```
simul.norm <- function(alpha=0.05, mu0=100,n=100,B=100000) {
   set.seed(1)
   output <- NULL
   for(i in 1:B) {
     echan <- rnorm(n,mean=1, sd=1 )
     xbar <- mean(echan)
     s <- sqrt(var(echan))
     testt <- sqrt(n)*(xbar - mu0)/s
     output[i] <- (testt > qt(1-alpha, n-1))
   }
   output
}

simul.unif <- function(alpha=0.05, mu0=100,n=100,B=100000) {
   set.seed(1)
   output <- NULL
   for(i in 1:B) {
     echan <- runif(n,min = 1-sqrt(3), max = 1+sqrt(3))
     xbar <- mean(echan)
     s <- sqrt(var(echan))
     testt <- sqrt(n)*(xbar - mu0)/s
     output[i] <- (testt > qt(1-alpha, n-1))
   }
   output
}

simul.gamma <- function(alpha=0.05, mu0=100,n=100,B=100000) {
   set.seed(1)
   output <- NULL
   for(i in 1:B) {
     echan <- rgamma(n,shape = 1, rate = 1)
     xbar <- mean(echan)
     s <- sqrt(var(echan))
     testt <- sqrt(n)*(xbar - mu0)/s
     output[i] <- (testt > qt(1-alpha, n-1))
   }
   output
}

B <- 10000
mu0 <- 1
# ---- illustration, n = 10 ----
n <- 10
simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))

simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))

simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))
```

```
# ---- illustration, n = 30 ----
n <- 30
simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))

simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))

simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))


# ---- illustration, n = 100 ----
n <- 100
simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
simul.norm.out5 <- simul.norm(0.05, mu0, n, B)

simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))

simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))

simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))


# ---- illustration, n = 1000 ----
n <- 1000
simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))

simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))

simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))
```

Simulations de Monte-Carlo

Code S-PLUS ou R

```
# === Comparaison de l'estimateur uuel Horvitz-Thompson ===
# ======= et l'estimateur par la regression ================


# ---- lecture de la population ----
mu284 <- read.table("mu284.txt")
yU <- mu284[,2]  # variable P85
xU <- mu284[,3]  # variable P75
N <- length(yU)



# ---- Quelques statistiques descriptives de population ----
tyU <- sum(yU)
txU <- sum(xU)
ybarU <- mean(yU)
xbarU <- mean(xU)
S2yU <- var(yU)
S2xU <- var(xU)


# ---- Taille de l'echantillon ----
n <- 100


# ---- Variances theoriques des estimateurs ----
# --- HT pour la moyenne ---
varHT <- (1/n - 1/N)* S2yU


# --- REG pour la moyenne ---
lm.out <- lm(yU ~ xU)
BU <- coef(lm.out)[2]
EU <- (yU - ybarU) - BU*(xU - xbarU)
S2EU <- var(EU)
varREG <- (1/n - 1/N)* S2EU


# --- Simulation ---
Nsim <- 1000
simul.HTvsREG <- function(n,yU,xU,Nsim=1000) {
  ybarU <- mean(yU)
  xbarU <- mean(xU)
  N <- length(yU)
  output.est.moy <- matrix(0, nrow = Nsim, ncol=2)
  output.est.var <- matrix(0, nrow = Nsim, ncol=2)
  output.ic <- matrix(0, nrow = Nsim, ncol=2)
  for(i in 1:Nsim) {
    echan <- sample(N,n)
    ys <- yU[echan]
    xs <- xU[echan]
    ybars <- mean(ys)
    xbars <- mean(xs)
    lm.out <- lm(ys ~ xs)
    Bs <- coef(lm.out)[2]
    yreg <- ybars + Bs*(xbarU - xbars)
    es <- (ys - ybars) - Bs*(xs - xbars)
    vhat.ybars <- (1/n-1/N)*var(ys)
    vhat.yreg <- (1/n-1/N)*var(es)
    ic.ybars <- ((ybarU > ybars - 1.96*sqrt(vhat.ybars)) & (ybarU < ybars +
1.96*sqrt(vhat.ybars)))
    ic.yreg <- ((ybarU > yreg - 1.96*sqrt(vhat.yreg)) & (ybarU < yreg +
1.96*sqrt(vhat.yreg)))
    output.est.moy[i,] <- c(ybars, yreg)
    output.est.var[i,] <- c(vhat.ybars, vhat.yreg)
    output.ic[i,] <- c(ic.ybars, ic.yreg)
  }
  list(est.moy = apply(output.est.moy,2,mean),
       est.biais = apply(output.est.moy,2,mean) - ybarU,
       est.var = apply(output.est.var,2,mean),
       est.ic = apply(output.ic,2,mean))
}


# --- Execution ---
ybarU
c(varHT,varREG)
set.seed(1)
simul.HTvsREG.out <- simul.HTvsREG(n,yU,xU,Nsim)
simul.HTvsREG.out

# ========= OUTPUT ========
> # --- Execution ---
> ybarU
[1] 29.36268
> c(varHT,varREG)
[1] 17.22147795  0.05517629
> set.seed(1)
> simul.HTvsREG.out <- simul.HTvsREG(n,yU,xU,Nsim)
> simul.HTvsREG.out
$est.moy:
[1] 29.31209 29.44182

$est.biais:
[1] -0.05058606  0.07914039

$est.var:
[1] 17.21342437  0.05033493

$est.ic:
[1] 0.814 0.826

>
```

```
# ========================= OUTPUT ======================
> # ---- illustration, n = 10 ----
> n <- 10
> simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
> simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
> simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
> c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))
[1] 0.0100 0.0478 0.1002
>
> simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
> simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
> simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
> c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))
[1] 0.0124 0.0549 0.1035
>
> simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
> simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
> simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
> c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))
[1] 0.0004 0.0143 0.0451


> # ---- illustration, n = 30 ----
> n <- 30
> simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
> simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
> simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
> c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))
[1] 0.0103 0.0484 0.0982
>
> simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
> simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
> simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
> c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))
[1] 0.0118 0.0521 0.0995
>
> simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
> simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
> simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
> c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))
[1] 0.0017 0.0225 0.0638


> # ---- illustration, n = 100 ----
> n <- 100
> simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
> simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
> simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
> c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))
[1] 0.0099 0.0488 0.0953
>
> simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
> simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
> simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
> c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))
[1] 0.0101 0.0530 0.1059
>
> simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
> simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
> simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
> c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))
[1] 0.0028 0.0306 0.0779


> # ---- illustration, n = 1000 ----
> n <- 1000
> simul.norm.out1 <- simul.norm(0.01, mu0, n, B)
> simul.norm.out5 <- simul.norm(0.05, mu0, n, B)
> simul.norm.out10 <- simul.norm(0.10, mu0, n, B)
> c(mean(simul.norm.out1),mean(simul.norm.out5),mean(simul.norm.out10))
[1] 0.0094 0.0469 0.0933
>
> simul.unif.out1 <- simul.unif(0.01, mu0, n, B)
> simul.unif.out5 <- simul.unif(0.05, mu0, n, B)
> simul.unif.out10 <- simul.unif(0.10, mu0, n, B)
> c(mean(simul.unif.out1),mean(simul.unif.out5),mean(simul.unif.out10))
[1] 0.0104 0.0511 0.0996
>
> simul.gamma.out1 <- simul.gamma(0.01, mu0, n, B)
> simul.gamma.out5 <- simul.gamma(0.05, mu0, n, B)
> simul.gamma.out10 <- simul.gamma(0.10, mu0, n, B)
> c(mean(simul.gamma.out1),mean(simul.gamma.out5),mean(simul.gamma.out10))
[1] 0.0074 0.0484 0.0968
```