Assignment 4

Student Name : 정석규

Student ID : 201724570

Q1.

1) Source code :

```
# Question1 - (a)
a = 0; b = 1

x <- runif(10000, a, b)
f <- function(x) x*(1-x^(2/3))^2
integral1 <- (b - a)*mean(f(x))

# Question1 - (b)
a = -2; b = 2

x <- runif(10000, a, b)
f <- function(x) x*exp(x/2)
integral2 <- (b - a)*mean(f(x))

# Question1 - (c)
a = 1; b = 5

x <- runif(10000, a, b)
f <- function(x) (exp(2*x)-2*exp(x))/(sqrt(3*exp(2*x)-6*exp(x)-1))
integral3 <- (b - a)*mean(f(x))

# Answer
c(integral1, integral2, integral3)
```

2) **R screenshot :**

```
> # Question1 - (a)
> a = 0; b = 1
>
> x <- runif(10000, a, b)
> f <- function(x) x*(1-x^(2/3))^2
> integral1 <- (b - a)*mean(f(x))
>
> # Question1 - (b)
> a = -2; b = 2
>
> x <- runif(10000, a, b)
> f <- function(x) x*exp(x/2)
> integral2 <- (b - a)*mean(f(x))
>
> # Question1 - (c)
> a = 1; b = 5
>
> x <- runif(10000, a, b)
> f <- function(x) (exp(2*x)-2*exp(x))/(sqrt(3*exp(2*x)-6*exp(x)-1))
> integral3 <- (b - a)*mean(f(x))
>
> # Answer
> c(integral1, integral2, integral3)
[1]  0.04981705  2.96657091 81.97758607
```

3) **Answer :** `[1]  0.04981705  2.96657091 81.97758607`

Q2.

1) **Source code :**

```
# Question2

X <- runif(10000, -1, 1); Y <- runif(10000, -1, 1)

Z <- as.numeric((X^2 + Y^2) <= 1)

c(pi/4, (pi/4)*(1-pi/4), mean(Z), var(Z))
```

2) **R screenshot :**

```
> # Question2
> X <- runif(10000, -1, 1); Y <- runif(10000, -1, 1)
> Z <- as.numeric((X^2 + Y^2) <= 1)
> c(pi/4, (pi/4)*(1-pi/4), mean(Z), var(Z))
[1] 0.7853982 0.1685479 0.7852000 0.1686778
```

3) **Answer :** `0.7853982 0.1685479 0.7852000 0.1686778`

Q3.

1) Source code :

```
# Question3
set.seed(12345)
nsamp <- 100; nrep <- 10000
mu <- 0; Sd <- c(1.0, 2.0, 3.0)
res <- matrix(0, length(Sd), 2)

for (k in 1:length(Sd)) {
  sd <- Sd[k]
  D <- rnorm(nsamp*nrep, mu, sd)
  X <- matrix(D, nrep, nsamp)
  Xbar <- apply(X, 1, sd)

  samp_med <- apply(X, 1, median)
  MX <- abs(X-samp_med)
  MAD <- apply(MX, 1, median)
  res[k, ] <- c(mean(Xbar), mean(1.4826*MAD))
}
colnames(res) <- c("sd", "MAD")
rownames(res) <- Sd
res
```

2) **R screenshot :**

```
> # Question3
> set.seed(12345)
> nsamp <- 100; nrep <- 10000
> mu <- 0; Sd <- c(1.0, 2.0, 3.0)
> res <- matrix(0, length(Sd), 2)
>
> for (k in 1:length(Sd)) {
+   sd <- Sd[k]
+   D <- rnorm(nsamp*nrep, mu, sd)
+   X <- matrix(D, nrep, nsamp)
+   Xbar <- apply(X, 1, sd)
+
+   samp_med <- apply(X, 1, median)
+   MX <- abs(X-samp_med)
+   MAD <- apply(MX, 1, median)
+   res[k, ] <- c(mean(Xbar), mean(1.4826*MAD))
+ }
> colnames(res) <- c("sd", "MAD")
> rownames(res) <- Sd
> res
         sd       MAD
1 0.9987222 0.9937832
2 1.9943034 1.9828289
3 2.9910507 2.9736209
```

3) **Answer :**

```
         sd       MAD
1 0.9987222 0.9937832
2 1.9943034 1.9828289
3 2.9910507 2.9736209
```

Q4.

1) Source code :

```
# Question4
set.seed(12345)
nsamp <- 100; nrep <- 10000
Alpha <- Beta <- c(0.1, 0.5, 1.0, 2.0)
res <- array(0, c(4,4,2), dimnames = list(Beta, Alpha, c("mean", "var")))
theory <- array(0, c(4,4,2), dimnames = list(Beta, Alpha, c("mean", "var")))


for (i in 1:length(Alpha)) {
   for (j in 1:length(Beta)) {
      alpha <- Alpha[i]; beta <- Beta[j]
      D <- rbeta(nsamp*nrep, alpha, beta)
      X <- matrix(D, nrep, nsamp)
      Xbar <- apply(X, 1, mean)
      varhat <- apply(X, 1, var)


      res[i, j, 1] <- mean(Xbar); res[i, j, 2] <- mean(varhat)
      theory[i, j, 1] <- alpha/(alpha+beta); theory[i, j, 2] <- (alpha*beta)/((alpha+beta)^2*(alpha+beta+1))
   }
}
res
theory
```

2) R screenshot :

```
> # Question4
> set.seed(12345)
> nsamp <- 100; nrep <- 10000
> Alpha <- Beta <- c(0.1, 0.5, 1.0, 2.0)
> res <- array(0, c(4,4,2), dimnames = list(Beta, Alpha, c("mean",
 "var")))
> theory <- array(0, c(4,4,2), dimnames = list(Beta, Alpha, c("mea
n", "var")))
>
> for (i in 1:length(Alpha)) {
+   for (j in 1:length(Beta)) {
+     alpha <- Alpha[i]; beta <- Beta[j]
+     D <- rbeta(nsamp*nrep, alpha, beta)
+     X <- matrix(D, nrep, nsamp)
+     Xbar <- apply(X, 1, mean)
+     varhat <- apply(X, 1, var)
+
+     res[i, j, 1] <- mean(Xbar); res[i, j, 2] <- mean(varhat)
+     theory[i, j, 1] <- alpha/(alpha+beta); theory[i, j, 2] <- (al
pha*beta)/((alpha+beta)^2*(alpha+beta+1))
+   }
+ }
> res
```

3) Answer :

```
> res
, , mean

          0.1       0.5         1         2
0.1 0.5000868 0.1659922 0.09084334 0.04757811
0.5 0.8330177 0.4997937 0.33371380 0.19984603
1   0.9090619 0.6667901 0.50012803 0.33329874
2   0.9525933 0.8001215 0.66687207 0.50018512

, , var

           0.1        0.5         1          2
0.1 0.20828731 0.08636510 0.03933638 0.01463007
0.5 0.08688412 0.12494730 0.08914603 0.04570713
1   0.03941975 0.08892550 0.08323933 0.05552802
2   0.01454444 0.04567589 0.05558954 0.05000196

> theory
, , mean

          0.1       0.5         1         2
0.1 0.5000000 0.1666667 0.09090909 0.04761905
0.5 0.8333333 0.5000000 0.33333333 0.20000000
1   0.9090909 0.6666667 0.50000000 0.33333333
2   0.9523810 0.8000000 0.66666667 0.50000000

, , var

           0.1        0.5         1          2
0.1 0.20833333 0.08680556 0.03935458 0.01462951
0.5 0.08680556 0.12500000 0.08888889 0.04571429
1   0.03935458 0.08888889 0.08333333 0.05555556
2   0.01462951 0.04571429 0.05555556 0.05000000
```