

## รายการอ้างอิง

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ภาคผนวก

โปรแกรมการคำนวณค่าองค์ประกอบความแปรปรวนด้วยวิธีความควรจะเป็นสูงสุด  
และวิธีความควรจะเป็นสูงสุดแบบมอนติคาร์โล

```

a_2
b_2
n_2
cv_0.1
h_1
u_40
trial_400
loop_500

var.e_((cv*u)^2)/((3*h)+1)
var.a_(h*var.e)
var.b_(h*var.e)
var.ab_(h*var.e)

md.ml_array(dim=c(1,loop))
md.mc_array(dim=c(1,loop))

newseta.mon_array(dim=c(1,trial))
tr.mon_array(dim=c(4,4,trial))
snewseta.mon_array(dim=c(4,1,trial))
y2.mon_array(dim=c(a,b,n))
y.mon_array(dim=c(a*b*n,1,trial))

if(a==2&b==2&n==2)
{
  a1_rep(c(1,0),4)
  a2_rep(c(0,1),4)
  aa_c(a1,a2)
  b1_rep(c(1,0),2)
  b2_rep(c(0,1),2)
  bb_rep(c(b1,b2),2)
  c1_rep(c(1,0,0,0),2)
  c2_rep(c(0,1,0,0),2)
}

```

```
    c3_rep(c(0,0,1,0),2)
    c4_rep(c(0,0,0,1),2)
    ab_c(c1,c2,c3,c4)
  }else

  if(a==2&b==2&n==3)
  {
    a1_rep(c(1,0),6)
    a2_rep(c(0,1),6)
    aa_c(a1,a2)
    b1_rep(c(1,0),3)
    b2_rep(c(0,1),3)
    bb_rep(c(b1,b2),2)
    c1_rep(c(1,0,0,0),3)
    c2_rep(c(0,1,0,0),3)
    c3_rep(c(0,0,1,0),3)
    c4_rep(c(0,0,0,1),3)
    ab_c(c1,c2,c3,c4)
  }else

  if(a==2&b==2&n==4)
  {
    a1_rep(c(1,0),8)
    a2_rep(c(0,1),8)
    aa_c(a1,a2)
    b1_rep(c(1,0),4)
    b2_rep(c(0,1),4)
    bb_rep(c(b1,b2),2)
    c1_rep(c(1,0,0,0),4)
    c2_rep(c(0,1,0,0),4)
    c3_rep(c(0,0,1,0),4)
    c4_rep(c(0,0,0,1),4)
    ab_c(c1,c2,c3,c4)
  }else
```

```

if(a==3&b==3&n==2)
{
    a1_rep(c(1,0,0),6)
    a2_rep(c(0,1,0),6)
    a3_rep(c(0,0,1),6)
    aa_c(a1,a2,a3)
    b1_rep(c(1,0,0),2)
    b2_rep(c(0,1,0),2)
    b3_rep(c(0,0,1),2)
    bb_rep(c(b1,b2,b3),3)
    c1_rep(c(1,0,0,0,0,0,0,0,0),2)
    c2_rep(c(0,1,0,0,0,0,0,0,0),2)
    c3_rep(c(0,0,1,0,0,0,0,0,0),2)
    c4_rep(c(0,0,0,1,0,0,0,0,0),2)
    c5_rep(c(0,0,0,0,1,0,0,0,0),2)
    c6_rep(c(0,0,0,0,0,1,0,0,0),2)
    c7_rep(c(0,0,0,0,0,0,1,0,0),2)
    c8_rep(c(0,0,0,0,0,0,0,1,0),2)
    c9_rep(c(0,0,0,0,0,0,0,0,1),2)
    ab_c(c1,c2,c3,c4,c5,c6,c7,c8,c9)
}else

if(a==3&b==3&n==3)
{
    a1_rep(c(1,0,0),9)
    a2_rep(c(0,1,0),9)
    a3_rep(c(0,0,1),9)
    aa_c(a1,a2,a3)
    b1_rep(c(1,0,0),3)
    b2_rep(c(0,1,0),3)
    b3_rep(c(0,0,1),3)
    bb_rep(c(b1,b2,b3),3)
    c1_rep(c(1,0,0,0,0,0,0,0,0),3)
    c2_rep(c(0,1,0,0,0,0,0,0,0),3)
    c3_rep(c(0,0,1,0,0,0,0,0,0),3)

```

```

c4_rep(c(0,0,0,1,0,0,0,0),3)
c5_rep(c(0,0,0,0,1,0,0,0),3)
c6_rep(c(0,0,0,0,0,1,0,0),3)
c7_rep(c(0,0,0,0,0,0,1,0),3)
c8_rep(c(0,0,0,0,0,0,0,1),3)
c9_rep(c(0,0,0,0,0,0,0,1),3)
ab_c(c1,c2,c3,c4,c5,c6,c7,c8,c9)
}else

if(a==3&b==3&n==4)
{
  a1_rep(c(1,0,0),12)
  a2_rep(c(0,1,0),12)
  a3_rep(c(0,0,1),12)
  aa_c(a1,a2,a3)
  b1_rep(c(1,0,0),4)
  b2_rep(c(0,1,0),4)
  b3_rep(c(0,0,1),4)
  bb_rep(c(b1,b2,b3),3)
  c1_rep(c(1,0,0,0,0,0,0,0),4)
  c2_rep(c(0,1,0,0,0,0,0,0),4)
  c3_rep(c(0,0,1,0,0,0,0,0),4)
  c4_rep(c(0,0,0,1,0,0,0,0),4)
  c5_rep(c(0,0,0,0,1,0,0,0),4)
  c6_rep(c(0,0,0,0,0,1,0,0),4)
  c7_rep(c(0,0,0,0,0,0,1,0),4)
  c8_rep(c(0,0,0,0,0,0,0,1),4)
  c9_rep(c(0,0,0,0,0,0,0,1),4)
  ab_c(c1,c2,c3,c4,c5,c6,c7,c8,c9)
}else

if(a==4&b==4&n==2)
{
  a1_rep(c(1,0,0,0),8)
  a2_rep(c(0,1,0,0),8)

```

```

a3_rep(c(0,0,1,0),8)
a4_rep(c(0,0,0,1),8)
aa_c(a1,a2,a3,a4)
b1_rep(c(1,0,0,0),2)
b2_rep(c(0,1,0,0),2)
b3_rep(c(0,0,1,0),2)
b4_rep(c(0,0,0,1),2)
bb_rep(c(b1,b2,b3,b4),4)
c1_rep(c(1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0),2)
c2_rep(c(0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0),2)
c3_rep(c(0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0),2)
c4_rep(c(0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0),2)
c5_rep(c(0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0),2)
c6_rep(c(0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0),2)
c7_rep(c(0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0),2)
c8_rep(c(0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0),2)
c9_rep(c(0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0),2)
c10_rep(c(0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0),2)
c11_rep(c(0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0),2)
c12_rep(c(0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0),2)
c13_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0),2)
c14_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0),2)
c15_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0),2)
c16_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1),2)
ab_c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16)
}else

if(a==4&b==4&n==3)
{
a1_rep(c(1,0,0,0),12)
a2_rep(c(0,1,0,0),12)
a3_rep(c(0,0,1,0),12)
a4_rep(c(0,0,0,1),12)
aa_c(a1,a2,a3,a4)
b1_rep(c(1,0,0,0),3)

```



```

b2_rep(c(0,1,0,0),3)
b3_rep(c(0,0,1,0),3)
b4_rep(c(0,0,0,1),3)
bb_rep(c(b1,b2,b3,b4),4)
c1_rep(c(1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0),3)
c2_rep(c(0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0),3)
c3_rep(c(0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0),3)
c4_rep(c(0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0),3)
c5_rep(c(0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0),3)
c6_rep(c(0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0),3)
c7_rep(c(0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0),3)
c8_rep(c(0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0),3)
c9_rep(c(0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0),3)
c10_rep(c(0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0),3)
c11_rep(c(0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0),3)
c12_rep(c(0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0),3)
c13_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0),3)
c14_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0),3)
c15_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0),3)
c16_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1),3)
ab_c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16)
}else

if(a==4&b==4&n==4)
{
a1_rep(c(1,0,0,0),16)
a2_rep(c(0,1,0,0),16)
a3_rep(c(0,0,1,0),16)
a4_rep(c(0,0,0,1),16)
aa_c(a1,a2,a3,a4)
b1_rep(c(1,0,0,0),4)
b2_rep(c(0,1,0,0),4)
b3_rep(c(0,0,1,0),4)
b4_rep(c(0,0,0,1),4)
bb_rep(c(b1,b2,b3,b4),4)

```

```

c1_rep(c(1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0),4)
c2_rep(c(0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0),4)
c3_rep(c(0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0),4)
c4_rep(c(0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0),4)
c5_rep(c(0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0),4)
c6_rep(c(0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0),4)
c7_rep(c(0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0),4)
c8_rep(c(0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0),4)
c9_rep(c(0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0),4)
c10_rep(c(0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0),4)
c11_rep(c(0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0),4)
c12_rep(c(0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0),4)
c13_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0),4)
c14_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0),4)
c15_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0),4)
c16_rep(c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1),4)
ab_c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10,c11,c12,c13,c14,c15,c16)

```

```

}else stop ("missing value")

```

```

z1_matrix(aa,ncol=a,byrow=T)
z1t_t(z1)
z11_z1%*%z1t
z2_matrix(bb,ncol=b,byrow=T)
z2t_t(z2)
z22_z2%*%z2t
z3_matrix(ab,ncol=a*b,byrow=T)
z3t_t(z3)
z33_z3%*%z3t
z4_diag(a*b*n)
z4t_t(z4)
z44_z4%*%z4t
for(l in 1:loop)
{
  data.e_array(morm(a*b*n,0,sqrt(var.e)),dim=c(a,b,n))
  data.a_array(morm(a,0,sqrt(var.a)),dim=c(a))
}

```

```

data.b_array(mnorm(b,0,sqrt(var.b)),dim=c(b))
data.ab_array(mnorm(a*b,0,sqrt(var.ab)),dim=c(a,b))

y_array(dim=c(a,b,n))
for(i in 1:a)
{
  for(j in 1:b)
  {
    for(k in 1:n)
    {
      y[i,j,k]_u + data.a[i] + data.b[j] + data.ab[i,j] + data.e[i,j,k]
    }
  }
}
s.s_0
for(i in 1:a)
{
  for(j in 1:b)
  {
    for(k in 1:n)
    {
      s.s_s.s + y[i,j,k]
    }
  }
}
s.s_(s.s^2)/(a*b*n)
s.e_0
for(i in 1:a)
{
  for(j in 1:b)
  {
    for(k in 1:n)
    {
      s.e_s.e + (y[i,j,k])^2
    }
  }
}

```

```

    }
  }
  s.a_0
  s.at_0
  for(i in 1:a)
  {
    for(j in 1:b)
    {
      for(k in 1:n)
      {
        s.at_s.at + y[i,j,k]
      }
    }
    s.a_s.a + (s.at^2)
    s.at_0
  }
  s.a_(s.a)/(b*n)
  s.b_0
  s.bt_0
  for(j in 1:b)
  {
    for(i in 1:a)
    {
      for(k in 1:n)
      {
        s.bt_s.bt + y[i,j,k]
      }
    }
    s.b_s.b + (s.bt^2)
    s.bt_0
  }
  s.b_(s.b)/(a*n)
  s.ab_0
  s.abt_0
  for(i in 1:a)

```

```

    {
      for(j in 1:b)
      {
        for(k in 1:n)
        {
          s.abt_s.abt + y[i,j,k]
        }
        s.ab_s.ab + (s.abt^2)
        s.abt_0
      }
    }
s.ab_(s.ab)/(n)

```

```

sst_s.e - s.s
ssa_s.a - s.s
ssb_s.b - s.s
ssab_s.ab - s.s - ssa - ssb
sse_sst - ssa - ssb - ssab
df.a_a-1
df.b_b-1
df.ab_(a-1)*(b-1)
df.e_a*b*(n-1)
msa_round(ssa/df.a,digits=6)
msb_round(ssb/df.b,digits=6)
msab_round(ssab/df.ab,digits=6)
mse_round(sse/df.e,digits=6)
cl.a_round((msa-msab)/(b*n),digits=6)
cl.b_round((msb-msab)/(a*n),digits=6)
cl.ab_round((msab-mse)/(n),digits=6)
cl.e_mse

```

```

if(cl.a < 0)    {cl.a_var.a}
if(cl.b < 0)    {cl.b_var.b}
if(cl.ab < 0)   {cl.ab_var.ab}
if(cl.e < 0)    {cl.e_var.e}

```

```

if(a==2&b==2&n==2) {yn_c(y[1,1.],y[1,2.],y[2,1.],y[2,2.])}else
if(a==2&b==2&n==3) {yn_c(y[1,1.],y[1,2.],y[2,1.],y[2,2.])}else
if(a==2&b==2&n==4) {yn_c(y[1,1.],y[1,2.],y[2,1.],y[2,2.])}else
if(a==3&b==3&n==2) {yn_c(y[1,1.],y[1,2.],y[1,3.],y[2,1.],y[2,2.],y[2,3.],y[3,1.],y[3,2.],y[3,3.])} else
if(a==3&b==3&n==3) {yn_c(y[1,1.],y[1,2.],y[1,3.],y[2,1.],y[2,2.],y[2,3.],y[3,1.],y[3,2.],y[3,3.])} else
if(a==3&b==3&n==4) {yn_c(y[1,1.],y[1,2.],y[1,3.],y[2,1.],y[2,2.],y[2,3.],y[3,1.],y[3,2.],y[3,3.])} else
if(a==4&b==4&n==2)
    {yn_c(y[1,1.],y[1,2.],y[1,3.],y[1,4.],y[2,1.],y[2,2.],y[2,3.],y[2,4.],y[3,1.],y[3,2.],y[3,3.],y[3,4.])}
    else
if(a==4&b==4&n==3)
    {yn_c(y[1,1.],y[1,2.],y[1,3.],y[1,4.],y[2,1.],y[2,2.],y[2,3.],y[2,4.],y[3,1.],y[3,2.],y[3,3.],y[3,4.])}
    else
if(a==4&b==4&n==4)
    {yn_c(y[1,1.],y[1,2.],y[1,3.],y[1,4.],y[2,1.],y[2,2.],y[2,3.],y[2,4.],y[3,1.],y[3,2.],y[3,3.],y[3,4.])}
    else stop("missing value")

yy_matrix(y,ncol=1,byrow=T)
yb_mean(y)
ybar_matrix(rep(yb,a*b*n),ncol=1,byrow=T)
yu_yy-ybar

maxi_300
eps_0.000001
iter_0
con_F

newseta_matrix(c(cl.a,cl.b,cl.ab,cl.e),ncol=1,byrow=T)
while(!(con)&(iter<maxi))
{
    iter_iter+1
    seta_newseta
    va_newseta[1]
    vb_newseta[2]
}

```

vab\_newseta[3]

ve\_newseta[4]

$v_{z11}va + v_{z22}vb + v_{z33}vab + v_{z44}ve$

vin\_ginverse(v)

vz11\_vin%\*%z11

vz22\_vin%\*%z22

vz33\_vin%\*%z33

vz44\_vin%\*%z44

trvz11\_sum(diag(vz11))

trvz22\_sum(diag(vz22))

trvz33\_sum(diag(vz33))

trvz44\_sum(diag(vz44))

$u1_{((t(yu)\%*%vz11\%*%vin\%*%yu)/2)-(trvz11/2)}$

$u2_{((t(yu)\%*%vz22\%*%vin\%*%yu)/2)-(trvz22/2)}$

$u3_{((t(yu)\%*%vz33\%*%vin\%*%yu)/2)-(trvz33/2)}$

$u4_{((t(yu)\%*%vz44\%*%vin\%*%yu)/2)-(trvz44/2)}$

AA\_vz11%\*%vz11

BB\_vz22%\*%vz22

ABAB\_vz33%\*%vz33

EE\_vz44%\*%vz44

AABB\_vz11%\*%vz22

AAAB\_vz11%\*%vz33

AAEE\_vz11%\*%vz44

BBAB\_vz22%\*%vz33

BBEE\_vz22%\*%vz44

ABEE\_vz33%\*%vz44

trAA\_sum(diag(AA))

trBB\_sum(diag(BB))

trABAB\_sum(diag(ABAB))

trEE\_sum(diag(EE))

```

trAABB_sum(diag(AABB))
trAAAB_sum(diag(AAAB))
trAAEE_sum(diag(AAEE))
trBBAB_sum(diag(BBAB))
trBBEE_sum(diag(BBEE))
trABEE_sum(diag(ABEE))

h11_(trAA/2)-(t(yu)%*%AA%*%vin%*%yu)
h12_(trAABB/2)-(t(yu)%*%AABB%*%vin%*%yu)
h13_(trAAAB/2)-(t(yu)%*%AAAB%*%vin%*%yu)
h14_(trAAEE/2)-(t(yu)%*%AAEE%*%vin%*%yu)
h22_(trBB/2)-(t(yu)%*%BB%*%vin%*%yu)
h23_(trBBAB/2)-(t(yu)%*%BBAB%*%vin%*%yu)
h24_(trBBEE/2)-(t(yu)%*%BBEE%*%vin%*%yu)
h33_(trABAB/2)-(t(yu)%*%ABAB%*%vin%*%yu)
h34_(trABEE/2)-(t(yu)%*%ABEE%*%vin%*%yu)
h44_(trEE/2)-(t(yu)%*%EE%*%vin%*%yu)

uu_matrix(c(u1,u2,u3,u4),ncol=1,byrow=T)
hh_matrix(c(h11,h12,h13,h14,h12,h22,h23,h24,h13,h23,h33,h34,h14,h24,h34,h44),ncol=4,byrow
=T)

hin_ginverse(hh)
newseta_setahin%*%uu
con_all(abs(newseta-seta)<eps)

if(newseta[1]<0) {newseta[1]_0}
if(newseta[2]<0) {newseta[2]_0}
if(newseta[3]<0) {newseta[3]_0}
if(newseta[4]<0) {newseta[4]_0}
}
cat("\n")

for(z in 1:trial)

```



```

{
  data.em_array(morm(a*b*n,0,sqrt(newseta[4])),dim=c(a,b,n))
  data.am_array(morm(a,0,sqrt(newseta[1])),dim=c(a))
  data.bm_array(morm(b,0,sqrt(newseta[2])),dim=c(b))
  data.abm_array(morm(a*b,0,sqrt(newseta[3])),dim=c(a,b))

  for(i in 1:a)
  {
    for(j in 1:b)
    {
      for(k in 1:n)
      {
        y2.mon[i,j,k]_u + data.am[i] + data.bm[j] + data.abm[i,j] + data.em[i,j,k]
      }
    }
  }

  y.mon_matrix(y2.mon,ncol=1,byrow=T)
  yb.mon_mean(y.mon)
  ybar.mon_matrix(rep(yb.mon,a*b*n),ncol=1,byrow=T)
  yu.mon_y.mon-ybar.mon

  maxi.mon_300
  eps.mon_0.000001
  iter.mon_0
  con.mon_F

  newseta.mon_matrix(c(cl.a,cl.b,cl.ab,cl.e),ncol=1,byrow=T)
  while((!con.mon)&(iter.mon<maxi.mon))
  {
    iter.mon_iter.mon+1
    seta.mon_newseta.mon
    va.mon_newseta.mon[1]
    vb.mon_newseta.mon[2]
    vab.mon_newseta.mon[3]
    ve.mon_newseta.mon[4]
  }

```

$v.mon_{(z11*va.mon)+(z22*vb.mon)+(z33*vab.mon)+(z44*ve.mon)}$

$vin.mon_{ginverse(v.mon)}$

$vz11.mon_{vin.mon}^{z11}$

$vz22.mon_{vin.mon}^{z22}$

$vz33.mon_{vin.mon}^{z33}$

$vz44.mon_{vin.mon}^{z44}$

$trvz11.mon_{sum(diag(vz11.mon))}$

$trvz22.mon_{sum(diag(vz22.mon))}$

$trvz33.mon_{sum(diag(vz33.mon))}$

$trvz44.mon_{sum(diag(vz44.mon))}$

$u1.mon_{((t(yu.mon)^{z11}vz11.mon^{z11}vin.mon^{z11}yu.mon)/2)-(trvz11.mon/2)}$

$u2.mon_{((t(yu.mon)^{z22}vz22.mon^{z22}vin.mon^{z22}yu.mon)/2)-(trvz22.mon/2)}$

$u3.mon_{((t(yu.mon)^{z33}vz33.mon^{z33}vin.mon^{z33}yu.mon)/2)-(trvz33.mon/2)}$

$u4.mon_{((t(yu.mon)^{z44}vz44.mon^{z44}vin.mon^{z44}yu.mon)/2)-(trvz44.mon/2)}$

$AA.mon_{vz11.mon}^{vz11.mon}$

$BB.mon_{vz22.mon}^{vz22.mon}$

$ABAB.mon_{vz33.mon}^{vz33.mon}$

$EE.mon_{vz44.mon}^{vz44.mon}$

$AABB.mon_{vz11.mon}^{vz22.mon}$

$AAAB.mon_{vz11.mon}^{vz33.mon}$

$AAEE.mon_{vz11.mon}^{vz44.mon}$

$BBAB.mon_{vz22.mon}^{vz33.mon}$

$BBEE.mon_{vz22.mon}^{vz44.mon}$

$ABEE.mon_{vz33.mon}^{vz44.mon}$

$trAA.mon_{sum(diag(AA.mon))}$

$trBB.mon_{sum(diag(BB.mon))}$

$trABAB.mon_{sum(diag(ABAB.mon))}$

$trEE.mon_{sum(diag(EE.mon))}$

$trAABB.mon_{sum(diag(AABB.mon))}$

```
trAAAB.mon_sum(diag(AAAB.mon))
```

```
trAAEE.mon_sum(diag(AAEE.mon))
```

```
trBBAB.mon_sum(diag(BBAB.mon))
```

```
trBBEE.mon_sum(diag(BBEE.mon))
```

```
trABEE.mon_sum(diag(ABEE.mon))
```

```
h11.mon_(trAA.mon/2)-(t(yu.mon)**%AA.mon**%vin.mon**%yu.mon)
```

```
h12.mon_(trAABB.mon/2)-(t(yu.mon)**%AABB.mon**%vin.mon**%yu.mon)
```

```
h13.mon_(trAAAB.mon/2)-(t(yu.mon)**%AAAB.mon**%vin.mon**%yu.mon)
```

```
h14.mon_(trAAEE.mon/2)-(t(yu.mon)**%AAEE.mon**%vin.mon**%yu.mon)
```

```
h22.mon_(trBB.mon/2)-(t(yu.mon)**%BB.mon**%vin.mon**%yu.mon)
```

```
h23.mon_(trBBAB.mon/2)-(t(yu.mon)**%BBAB.mon**%vin.mon**%yu.mon)
```

```
h24.mon_(trBBEE.mon/2)-(t(yu.mon)**%BBEE.mon**%vin.mon**%yu.mon)
```

```
h33.mon_(trABAB.mon/2)-(t(yu.mon)**%ABAB.mon**%vin.mon**%yu.mon)
```

```
h34.mon_(trABEE.mon/2)-(t(yu.mon)**%ABEE.mon**%vin.mon**%yu.mon)
```

```
h44.mon_(trEE.mon/2)-(t(yu.mon)**%EE.mon**%vin.mon**%yu.mon)
```

```
uu.mon_matrix(c(u1.mon,u2.mon,u3.mon,u4.mon),ncol=1,byrow=T)
```

```
hh.mon_matrix(c(h11.mon,h12.mon,h13.mon,h14.mon,h12.mon,h22.mon,h23.mon,h24.mon,h13.
mon,h23.mon,h33.mon,h34.mon,h14.mon,h24.mon,h34.mon,h44.mon),ncol=4,byrow=T)
```

```
hin.mon_ginverse(hh.mon)
```

```
newseta.mon_seta.mon-hin.mon**%uu.mon
```

```
con.mon_all(abs(newseta.mon-seta.mon)<eps.mon)
```

```
if(newseta.mon[1]<0) {newseta.mon[1]_0}
```

```
if(newseta.mon[2]<0) {newseta.mon[2]_0}
```

```
if(newseta.mon[3]<0) {newseta.mon[3]_0}
```

```
if(newseta.mon[4]<0) {newseta.mon[4]_0}
```

```
}
```

```
nc_array(newseta.mon,dim=c(4,1))
```

```
snewseta.mon[,z]_array(nc)
```

```
tr_matrix(c(trAA.mon/2,trAABB.mon/2,trAAAB.mon/2,trAAEE.mon/2,
```

```
trAABB.mon/2,trBB.mon/2,trBBAB.mon/2,trBBEE.mon/2,
```

```
trAAAB.mon/2,trBBAB.mon/2,trABAB.mon/2,trABEE.mon/2,
```

```

trAAEE.mon/2,trBBEE.mon/2,trABEE.mon/2,trEE.mon/2),ncol=4,byrow=T)
trc_solve(tr)
tr.mon[,z]_array(trc)
}
s1_sum((snewseta.mon[1,,])/trial)
s2_sum((snewseta.mon[2,,])/trial)
s3_sum((snewseta.mon[3,,])/trial)
s4_sum((snewseta.mon[4,,])/trial)

tr11_(sum(tr.mon[1,1,])/trial)
tr22_(sum(tr.mon[2,2,])/trial)
tr33_(sum(tr.mon[3,3,])/trial)
tr44_(sum(tr.mon[4,4,])/trial)
tr12_(sum(tr.mon[1,2,])/trial)
tr13_(sum(tr.mon[1,3,])/trial)
tr14_(sum(tr.mon[1,4,])/trial)
tr23_(sum(tr.mon[2,3,])/trial)
tr24_(sum(tr.mon[2,4,])/trial)
tr34_(sum(tr.mon[3,4,])/trial)

cc.mc_c(tr11,tr12,tr13,tr14,tr12,tr22,tr23,tr24,tr13,tr23,tr33,tr34,tr14,tr24,tr34,tr44)
co.mc_matrix(cc.mc,ncol=4,byrow=T)
nv.mc_matrix(c(s1,s2,s3,s4),ncol=1,byrow=T)
vr.mc_matrix(c(var.a,var.b,var.ab,var.e),ncol=4,byrow=T)
md.mc[l]_sqrt(mahalanobis(vr.mc,nv.mc,co.mc))

cc.ml_matrix(c(trAA/2,trAABB/2,trAAAB/2,trAAEE/2,
trAABB/2,trBB/2,trBBAB/2,trBBEE/2,
trAAAB/2,trBBAB/2,trABAB/2,trABEE/2,
trAAEE/2,trBBEE/2,trABEE/2,trEE/2),ncol=4,byrow=T)
co.ml_solve(cc.ml)
nv.ml_matrix(newseta,ncol=1,byrow=T)
vr.ml_matrix(c(var.a,var.b,var.ab,var.e),ncol=4,byrow=T)
md.ml[l]_sqrt(mahalanobis(vr.ml,nv.ml,co.ml))
cat("loop l:",l)

```

```
}
```

```
amd.ml_(sum(md.ml))/loop
```

```
amd.mc_(sum(md.mc))/loop
```

```
amd.ml
```

```
amd.mc
```

## ประวัติผู้เขียนวิทยานิพนธ์



นางสาววนิดา ลิ้มมัน เกิดเมื่อวันที่ 28 พฤศจิกายน พ.ศ. 2522 สำเร็จ การศึกษาปริญญาตรีวิทยาศาสตร์บัณฑิต สาขาวิชาสถิติ ภาควิชาสถิติ คณะวิทยาศาสตร์และ เทคโนโลยี มหาวิทยาลัยธรรมศาสตร์ ปีการศึกษา 2543 จากนั้นเข้าศึกษาต่อในหลักสูตรสถิติ ศาสตรมหาบัณฑิต ที่จุฬาลงกรณ์มหาวิทยาลัย เมื่อ พ.ศ.2544