

Bios 6301: Assignment 3

Rui Wang

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Due Thursday, 08 October, 1:00 PM

50 points total.

$5^{n=\text{day}}$ points taken off for each day late.

This assignment includes turning in the first two assignments. All three should include knitr files (named `homework1.rmd`, `homework2.rmd`, `homework3.rmd`) along with valid PDF output files. Inside each file, clearly indicate which parts of your responses go with which problems (you may use the original homework document as a template). Add your name as `author` to the file's metadata section. Raw R code/output or word processor files are not acceptable.

Failure to properly name files or include author name may result in 5 points taken off.

Question 1

10 points

1. Use GitHub to turn in the first three homework assignments. Make sure the teacher (couthcommander) and TA (trippcm) are collaborators. (5 points)
2. Commit each assignment individually. This means your repository should have at least three commits. (5 points)

Question 2

15 points

Write a simulation to calculate the power for the following study design. The study has two variables, treatment group and outcome. There are two treatment groups (0, 1) and they should be assigned randomly with equal probability. The outcome should be a random normal variable with a mean of 60 and standard deviation of 20. If a patient is in the treatment group, add 5 to the outcome. 5 is the true treatment effect. Create a linear model for the outcome by the treatment group, and extract the p-value (hint: see assignment1). Test if the p-value is less than or equal to the alpha level, which should be set to 0.05.

Repeat this procedure 1000 times. The power is calculated by finding the percentage of times the p-value is less than or equal to the alpha level. Use the `set.seed` command so that the professor can reproduce your results.

1. Find the power when the sample size is 100 patients. (10 points)

```
set.seed(100)
n <- 100
pvals <- numeric(n)
# iterate 1000 times, saving each p value
for (i in 1:1000) {
  # Bernoulli distribution
  treat <- rbinom(n,1,0.5)
```

```

# add 5 to the outcome if the treat is 1
outcome <- rnorm(n, 60, 20) + treat * 5
x <- data.frame(treat, outcome)
pvals[i] <- t.test(outcome ~ treat, dat = x, var.equal = TRUE)$p.value
}
power_100 <- mean(pvals <= 0.05 )*100
power_100

```

```
## [1] 23.6
```

1. Find the power when the sample size is 1000 patients. (5 points)

```

set.seed(1000)
n <- 1000
pvals <- numeric(n)
# iterate 1000 times, saving each p value
for (i in 1:1000) {
  # Bernoulli distribution
  treat <- rbinom(n,1,0.5)
  # add 5 to the outcome if the treat is 1
  outcome <- rnorm(n, 60, 20) + treat * 5
  x <- data.frame(treat, outcome)
  pvals[i] <- t.test(outcome ~ treat, dat = x, var.equal = TRUE)$p.value
}
power_1000 <- mean(pvals <= 0.05 )*100
power_1000

```

```
## [1] 96.8
```

Question 3

15 points

Obtain a copy of the football-values lecture. Save the 2015/proj_rb15.csv file in your working directory. Read in the data set and remove the first two columns.

1. Show the correlation matrix of this data set. (3 points)

```

setwd("/Users/ruiwang/Dropbox/Biostatistics/6301/homework")
fb <- data.frame(read.csv("proj_rb15.csv"))
# remove the first two columns
fb <- fb[,c(-1,-2)]
# show the correlation matrix of this data set
cor.fb <- cor(fb)
cor.fb

```

```

##           rush_att rush_yds rush_tds  rec_att  rec_yds  rec_tds
## rush_att 1.0000000 0.9975511 0.9723599 0.7694384 0.7402687 0.5969159
## rush_yds 0.9975511 1.0000000 0.9774974 0.7645768 0.7345496 0.6020994

```

```
## rush_tds 0.9723599 0.9774974 1.0000000 0.7263519 0.6984860 0.5908348
## rec_att 0.7694384 0.7645768 0.7263519 1.0000000 0.9944243 0.8384359
## rec_yds 0.7402687 0.7345496 0.6984860 0.9944243 1.0000000 0.8518924
## rec_tds 0.5969159 0.6020994 0.5908348 0.8384359 0.8518924 1.0000000
## fumbles 0.8589364 0.8583243 0.8526904 0.7459076 0.7224865 0.6055598
## fpts 0.9824135 0.9843044 0.9689472 0.8556928 0.8340195 0.7133908
## fumbles fpts
## rush_att 0.8589364 0.9824135
## rush_yds 0.8583243 0.9843044
## rush_tds 0.8526904 0.9689472
## rec_att 0.7459076 0.8556928
## rec_yds 0.7224865 0.8340195
## rec_tds 0.6055598 0.7133908
## fumbles 1.0000000 0.8635550
## fpts 0.8635550 1.0000000
```

```
var.fb<-var(fb)
var.fb
```

```
## rush_att rush_yds rush_tds rec_att rec_yds
## rush_att 6328.46094 27979.7864 192.0590190 905.61735 7114.11126
## rush_yds 27979.78642 124314.0880 855.7254243 3988.44050 31286.96872
## rush_tds 192.05902 855.7254 6.1647756 26.68256 209.50699
## rec_att 905.61735 3988.4405 26.6825607 218.89892 1777.36140
## rec_yds 7114.11126 31286.9687 209.5069913 1777.36140 14593.66553
## rec_tds 30.99774 138.5786 0.9576186 8.09766 67.17920
## fumbles 67.34980 298.2894 2.0867780 10.87760 86.02767
## fpts 4712.19384 20925.1864 145.0569358 763.34248 6074.88603
## rec_tds fumbles fpts
## rush_att 30.9977423 67.3497975 4712.19384
## rush_yds 138.5786082 298.2893881 20925.18645
## rush_tds 0.9576186 2.0867780 145.05694
## rec_att 8.0976598 10.8775990 763.34248
## rec_yds 67.1791959 86.0276733 6074.88603
## rec_tds 0.4261237 0.3896289 28.07858
## fumbles 0.3896289 0.9715215 51.32110
## fpts 28.0785773 51.3211018 3635.46115
```

```
mean.fb<-colMeans(fb)
mean.fb
```

```
## rush_att rush_yds rush_tds rec_att rec_yds rec_tds
## 63.4651282 271.3948718 1.8323077 14.4671795 115.1815385 0.5400000
## fumbles fpts
## 0.7912821 51.2610256
```

1. Generate a data set with 30 rows that has a similar correlation structure. Repeat the procedure 10,000 times and return the mean correlation matrix. (10 points)

```
library(MASS)
loops <- 1e4
keep.1 <- 0
```

```

set.seed(1)
for (i in seq(loops)) {
  fb.sim <- as.data.frame(mvrnorm(n=30, mu = mean.fb, Sigma=var.fb))
  keep.1 <- keep.1 + cor(fb.sim)/loops
}
# a similar correlation
keep.1

```

```

##          rush_att rush_yds rush_tds  rec_att  rec_yds  rec_tds
## rush_att 1.0000000 0.9974500 0.9713472 0.7643291 0.7350341 0.5911347
## rush_yds 0.9974500 1.0000000 0.9767243 0.7593050 0.7291431 0.5962737
## rush_tds 0.9713472 0.9767243 1.0000000 0.7205943 0.6926162 0.5849183
## rec_att  0.7643291 0.7593050 0.7205943 1.0000000 0.9942779 0.8347768
## rec_yds  0.7350341 0.7291431 0.6926162 0.9942779 1.0000000 0.8483749
## rec_tds  0.5911347 0.5962737 0.5849183 0.8347768 0.8483749 1.0000000
## fumbles  0.8545518 0.8538644 0.8478191 0.7410831 0.7175978 0.6001970
## fpts     0.9817474 0.9836956 0.9677966 0.8520135 0.8300580 0.7081649
##          fumbles      fpts
## rush_att 0.8545518 0.9817474
## rush_yds 0.8538644 0.9836956
## rush_tds 0.8478191 0.9677966
## rec_att  0.7410831 0.8520135
## rec_yds  0.7175978 0.8300580
## rec_tds  0.6001970 0.7081649
## fumbles  1.0000000 0.8593798
## fpts     0.8593798 1.0000000

```

```
cor(fb)
```

```

##          rush_att rush_yds rush_tds  rec_att  rec_yds  rec_tds
## rush_att 1.0000000 0.9975511 0.9723599 0.7694384 0.7402687 0.5969159
## rush_yds 0.9975511 1.0000000 0.9774974 0.7645768 0.7345496 0.6020994
## rush_tds 0.9723599 0.9774974 1.0000000 0.7263519 0.6984860 0.5908348
## rec_att  0.7694384 0.7645768 0.7263519 1.0000000 0.9944243 0.8384359
## rec_yds  0.7402687 0.7345496 0.6984860 0.9944243 1.0000000 0.8518924
## rec_tds  0.5969159 0.6020994 0.5908348 0.8384359 0.8518924 1.0000000
## fumbles  0.8589364 0.8583243 0.8526904 0.7459076 0.7224865 0.6055598
## fpts     0.9824135 0.9843044 0.9689472 0.8556928 0.8340195 0.7133908
##          fumbles      fpts
## rush_att 0.8589364 0.9824135
## rush_yds 0.8583243 0.9843044
## rush_tds 0.8526904 0.9689472
## rec_att  0.7459076 0.8556928
## rec_yds  0.7224865 0.8340195
## rec_tds  0.6055598 0.7133908
## fumbles  1.0000000 0.8635550
## fpts     0.8635550 1.0000000

```

1. Generate a data set with 30 rows that has the exact correlation structure as the original data set. (2 points)

```
# set empirical equals TRUE value, we can have the exact correlation structure
fb.sim <- mvrnorm(n=30, mu = mean.fb, Sigma=var.fb, empirical = TRUE)
cor(fb.sim)
```

```
##          rush_att rush_yds rush_tds rec_att rec_yds rec_tds
## rush_att 1.0000000 0.9975511 0.9723599 0.7694384 0.7402687 0.5969159
## rush_yds 0.9975511 1.0000000 0.9774974 0.7645768 0.7345496 0.6020994
## rush_tds 0.9723599 0.9774974 1.0000000 0.7263519 0.6984860 0.5908348
## rec_att  0.7694384 0.7645768 0.7263519 1.0000000 0.9944243 0.8384359
## rec_yds  0.7402687 0.7345496 0.6984860 0.9944243 1.0000000 0.8518924
## rec_tds  0.5969159 0.6020994 0.5908348 0.8384359 0.8518924 1.0000000
## fumbles  0.8589364 0.8583243 0.8526904 0.7459076 0.7224865 0.6055598
## fpts     0.9824135 0.9843044 0.9689472 0.8556928 0.8340195 0.7133908
##          fumbles      fpts
## rush_att 0.8589364 0.9824135
## rush_yds 0.8583243 0.9843044
## rush_tds 0.8526904 0.9689472
## rec_att  0.7459076 0.8556928
## rec_yds  0.7224865 0.8340195
## rec_tds  0.6055598 0.7133908
## fumbles  1.0000000 0.8635550
## fpts     0.8635550 1.0000000
```

```
cor.fb
```

```
##          rush_att rush_yds rush_tds rec_att rec_yds rec_tds
## rush_att 1.0000000 0.9975511 0.9723599 0.7694384 0.7402687 0.5969159
## rush_yds 0.9975511 1.0000000 0.9774974 0.7645768 0.7345496 0.6020994
## rush_tds 0.9723599 0.9774974 1.0000000 0.7263519 0.6984860 0.5908348
## rec_att  0.7694384 0.7645768 0.7263519 1.0000000 0.9944243 0.8384359
## rec_yds  0.7402687 0.7345496 0.6984860 0.9944243 1.0000000 0.8518924
## rec_tds  0.5969159 0.6020994 0.5908348 0.8384359 0.8518924 1.0000000
## fumbles  0.8589364 0.8583243 0.8526904 0.7459076 0.7224865 0.6055598
## fpts     0.9824135 0.9843044 0.9689472 0.8556928 0.8340195 0.7133908
##          fumbles      fpts
## rush_att 0.8589364 0.9824135
## rush_yds 0.8583243 0.9843044
## rush_tds 0.8526904 0.9689472
## rec_att  0.7459076 0.8556928
## rec_yds  0.7224865 0.8340195
## rec_tds  0.6055598 0.7133908
## fumbles  1.0000000 0.8635550
## fpts     0.8635550 1.0000000
```

Question 4

10 points

Use \LaTeX to create the following expressions.

1. Hint: `\Rightarrow` (4 points)

$$P(B) = \sum_j P(B|A_j)P(A_j),$$

$$\Rightarrow P(A_i|B) = \frac{P(B|A_i)P(A_i)}{\sum_j P(B|A_j)P(A_j)}$$

$$P(B) = \sum_j P(B|A_j)P(A_j),$$

$$\Rightarrow P(A_i|B) = \frac{P(B|A_i)P(A_i)}{\sum_j P(B|A_j)P(A_j)}$$

2. Hint: \zetaeta (3 points)

$$\hat{f}(\zeta) = \int_{-\infty}^{\infty} f(x) e^{-2\pi i x \zeta} dx$$

$$\hat{f}(\zeta) = \int_{-\infty}^{\infty} f(x) e^{-2\pi i x \zeta} dx$$

3. Hint: \partialpartial (3 points)

$$\mathbf{J} = \frac{d\mathbf{f}}{d\mathbf{x}} = \left[\frac{\partial \mathbf{f}}{\partial x_1} \cdots \frac{\partial \mathbf{f}}{\partial x_n} \right] = \begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \cdots & \frac{\partial f_1}{\partial x_n} \\ \vdots & \ddots & \vdots \\ \frac{\partial f_m}{\partial x_1} & \cdots & \frac{\partial f_m}{\partial x_n} \end{bmatrix}$$

$$J = \frac{df}{dx} = \left[\frac{\partial f}{\partial x_1} \cdots \frac{\partial f}{\partial x_n} \right] = \begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \cdots & \frac{\partial f_1}{\partial x_n} \\ \vdots & \ddots & \vdots \\ \frac{\partial f_m}{\partial x_1} & \cdots & \frac{\partial f_m}{\partial x_n} \end{bmatrix}$$