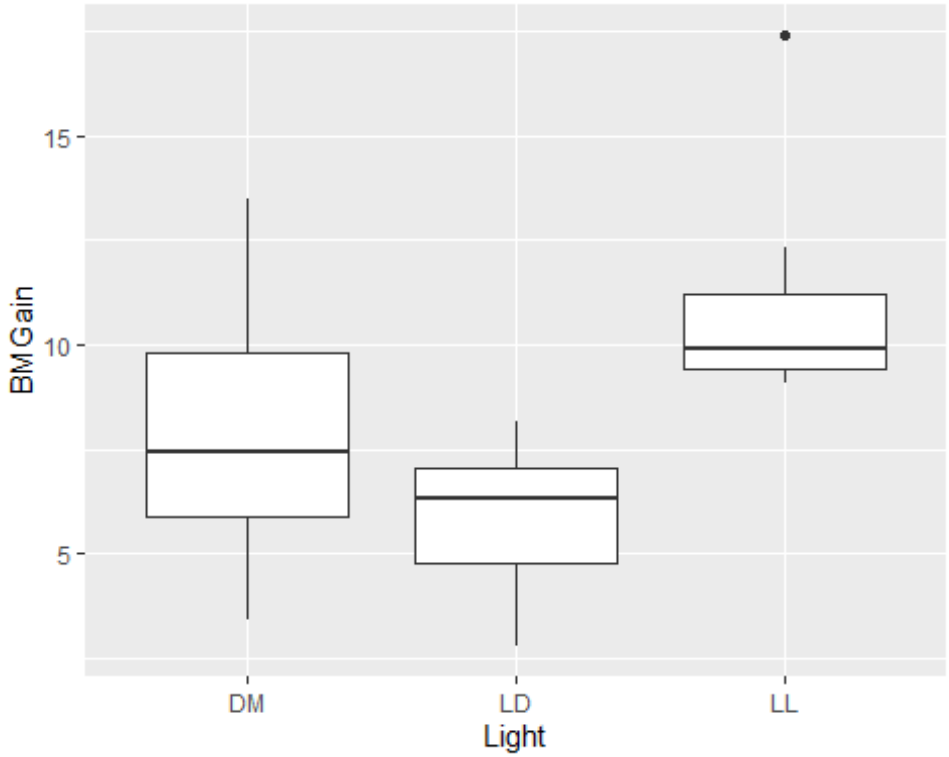
Question 1



According to the plot, we can find that the average of weight gain in bright light group is higher than that in dim light group and the dark light group. The difference of weight gain in dim light group is the highest.

Question 2

Light	BMGain	Corticosterone	DayPct	Consumption	GlucoseInt	GTT15	GTT120	Activity
LD	5.02	87.838	31.063	3.791	No	228.448	134.483	1437
LD	6.67	191.220	41.408	3.923	No	231.183	220.430	2541
LD	8.17	67.700	47.573	4.489	No	226.563	141.406	346
LD	2.79	41.017	34.947	4.161	No	323.077	199.038	5837
LD	8.13	21.817	41.940	4.416	No	500.000	190.361	877
LD	6.34	23.403	40.500	4.890	No	280.000	118.333	1649
LD	6.32	70.470	28.950	4.946	No	299.174	153.719	728
LD	3.97	56.718	21.846	4.004	No	461.250	230.000	6048

Light	BMGain	Corticosterone	DayPct	Consumption	GlucoseInt	GTT15	GTT120	Activity
LL	9.89	42.132	71.552	3.387	Yes	378.704	328.704	5752
LL	9.58	48.238	61.453	3.451	No	379.091	227.273	1256
LL	11.20	92.191	85.978	3.501	Yes	366.129	383.871	244
LL	9.05	51.999	64.827	4.240	No	392.373	250.000	931
LL	12.33	12.252	81.600	3.479	Yes	466.346	470.192	3582
LL	9.39	3.000	87.257	5.940	Yes	259.615	413.462	2657
LL	10.88	132.400	70.441	4.586	No	348.780	126.016	153
LL	9.37	8.615	84.415	4.873	Yes	335.652	286.957	4482
LL	17.40	66.679	81.636	7.177	Yes	435.644	405.941	6702

Records of subset datasets of dark light group and bright light group are shown above. There are 8 records in dark light group data and 9 records in bright light group data.

Question 3

The observed outcomes: $Y_{i,j}$, where i stands for individuals and j stands for treatment.

The treatment assignment vector: A_j, where $j = 0,1$. $j = 0$ stands for being assigned to darkness and $j = 1$ stands for being assigned to bright light.

The covariates: C

Question 4

$$T_{obs} = \frac{\sum_{i=1}^{n} A_i Y_{1i}}{N_1} - \frac{\sum_{i=1}^{n} A_i Y_{0i}}{N_0} = 5.08$$

Question 5

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]    0    0    0    0    0    0    0    0    1     1     1     1     1
## [2,]    0    0    0    0    0    0    0    1    0     1     1     1     1
## [3,]    0    0    0    0    0    0    0    1    1     0     1     1     1
## [4,]    0    0    0    0    0    0    0    1    1     1     0     1     1
## [5,]    0    0    0    0    0    0    0    1    1     1     1     0     1
## [6,]    0    0    0    0    0    0    0    1    1     1     1     1     0
##      [,14] [,15] [,16] [,17]
## [1,]     1     1     1     1
## [2,]     1     1     1     1
## [3,]     1     1     1     1
## [4,]     1     1     1     1
## [5,]     1     1     1     1
## [6,]     1     1     1     1
```

The first 6 possibilities are shown above. There are 24310 different possibilities are there for A.

Question 6

The sharp null hypothesis is there is no treatment effect:

$$H_0: \tau_i = Y_{1i} - Y_{0i} = 0$$

which means the vector of observed outcomes Y does not change with different A_i.

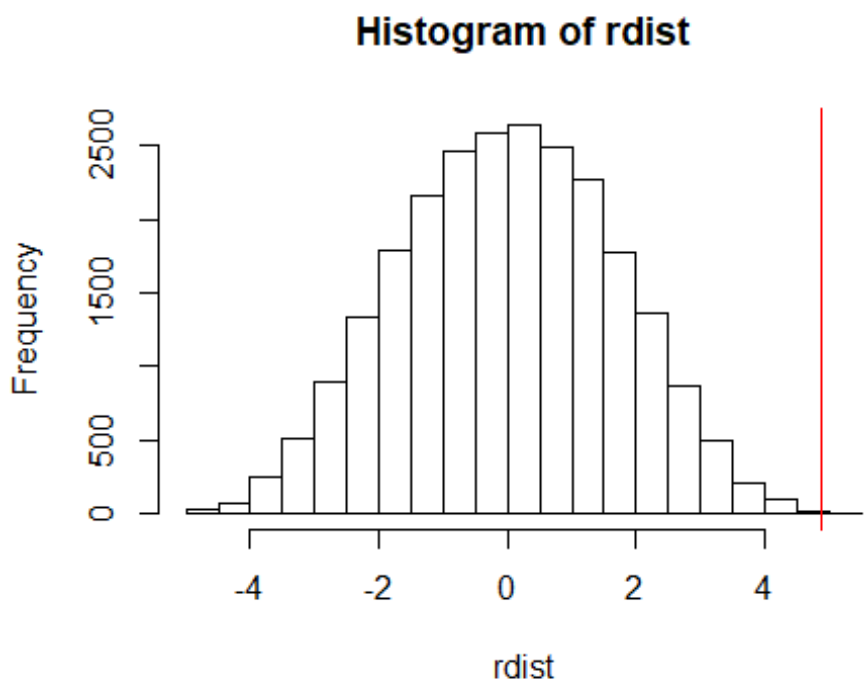
Calculating by R, we can get the test statistic under the first possibilities for A is 1.552.

Quetion 7

```
##  [1]  1.551527778 -0.700972222  0.290694444 -0.006805556 -0.358611111
##  [6]  0.713333333 -0.002083333  0.718055556 -1.898055556  1.272916667
## [11]  0.569305556  1.560972222  1.263472222  0.911666667  1.983611111
## [16]  1.268194444  1.988333333 -0.627777778  2.543194444 -0.691527778
```

The first 20 values of possible T_{null} are shown above.

Question 8



The plot of T's distribution and the observed test statistic are shown above.

Question 9

The exact p-value based on this distribution is 4.113533510^{-5}.

Question 10

According to the plot and caculated p-value, we can find that the p-value is pretty small, which means the sharp null hypothesis needs to be rejected and there is treatment effect on outcomes.

Appendix

```
knitr::opts_chunk$set(echo = FALSE)
library(ggplot2)
library(tidyverse)
library(perm)
library(ri)
light = read.csv("./light.csv")
# Quetion 1
light %>%
  ggplot(aes(x = Light, y = BMGain)) +
  geom_boxplot()
# Question 2
subset_LD = light %>%
  filter(Light == "LD")
subset_LL = light %>%
  filter(Light == "LL")
subset_LD %>% knitr::kable()
subset_LL %>% knitr::kable()
# Question 4
T_obs = mean(subset_LL$BMGain) - mean(subset_LD$BMGain)
# Question 5
Amatrix = chooseMatrix(17, 9)
Amatrix %>%
  head()
# Question 6
subset = light %>%
  filter(Light %in% c("LD", "LL"))
Y = subset$BMGain
A_tilde = Amatrix[1,]
test_sta = round(mean(Y[A_tilde==1]) -  mean(Y[A_tilde==0]), 3)
# Question 7
rdist = rep(NA, times = nrow(Amatrix))
for(i in 1:nrow(Amatrix)){
  A_tilde = Amatrix[i,]
  rdist[i] = mean(Y[A_tilde==1]) -  mean(Y[A_tilde==0])
}
rdist[c(1:20)]
# Question 8
pval = mean(rdist>=T_obs)
quant = quantile(rdist, probs = 1-pval)
hist(rdist)
abline(v = quant, col = "red")
```