

ภาคผนวก

ภาคผนวก ก

คำสั่งโปรแกรม R ที่ใช้ในงานวิจัย

 ความน่าจะเป็นของความผิดพลาดแบบที่ 1

การแจกแจงปรกติ (0,16) กรณี 3 ประชากร

library(lawstat)

M=5000

N=3

O=10

alpha=c(0.01,0.05,0.1)

n1=c(10,30,50,70,100,5,25,45,65,95)

n2=c(10,30,50,70,100,10,30,50,70,100)

n3=c(10,30,50,70,100,15,35,55,75,105)

COUNT <- array(rep(0, 3*6*10), dim=c(3,6,10))

for(j in 1:N)

{

for(k in 1:O)

{

for(l in 1:M)

{

x1=rnorm(n1[k],0,sqrt(16))

x2=rnorm(n2[k],0,sqrt(16))

x3=rnorm(n3[k],0,sqrt(16))

x=c(x1,x2,x3)

g1=rep(1,n1[k])

g2=rep(2,n2[k])

g3=rep(3,n3[k])

g=c(g1,g2,g3)

df = data.frame(x,g)

bart = bartlett.test(df\$x,df\$g)

if(bart\$p.value<=alpha[j]) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[k]-1)*log(var(x1),exp(1)))+((n2[k]-1)*log(var(x2),exp(1)))+((n3[k]-1)*log(var(x3),exp(1)))

n = n1[k]+n2[k]+n3[k]

tb = ta/(n-3)

```

t = ((n1[k]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[k]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[k]-
1)*((log(var(x3),exp(1))-tb)^2))
leh = ((n-3)*t)/((2*n)-12)
pvalueleh=1-pchisq(leh,2)
if(pvalueleh<=alpha[j]) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha[j]) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha[j]) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[k]-1.5)*n1[k]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[k]-1)))/((n1[k]-1)*(n1[k]-2))
z2=(((n2[k]-1.5)*n2[k]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[k]-1)))/((n2[k]-1)*(n2[k]-2))
z3=(((n3[k]-1.5)*n3[k]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[k]-1)))/((n3[k]-1)*(n3[k]-2))
z=c(z1,z2,z3)
A=(n1[k]*(mean(z1)-mean(z))^2)+(n2[k]*(mean(z2)-mean(z))^2)+(n3[k]*(mean(z3)-
mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
B=c(b1,b2,b3)
OB=(A/2)/(sum(B)/(n-3))
criticalOB=qf(1-alpha[j],2,n-3)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3))
size=c(n1[k],n2[k],n3[k])
if(var(x1)== max(var))
G=((n1[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3)))
criticalg=1/(1+(((sum(size)-3)/(n1[k]-1))-1)/(qf(1-(alpha[j]/3),(n1[k]-1),(sum(size)-3)-(n1[k]-
1))))))
if(var(x2)== max(var))
G=((n2[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3)))
criticalg=1/(1+(((sum(size)-3)/(n2[k]-1))-1)/(qf(1-(alpha[j]/3),(n2[k]-1),(sum(size)-3)-(n2[k]-
1))))))
if(var(x3)== max(var))
G=((n3[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3)))

```

```

criticalg=1/(1+((((sum(size)-3)/(n3[k]-1))-1)/(qf(1-(alpha[j]/3),(n3[k]-1),(sum(size)-3)-(n3[k]-1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]

```

การแจกแจงปรกติ (0,16) กรณี 4 ประชากร

```

library(lawstat)
M=5000
N=3
O=10
alpha=c(0.01,0.05,0.1)
n1=c(10,30,50,70,100,5,25,45,65,95)
n2=c(10,30,50,70,100,10,30,50,70,100)
n3=c(10,30,50,70,100,15,35,55,75,105)
n4=c(10,30,50,70,100,20,40,60,80,110)

COUNT <- array(rep(0, 3*6*10), dim=c(3,6,10))
for(j in 1:N)
{
for(k in 1:O)
{
for(l in 1:M)
{
x1=rnorm(n1[k],0,sqrt(16))
x2=rnorm(n2[k],0,sqrt(16))
x3=rnorm(n3[k],0,sqrt(16))
x4=rnorm(n4[k],0,sqrt(16))
x=c(x1,x2,x3,x4)
g1=rep(1,n1[k])

```

```

g2=rep(2,n2[k])
g3=rep(3,n3[k])
g4=rep(4,n4[k])
g=c(g1,g2,g3,g4)
df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)
if(bart$p.value<=alpha[j]) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[k]-1)*log(var(x1),exp(1)))+((n2[k]-1)*log(var(x2),exp(1)))+((n3[k]-
1)*log(var(x3),exp(1)))+((n4[k]-1)*log(var(x4),exp(1)))
n = n1[k]+n2[k]+n3[k]+n4[k]
tb = ta/(n-4)
t = ((n1[k]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[k]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[k]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[k]-1)*((log(var(x4),exp(1))-tb)^2))
leh = ((n-4)*t)/((2*n)-16)
pvalueleh=1-pchisq(leh,3)
if(pvalueleh<=alpha[j]) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha[j]) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha[j]) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[k]-1.5)*n1[k]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[k]-1)))/((n1[k]-1)*(n1[k]-2))
z2=(((n2[k]-1.5)*n2[k]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[k]-1)))/((n2[k]-1)*(n2[k]-2))
z3=(((n3[k]-1.5)*n3[k]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[k]-1)))/((n3[k]-1)*(n3[k]-2))
z4=(((n4[k]-1.5)*n4[k]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[k]-1)))/((n4[k]-1)*(n4[k]-2))
z=c(z1,z2,z3,z4)
A=(n1[k]*(mean(z1)-mean(z))^2)+(n2[k]*(mean(z2)-mean(z))^2)+(n3[k]*(mean(z3)-
mean(z))^2)+(n4[k]*(mean(z4)-mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
b4=(z4-mean(z4))^2
B=c(b1,b2,b3,b4)
OB=(A/3)/(sum(B)/(n-4))

```

```

criticalOB=qf(1-alpha[j],3,n-4)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3),var(x4))
size=c(n1[k],n2[k],n3[k],n4[k])
if(var(x1)== max(var))
G=((n1[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n1[k]-1))-1)/(qf(1-(alpha[j]/4),(n1[k]-1),(sum(size)-4)-(n1[k]-
1))))))
if(var(x2)== max(var))
G=((n2[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n2[k]-1))-1)/(qf(1-(alpha[j]/4),(n2[k]-1),(sum(size)-4)-(n2[k]-
1))))))
if(var(x3)== max(var))
G=((n3[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n3[k]-1))-1)/(qf(1-(alpha[j]/4),(n3[k]-1),(sum(size)-4)-(n3[k]-
1))))))
if(var(x4)== max(var))
G=((n4[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n4[k]-1))-1)/(qf(1-(alpha[j]/4),(n4[k]-1),(sum(size)-4)-(n4[k]-
1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]

```

การแจกแจงปรกติ (0,16) กรณี 5 ประชากร

```
library(lawstat)
```

```
M=5000
```

```
N=3
```

```
O=10
```

```
alpha=c(0.01,0.05,0.1)
```

```
n1=c(10,30,50,70,100,5,25,45,65,95)
```

```
n2=c(10,30,50,70,100,10,30,50,70,100)
```

```
n3=c(10,30,50,70,100,15,35,55,75,105)
```

```
n4=c(10,30,50,70,100,20,40,60,80,110)
```

```
n5=c(10,30,50,70,100,25,45,65,85,115)
```

```
COUNT <- array(rep(0, 3*6*10), dim=c(3,6,10))
```

```
for(j in 1:N)
```

```
{
```

```
for(k in 1:O)
```

```
{
```

```
for(l in 1:M)
```

```
{
```

```
x1=rnorm(n1[k],0,sqrt(16))
```

```
x2=rnorm(n2[k],0,sqrt(16))
```

```
x3=rnorm(n3[k],0,sqrt(16))
```

```
x4=rnorm(n4[k],0,sqrt(16))
```

```
x5=rnorm(n5[k],0,sqrt(16))
```

```
x=c(x1,x2,x3,x4,x5)
```

```
g1=rep(1,n1[k])
```

```
g2=rep(2,n2[k])
```

```
g3=rep(3,n3[k])
```

```
g4=rep(4,n4[k])
```

```
g5=rep(5,n5[k])
```

```
g=c(g1,g2,g3,g4,g5)
```

```
df = data.frame(x,g)
```

```
bart = bartlett.test(df$x,df$g)
```

```
if(bart$p.value<=alpha[j]) COUNT[j,1,k]=COUNT[j,1,k]+1
```

```
ta = ((n1[k]-1)*log(var(x1),exp(1)))+((n2[k]-1)*log(var(x2),exp(1)))+((n3[k]-1)*log(var(x3),exp(1)))+((n4[k]-1)*log(var(x4),exp(1)))+((n5[k]-1)*log(var(x5),exp(1)))
```

```

n = n1[k]+n2[k]+n3[k]+n4[k]+n5[k]
tb = ta/(n-5)
t = ((n1[k]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[k]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[k]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[k]-1)*((log(var(x4),exp(1))-tb)^2))+((n5[k]-
1)*((log(var(x5),exp(1))-tb)^2))
leh = ((n-5)*t)/((2*n)-20)
pvalueleh=1-pchisq(leh,4)
if(pvalueleh<=alpha[j]) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha[j]) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha[j]) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[k]-1.5)*n1[k]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[k]-1)))/((n1[k]-1)*(n1[k]-2))
z2=(((n2[k]-1.5)*n2[k]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[k]-1)))/((n2[k]-1)*(n2[k]-2))
z3=(((n3[k]-1.5)*n3[k]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[k]-1)))/((n3[k]-1)*(n3[k]-2))
z4=(((n4[k]-1.5)*n4[k]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[k]-1)))/((n4[k]-1)*(n4[k]-2))
z5=(((n5[k]-1.5)*n5[k]*(x5-mean(x5))^2)-(0.5*var(x5)*(n5[k]-1)))/((n5[k]-1)*(n5[k]-2))
z=c(z1,z2,z3,z4,z5)
A=(n1[k]*(mean(z1)-mean(z))^2)+(n2[k]*(mean(z2)-mean(z))^2)+(n3[k]*(mean(z3)-
mean(z))^2)+(n4[k]*(mean(z4)-mean(z))^2)+(n5[k]*(mean(z5)-mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
b4=(z4-mean(z4))^2
b5=(z5-mean(z5))^2
B=c(b1,b2,b3,b4,b5)
OB=(A/4)/(sum(B)/(n-5))
criticalOB=qf(1-alpha[j],4,n-5)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3),var(x4),var(x5))
size=c(n1[k],n2[k],n3[k],n4[k],n5[k])
if(var(x1)== max(var))
G=((n1[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4))+((n5[k]-1)*var(x5)))

```

```

criticalg=1/(1+(((sum(size)-5)/(n1[k]-1))-1)/(qf(1-(alpha[j]/5),(n1[k]-1),(sum(size)-5)-(n1[k]-1))))))
if(var(x2)== max(var))
G=((n2[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n2[k]-1))-1)/(qf(1-(alpha[j]/5),(n2[k]-1),(sum(size)-5)-(n2[k]-1))))))
if(var(x3)== max(var))
G=((n3[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n3[k]-1))-1)/(qf(1-(alpha[j]/5),(n3[k]-1),(sum(size)-5)-(n3[k]-1))))))
if(var(x4)== max(var))
G=((n4[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n4[k]-1))-1)/(qf(1-(alpha[j]/5),(n4[k]-1),(sum(size)-5)-(n4[k]-1))))))
if(var(x5)== max(var))
G=((n5[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n5[k]-1))-1)/(qf(1-(alpha[j]/5),(n5[k]-1),(sum(size)-5)-(n5[k]-1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]

```

การแจกแจงแกมมา (16,1) กรณี 3 ประชากร

```
library(lawstat)
```

```
M=5000
```

```
N=3
```

```
O=10
```

```
alpha=c(0.01,0.05,0.1)
```

```
n1=c(10,30,50,70,100,5,25,45,65,95)
```

```
n2=c(10,30,50,70,100,10,30,50,70,100)
```

```
n3=c(10,30,50,70,100,15,35,55,75,105)
```

```
COUNT <- array(rep(0, 3*6*10), dim=c(3,6,10))
```

```
for(j in 1:N)
```

```
{
```

```
for(k in 1:O)
```

```
{
```

```
for(l in 1:M)
```

```
{
```

```
x1=rgamma(n1[k],16,1/1)
```

```
x2=rgamma(n2[k],16,1/1)
```

```
x3=rgamma(n3[k],16,1/1)
```

```
x=c(x1,x2,x3)
```

```
g1=rep(1,n1[k])
```

```
g2=rep(2,n2[k])
```

```
g3=rep(3,n3[k])
```

```
g=c(g1,g2,g3)
```

```
df = data.frame(x,g)
```

```
bart = bartlett.test(df$x,df$g)
```

```
if(bart$p.value<=alpha[j]) COUNT[j,1,k]=COUNT[j,1,k]+1
```

```
ta = ((n1[k]-1)*log(var(x1),exp(1)))+((n2[k]-1)*log(var(x2),exp(1)))+((n3[k]-1)*log(var(x3),exp(1)))
```

```
n = n1[k]+n2[k]+n3[k]
```

```
tb = ta/(n-3)
```

```
t = ((n1[k]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[k]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[k]-1)*((log(var(x3),exp(1))-tb)^2))
```

```
leh = ((n-3)*t)/((2*n)-12)
```

```
pvalueleh=1-pchisq(leh,2)
```

```

if(pvalueleh<=alpha[j]) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha[j]) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha[j]) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[k]-1.5)*n1[k]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[k]-1)))/((n1[k]-1)*(n1[k]-2))
z2=(((n2[k]-1.5)*n2[k]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[k]-1)))/((n2[k]-1)*(n2[k]-2))
z3=(((n3[k]-1.5)*n3[k]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[k]-1)))/((n3[k]-1)*(n3[k]-2))
z=c(z1,z2,z3)
A=(n1[k]*(mean(z1)-mean(z))^2)+(n2[k]*(mean(z2)-mean(z))^2)+(n3[k]*(mean(z3)-
mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
B=c(b1,b2,b3)
OB=(A/2)/(sum(B)/(n-3))
criticalOB=qf(1-alpha[j],2,n-3)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3))
size=c(n1[k],n2[k],n3[k])
if(var(x1)== max(var))
G=((n1[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3)))
criticalg=1/(1+(((sum(size)-3)/(n1[k]-1))-1)/(qf(1-(alpha[j]/3),(n1[k]-1),(sum(size)-3)-(n1[k]-
1))))))
if(var(x2)== max(var))
G=((n2[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3)))
criticalg=1/(1+(((sum(size)-3)/(n2[k]-1))-1)/(qf(1-(alpha[j]/3),(n2[k]-1),(sum(size)-3)-(n2[k]-
1))))))
if(var(x3)== max(var))
G=((n3[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3)))
criticalg=1/(1+(((sum(size)-3)/(n3[k]-1))-1)/(qf(1-(alpha[j]/3),(n3[k]-1),(sum(size)-3)-(n3[k]-
1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}

```

```

}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M

```

```

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]

```

การแจกแจงแกมมา (16,1) กรณี 4 ประชากร

```

library(lawstat)
M=5000
N=3
O=10
alpha=c(0.01,0.05,0.1)
n1=c(10,30,50,70,100,5,25,45,65,95)
n2=c(10,30,50,70,100,10,30,50,70,100)
n3=c(10,30,50,70,100,15,35,55,75,105)
n4=c(10,30,50,70,100,20,40,60,80,110)

COUNT <- array(rep(0, 3*6*10), dim=c(3,6,10))
for(j in 1:N)
{
for(k in 1:O)
{
for(l in 1:M)
{
x1=rgamma(n1[k],16,1/1)
x2=rgamma(n2[k],16,1/1)
x3=rgamma(n3[k],16,1/1)
x4=rgamma(n4[k],16,1/1)
x=c(x1,x2,x3,x4)
g1=rep(1,n1[k])
g2=rep(2,n2[k])
g3=rep(3,n3[k])
g4=rep(4,n4[k])
g=c(g1,g2,g3,g4)

```

```

df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)
if(bart$p.value<=alpha[j]) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[k]-1)*log(var(x1),exp(1)))+(n2[k]-1)*log(var(x2),exp(1))+(n3[k]-
1)*log(var(x3),exp(1))+(n4[k]-1)*log(var(x4),exp(1))
n = n1[k]+n2[k]+n3[k]+n4[k]
tb = ta/(n-4)
t = ((n1[k]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[k]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[k]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[k]-1)*((log(var(x4),exp(1))-tb)^2))
leh = ((n-4)*t)/((2*n)-16)
pvalueleh=1-pchisq(leh,3)
if(pvalueleh<=alpha[j]) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha[j]) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha[j]) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[k]-1.5)*n1[k]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[k]-1)))/((n1[k]-1)*(n1[k]-2))
z2=(((n2[k]-1.5)*n2[k]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[k]-1)))/((n2[k]-1)*(n2[k]-2))
z3=(((n3[k]-1.5)*n3[k]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[k]-1)))/((n3[k]-1)*(n3[k]-2))
z4=(((n4[k]-1.5)*n4[k]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[k]-1)))/((n4[k]-1)*(n4[k]-2))
z=c(z1,z2,z3,z4)
A=(n1[k]*(mean(z1)-mean(z))^2)+(n2[k]*(mean(z2)-mean(z))^2)+(n3[k]*(mean(z3)-
mean(z))^2)+(n4[k]*(mean(z4)-mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
b4=(z4-mean(z4))^2
B=c(b1,b2,b3,b4)
OB=(A/3)/(sum(B)/(n-4))
criticalOB=qf(1-alpha[j],3,n-4)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3),var(x4))

```

```

size=c(n1[k],n2[k],n3[k],n4[k])
if(var(x1)== max(var))
G=((n1[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n1[k]-1))-1)/(qf(1-(alpha[j]/4),(n1[k]-1),(sum(size)-4)-(n1[k]-
1))))))
if(var(x2)== max(var))
G=((n2[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n2[k]-1))-1)/(qf(1-(alpha[j]/4),(n2[k]-1),(sum(size)-4)-(n2[k]-
1))))))
if(var(x3)== max(var))
G=((n3[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n3[k]-1))-1)/(qf(1-(alpha[j]/4),(n3[k]-1),(sum(size)-4)-(n3[k]-
1))))))
if(var(x4)== max(var))
G=((n4[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4)))
criticalg=1/(1+(((sum(size)-4)/(n4[k]-1))-1)/(qf(1-(alpha[j]/4),(n4[k]-1),(sum(size)-4)-(n4[k]-
1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]

```

การแจกแจงแกมมา (16,1) กรณี 5 ประชากร

```

library(lawstat)
M=5000
N=3
O=10
alpha=c(0.01,0.05,0.1)
n1=c(10,30,50,70,100,5,25,45,65,95)
n2=c(10,30,50,70,100,10,30,50,70,100)
n3=c(10,30,50,70,100,15,35,55,75,105)
n4=c(10,30,50,70,100,20,40,60,80,110)
n5=c(10,30,50,70,100,25,45,65,85,115)

COUNT <- array(rep(0, 3*6*10), dim=c(3,6,10))
for(j in 1:N)
{
  for(k in 1:O)
  {
    for(l in 1:M)
    {
      x1=rgamma(n1[k],16,1/1)
      x2=rgamma(n2[k],16,1/1)
      x3=rgamma(n3[k],16,1/1)
      x4=rgamma(n4[k],16,1/1)
      x5=rgamma(n5[k],16,1/1)
      x=c(x1,x2,x3,x4,x5)
      g1=rep(1,n1[k])
      g2=rep(2,n2[k])
      g3=rep(3,n3[k])
      g4=rep(4,n4[k])
      g5=rep(5,n5[k])
      g=c(g1,g2,g3,g4,g5)
      df = data.frame(x,g)

      bart = bartlett.test(df$x,df$g)
      if(bart$p.value<=alpha[j]) COUNT[j,1,k]=COUNT[j,1,k]+1
    }
  }
}

```

```

ta = ((n1[k]-1)*log(var(x1),exp(1)))+((n2[k]-1)*log(var(x2),exp(1)))+((n3[k]-
1)*log(var(x3),exp(1)))+((n4[k]-1)*log(var(x4),exp(1)))+((n5[k]-1)*log(var(x5),exp(1)))
n = n1[k]+n2[k]+n3[k]+n4[k]+n5[k]
tb = ta/(n-5)
t = ((n1[k]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[k]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[k]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[k]-1)*((log(var(x4),exp(1))-tb)^2))+((n5[k]-
1)*((log(var(x5),exp(1))-tb)^2))
leh = ((n-5)*t)/((2*n)-20)
pvalueleh=1-pchisq(leh,4)
if(pvalueleh<=alpha[j]) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha[j]) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha[j]) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[k]-1.5)*n1[k]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[k]-1)))/((n1[k]-1)*(n1[k]-2))
z2=(((n2[k]-1.5)*n2[k]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[k]-1)))/((n2[k]-1)*(n2[k]-2))
z3=(((n3[k]-1.5)*n3[k]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[k]-1)))/((n3[k]-1)*(n3[k]-2))
z4=(((n4[k]-1.5)*n4[k]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[k]-1)))/((n4[k]-1)*(n4[k]-2))
z5=(((n5[k]-1.5)*n5[k]*(x5-mean(x5))^2)-(0.5*var(x5)*(n5[k]-1)))/((n5[k]-1)*(n5[k]-2))
z=c(z1,z2,z3,z4,z5)
A=(n1[k]*(mean(z1)-mean(z))^2)+(n2[k]*(mean(z2)-mean(z))^2)+(n3[k]*(mean(z3)-
mean(z))^2)+(n4[k]*(mean(z4)-mean(z))^2)+(n5[k]*(mean(z5)-mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
b4=(z4-mean(z4))^2
b5=(z5-mean(z5))^2
B=c(b1,b2,b3,b4,b5)
OB=(A/4)/(sum(B)/(n-5))
criticalOB=qf(1-alpha[j],4,n-5)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3),var(x4),var(x5))
size=c(n1[k],n2[k],n3[k],n4[k],n5[k])
if(var(x1)== max(var))

```

```

G=((n1[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n1[k]-1))-1)/(qf(1-(alpha[j]/5),(n1[k]-1),(sum(size)-5)-(n1[k]-
1))))))
if(var(x2)== max(var))
G=((n2[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n2[k]-1))-1)/(qf(1-(alpha[j]/5),(n2[k]-1),(sum(size)-5)-(n2[k]-
1))))))
if(var(x3)== max(var))
G=((n3[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n3[k]-1))-1)/(qf(1-(alpha[j]/5),(n3[k]-1),(sum(size)-5)-(n3[k]-
1))))))
if(var(x4)== max(var))
G=((n4[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n4[k]-1))-1)/(qf(1-(alpha[j]/5),(n4[k]-1),(sum(size)-5)-(n4[k]-
1))))))
if(var(x5)== max(var))
G=((n5[k]-1)*max(var))/(((n1[k]-1)*var(x1))+((n2[k]-1)*var(x2))+((n3[k]-1)*var(x3))+((n4[k]-
1)*var(x4))+((n5[k]-1)*var(x5)))
criticalg=1/(1+(((sum(size)-5)/(n5[k]-1))-1)/(qf(1-(alpha[j]/5),(n5[k]-1),(sum(size)-5)-(n5[k]-
1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]

```

กำลังการทดสอบ

การแจกแจงปรกติ (0,16) กรณี 3 ประชากร

```
library(lawstat)
M=5000
N=10
O=6
alpha=0.01
n1=c(10,30,50,70,100,5,25,45,65,95)
n2=c(10,30,50,70,100,10,30,50,70,100)
n3=c(10,30,50,70,100,15,35,55,75,105)
mu1=c(16,16,16,16,16,16)
mu2=c(18,20,26,28,34,52)
mu3=c(20,24,36,40,52,88)
var1=c(16,16,16,16,16,16)
var2=c(18,20,26,28,34,52)
var3=c(20,24,36,40,52,88)
COUNT <- array(rep(0, 10*6*6), dim=c(10,6,6))
for(j in 1:N)
{
  for(k in 1:O)
  {
    for(l in 1:M)
    {
      x1=rnorm(n1[j],mu1[k],sqrt(var1[k]))
      x2=rnorm(n2[j],mu2[k],sqrt(var2[k]))
      x3=rnorm(n3[j],mu3[k],sqrt(var3[k]))
      x=c(x1,x2,x3)
      g1=rep(1,n1[j])
      g2=rep(2,n2[j])
      g3=rep(3,n3[j])
      g=c(g1,g2,g3)
      df = data.frame(x,g)

      bart = bartlett.test(df$x,df$g)
      if(bart$p.value<=alpha) COUNT[j,1,k]=COUNT[j,1,k]+1
```

```

ta = ((n1[j]-1)*log(var(x1),exp(1)))+(n2[j]-1)*log(var(x2),exp(1)))+(n3[j]-
1)*log(var(x3),exp(1))
n = n1[j]+n2[j]+n3[j]
tb = ta/(n-3)
t = ((n1[j]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[j]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[j]-
1)*((log(var(x3),exp(1))-tb)^2))
leh = ((n-3)*t)/((2*n)-12)
pvalueleh=1-pchisq(leh,2)
if(pvalueleh<=alpha) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[j]-1.5)*n1[j]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[j]-1)))/((n1[j]-1)*(n1[j]-2))
z2=(((n2[j]-1.5)*n2[j]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[j]-1)))/((n2[j]-1)*(n2[j]-2))
z3=(((n3[j]-1.5)*n3[j]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[j]-1)))/((n3[j]-1)*(n3[j]-2))
z=c(z1,z2,z3)
A=(n1[j]*(mean(z1)-mean(z))^2)+(n2[j]*(mean(z2)-mean(z))^2)+(n3[j]*(mean(z3)-
mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
B=c(b1,b2,b3)
OB=(A/2)/(sum(B)/(n-3))
criticalOB=qf(1-alpha,2,n-3)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3))
size=c(n1[j],n2[j],n3[j])
if(var(x1)== max(var))
G=((n1[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3)))
criticalg=1/(1+(((sum(size)-3)/(n1[j]-1)-1)/(qf(1-(alpha/3),(n1[j]-1),(sum(size)-3)-(n1[j]-
1))))))

```

```

if(var(x2)== max(var))
G=((n2[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3)))
criticalg=1/(1+((((sum(size)-3)/(n2[j]-1))-1)/(qf(1-(alpha/3),(n2[j]-1),(sum(size)-3)-(n2[j]-
1))))))
if(var(x3)== max(var))
G=((n3[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3)))
criticalg=1/(1+((((sum(size)-3)/(n3[j]-1))-1)/(qf(1-(alpha/3),(n3[j]-1),(sum(size)-3)-(n3[j]-
1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M
COUNT[4,,]=COUNT[4,,]/M
COUNT[5,,]=COUNT[5,,]/M
COUNT[6,,]=COUNT[6,,]/M
COUNT[7,,]=COUNT[7,,]/M
COUNT[8,,]=COUNT[8,,]/M
COUNT[9,,]=COUNT[9,,]/M
COUNT[10,,]=COUNT[10,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]
COUNT[4,,]
COUNT[5,,]
COUNT[6,,]
COUNT[7,,]
COUNT[8,,]
COUNT[9,,]
COUNT[10,,]

```

การแจกแจงปรกติ (0,16) กรณี 4 ประชากร

```

library(lawstat)
M=5000
N=10
O=6
alpha=0.01
n1=c(10,30,50,70,100,5,25,45,65,95)
n2=c(10,30,50,70,100,10,30,50,70,100)
n3=c(10,30,50,70,100,15,35,55,75,105)
n4=c(10,30,50,70,100,20,40,60,80,110)
mu1=c(16,16,16,16,16,16)
mu2=c(18,20,22,24,30,36)
mu3=c(20,24,28,32,44,56)
mu4=c(22,28,34,40,58,76)
var1=c(16,16,16,16,16,16)
var2=c(18,20,22,24,30,36)
var3=c(20,24,28,32,44,56)
var4=c(22,28,34,40,58,76)
COUNT <- array(rep(0, 10*6*6), dim=c(10,6,6))
for(j in 1:N)
{
for(k in 1:O)
{
for(l in 1:M)
{
x1=rnorm(n1[j],mu1[k],sqrt(var1[k]))
x2=rnorm(n2[j],mu2[k],sqrt(var2[k]))
x3=rnorm(n3[j],mu3[k],sqrt(var3[k]))
x4=rnorm(n4[j],mu4[k],sqrt(var4[k]))
x=c(x1,x2,x3,x4)
g1=rep(1,n1[j])
g2=rep(2,n2[j])
g3=rep(3,n3[j])
g4=rep(4,n4[j])
g=c(g1,g2,g3,g4)
df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)

```

```

if(bart$p.value<=alpha) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[j]-1)*log(var(x1),exp(1)))+(n2[j]-1)*log(var(x2),exp(1))+(n3[j]-
1)*log(var(x3),exp(1))+(n4[j]-1)*log(var(x4),exp(1))
n = n1[j]+n2[j]+n3[j]+n4[j]
tb = ta/(n-4)
t = ((n1[j]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[j]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[j]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[j]-1)*((log(var(x4),exp(1))-tb)^2))
leh = ((n-4)*t)/((2*n)-16)
pvalueleh=1-pchisq(leh,3)
if(pvalueleh<=alpha) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[j]-1.5)*n1[j]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[j]-1)))/((n1[j]-1)*(n1[j]-2))
z2=(((n2[j]-1.5)*n2[j]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[j]-1)))/((n2[j]-1)*(n2[j]-2))
z3=(((n3[j]-1.5)*n3[j]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[j]-1)))/((n3[j]-1)*(n3[j]-2))
z4=(((n4[j]-1.5)*n4[j]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[j]-1)))/((n4[j]-1)*(n4[j]-2))
z=c(z1,z2,z3,z4)
A=(n1[j]*(mean(z1)-mean(z))^2)+(n2[j]*(mean(z2)-mean(z))^2)+(n3[j]*(mean(z3)-
mean(z))^2)+(n4[j]*(mean(z4)-mean(z))^2)
b1=(z1-mean(z1))^2
b2=(z2-mean(z2))^2
b3=(z3-mean(z3))^2
b4=(z4-mean(z4))^2
B=c(b1,b2,b3,b4)
OB=(A/3)/(sum(B)/(n-4))
criticalOB=qf(1-alpha,3,n-4)
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1

var=c(var(x1),var(x2),var(x3),var(x4))
size=c(n1[j],n2[j],n3[j],n4[j])
if(var(x1)== max(var))

```

```

G=((n1[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-
1)*var(x4)))
criticalg=1/(1+((((sum(size)-4)/(n1[j]-1))-1)/(qf(1-(alpha/4),(n1[j]-1),(sum(size)-4)-(n1[j]-
1))))))
if(var(x2)== max(var))
G=((n2[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-
1)*var(x4)))
criticalg=1/(1+((((sum(size)-4)/(n2[j]-1))-1)/(qf(1-(alpha/4),(n2[j]-1),(sum(size)-4)-(n2[j]-
1))))))
if(var(x3)== max(var))
G=((n3[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-
1)*var(x4)))
criticalg=1/(1+((((sum(size)-4)/(n3[j]-1))-1)/(qf(1-(alpha/4),(n3[j]-1),(sum(size)-4)-(n3[j]-
1))))))
if(var(x4)== max(var))
G=((n4[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-
1)*var(x4)))
criticalg=1/(1+((((sum(size)-4)/(n4[j]-1))-1)/(qf(1-(alpha/4),(n4[j]-1),(sum(size)-4)-(n4[j]-
1))))))
if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
}
}
}
COUNT[1,,]=COUNT[1,,]/M
COUNT[2,,]=COUNT[2,,]/M
COUNT[3,,]=COUNT[3,,]/M
COUNT[4,,]=COUNT[4,,]/M
COUNT[5,,]=COUNT[5,,]/M
COUNT[6,,]=COUNT[6,,]/M
COUNT[7,,]=COUNT[7,,]/M
COUNT[8,,]=COUNT[8,,]/M
COUNT[9,,]=COUNT[9,,]/M
COUNT[10,,]=COUNT[10,,]/M

COUNT[1,,]
COUNT[2,,]
COUNT[3,,]
COUNT[4,,]

```

```

COUNT[5,,]
COUNT[6,,]
COUNT[7,,]
COUNT[8,,]
COUNT[9,,]
COUNT[10,,]

```

การแจกแจงปรกติ (0,16) กรณี 5 ประชากร

```

library(lawstat)
M=5000
N=10
O=6
alpha=0.01
n1=c(10,30,50,70,100,5,25,45,65,95)
n2=c(10,30,50,70,100,10,30,50,70,100)
n3=c(10,30,50,70,100,15,35,55,75,105)
n4=c(10,30,50,70,100,20,40,60,80,110)
n5=c(10,30,50,70,100,25,45,65,85,115)
mu1=c(16,16,16,16,16,16)
mu2=c(18,20,22,24,30,36)
mu3=c(20,24,28,32,44,56)
mu4=c(22,28,34,40,58,76)
mu5=c(24,32,40,48,72,96)
var1=c(16,16,16,16,16,16)
var2=c(18,20,22,24,30,36)
var3=c(20,24,28,32,44,56)
var4=c(22,28,34,40,58,76)
var5=c(24,32,40,48,72,96)
COUNT <- array(rep(0, 10*6*6), dim=c(10,6,6))
for(j in 1:N)
{
for(k in 1:O)
{
for(l in 1:M)
{
x1=rnorm(n1[j],mu1[k],sqrt(var1[k]))
x2=rnorm(n2[j],mu2[k],sqrt(var2[k]))
x3=rnorm(n3[j],mu3[k],sqrt(var3[k]))

```

```

x4=rnorm(n4[j],mu4[k],sqrt(var4[k]))
x5=rnorm(n5[j],mu5[k],sqrt(var5[k]))
x=c(x1,x2,x3,x4,x5)
g1=rep(1,n1[j])
g2=rep(2,n2[j])
g3=rep(3,n3[j])
g4=rep(4,n4[j])
g5=rep(5,n5[j])
g=c(g1,g2,g3,g4,g5)
df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)
if(bart$p.value<=alpha) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[j]-1)*log(var(x1),exp(1)))+((n2[j]-1)*log(var(x2),exp(1)))+((n3[j]-
1)*log(var(x3),exp(1)))+((n4[j]-1)*log(var(x4),exp(1)))+((n5[j]-1)*log(var(x5),exp(1)))
n = n1[j]+n2[j]+n3[j]+n4[j]+n5[j]
tb = ta/(n-5)
t = ((n1[j]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[j]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[j]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[j]-1)*((log(var(x4),exp(1))-tb)^2))+((n5[j]-
1)*((log(var(x5),exp(1))-tb)^2))
leh = ((n-5)*t)/((2*n)-20)
pvalueleh=1-pchisq(leh,4)
if(pvalueleh<=alpha) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")
if(leve$p.value<=alpha) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")
if(bf$p.value<=alpha) COUNT[j,4,k]=COUNT[j,4,k]+1

z1=(((n1[j]-1.5)*n1[j]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[j]-1)))/((n1[j]-1)*(n1[j]-2))
z2=(((n2[j]-1.5)*n2[j]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[j]-1)))/((n2[j]-1)*(n2[j]-2))
z3=(((n3[j]-1.5)*n3[j]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[j]-1)))/((n3[j]-1)*(n3[j]-2))
z4=(((n4[j]-1.5)*n4[j]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[j]-1)))/((n4[j]-1)*(n4[j]-2))
z5=(((n5[j]-1.5)*n5[j]*(x5-mean(x5))^2)-(0.5*var(x5)*(n5[j]-1)))/((n5[j]-1)*(n5[j]-2))
z=c(z1,z2,z3,z4,z5)

```

$$A=(n1[j]*(\text{mean}(z1)-\text{mean}(z))^2)+(n2[j]*(\text{mean}(z2)-\text{mean}(z))^2)+(n3[j]*(\text{mean}(z3)-\text{mean}(z))^2)+(n4[j]*(\text{mean}(z4)-\text{mean}(z))^2)+(n5[j]*(\text{mean}(z5)-\text{mean}(z))^2)$$

$$b1=(z1-\text{mean}(z1))^2$$

$$b2=(z2-\text{mean}(z2))^2$$

$$b3=(z3-\text{mean}(z3))^2$$

$$b4=(z4-\text{mean}(z4))^2$$

$$b5=(z5-\text{mean}(z5))^2$$

$$B=c(b1,b2,b3,b4,b5)$$

$$OB=(A/4)/(\text{sum}(B)/(n-5))$$

$$\text{criticalOB}=\text{qf}(1-\alpha,4,n-5)$$

$$\text{if}(OB \geq \text{criticalOB}) \text{COUNT}[j,5,k]=\text{COUNT}[j,5,k]+1$$

$$\text{var}=c(\text{var}(x1),\text{var}(x2),\text{var}(x3),\text{var}(x4),\text{var}(x5))$$

$$\text{size}=c(n1[j],n2[j],n3[j],n4[j],n5[j])$$

$$\text{if}(\text{var}(x1) == \max(\text{var}))$$

$$G=((n1[j]-1)*\max(\text{var}))/(((n1[j]-1)*\text{var}(x1))+((n2[j]-1)*\text{var}(x2))+((n3[j]-1)*\text{var}(x3))+((n4[j]-1)*\text{var}(x4))+((n5[j]-1)*\text{var}(x5)))$$

$$\text{criticalg}=1/(1+(((\text{sum}(\text{size})-5)/(n1[j]-1)-1)/(\text{qf}(1-(\alpha/5),(n1[j]-1),(\text{sum}(\text{size})-5)-(n1[j]-1))))))$$

$$\text{if}(\text{var}(x2) == \max(\text{var}))$$

$$G=((n2[j]-1)*\max(\text{var}))/(((n1[j]-1)*\text{var}(x1))+((n2[j]-1)*\text{var}(x2))+((n3[j]-1)*\text{var}(x3))+((n4[j]-1)*\text{var}(x4))+((n5[j]-1)*\text{var}(x5)))$$

$$\text{criticalg}=1/(1+(((\text{sum}(\text{size})-5)/(n2[j]-1)-1)/(\text{qf}(1-(\alpha/5),(n2[j]-1),(\text{sum}(\text{size})-5)-(n2[j]-1))))))$$

$$\text{if}(\text{var}(x3) == \max(\text{var}))$$

$$G=((n3[j]-1)*\max(\text{var}))/(((n1[j]-1)*\text{var}(x1))+((n2[j]-1)*\text{var}(x2))+((n3[j]-1)*\text{var}(x3))+((n4[j]-1)*\text{var}(x4))+((n5[j]-1)*\text{var}(x5)))$$

$$\text{criticalg}=1/(1+(((\text{sum}(\text{size})-5)/(n3[j]-1)-1)/(\text{qf}(1-(\alpha/5),(n3[j]-1),(\text{sum}(\text{size})-5)-(n3[j]-1))))))$$

$$\text{if}(\text{var}(x4) == \max(\text{var}))$$

$$G=((n4[j]-1)*\max(\text{var}))/(((n1[j]-1)*\text{var}(x1))+((n2[j]-1)*\text{var}(x2))+((n3[j]-1)*\text{var}(x3))+((n4[j]-1)*\text{var}(x4))+((n5[j]-1)*\text{var}(x5)))$$

$$\text{criticalg}=1/(1+(((\text{sum}(\text{size})-5)/(n4[j]-1)-1)/(\text{qf}(1-(\alpha/5),(n4[j]-1),(\text{sum}(\text{size})-5)-(n4[j]-1))))))$$

$$\text{if}(\text{var}(x5) == \max(\text{var}))$$

$$G=((n5[j]-1)*\max(\text{var}))/(((n1[j]-1)*\text{var}(x1))+((n2[j]-1)*\text{var}(x2))+((n3[j]-1)*\text{var}(x3))+((n4[j]-1)*\text{var}(x4))+((n5[j]-1)*\text{var}(x5)))$$

criticalg=1/(1+((((sum(size)-5)/(n5[j]-1))-1)/(qf(1-(alpha/5),(n5[j]-1),(sum(size)-5)-(n5[j]-1))))))

if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1

}

}

}

COUNT[1,,]=COUNT[1,,]/M

COUNT[2,,]=COUNT[2,,]/M

COUNT[3,,]=COUNT[3,,]/M

COUNT[4,,]=COUNT[4,,]/M

COUNT[5,,]=COUNT[5,,]/M

COUNT[6,,]=COUNT[6,,]/M

COUNT[7,,]=COUNT[7,,]/M

COUNT[8,,]=COUNT[8,,]/M

COUNT[9,,]=COUNT[9,,]/M

COUNT[10,,]=COUNT[10,,]/M

COUNT[1,,]

COUNT[2,,]

COUNT[3,,]

COUNT[4,,]

COUNT[5,,]

COUNT[6,,]

COUNT[7,,]

COUNT[8,,]

COUNT[9,,]

COUNT[10,,]

การแจกแจงแกมมา (16,1) กรณี 3 ประชากร

```

library(lawstat)

M=5000

N=10

O=6

alpha=0.01

n1=c(10,30,50,70,100,5,25,45,65,95)

n2=c(10,30,50,70,100,10,30,50,70,100)

n3=c(10,30,50,70,100,15,35,55,75,105)

alpha1=c(16,16,16,16,16,16)

alpha2=c(18,20,26,28,34,52)

alpha3=c(20,24,36,40,52,88)

beta1=1

beta2=1

beta3=1

COUNT <- array(rep(0, 10*6*6), dim=c(10,6,6))

for(j in 1:N)

{

for(k in 1:O)

{

for(l in 1:M)

{

x1=rgamma(n1[j],alpha1[k],1/beta1)

x2=rgamma(n2[j],alpha2[k],1/beta2)

x3=rgamma(n3[j],alpha3[k],1/beta3)

```

```

x=c(x1,x2,x3)

g1=rep(1,n1[j])

g2=rep(2,n2[j])

g3=rep(3,n3[j])

g=c(g1,g2,g3)

df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)

if(bart$p.value<alpha) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[j]-1)*log(var(x1),exp(1)))+((n2[j]-1)*log(var(x2),exp(1)))+((n3[j]-
1)*log(var(x3),exp(1)))

n = n1[j]+n2[j]+n3[j]

tb = ta/(n-3)

t = ((n1[j]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[j]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[j]-
1)*((log(var(x3),exp(1))-tb)^2))

leh = ((n-3)*t)/((2*n)-12)

pvalueleh=1-pchisq(leh,2)

if(pvalueleh<alpha) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")

if(leve$p.value<alpha) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")

if(bf$p.value<alpha) COUNT[j,4,k]=COUNT[j,4,k]+1

```

$$z1 = (((n1[j]-1.5)*n1[j]*(x1-\text{mean}(x1))^2) - (0.5*\text{var}(x1)*(n1[j]-1))) / ((n1[j]-1)*(n1[j]-2))$$

$$z2 = (((n2[j]-1.5)*n2[j]*(x2-\text{mean}(x2))^2) - (0.5*\text{var}(x2)*(n2[j]-1))) / ((n2[j]-1)*(n2[j]-2))$$

$$z3 = (((n3[j]-1.5)*n3[j]*(x3-\text{mean}(x3))^2) - (0.5*\text{var}(x3)*(n3[j]-1))) / ((n3[j]-1)*(n3[j]-2))$$

$$z = c(z1, z2, z3)$$

$$A = (n1[j]*(\text{mean}(z1) - \text{mean}(z))^2) + (n2[j]*(\text{mean}(z2) - \text{mean}(z))^2) + (n3[j]*(\text{mean}(z3) - \text{mean}(z))^2)$$

$$b1 = (z1 - \text{mean}(z1))^2$$

$$b2 = (z2 - \text{mean}(z2))^2$$

$$b3 = (z3 - \text{mean}(z3))^2$$

$$B = c(b1, b2, b3)$$

$$OB = (A/2) / (\text{sum}(B) / (n-3))$$

$$\text{criticalOB} = \text{qf}(1-\alpha, 2, n-3)$$

$$\text{if}(OB \geq \text{criticalOB}) \text{COUNT}[j, 5, k] = \text{COUNT}[j, 5, k] + 1$$

$$\text{var} = c(\text{var}(x1), \text{var}(x2), \text{var}(x3))$$

$$\text{size} = c(n1[j], n2[j], n3[j])$$

$$\text{if}(\text{var}(x1) == \text{max}(\text{var}))$$

$$G = ((n1[j]-1)*\text{max}(\text{var})) / (((n1[j]-1)*\text{var}(x1)) + ((n2[j]-1)*\text{var}(x2)) + ((n3[j]-1)*\text{var}(x3)))$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 3) / (n1[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/3), (n1[j] - 1), (\text{sum}(\text{size}) - 3) - (n1[j] - 1))))))$$

$$\text{if}(\text{var}(x2) == \text{max}(\text{var}))$$

$$G = ((n2[j]-1)*\text{max}(\text{var})) / (((n1[j]-1)*\text{var}(x1)) + ((n2[j]-1)*\text{var}(x2)) + ((n3[j]-1)*\text{var}(x3)))$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 3) / (n2[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/3), (n2[j] - 1), (\text{sum}(\text{size}) - 3) - (n2[j] - 1))))))$$

$$\text{if}(\text{var}(x3) == \text{max}(\text{var}))$$

$$G = ((n3[j]-1)*\text{max}(\text{var})) / (((n1[j]-1)*\text{var}(x1)) + ((n2[j]-1)*\text{var}(x2)) + ((n3[j]-1)*\text{var}(x3)))$$

criticalg=1/(1+((((sum(size)-3)/(n3[j]-1))-1)/(qf(1-(alpha/3),(n3[j]-1),(sum(size)-3)-(n3[j]-1))))))

if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1

}}

COUNT[1,,]=COUNT[1,,]/M

COUNT[2,,]=COUNT[2,,]/M

COUNT[3,,]=COUNT[3,,]/M

COUNT[4,,]=COUNT[4,,]/M

COUNT[5,,]=COUNT[5,,]/M

COUNT[6,,]=COUNT[6,,]/M

COUNT[7,,]=COUNT[7,,]/M

COUNT[8,,]=COUNT[8,,]/M

COUNT[9,,]=COUNT[9,,]/M

COUNT[10,,]=COUNT[10,,]/M

COUNT[1,,]

COUNT[2,,]

COUNT[3,,]

COUNT[4,,]

COUNT[5,,]

COUNT[6,,]

COUNT[7,,]

COUNT[8,,]

COUNT[9,,]

COUNT[10,,]

การแจกแจงแกมมา (16,1) กรณี 4 ประชากร

```
library(lawstat)
```

```
M=5000
```

```
N=10
```

```
O=6
```

```
alpha=0.01
```

```
n1=c(10,30,50,70,100,5,25,45,65,95)
```

```
n2=c(10,30,50,70,100,10,30,50,70,100)
```

```
n3=c(10,30,50,70,100,15,35,55,75,105)
```

```
n4=c(10,30,50,70,100,20,40,60,80,110)
```

```
alpha1=c(16,16,16,16,16,16)
```

```
alpha2=c(18,20,22,24,30,36)
```

```
alpha3=c(20,24,28,32,44,56)
```

```
alpha4=c(22,28,34,40,58,76)
```

```
beta1=1
```

```
beta2=1
```

```
beta3=1
```

```
beta4=1
```

```
COUNT <- array(rep(0, 10*6*6), dim=c(10,6,6))
```

```
for(j in 1:N)
```

```
{
```

```
for(k in 1:O)
```

```
{
```

```
for(l in 1:M)
```

```
{
```

```

x1=rgamma(n1[j],alpha1[k],1/beta1)
x2=rgamma(n2[j],alpha2[k],1/beta2)
x3=rgamma(n3[j],alpha3[k],1/beta3)
x4=rgamma(n4[j],alpha4[k],1/beta4)
x=c(x1,x2,x3,x4)

g1=rep(1,n1[j])
g2=rep(2,n2[j])
g3=rep(3,n3[j])
g4=rep(4,n4[j])
g=c(g1,g2,g3,g4)

df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)

if(bart$p.value<=alpha) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[j]-1)*log(var(x1),exp(1)))+((n2[j]-1)*log(var(x2),exp(1)))+((n3[j]-
1)*log(var(x3),exp(1)))+((n4[j]-1)*log(var(x4),exp(1)))

n = n1[j]+n2[j]+n3[j]+n4[j]

tb = ta/(n-4)

t = ((n1[j]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[j]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[j]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[j]-1)*((log(var(x4),exp(1))-tb)^2))

leh = ((n-4)*t)/((2*n)-16)

pvalueleh=1-pchisq(leh,3)

if(pvalueleh<=alpha) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")

if(leve$p.value<=alpha) COUNT[j,3,k]=COUNT[j,3,k]+1

```

```
bf = levene.test(df$x,df$g,"median")
```

```
if(bf$p.value<=alpha) COUNT[j,4,k]=COUNT[j,4,k]+1
```

```
z1=(((n1[j]-1.5)*n1[j]*(x1-mean(x1))^2)-(0.5*var(x1)*(n1[j]-1)))/((n1[j]-1)*(n1[j]-2))
```

```
z2=(((n2[j]-1.5)*n2[j]*(x2-mean(x2))^2)-(0.5*var(x2)*(n2[j]-1)))/((n2[j]-1)*(n2[j]-2))
```

```
z3=(((n3[j]-1.5)*n3[j]*(x3-mean(x3))^2)-(0.5*var(x3)*(n3[j]-1)))/((n3[j]-1)*(n3[j]-2))
```

```
z4=(((n4[j]-1.5)*n4[j]*(x4-mean(x4))^2)-(0.5*var(x4)*(n4[j]-1)))/((n4[j]-1)*(n4[j]-2))
```

```
z=c(z1,z2,z3,z4)
```

```
A=(n1[j]*(mean(z1)-mean(z))^2)+(n2[j]*(mean(z2)-mean(z))^2)+(n3[j]*(mean(z3)-
mean(z))^2)+(n4[j]*(mean(z4)-mean(z))^2)
```

```
b1=(z1-mean(z1))^2
```

```
b2=(z2-mean(z2))^2
```

```
b3=(z3-mean(z3))^2
```

```
b4=(z4-mean(z4))^2
```

```
B=c(b1,b2,b3,b4)
```

```
OB=(A/3)/(sum(B)/(n-4))
```

```
criticalOB=qf(1-alpha,3,n-4)
```

```
if(OB>=criticalOB) COUNT[j,5,k]=COUNT[j,5,k]+1
```

```
var=c(var(x1),var(x2),var(x3),var(x4))
```

```
size=c(n1[j],n2[j],n3[j],n4[j])
```

```
if(var(x1)== max(var))
```

```
G=((n1[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-
1)*var(x4)))
```

criticalg=1/(1+(((sum(size)-4)/(n1[j]-1))-1)/(qf(1-(alpha/4),(n1[j]-1),(sum(size)-4)-(n1[j]-1))))))

if(var(x2)== max(var))

G=((n2[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-1)*var(x4)))

criticalg=1/(1+(((sum(size)-4)/(n2[j]-1))-1)/(qf(1-(alpha/4),(n2[j]-1),(sum(size)-4)-(n2[j]-1))))))

if(var(x3)== max(var))

G=((n3[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-1)*var(x4)))

criticalg=1/(1+(((sum(size)-4)/(n3[j]-1))-1)/(qf(1-(alpha/4),(n3[j]-1),(sum(size)-4)-(n3[j]-1))))))

if(var(x4)== max(var))

G=((n4[j]-1)*max(var))/(((n1[j]-1)*var(x1))+((n2[j]-1)*var(x2))+((n3[j]-1)*var(x3))+((n4[j]-1)*var(x4)))

criticalg=1/(1+(((sum(size)-4)/(n4[j]-1))-1)/(qf(1-(alpha/4),(n4[j]-1),(sum(size)-4)-(n4[j]-1))))))

if(G>=criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1

}}}

COUNT[1,,]=COUNT[1,,]/M

COUNT[2,,]=COUNT[2,,]/M

COUNT[3,,]=COUNT[3,,]/M

COUNT[4,,]=COUNT[4,,]/M

COUNT[5,,]=COUNT[5,,]/M

COUNT[6,,]=COUNT[6,,]/M

COUNT[7,,]=COUNT[7,,]/M

COUNT[8,,]=COUNT[8,,]/M

COUNT[9,,]=COUNT[9,,]/M

COUNT[10,,]=COUNT[10,,]/M

COUNT[1,,]

COUNT[2,,]

COUNT[3,,]

COUNT[4,,]

COUNT[5,,]

COUNT[6,,]

COUNT[7,,]

COUNT[8,,]

COUNT[9,,]

COUNT[10,,]

การแจกแจงแกมมา (16,1) กรณี 5 ประชากร

library(lawstat)

M=5000

N=10

O=6

alpha=0.01

n1=c(10,30,50,70,100,5,25,45,65,95)

n2=c(10,30,50,70,100,10,30,50,70,100)

n3=c(10,30,50,70,100,15,35,55,75,105)

n4=c(10,30,50,70,100,20,40,60,80,110)

n5=c(10,30,50,70,100,25,45,65,85,115)

```
alpha1=c(16,16,16,16,16,16)
alpha2=c(18,20,22,24,30,36)
alpha3=c(20,24,28,32,44,56)
alpha4=c(22,28,34,40,58,76)
alpha5=c(24,32,40,48,72,96)

beta1=1
beta2=1
beta3=1
beta4=1
beta5=1

COUNT <- array(rep(0, 10*6*6), dim=c(10,6,6))

for(j in 1:N)
{
  for(k in 1:O)
  {
    for(l in 1:M)
    {
      x1=rgamma(n1[j],alpha1[k],1/beta1)
      x2=rgamma(n2[j],alpha2[k],1/beta2)
      x3=rgamma(n3[j],alpha3[k],1/beta3)
      x4=rgamma(n4[j],alpha4[k],1/beta4)
      x5=rgamma(n5[j],alpha5[k],1/beta5)
      x=c(x1,x2,x3,x4,x5)
      g1=rep(1,n1[j])
      g2=rep(2,n2[j])
```

```

g3=rep(3,n3[j])
g4=rep(4,n4[j])
g5=rep(5,n5[j])
g=c(g1,g2,g3,g4,g5)
df = data.frame(x,g)

bart = bartlett.test(df$x,df$g)

if(bart$p.value<=alpha) COUNT[j,1,k]=COUNT[j,1,k]+1

ta = ((n1[j]-1)*log(var(x1),exp(1)))+((n2[j]-1)*log(var(x2),exp(1)))+((n3[j]-
1)*log(var(x3),exp(1)))+((n4[j]-1)*log(var(x4),exp(1)))+((n5[j]-1)*log(var(x5),exp(1)))

n = n1[j]+n2[j]+n3[j]+n4[j]+n5[j]

tb = ta/(n-5)

t = ((n1[j]-1)*((log(var(x1),exp(1))-tb)^2))+((n2[j]-1)*((log(var(x2),exp(1))-tb)^2))+((n3[j]-
1)*((log(var(x3),exp(1))-tb)^2))+((n4[j]-1)*((log(var(x4),exp(1))-tb)^2))+((n5[j]-
1)*((log(var(x5),exp(1))-tb)^2))

leh = ((n-5)*t)/((2*n)-20)

pvalueleh=1-pchisq(leh,4)

if(pvalueleh<=alpha) COUNT[j,2,k]=COUNT[j,2,k]+1

leve = levene.test(df$x,df$g,"mean")

if(leve$p.value<=alpha) COUNT[j,3,k]=COUNT[j,3,k]+1

bf = levene.test(df$x,df$g,"median")

if(bf$p.value<=alpha) COUNT[j,4,k]=COUNT[j,4,k]+1

```

$$z1 = (((n1[j]-1.5)*n1[j]*(x1-\text{mean}(x1))^2 - (0.5*\text{var}(x1)*(n1[j]-1)))) / ((n1[j]-1)*(n1[j]-2))$$

$$z2 = (((n2[j]-1.5)*n2[j]*(x2-\text{mean}(x2))^2 - (0.5*\text{var}(x2)*(n2[j]-1)))) / ((n2[j]-1)*(n2[j]-2))$$

$$z3 = (((n3[j]-1.5)*n3[j]*(x3-\text{mean}(x3))^2 - (0.5*\text{var}(x3)*(n3[j]-1)))) / ((n3[j]-1)*(n3[j]-2))$$

$$z4 = (((n4[j]-1.5)*n4[j]*(x4-\text{mean}(x4))^2 - (0.5*\text{var}(x4)*(n4[j]-1)))) / ((n4[j]-1)*(n4[j]-2))$$

$$z5 = (((n5[j]-1.5)*n5[j]*(x5-\text{mean}(x5))^2 - (0.5*\text{var}(x5)*(n5[j]-1)))) / ((n5[j]-1)*(n5[j]-2))$$

$$z = c(z1, z2, z3, z4, z5)$$

$$A = (n1[j]*(\text{mean}(z1) - \text{mean}(z))^2) + (n2[j]*(\text{mean}(z2) - \text{mean}(z))^2) + (n3[j]*(\text{mean}(z3) - \text{mean}(z))^2) + (n4[j]*(\text{mean}(z4) - \text{mean}(z))^2) + (n5[j]*(\text{mean}(z5) - \text{mean}(z))^2)$$

$$b1 = (z1 - \text{mean}(z1))^2$$

$$b2 = (z2 - \text{mean}(z2))^2$$

$$b3 = (z3 - \text{mean}(z3))^2$$

$$b4 = (z4 - \text{mean}(z4))^2$$

$$b5 = (z5 - \text{mean}(z5))^2$$

$$B = c(b1, b2, b3, b4, b5)$$

$$OB = (A/4) / (\text{sum}(B) / (n-5))$$

$$\text{criticalOB} = \text{qf}(1-\alpha, 4, n-5)$$

$$\text{if}(OB \geq \text{criticalOB}) \text{COUNT}[j, 5, k] = \text{COUNT}[j, 5, k] + 1$$

$$\text{var} = c(\text{var}(x1), \text{var}(x2), \text{var}(x3), \text{var}(x4), \text{var}(x5))$$

$$\text{size} = c(n1[j], n2[j], n3[j], n4[j], n5[j])$$

$$\text{if}(\text{var}(x1) == \text{max}(\text{var}))$$

$$G = ((n1[j]-1)*\text{max}(\text{var})) / (((n1[j]-1)*\text{var}(x1)) + ((n2[j]-1)*\text{var}(x2)) + ((n3[j]-1)*\text{var}(x3)) + ((n4[j]-1)*\text{var}(x4)) + ((n5[j]-1)*\text{var}(x5)))$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 5) / (n1[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/5), (n1[j] - 1), (\text{sum}(\text{size}) - 5) - (n1[j] - 1))))))$$

```
if(var(x2)== max(var))
```

$$G = \frac{(n2[j]-1) \cdot \max(\text{var})}{((n1[j]-1) \cdot \text{var}(x1)) + ((n2[j]-1) \cdot \text{var}(x2)) + ((n3[j]-1) \cdot \text{var}(x3)) + ((n4[j]-1) \cdot \text{var}(x4)) + ((n5[j]-1) \cdot \text{var}(x5))}$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 5) / (n2[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/5), (n2[j] - 1), (\text{sum}(\text{size}) - 5) - (n2[j] - 1))))))$$

```
if(var(x3)== max(var))
```

$$G = \frac{(n3[j]-1) \cdot \max(\text{var})}{((n1[j]-1) \cdot \text{var}(x1)) + ((n2[j]-1) \cdot \text{var}(x2)) + ((n3[j]-1) \cdot \text{var}(x3)) + ((n4[j]-1) \cdot \text{var}(x4)) + ((n5[j]-1) \cdot \text{var}(x5))}$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 5) / (n3[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/5), (n3[j] - 1), (\text{sum}(\text{size}) - 5) - (n3[j] - 1))))))$$

```
if(var(x4)== max(var))
```

$$G = \frac{(n4[j]-1) \cdot \max(\text{var})}{((n1[j]-1) \cdot \text{var}(x1)) + ((n2[j]-1) \cdot \text{var}(x2)) + ((n3[j]-1) \cdot \text{var}(x3)) + ((n4[j]-1) \cdot \text{var}(x4)) + ((n5[j]-1) \cdot \text{var}(x5))}$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 5) / (n4[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/5), (n4[j] - 1), (\text{sum}(\text{size}) - 5) - (n4[j] - 1))))))$$

```
if(var(x5)== max(var))
```

$$G = \frac{(n5[j]-1) \cdot \max(\text{var})}{((n1[j]-1) \cdot \text{var}(x1)) + ((n2[j]-1) \cdot \text{var}(x2)) + ((n3[j]-1) \cdot \text{var}(x3)) + ((n4[j]-1) \cdot \text{var}(x4)) + ((n5[j]-1) \cdot \text{var}(x5))}$$

$$\text{criticalg} = 1 / (1 + (((\text{sum}(\text{size}) - 5) / (n5[j] - 1)) - 1) / (\text{qf}(1 - (\alpha/5), (n5[j] - 1), (\text{sum}(\text{size}) - 5) - (n5[j] - 1))))))$$

```
if(G >= criticalg) COUNT[j,6,k]=COUNT[j,6,k]+1
```

```
}}
```

```
COUNT[1,,]=COUNT[1,,]/M
```

```
COUNT[2,,]=COUNT[2,,]/M
```

```
COUNT[3,,]=COUNT[3,,]/M
```

```
COUNT[4,,]=COUNT[4,,]/M
```

```
COUNT[5,,]=COUNT[5,,]/M
```

COUNT[6,,]=COUNT[6,,]/M

COUNT[7,,]=COUNT[7,,]/M

COUNT[8,,]=COUNT[8,,]/M

COUNT[9,,]=COUNT[9,,]/M

COUNT[10,,]=COUNT[10,,]/M

COUNT[1,,]

COUNT[2,,]

COUNT[3,,]

COUNT[4,,]

COUNT[5,,]

COUNT[6,,]

COUNT[7,,]

COUNT[8,,]

COUNT[9,,]

COUNT[10,,]

กราฟการแจกแจงปกติ

```
x = seq(-20,20,length.out = 50)

plot(x,dnorm(x,0,sqrt(16)),col = "red",type = "l",lwd = 2,ly = 1,ylab = "f(x)",main =
"Normal probability
density function")

lines(x,dnorm(x,0,sqrt(64)),col = "blue",type = "l",lwd = 2,ly = 2)

labels = c("Normal (0,16)","Normal (0,64)")

colors = c("red","blue")

ltys = c(1,2)

legend("topright",inset = .03,labels,lwd = 2,ly = ltys,col = colors)
```

กราฟการแจกแจงแกมมา

```
x=seq(0,100,length.out = 100)

plot(x,dgamma(x,16,1/1),col = "red",type = "l",lwd = 2,ly = 1,ylab = "f(x)",main =
"Gamma probability
density function")

lines(x,dgamma(x,64,1/1),col = "blue",type = "l",lwd = 2,ly = 2)

labels = c("gamma(16,1)","gamma(64,1)")

colors = c("red","blue")

ltys = c(1,2)

legend("topright",inset = .05,labels,lwd = 2,ly = ltys,col = colors)
```

กราฟเปรียบเทียบความน่าจะเป็นของความผิดพลาดแบบที่ 1

```
BradUp1 = rep(0.015,5)
BradLow1 = rep(0.005,5)
bart1 = c(0.0098,0.0096,0.0112,0.0102,0.0116)
leh1 = c(0.0278,0.0156,0.0132,0.0128,0.0132)
leve1 = c(0.0126,0.0114,0.0128,0.0118,0.0126)
bf1 = c(0.0054,0.0074,0.0092,0.0094,0.0106)
OB1 = c(0.0036,0.0062,0.0074,0.0088,0.0084)
G1 = c(0.0102,0.0094,0.0116,0.0092,0.0080)
y = c('(10,10,10)', '(30,30,30)', '(50,50,50)', '(70,70,70)', '(100,100,100)')
x = seq(1,5)
plot(x,bart1,type = "b",col = "red",xaxt = "n",ylim = c(0.000,0.03),main = "Normal
Distribution
alpha = 0.01",xlab = "(n1,n2,n3)",ylab = "Type I Error",pch = 6)
lines(x,leh1,type = "b",col = "violet",pch = 5)
lines(x,leve1,type = "b",col = "blue",pch = 3)
lines(x,bf1,type = "b",col = "green",pch = 15)
lines(x,OB1,type = "b",col = "brown",pch = 16)
lines(x,G1,type = "b",col = "black",pch = 17)
lines(x,BradUp1,type = "l",lty = 2)
lines(x,BradLow1,type = "l",lty = 2)
axis(1, at = 1:5, labels = y)
labels = c("Bartlett", "Lehmann", "Levene", "Brown-Frosythe", "O-Brien", "G")
colors = c("red", "violet", "blue", "green", "brown", "black")
```

```
pchh = c(6,5,3,15,16,17)
```

```
legend("topright",inset = .05,labels,lwd = 2,lty = 1,col = colors,pch = pchh)
```

กราฟเปรียบเทียบกำลังการทดสอบ

```
bart1 = c(0.0114,0.0178,0.0430,0.0598,0.1020,0.2744)
```

```
leve1 = c(0.0192,0.0216,0.0468,0.0638,0.0882,0.1828)
```

```
bf1 = c(0.0074,0.0102,0.0194,0.0328,0.0430,0.0900)
```

```
G1 = c(0.0120,0.0210,0.0450,0.0604,0.0948,0.1664)
```

```
bart2 = c(0.0178,0.0448,0.2388,0.3192,0.5888,0.9472)
```

```
leve2 = c(0.0210,0.0422,0.1842,0.2472,0.4572,0.8462)
```

```
bf2 = c(0.0136,0.0286,0.1480,0.1972,0.3916,0.7970)
```

```
OB2 = c(0.0132,0.0312,0.1366,0.1836,0.3516,0.6898)
```

```
G2 = c(0.0170,0.0396,0.1750,0.2170,0.3752,0.6236)
```

```
bart3 = c(0.0250,0.0824,0.4704,0.6208,0.8862,0.9988)
```

```
leh3 = c(0.0304,0.0942,0.5042,0.6610,0.9078,0.9992)
```

```
leve3 = c(0.0244,0.0686,0.3792,0.5016,0.7948,0.9930)
```

```
bf3 = c(0.0182,0.0576,0.3414,0.4634,0.7634,0.9894)
```

```
OB3 = c(0.0214,0.0580,0.3508,0.4788,0.7488,0.9788)
```

```
G3 = c(0.0244,0.0670,0.3176,0.4250,0.6238,0.8734)
```

```
bart4 = c(0.0316,0.1246,0.6738,0.8072,0.9768,1.0000)
```

```
leh4 = c(0.0366,0.1370,0.7050,0.8292,0.9818,1.0000)
```

```
leve4 = c(0.0318,0.1048,0.5780,0.7122,0.9410,0.9998)
```

```
bf4 = c(0.0280,0.0920,0.5486,0.6840,0.9302,0.9998)
```

```

OB4 = c(0.0300,0.1002,0.5796,0.7074,0.9316,0.9998)
G4 = c(0.0310,0.0984,0.4776,0.5820,0.7908,0.9682)
bart5 = c(0.0466,0.1992,0.8706,0.9498,0.9984,1.0000)
leh5 = c(0.0512,0.2110,0.8836,0.9568,0.9988,1.0000)
leve5 = c(0.0418,0.1702,0.7932,0.8980,0.9934,1.0000)
bf5 = c(0.0366,0.1576,0.7782,0.8898,0.9912,1.0000)
OB5 = c(0.0432,0.1704,0.8118,0.9152,0.9940,1.0000)
G5 = c(0.0430,0.1572,0.6654,0.7848,0.9326,0.9982)
y = c('0.4082','0.8165','2.0412','2.4495','3.6742','7.3485')
x = seq(1,6)

plot(x,bart1,type = "b",lty = 1,lwd = 1,col = "red",xaxt = "n",ylim = c(0,1),main =
"Normal Distribution

alpha = 0.01 , (n1,n2,n3) = (10,10,10)",xlab = "Noncentrality Parameter",ylab = "Power
of The Test",pch = 6,cex = 1.5)

lines(x,leve1,type = "b",lty = 1,lwd = 1,col = "blue",pch = 3,cex=1.5)

lines(x,bf1,type = "b",lty = 1,lwd = 1,col = "green",pch = 15,cex=1.5)

lines(x,G1,type = "b",lty = 1,lwd = 1,col = "black",pch = 17,cex=1.5)

axis(1, at = 1:6, labels = y)

labels = c("Bartlett","Levene","Brown-Frosythe","G")

colors = c("red","blue","green","black")

pchh = c(6,3,15,17)

legend("topleft",inset = .025,labels,lwd = 1,lty = 1,col = colors,pch = pchh)

plot(x,bart2,type = "b",lty = 1,lwd = 1,col = "red",xaxt = "n",ylim = c(0,1),main =
"Normal Distribution

alpha = 0.01 , (n1,n2,n3) = (30,30,30)",xlab = "Noncentrality Parameter",ylab = "Power
of The Test",pch = 6,cex = 1.5)

```

```

lines(x,leve2,type = "b",lty = 1,lwd = 1,col = "blue",pch = 3,cex=1.5)
lines(x,bf2,type = "b",lty = 1,lwd = 1,col = "green",pch = 15,cex=1.5)
lines(x,OB2,type = "b",lty = 1,lwd = 1,col = "brown",pch = 16,cex=1.5)
lines(x,G2,type = "b",lty = 1,lwd = 1,col = "black",pch = 17,cex=1.5)
axis(1, at = 1:6, labels = y)
labels = c("Bartlett","Levene","Brown-Frosythe","O-Brien","G")
colors = c("red","blue","green","brown","black")
pchh = c(6,3,15,16,17)
legend("topleft",inset = .025,labels,lwd = 1,lty = 1,col = colors,pch = pchh)
plot(x,bart3,type = "b",lty = 1,lwd = 1,col = "red",xaxt = "n",ylim = c(0,1),main =
"Normal Distribution
alpha = 0.01 , (n1,n2,n3) = (50,50,50)",xlab = "Noncentrality Parameter",ylab = "Power
of The Test",pch = 6,cex = 1.5)
lines(x,leh3,type = "b",lty = 1,lwd = 1,col = "violet",pch = 5,cex=1.5)
lines(x,leve3,type = "b",lty = 1,lwd = 1,col = "blue",pch = 3,cex=1.5)
lines(x,bf3,type = "b",lty = 1,lwd = 1,col = "green",pch = 15,cex=1.5)
lines(x,OB3,type = "b",lty = 1,lwd = 1,col = "brown",pch = 16,cex=1.5)
lines(x,G3,type = "b",lty = 1,lwd = 1,col = "black",pch = 17,cex=1.5)
axis(1, at = 1:6, labels = y)
labels = c("Bartlett","Lehmann","Levene","Brown-Frosythe","O-Brien","G")
colors = c("red","violet","blue","green","brown","black")
pchh = c(6,5,3,15,16,17)
legend("topleft",inset = .025,labels,lwd = 1,lty = 1,col = colors,pch = pchh)
plot(x,bart4,type = "b",lty = 1,lwd = 1,col = "red",xaxt = "n",ylim = c(0,1),main =
"Normal Distribution

```

```
alpha = 0.01 , (n1,n2,n3) = (70,70,70)",xlab = "Noncentrality Parameter",ylab = "Power
of The Test",pch = 6,cex = 1.5)
```

```
lines(x,leh4,type = "b",lty = 1,lwd = 1,col = "violet",pch = 5,cex=1.5)
```

```
lines(x,leve4,type = "b",lty = 1,lwd = 1,col = "blue",pch = 3,cex=1.5)
```

```
lines(x,bf4,type = "b",lty = 1,lwd = 1,col = "green",pch = 15,cex=1.5)
```

```
lines(x,OB4,type = "b",lty = 1,lwd = 1,col = "brown",pch = 16,cex=1.5)
```

```
lines(x,G4,type = "b",lty = 1,lwd = 1,col = "black",pch = 17,cex=1.5)
```

```
axis(1, at = 1:6, labels = y)
```

```
labels = c("Bartlett","Lehmann","Levene","Brown-Frosythe","O-Brien","G")
```

```
colors = c("red","violet","blue","green","brown","black")
```

```
pchh = c(6,5,3,15,16,17)
```

```
legend("topleft",inset = .025,labels,lwd = 1,lty = 1,col = colors,pch = pchh)
```

```
plot(x,bart5,type = "b",lty = 1,lwd = 1,col = "red",xaxt = "n",ylim = c(0,1),main =
"Normal Distribution
```

```
alpha = 0.01 , (n1,n2,n3) = (100,100,100)",xlab = "Noncentrality Parameter",ylab =
"Power of The Test",pch = 6,cex = 1.5)
```

```
lines(x,leh5,type = "b",lty = 1,lwd = 1,col = "violet",pch = 5,cex=1.5)
```

```
lines(x,leve5,type = "b",lty = 1,lwd = 1,col = "blue",pch = 3,cex=1.5)
```

```
lines(x,bf5,type = "b",lty = 1,lwd = 1,col = "green",pch = 15,cex=1.5)
```

```
lines(x,OB5,type = "b",lty = 1,lwd = 1,col = "brown",pch = 16,cex=1.5)
```

```
lines(x,G5,type = "b",lty = 1,lwd = 1,col = "black",pch = 17,cex=1.5)
```

```
axis(1, at = 1:6, labels = y)
```

```
labels = c("Bartlett","Lehmann","Levene","Brown-Frosythe","O-Brien","G")
```

```
colors = c("red","violet","blue","green","brown","black")
```

```
pchh = c(6,5,3,15,16,17)
```

```
legend("topleft",inset = .025,labels,lwd = 1,lty = 1,col = colors,pch = pchh)
```