بسم الله الرحمن الرحیم

تمرینات سری اول درس تحلیل و طراحی آماری فرایندها

دستورالعمل: تمامی کدها در فایل با پسوند آر بارگذاری شود و توضیح مربوط به هر تمرین میتواند به صورت کامنت در فایل آر و یا در پی دی اف جداگانه تحویل داده شود.

تنها در سوالاتی که هر دو فرض نرمالیتی و همگنی واریانس برقرار نیست از آزمون پارامتری استفاده نکنید و اگر یکی هم برقرار بود، (تنها برای این سری تمرینات)، آزمون مناسب انجام شود.

سوال ۱ .پژوهشگران BMI بیماران دیابتی را قبل و بعد از چند هفته رژیم ثبت کردند .آیا رژیم باعث کاهش معنی دار BMIشده است؟

```
before <- c(30.1,32.0,29.5,33.1,31.8,29.9,34.2,30.6,31.2,33.5,
32.1,29.7,30.9,31.5,33.0,30.3,31.9,32.5,29.8,34.0)
after <- c(28.4,30.2,28.0,30.9,30.1,28.8,31.5,29.6,29.9,31.8,
30.5,28.9,29.7,30.6,31.0,29.5,30.7,31.2,28.6,32.1)
```

2. 60 patients on a new anemia regimen. Test whether mean hemoglobin differs from population μ = 13.5 g/dL.

```
hb <- c(14.83, 12.98, 13.23, 13.44, 13.29, 11.60, 12.99, 12.77, 12.27, 12.95,
13.42, 11.86, 13.01, 11.64, 12.39, 12.95, 13.85, 13.30, 12.18, 13.31,
12.53, 12.12, 12.96, 12.77, 12.32, 11.56, 12.14, 13.56, 13.27, 13.06,
12.30, 12.58, 12.63, 12.12, 12.22, 12.88, 12.13, 12.73, 12.86, 13.40,
13.69, 11.77, 12.44, 13.67, 12.11, 13.89, 12.02, 13.24, 13.98, 14.11,
14.22, 11.78, 12.39, 12.82, 13.64, 13.74, 12.87, 12.64, 11.58, 12.47)
```

3. Compare BRCA1 expression between breast cancer patients and healthy controls. Which is . .greater?

```
cancer <- c(8.61, 5.24, 6.45, 7.22, 6.60, 8.36, 6.07, 8.12, 6.92, 7.33,
```

5.45, 6.77, 7.24, 5.18, 6.69, 7.19, 6.94, 6.59, 7.21, 7.33,
8.85, 7.08, 4.98, 7.36, 6.60, 8.88, 6.05, 7.99, 7.35, 6.67,
6.45, 8.16, 7.59, 7.16, 8.42, 8.88, 6.27, 7.12, 6.18, 8.27,
7.42, 8.39, 8.58, 6.49, 7.21, 8.07, 6.61, 6.60, 6.27, 7.85,
7.95, 7.06, 5.32, 6.55, 6.29, 7.46, 6.77, 6.14, 7.18, 7.04,
6.80, 8.09, 6.23, 6.94, 6.58, 6.66, 6.37, 6.95, 7.13, 6.52)
control <- c(4.72, 5.35, 5.88, 6.08, 4.96, 4.05, 5.01, 4.98, 4.57, 4.88,
5.46, 5.07, 4.68, 4.86, 5.17, 4.56, 4.71, 5.95, 5.18, 4.85,
4.92, 4.96, 5.22, 4.42, 4.99, 5.58, 5.35, 4.90, 5.55, 6.88,
4.93, 4.77, 5.05, 5.09, 5.81, 4.97, 5.18, 4.95, 4.52, 6.05,
5.51, 4.41, 5.29, 5.69, 5.07, 4.62, 5.01, 5.86, 5.46, 5.56,
4.86, 5.18, 5.39, 4.90, 5.22, 5.14, 4.99, 5.63, 5.11, 5.28, 5.71, 5.31, 5.18, 5.02, 4.88)

4. Compare Genotype (AA vs AG) × Treatment (Drug vs Placebo) by simulation by yourself with the rnorm based on this instruction. (Use set.seed(1)).
n_per_cell <- 40
genotype <- rep(c("AA","AG"), each = 2 * n_per_cell) # will repeat correctly with treatment below
treatment <- rep(rep(c("Drug","Placebo"), each = n_per_cell), 2)
# generate means per cell: (sd for all of them is 5)
# AA + Placebo: mu = 50
# AA + Drug : mu = 60
# AG + Placebo: mu = 55
# AG + Drug : mu = 65

5. Simulate paired data for n = 60 patients, baseline mean enzyme activity = 40 (SD = 5), expected INCREASE after therapy = +8 (SD of change =4). Test whether therapy increases enzyme activity or not. (Use set.seed(1))

6. 60 patients; measure total cholesterol (mg/dL) pre-op and 3 months post-op. Test whether surgery reduces cholesterol.
before <- c(228.45, 198.45, 225.01, 220.55, 209.81, 205.05, 243.45, 206.53,
199.84, 214.14, 235.10, 252.23, 201.69, 240.97, 231.13, 216.03,
210.72, 217.27, 236.58, 227.21, 211.36, 231.26, 223.95, 222.57,
214.61, 203.97, 210.77, 234.46, 201.64, 239.79, 219.06, 219.72,

236.22, 228.69, 200.61, 199.18, 210.06, 208.68, 219.09, 220.21,
241.95, 223.35, 223.19, 214.93, 219.83, 196.72, 240.66, 228.11,
227.09, 195.51, 223.66, 236.95, 239.24, 216.38, 200.95, 217.70,
216.14, 242.08, 232.43, 234.90)
after <- c(210.70, 188.20, 210.65, 203.17, 196.46, 183.95, 220.60, 189.23,
184.39, 201.69, 217.71, 235.09, 199.22, 230.29, 210.45, 201.45,
199.75, 201.13, 211.78, 205.38, 196.06, 206.90, 201.11, 199.04,
190.94, 193.62, 194.40, 213.12, 193.31, 221.94, 198.40, 203.43,
206.28, 211.46, 190.43, 196.91, 192.04, 193.30, 199.09, 202.21,
228.84, 205.45, 207.07, 201.36, 202.85, 186.70, 215.75, 206.11,
211.77, 190.68, 206.76, 228.60, 207.30, 201.05, 189.57, 203.86,
205.16, 217.96, 211.42, 206.49)

7. Using a recent NHANES cycle (e.g., 2015–2016), test whether BMI differs by smoking status (Never / Former / Current) and gender.
Hint: all of the parts of code are here and just recognise which type of test must be done and do it.

```
install.packages("NHANES")
library(NHANES)
data("NHANES") # large combined example from the package (not full CDC release)
# Inspect variables
str(NHANES)
# We'll use BMI, SmokingStatus (e.g., SmokesNow), Gender
df <- NHANES[, c("Gender","BMI","Smokes") ] #### column names depend on package version
# Rename / factor
df <- na.omit(df)
df$Smoking <- factor(df$Smokes, levels=unique(df$Smokes))
df$Gender <- factor(df$Gender)
```

8. 3 groups: Low-fat (n=60), Keto (n=60), Mediterranean (n=60). Test whether mean cholesterol differs across diets. If yes, which ones?

chol_LowFat <- c(195.97, 186.86, 189.03, 189.03, 190.19, 203.14, 198.72,

185.93, 192.99, 193.13, 186.98, 183.74, 199.24, 200.01,

181.74, 183.36, 196.08, 186.27, 184.49, 191.12, 195.17,

189.68, 188.91, 185.33, 199.64, 196.93, 193.29, 198.34,

182.27, 187.30, 183.60, 193.66, 198.45, 194.25, 189.93,

197.37, 199.21, 201.72, 196.69, 190.36, 186.18, 196.35,

185.68, 191.05, 189.93, 201.98, 196.13,

192.42, 201.34, 186.29, 204.12, 190.66, 196.55, 197.50,

196.07, 188.90, 191.83, 201.10, 195.04, 185.74)

chol_Keto <- c(205.30, 211.92, 202.25, 216.14, 211.79, 208.92, 200.17,

198.94, 206.09, 205.63, 233.53, 206.89, 208.25, 193.62,

210.22, 218.27, 206.82, 217.37, 209.53, 219.79, 219.08,

206.31, 213.81, 195.64, 208.90, 206.06, 226.72, 210.27,

200.29, 215.18, 213.84, 200.99, 210.90, 223.87, 198.52,

198.43, 227.07, 217.36, 209.20, 204.24,

217.06, 220.65, 205.54, 213.00, 226.76, 217.85, 204.19,

206.54, 201.46, 208.70, 216.05, 203.96, 206.56, 216.00,

214.28, 206.53, 216.20, 208.10, 210.72, 214.56)

chol_Med <- c(197.47, 199.80, 198.03, 201.03, 199.51, 194.02, 196.27,

191.41, 183.95, 203.61, 201.29, 198.35, 196.57, 193.36,

207.24, 199.31, 204.96, 199.23, 191.87, 200.03, 193.05,

200.66, 209.10, 183.80, 200.99, 195.73, 190.65, 201.06,

197.32, 195.81, 184.08, 206.13, 206.15, 200.11, 193.90,

190.49, 195.11, 196.68, 192.51, 203.76, 204.05, 193.84,

193.82, 193.01, 196.66, 197.12, 196.64, 190.78, 196.73,

200.28, 204.56, 204.07, 200.03, 187.63, 196.52, 201.90,

192.19, 195.22, 200.07, 201.79)

۹. در یک مطالعهٔ بیان ژنی، سطح بیان ژن GENE-X در ۴ نوع سلول شامل:
Cardiac, Adipose, Neuronal, Fibroblast
اندازه‌گیری شده است. از هر نوع سلول۲۵ نمونه وجود دارد.

آیا میانگین بیان ژن بین انواع سلول‌ها تفاوت دارد؟
درصورت معنی‌دار بودن، کدام گروه‌ها با هم متفاوت‌اند؟

```
Set.seed(1)
expr <- c(
  rnorm(25, mean = 10.5, sd = 0.6),
  rnorm(25, mean = 9.8, sd = 0.6),
  rnorm(25, mean = 11.2, sd = 0.7),
  rnorm(25, mean = 10.0, sd = 0.5)
)

cell_type <- factor(rep(c("Cardiac","Adipose","Neuronal","Fibroblast"), each = 25))
df1 <- data.frame(expr, cell_type)
```

۱۰. در یک مطالعهٔ کنترل درد بعد از جراحی، شدت درد (VAS score) در سه گروه درمانی بررسی شد

مورفین

کتورولاک

دارونما

.از هر گروه ۳۰ بیمار بررسی شده‌اند
آیا میانگین شدت درد در سه گروه تفاوت دارد؟
در صورت وجود اختلاف، کدام درمان مؤثرتر است؟

```
set.seed(1)

pain_morphine <- rnorm(30, mean = 3.2, sd = 1.0)
```

```
pain_ketorolac <- rnorm(30, mean = 4.0, sd = 1.1)
pain_placebo <- rnorm(30, mean = 6.2, sd = 1.3)
```

۱۱. تاثیر دارو و جنسیت افراد بر گلوکز خون بر این اساس در نظر گرفته شود که دو داروی a و b هر کدام بر نصف جمعیت زن و نصف جمعیت مرد در نظر گرفته شود .اثر این دو عامل و اثر متقابل آنها بر قند خون را در نظر بگیرید و تفسیر کنید.(راهنمایی :۱۰۰ داده اول دارو a و ۱۰۰ داده بعدی داروی b ، و در مورد جنسیت، ۵۰ داده اول و ۵۰ داده سوم مرد و بقیه داده ها زن هستند).

```
glucose <- c(
  99.97, 93.62, 101.48, 110.23, 92.66, 99.01, 81.46, 97.62, 82.35, 92.34,
  122.21, 98.85, 88.40, 81.30, 103.38, 96.46, 84.51, 105.30, 84.30, 93.79,
  103.14, 84.37, 94.85, 99.30, 114.23, 93.67, 94.79, 109.30, 104.32, 101.45,
  96.84, 87.35, 84.76, 97.84, 92.22, 95.75, 95.56, 107.34, 96.87, 94.11,
  92.39, 95.85, 92.27, 86.54, 86.24, 102.99, 97.60, 97.30, 83.56, 97.16,
  85.45, 94.32, 88.66, 79.86, 95.80, 107.96, 89.59, 100.34, 89.25, 95.36,
  91.25, 98.66, 89.93, 102.46, 82.46, 105.13, 94.85, 87.08, 90.63, 95.66,
  96.48, 94.42, 95.03, 95.67, 99.58, 84.11, 103.62, 102.78, 86.08, 99.06,
  92.07, 95.80, 86.62, 90.86, 86.98, 96.07, 101.11, 106.44, 102.15, 88.45,
  96.79, 90.41, 97.64, 97.53, 96.92, 106.93, 96.59, 88.83, 101.73, 85.22,
  109.56, 95.94, 106.67, 100.97, 107.92, 110.29, 112.92, 95.28, 88.00, 108.21,
  96.85, 90.30, 106.06, 103.20, 109.65, 94.36, 92.77, 102.51, 95.92, 108.50,
  112.95, 108.76, 110.45, 108.34, 110.80, 98.64, 108.61, 109.92, 98.64, 95.05,
  116.15, 105.94, 96.94, 108.93, 100.20, 116.48, 97.06, 111.59, 125.11, 99.67,
  106.22, 100.59, 103.78, 100.48, 100.11, 117.46, 104.66, 115.58, 101.33, 107.29,
  99.43, 106.07, 104.50, 101.37, 112.38, 107.66, 103.62, 103.18, 111.85, 96.46,
  102.16, 94.67, 102.65, 117.17, 104.61, 97.88, 106.51, 106.86, 114.62, 95.32,
  111.03, 100.27, 103.74, 94.70, 106.59, 111.12, 103.27, 95.48, 100.20, 111.09,
  101.00, 87.30, 120.05, 103.86, 97.40, 101.61, 96.83, 119.66, 97.66, 103.88,
  93.12, 119.26, 91.30, 107.20, 105.98, 107.02, 117.05, 117.49, 100.22, 115.11
)
```