No screening

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```
########################################
####improved r code for cvd screening#####
########################################

################################
#####no screening
################################

###1. transition matrix
library(openxlsx)
rate_data <-read.csv("data/ghdx_data.csv")
source("function/transform_func.R")
p1_0 <- RateToProb(rate_data$incidence, 1)
p2_0 <- RateToProb(rate_data$death_CVD, 1)
p3 <- RateToProb(rate_data$death_nonCVD, 1)
p5_0 <- ProbFactor(p1_0, 3.12)
p7 <- ProbFactor(p1_0, 1.37)

n_state=4
names_state=c("s1","s2","s3","s4")
n_population=14
names_population=c("m_40","m_45","m_50","m_55",
                   "m_60","m_65","m_70","f_40",
                   "f_45","f_50","f_55","f_60",
                   "f_65","f_70")

a_P<-array(0,
           dim=c(n_state,n_state,10,n_population),
           dimnames=list(names_state,names_state,1:10,names_population))
p1 <- array(0,
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))
##s1 to s2
p2 <- array(0,
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))
##s1 to s3
p4 <- array(0,
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))
##s1 being s1
set.seed(1)
```

```r
p8 <- array(runif(140,min=0.02,max=0.1),
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))  ##cvd Probability of acute death


p5 <- array(0,
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))
##s2 to s4

p6 <- array(0,
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))
## s2 being s2

for (i in 1:14){
  if (i==7 | i==14){
    a_P["s1","s3",1:10,i]<-p3[i]
    a_P["s2","s3",1:10,i]<-p3[i]
    for ( j in 1:10){
      p2[j,i]<-p2_0[i]+p1_0[i]*p7[i]*p8[j,i]
      p1[j,i]<-p1_0[i]*(1-p7[i]*p8[j,i])
      p4[j,i]<-1-p1[j,i]-p2[j,i]-p3[i]
      p5[j,i]<-p5_0[i]+p7[i]*p8[j,i]
      p6[j,i]<-1-p5[j,i]-p3[i]
      a_P["s1","s2",j,i]<-p1[j,i]
      a_P["s1","s4",j,i]<-p2[j,i]
      a_P["s1","s1",j,i]<-p4[j,i]
      a_P["s2","s2",j,i]<-p6[j,i]
      a_P["s2","s4",j,i]<-p5[j,i]
    }
    a_P["s3","s3",1:10,i]<-1
    a_P["s4","s4",1:10,i]<-1
  }
  else{
    ### the first 5 years
    a_P["s1","s3",1:5,i]<-p3[i]
    a_P["s2","s3",1:5,i]<-p3[i]
    for ( j in 1:5){
      p2[j,i]<-p2_0[i]+p1_0[i]*p7[i]*p8[j,i]
      p1[j,i]<-p1_0[i]*(1-p7[i]*p8[j,i])
      p4[j,i]<-1-p1[j,i]-p2[j,i]-p3[i]
      p5[j,i]<-p5_0[i]+p7[i]*p8[j,i]
      p6[j,i]<-1-p5[j,i]-p3[i]
      a_P["s1","s2",j,i]<-p1[j,i]
      a_P["s1","s4",j,i]<-p2[j,i]
      a_P["s1","s1",j,i]<-p4[j,i]
      a_P["s2","s2",j,i]<-p6[j,i]
      a_P["s2","s4",j,i]<-p5[j,i]
    }
    a_P["s3","s3",1:5,i]<-1
    a_P["s4","s4",1:5,i]<-1
```

```
    ## the second 5 years
    a_P["s1","s3",6:10,i]<-p3[i+1]
    a_P["s2","s3",6:10,i]<-p3[i+1]
    for ( j in 6:10){
      p2[j,i]<-p2_0[i+1]+p1_0[i+1]*p7[i+1]*p8[j,i]
      p1[j,i]<-p1_0[i+1]*(1-p7[i+1]*p8[j,i])
      p4[j,i]<-1-p1[j,i]-p2[j,i]-p3[i+1]
      p5[j,i]<-p5_0[i+1]+p7[i+1]*p8[j,i]
      p6[j,i]<-1-p5[j,i]-p3[i]
      a_P["s1","s2",j,i]<-p1[j,i]
      a_P["s1","s4",j,i]<-p2[j,i]
      a_P["s1","s1",j,i]<-p4[j,i]
      a_P["s2","s2",j,i]<-p6[j,i]
      a_P["s2","s4",j,i]<-p5[j,i]
    }
    a_P["s3","s3",6:10,i]<-1
    a_P["s4","s4",6:10,i]<-1
  }
}

a_P
```

```
## , , 1, m_40
##
##         s1          s2          s3           s4
## s1 0.99281 0.003879602 0.002490893 0.0008195143
## s2 0.00000 0.985281955 0.002490893 0.0122271526
## s3 0.00000 0.000000000 1.000000000 0.0000000000
## s4 0.00000 0.000000000 0.000000000 1.0000000000
##
## , , 2, m_40
##
##         s1          s2          s3         s4
## s1 0.99281 0.003879426 0.002490893 0.00081969
## s2 0.00000 0.985236677 0.002490893 0.01227243
## s3 0.00000 0.000000000 1.000000000 0.00000000
## s4 0.00000 0.000000000 0.000000000 1.00000000
##
## , , 3, m_40
##
##         s1          s2          s3           s4
## s1 0.99281 0.003879095 0.002490893 0.0008200208
## s2 0.00000 0.985151429 0.002490893 0.0123576781
## s3 0.00000 0.000000000 1.000000000 0.0000000000
## s4 0.00000 0.000000000 0.000000000 1.0000000000
##
## , , 4, m_40
##
##         s1          s2          s3           s4
## s1 0.99281 0.003878543 0.002490893 0.0008205734
## s2 0.00000 0.985009008 0.002490893 0.0125000990
## s3 0.00000 0.000000000 1.000000000 0.0000000000
## s4 0.00000 0.000000000 0.000000000 1.0000000000
```

```
##
## , , 5, m_40
##
##         s1          s2          s3           s4
## s1 0.99281 0.003879707 0.002490893 0.0008194091
## s2 0.00000 0.985309061 0.002490893 0.0122000462
## s3 0.00000 0.000000000 1.000000000 0.0000000000
## s4 0.00000 0.000000000 0.000000000 1.0000000000
##
## , , 6, m_40
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006700764 0.00339323 0.001344749
## s2 0.0000000 0.976036421 0.00339323 0.021472687
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 7, m_40
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006700537 0.00339323 0.001344977
## s2 0.0000000 0.976002484 0.00339323 0.021506623
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 8, m_40
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006701932 0.00339323 0.001343581
## s2 0.0000000 0.976210624 0.00339323 0.021298484
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 9, m_40
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006702088 0.00339323 0.001343425
## s2 0.0000000 0.976233855 0.00339323 0.021275253
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 10, m_40
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006704878 0.00339323 0.001340636
## s2 0.0000000 0.976649821 0.00339323 0.020859286
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 1, m_45
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006704169 0.00339323 0.001341345
## s2 0.0000000 0.975641764 0.00339323 0.020965006
```

```
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 2, m_45
##
##           s1          s2         s3         s4
## s1 0.9885613 0.006704314 0.00339323 0.00134120
## s2 0.0000000 0.975663334 0.00339323 0.02094344
## s3 0.0000000 0.000000000 1.00000000 0.00000000
## s4 0.0000000 0.000000000 0.00000000 1.00000000
##
## , , 3, m_45
##
##           s1          s2         s3         s4
## s1 0.9885613 0.006701803 0.00339323 0.00134371
## s2 0.0000000 0.975289058 0.00339323 0.02131771
## s3 0.0000000 0.000000000 1.00000000 0.00000000
## s4 0.0000000 0.000000000 0.00000000 1.00000000
##
## , , 4, m_45
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006703293 0.00339323 0.001342221
## s2 0.0000000 0.975511160 0.00339323 0.021095611
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 5, m_45
##
##           s1          s2         s3          s4
## s1 0.9885613 0.006701396 0.00339323 0.001344117
## s2 0.0000000 0.975228335 0.00339323 0.021378435
## s3 0.0000000 0.000000000 1.00000000 0.000000000
## s4 0.0000000 0.000000000 0.00000000 1.000000000
##
## , , 6, m_45
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01049938 0.004938764 0.002308367
## s2 0.0000000 0.96367725 0.004938764 0.032929516
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 7, m_45
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01049673 0.004938764 0.002311018
## s2 0.0000000 0.96342495 0.004938764 0.033181821
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 8, m_45
##
##           s1         s2          s3          s4
```

```
## s1 0.9822535 0.01049342 0.004938764 0.002314325
## s2 0.0000000 0.96311027 0.004938764 0.033496500
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 9, m_45
##
##           s1        s2          s3          s4
## s1 0.9822535 0.0105008 0.004938764 0.002306948
## s2 0.0000000 0.9638122 0.004938764 0.032794525
## s3 0.0000000 0.0000000 1.000000000 0.000000000
## s4 0.0000000 0.0000000 0.000000000 1.000000000
##
## , , 10, m_45
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01049601 0.004938764 0.002311739
## s2 0.0000000 0.96335631 0.004938764 0.033250458
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 1, m_50
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01049411 0.004938764 0.002313635
## s2 0.0000000 0.96163036 0.004938764 0.033430876
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 2, m_50
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01050283 0.004938764 0.002304924
## s2 0.0000000 0.96245933 0.004938764 0.032601909
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 3, m_50
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01049753 0.004938764 0.002310223
## s2 0.0000000 0.96195507 0.004938764 0.033106165
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 4, m_50
##
##           s1         s2          s3         s4
## s1 0.9822535 0.01050387 0.004938764 0.00230388
## s2 0.0000000 0.96255867 0.004938764 0.03250257
## s3 0.0000000 0.00000000 1.000000000 0.00000000
## s4 0.0000000 0.00000000 0.000000000 1.00000000
##
## , , 5, m_50
```

```
##
##           s1         s2          s3          s4
## s1 0.9822535 0.01050216 0.004938764 0.002305588
## s2 0.0000000 0.96239614 0.004938764 0.032665098
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 6, m_50
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01515872 0.00725555 0.003674257
## s2 0.0000000 0.94813980 0.00725555 0.046921431
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 7, m_50
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01516808 0.00725555 0.003664902
## s2 0.0000000 0.94875624 0.00725555 0.046304998
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 8, m_50
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01515882 0.00725555 0.003674163
## s2 0.0000000 0.94814597 0.00725555 0.046915269
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 9, m_50
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01514659 0.00725555 0.003686393
## s2 0.0000000 0.94734004 0.00725555 0.047721199
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 10, m_50
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01515987 0.00725555 0.003673108
## s2 0.0000000 0.94821549 0.00725555 0.046845742
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 1, m_55
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01515631 0.00725555 0.003676665
## s2 0.0000000 0.94566430 0.00725555 0.047080145
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
```

```
##
## , , 2, m_55
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01515336 0.00725555 0.003679613
## s2 0.0000000 0.94547000 0.00725555 0.047274450
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 3, m_55
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01515603 0.00725555 0.003676953
## s2 0.0000000 0.94564535 0.00725555 0.047099101
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 4, m_55
##
##           s1         s2         s3         s4
## s1 0.9739115 0.01516374 0.00725555 0.00366924
## s2 0.0000000 0.94615362 0.00725555 0.04659083
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 5, m_55
##
##           s1         s2         s3          s4
## s1 0.9739115 0.01514765 0.00725555 0.003685331
## s2 0.0000000 0.94509324 0.00725555 0.047651212
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 6, m_55
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02178845 0.01109697 0.006431151
## s2 0.0000000 0.92544974 0.01109697 0.067294712
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 7, m_55
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02178193 0.01109697 0.006437671
## s2 0.0000000 0.92515115 0.01109697 0.067593304
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 8, m_55
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02181751 0.01109697 0.006402094
## s2 0.0000000 0.92678045 0.01109697 0.065964001
```

```
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 9, m_55
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02178559 0.01109697 0.006434015
## s2 0.0000000 0.92531858 0.01109697 0.067425865
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 10, m_55
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02180178 0.01109697 0.006417819
## s2 0.0000000 0.92606033 0.01109697 0.066684124
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 1, m_60
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02178055 0.01109697 0.006439056
## s2 0.0000000 0.92124632 0.01109697 0.067656707
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 2, m_60
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02178956 0.01109697 0.006430042
## s2 0.0000000 0.92165914 0.01109697 0.067243892
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 3, m_60
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02178252 0.01109697 0.006437085
## s2 0.0000000 0.92133657 0.01109697 0.067566460
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 4, m_60
##
##           s1         s2         s3          s4
## s1 0.9606834 0.02179444 0.01109697 0.006425167
## s2 0.0000000 0.92188236 0.01109697 0.067020674
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 5, m_60
##
##           s1         s2         s3          s4
```

```
## s1 0.9606834 0.02179564 0.01109697 0.006423959
## s2 0.0000000 0.92193771 0.01109697 0.066965319
## s3 0.0000000 0.00000000 1.00000000 0.000000000
## s4 0.0000000 0.00000000 0.00000000 1.000000000
##
## , , 6, m_60
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03040022 0.01680322 0.01119783
## s2 0.0000000 0.89607237 0.01680322 0.09283066
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 7, m_60
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03047747 0.01680322 0.01112058
## s2 0.0000000 0.89860488 0.01680322 0.09029816
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 8, m_60
##
##           s1        s2         s3         s4
## s1 0.9415987 0.0304317 0.01680322 0.01116636
## s2 0.0000000 0.8971043 0.01680322 0.09179876
## s3 0.0000000 0.0000000 1.00000000 0.00000000
## s4 0.0000000 0.0000000 0.00000000 1.00000000
##
## , , 9, m_60
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03040597 0.01680322 0.01119208
## s2 0.0000000 0.89626095 0.01680322 0.09264208
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 10, m_60
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03040996 0.01680322 0.01118809
## s2 0.0000000 0.89639181 0.01680322 0.09251122
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 1, m_65
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03043166 0.01680322 0.01116639
## s2 0.0000000 0.89139673 0.01680322 0.09180005
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 2, m_65
```

```
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03039297 0.01680322 0.01120508
## s2 0.0000000 0.89012856 0.01680322 0.09306821
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 3, m_65
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03043564 0.01680322 0.01116241
## s2 0.0000000 0.89152739 0.01680322 0.09166939
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 4, m_65
##
##           s1         s2         s3         s4
## s1 0.9415987 0.03045514 0.01680322 0.01114291
## s2 0.0000000 0.89216645 0.01680322 0.09103033
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 5, m_65
##
##           s1        s2         s3         s4
## s1 0.9415987 0.0304727 0.01680322 0.01112535
## s2 0.0000000 0.8927421 0.01680322 0.09045469
## s3 0.0000000 0.0000000 1.00000000 0.00000000
## s4 0.0000000 0.0000000 0.00000000 1.00000000
##
## , , 6, m_65
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04258406 0.02596204 0.01984836
## s2 0.0000000 0.85954760 0.02596204 0.12364918
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 7, m_65
##
##           s1        s2         s3         s4
## s1 0.9116055 0.0425415 0.02596204 0.01989092
## s2 0.0000000 0.8585498 0.02596204 0.12464694
## s3 0.0000000 0.0000000 1.00000000 0.00000000
## s4 0.0000000 0.0000000 0.00000000 1.00000000
##
## , , 8, m_65
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04250178 0.02596204 0.01993064
## s2 0.0000000 0.85761854 0.02596204 0.12557823
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
```

```
##
## , , 9, m_65
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04247363 0.02596204 0.01995878
## s2 0.0000000 0.85695874 0.02596204 0.12623804
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 10, m_65
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04252372 0.02596204 0.01990869
## s2 0.0000000 0.85813308 0.02596204 0.12506370
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 1, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04242439 0.02596204 0.02000803
## s2 0.0000000 0.84664539 0.02596204 0.12739257
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 2, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04254595 0.02596204 0.01988647
## s2 0.0000000 0.84949535 0.02596204 0.12454262
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 3, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04251347 0.02596204 0.01991895
## s2 0.0000000 0.84873387 0.02596204 0.12530409
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 4, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04253833 0.02596204 0.01989408
## s2 0.0000000 0.84931682 0.02596204 0.12472114
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 5, m_70
##
##           s1         s2         s3        s4
## s1 0.9116055 0.04247582 0.02596204 0.0199566
## s2 0.0000000 0.84785117 0.02596204 0.1261868
```

```
## s3 0.0000000 0.00000000 1.00000000 0.0000000
## s4 0.0000000 0.00000000 0.00000000 1.0000000
##
## , , 6, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04255293 0.02596204 0.01987948
## s2 0.0000000 0.84965912 0.02596204 0.12437884
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 7, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04250965 0.02596204 0.01992277
## s2 0.0000000 0.84864422 0.02596204 0.12539374
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 8, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04245316 0.02596204 0.01997926
## s2 0.0000000 0.84731990 0.02596204 0.12671806
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 9, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04258704 0.02596204 0.01984537
## s2 0.0000000 0.85045883 0.02596204 0.12357914
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 10, m_70
##
##           s1         s2         s3         s4
## s1 0.9116055 0.04243176 0.02596204 0.02000065
## s2 0.0000000 0.84681822 0.02596204 0.12721974
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 1, f_40
##
##          s1          s2          s3           s4
## s1 0.993978 0.004533362 0.001136354 0.0003522638
## s2 0.000000 0.984557862 0.001136354 0.0143057843
## s3 0.000000 0.000000000 1.000000000 0.0000000000
## s4 0.000000 0.000000000 0.000000000 1.0000000000
##
## , , 2, f_40
##
##          s1          s2          s3           s4
```

```
## s1 0.993978 0.004532236 0.001136354 0.0003533896
## s2 0.000000 0.984309595 0.001136354 0.0145540512
## s3 0.000000 0.000000000 1.000000000 0.0000000000
## s4 0.000000 0.000000000 0.000000000 1.0000000000
##
## , , 3, f_40
##
##          s1          s2          s3           s4
## s1 0.993978 0.004533345 0.001136354 0.0003522809
## s2 0.000000 0.984554086 0.001136354 0.0143095604
## s3 0.000000 0.000000000 1.000000000 0.0000000000
## s4 0.000000 0.000000000 0.000000000 1.0000000000
##
## , , 4, f_40
##
##          s1          s2          s3           s4
## s1 0.993978 0.004533374 0.001136354 0.0003522519
## s2 0.000000 0.984560491 0.001136354 0.0143031556
## s3 0.000000 0.000000000 1.000000000 0.0000000000
## s4 0.000000 0.000000000 0.000000000 1.0000000000
##
## , , 5, f_40
##
##          s1          s2          s3           s4
## s1 0.993978 0.004533053 0.001136354 0.0003525727
## s2 0.000000 0.984489749 0.001136354 0.0143738976
## s3 0.000000 0.000000000 1.000000000 0.0000000000
## s4 0.000000 0.000000000 0.000000000 1.0000000000
##
## , , 6, f_40
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007062658 0.001618689 0.0006490324
## s2 0.0000000 0.976251714 0.001618689 0.0226119326
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 7, f_40
##
##           s1         s2          s3           s4
## s1 0.9906696 0.00706281 0.001618689 0.0006488802
## s2 0.0000000 0.97627324 0.001618689 0.0225904052
## s3 0.0000000 0.00000000 1.000000000 0.0000000000
## s4 0.0000000 0.00000000 0.000000000 1.0000000000
##
## , , 8, f_40
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007065401 0.001618689 0.0006462892
## s2 0.0000000 0.976639785 0.001618689 0.0222238608
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 9, f_40
```

```
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007063285 0.001618689 0.0006484049
## s2 0.0000000 0.976340483 0.001618689 0.0225231632
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 10, f_40
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007062284 0.001618689 0.0006494061
## s2 0.0000000 0.976198844 0.001618689 0.0226648025
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 1, f_45
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007065157 0.001618689 0.0006465332
## s2 0.0000000 0.976122933 0.001618689 0.0222583786
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 2, f_45
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007063639 0.001618689 0.0006480509
## s2 0.0000000 0.975908226 0.001618689 0.0224730856
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 3, f_45
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007065346 0.001618689 0.0006463438
## s2 0.0000000 0.976149720 0.001618689 0.0222315918
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 4, f_45
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007065754 0.001618689 0.0006459361
## s2 0.0000000 0.976207398 0.001618689 0.0221739135
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
##
## , , 5, f_45
##
##           s1          s2          s3           s4
## s1 0.9906696 0.007063396 0.001618689 0.0006482944
## s2 0.0000000 0.975873783 0.001618689 0.0225075281
## s3 0.0000000 0.000000000 1.000000000 0.0000000000
## s4 0.0000000 0.000000000 0.000000000 1.0000000000
```

```
##
## , , 6, f_45
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007681 0.00247194 0.001210297
## s2 0.000000 0.96708588 0.00247194 0.031295433
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 7, f_45
##
##          s1         s2         s3         s4
## s1 0.986241 0.01007117 0.00247194 0.00121594
## s2 0.000000 0.96652617 0.00247194 0.03185514
## s3 0.000000 0.00000000 1.00000000 0.00000000
## s4 0.000000 0.00000000 0.00000000 1.00000000
##
## , , 8, f_45
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007771 0.00247194 0.001209398
## s2 0.000000 0.96717505 0.00247194 0.031206263
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 9, f_45
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007633 0.00247194 0.001210772
## s2 0.000000 0.96703877 0.00247194 0.031342546
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 10, f_45
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007747 0.00247194 0.001209638
## s2 0.000000 0.96715126 0.00247194 0.031230055
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 1, f_50
##
##          s1        s2         s3          s4
## s1 0.986241 0.0100764 0.00247194 0.001210707
## s2 0.000000 0.9661920 0.00247194 0.031336096
## s3 0.000000 0.0000000 1.00000000 0.000000000
## s4 0.000000 0.0000000 0.00000000 1.000000000
##
## , , 2, f_50
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007841 0.00247194 0.001208702
## s2 0.000000 0.96639088 0.00247194 0.031137176
```

```
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 3, f_50
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007193 0.00247194 0.001215176
## s2 0.000000 0.96574869 0.00247194 0.031779368
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 4, f_50
##
##          s1         s2         s3          s4
## s1 0.986241 0.01006933 0.00247194 0.001217773
## s2 0.000000 0.96549111 0.00247194 0.032036949
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 5, f_50
##
##          s1         s2         s3          s4
## s1 0.986241 0.01007041 0.00247194 0.001216693
## s2 0.000000 0.96559829 0.00247194 0.031929775
## s3 0.000000 0.00000000 1.00000000 0.000000000
## s4 0.000000 0.00000000 0.00000000 1.000000000
##
## , , 6, f_50
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01361887 0.003698145 0.002033222
## s2 0.0000000 0.95460911 0.003698145 0.042918949
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 7, f_50
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362581 0.003698145 0.002026283
## s2 0.0000000 0.95511787 0.003698145 0.042410190
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 8, f_50
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362673 0.003698145 0.002025366
## s2 0.0000000 0.95518509 0.003698145 0.042342971
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 9, f_50
##
##           s1         s2          s3          s4
```

```
## s1 0.9806498 0.01361859 0.003698145 0.002033497
## s2 0.0000000 0.95458894 0.003698145 0.042939121
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 10, f_50
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362277 0.003698145 0.002029319
## s2 0.0000000 0.95489526 0.003698145 0.042632800
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 1, f_55
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362176 0.003698145 0.002030329
## s2 0.0000000 0.95359499 0.003698145 0.042706861
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 2, f_55
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362788 0.003698145 0.002024212
## s2 0.0000000 0.95404350 0.003698145 0.042258355
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 3, f_55
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362956 0.003698145 0.002022529
## s2 0.0000000 0.95416686 0.003698145 0.042134990
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 4, f_55
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01361491 0.003698145 0.002037186
## s2 0.0000000 0.95309230 0.003698145 0.043209560
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 5, f_55
##
##           s1         s2          s3          s4
## s1 0.9806498 0.01362219 0.003698145 0.002029898
## s2 0.0000000 0.95362657 0.003698145 0.042675281
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 6, f_55
```

```
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01808955 0.005832922 0.003881046
## s2 0.0000000 0.94098605 0.005832922 0.055315810
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 7, f_55
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01809254 0.005832922 0.003878054
## s2 0.0000000 0.94115130 0.005832922 0.055150551
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 8, f_55
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01808009 0.005832922 0.003890501
## s2 0.0000000 0.94046385 0.005832922 0.055838006
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 9, f_55
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01806418 0.005832922 0.003906417
## s2 0.0000000 0.93958477 0.005832922 0.056717084
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 10, f_55
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01807579 0.005832922 0.003894807
## s2 0.0000000 0.94022604 0.005832922 0.056075819
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 1, f_60
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01806232 0.005832922 0.003908277
## s2 0.0000000 0.93734730 0.005832922 0.056819777
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 2, f_60
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01807104 0.005832922 0.003899555
## s2 0.0000000 0.93782902 0.005832922 0.056338054
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
```

```
##
## , , 3, f_60
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01808442 0.005832922 0.003886168
## s2 0.0000000 0.93856836 0.005832922 0.055598717
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 4, f_60
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01808176 0.005832922 0.003888836
## s2 0.0000000 0.93842102 0.005832922 0.055746059
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 5, f_60
##
##           s1         s2          s3          s4
## s1 0.9721965 0.01809187 0.005832922 0.003878726
## s2 0.0000000 0.93897939 0.005832922 0.055187687
## s3 0.0000000 0.00000000 1.000000000 0.000000000
## s4 0.0000000 0.00000000 0.000000000 1.000000000
##
## , , 6, f_60
##
##          s1         s2          s3          s4
## s1 0.960545 0.02344859 0.009019082 0.006987323
## s2 0.000000 0.92375679 0.009019082 0.070410287
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 7, f_60
##
##          s1         s2          s3          s4
## s1 0.960545 0.02340657 0.009019082 0.007029349
## s2 0.000000 0.92196576 0.009019082 0.072201320
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 8, f_60
##
##          s1        s2          s3          s4
## s1 0.960545 0.0234432 0.009019082 0.006992714
## s2 0.000000 0.9235271 0.009019082 0.070640019
## s3 0.000000 0.0000000 1.000000000 0.000000000
## s4 0.000000 0.0000000 0.000000000 1.000000000
##
## , , 9, f_60
##
##          s1         s2          s3          s4
## s1 0.960545 0.02342267 0.009019082 0.007013239
## s2 0.000000 0.92265231 0.009019082 0.071514772
```

```
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 10, f_60
##
##          s1         s2          s3          s4
## s1 0.960545 0.02341108 0.009019082 0.007024834
## s2 0.000000 0.92215816 0.009019082 0.072008918
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 1, f_65
##
##          s1         s2          s3          s4
## s1 0.960545 0.02339004 0.009019082 0.007045876
## s2 0.000000 0.91807523 0.009019082 0.072905693
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 2, f_65
##
##          s1         s2          s3          s4
## s1 0.960545 0.02341973 0.009019082 0.007016189
## s2 0.000000 0.91934043 0.009019082 0.071640488
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 3, f_65
##
##          s1        s2          s3          s4
## s1 0.960545 0.0234204 0.009019082 0.007015516
## s2 0.000000 0.9193691 0.009019082 0.071611821
## s3 0.000000 0.0000000 1.000000000 0.000000000
## s4 0.000000 0.0000000 0.000000000 1.000000000
##
## , , 4, f_65
##
##          s1        s2          s3          s4
## s1 0.960545 0.0234390 0.009019082 0.006996917
## s2 0.000000 0.9201618 0.009019082 0.070819146
## s3 0.000000 0.0000000 1.000000000 0.000000000
## s4 0.000000 0.0000000 0.000000000 1.000000000
##
## , , 5, f_65
##
##          s1         s2          s3          s4
## s1 0.960545 0.02340422 0.009019082 0.007031697
## s2 0.000000 0.91867952 0.009019082 0.072301403
## s3 0.000000 0.00000000 1.000000000 0.000000000
## s4 0.000000 0.00000000 0.000000000 1.000000000
##
## , , 6, f_65
##
##           s1        s2         s3         s4
```

```
## s1 0.9385563 0.0332539 0.01479644 0.01339335
## s2 0.0000000 0.8912902 0.01479644 0.09969071
## s3 0.0000000 0.0000000 1.00000000 0.00000000
## s4 0.0000000 0.0000000 0.00000000 1.00000000
##
## , , 7, f_65
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03324701 0.01479644 0.01340024
## s2 0.0000000 0.89108349 0.01479644 0.09989743
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 8, f_65
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03328354 0.01479644 0.01336370
## s2 0.0000000 0.89217939 0.01479644 0.09880153
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 9, f_65
##
##           s1        s2         s3         s4
## s1 0.9385563 0.0332810 0.01479644 0.01336624
## s2 0.0000000 0.8921032 0.01479644 0.09887774
## s3 0.0000000 0.0000000 1.00000000 0.00000000
## s4 0.0000000 0.0000000 0.00000000 1.00000000
##
## , , 10, f_65
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03323683 0.01479644 0.01341041
## s2 0.0000000 0.89077834 0.01479644 0.10020258
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 1, f_70
##
##           s1         s2         s3        s4
## s1 0.9385563 0.03323934 0.01479644 0.0134079
## s2 0.0000000 0.88507620 0.01479644 0.1001274
## s3 0.0000000 0.00000000 1.00000000 0.0000000
## s4 0.0000000 0.00000000 0.00000000 1.0000000
##
## , , 2, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03329924 0.01479644 0.01334800
## s2 0.0000000 0.88687298 0.01479644 0.09833058
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 3, f_70
```

```
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03330424 0.01479644 0.01334301
## s2 0.0000000 0.88702286 0.01479644 0.09818070
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 4, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03323117 0.01479644 0.01341608
## s2 0.0000000 0.88483104 0.01479644 0.10037252
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 5, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03319677 0.01479644 0.01345047
## s2 0.0000000 0.88379940 0.01479644 0.10140415
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 6, f_70
##
##           s1         s2         s3        s4
## s1 0.9385563 0.03323655 0.01479644 0.0134107
## s2 0.0000000 0.88499239 0.01479644 0.1002112
## s3 0.0000000 0.00000000 1.00000000 0.0000000
## s4 0.0000000 0.00000000 0.00000000 1.0000000
##
## , , 7, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03324102 0.01479644 0.01340622
## s2 0.0000000 0.88512663 0.01479644 0.10007693
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 8, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03324522 0.01479644 0.01340203
## s2 0.0000000 0.88525250 0.01479644 0.09995106
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
##
## , , 9, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03318998 0.01479644 0.01345727
## s2 0.0000000 0.88359555 0.01479644 0.10160801
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
```

```
##
## , , 10, f_70
##
##           s1         s2         s3         s4
## s1 0.9385563 0.03324743 0.01479644 0.01339981
## s2 0.0000000 0.88531886 0.01479644 0.09988470
## s3 0.0000000 0.00000000 1.00000000 0.00000000
## s4 0.0000000 0.00000000 0.00000000 1.00000000
```

```
### Calculations
### 1. the population
population<-matrix(c(40,45,50,55,60,65,70,
                     40,45,50,55,60,65,70,
                     229,444,422,410,322,160,116,
                     498,856,822,842,519,394,187,
                     1,1,1,1,1,1,1,2,2,2,2,2,2,2),
                   ncol=3,nrow=14,
                   dimnames=list(1:14,c("age","num","sex")),byrow=F)
population  ##sex:1-male 2-female
```

```
##    age num sex
## 1   40 229   1
## 2   45 444   1
## 3   50 422   1
## 4   55 410   1
## 5   60 322   1
## 6   65 160   1
## 7   70 116   1
## 8   40 498   2
## 9   45 856   2
## 10  50 822   2
## 11  55 842   2
## 12  60 519   2
## 13  65 394   2
## 14  70 187   2
```

```
### 2.initial state
s_start <- matrix(NA,nrow=14,ncol=4,
                  dimnames=list(1:14,names_state))
s_start[,1]<-population[1:14,2]
s_start[,2]<-0
s_start[,3]<-0
s_start[,4]<-0
s_start
```

```
##     s1 s2 s3 s4
## 1  229  0  0  0
## 2  444  0  0  0
## 3  422  0  0  0
## 4  410  0  0  0
## 5  322  0  0  0
## 6  160  0  0  0
## 7  116  0  0  0
```

```
## 8  498  0  0  0
## 9  856  0  0  0
## 10 822  0  0  0
## 11 842  0  0  0
## 12 519  0  0  0
## 13 394  0  0  0
## 14 187  0  0  0
```

```
m_M<-array(NA,dim=c(10,4,14),
           dimnames=list(1:10,names_state,names_population))
for (i in 1:14) {
  m_M[1,,i]<-s_start[i,]
}
m_M
```

```
## , , m_40
##
##     s1 s2 s3 s4
## 1  229  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , m_45
##
##     s1 s2 s3 s4
## 1  444  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , m_50
##
##     s1 s2 s3 s4
## 1  422  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
```

```
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , m_55
##
##     s1 s2 s3 s4
## 1  410  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , m_60
##
##     s1 s2 s3 s4
## 1  322  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , m_65
##
##     s1 s2 s3 s4
## 1  160  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , m_70
##
##     s1 s2 s3 s4
## 1  116  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
```

```
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_40
##
##     s1 s2 s3 s4
## 1  498  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_45
##
##     s1 s2 s3 s4
## 1  856  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_50
##
##     s1 s2 s3 s4
## 1  822  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_55
##
##     s1 s2 s3 s4
## 1  842  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
```

```
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_60
##
##     s1 s2 s3 s4
## 1  519  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_65
##
##     s1 s2 s3 s4
## 1  394  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
##
## , , f_70
##
##     s1 s2 s3 s4
## 1  187  0  0  0
## 2   NA NA NA NA
## 3   NA NA NA NA
## 4   NA NA NA NA
## 5   NA NA NA NA
## 6   NA NA NA NA
## 7   NA NA NA NA
## 8   NA NA NA NA
## 9   NA NA NA NA
## 10  NA NA NA NA
```

```
###3) sates of 10 cycles
uti <- c(1,0.9,0,0)  # utility values
uti2 <- -0.038  ## TODO: how to get
year <- c(1,1,0,0)
n_cnew <- array(0,
```

```
                dim=c(10,1,14),
                dimnames=list(1:10,"num",names_population))  ## new events of CVD
n_clive <- array(0,
                 dim=c(10,1,14),
                 dimnames=list(1:10,"num",names_population))

n_cvd <- 0
n_cd <- 0
n_nd <- 0
n_d <- 0
qaly <- 0
qaly_m <- array(0,
                dim=c(10,4,14),
                dimnames=list(1:10,names_state,names_population))
for (i in 1:14){
  qaly_m[1,,i]<-m_M[1,,i] * uti  ## the 1st year qaly
}
lifeyear<-0
lifeyear_m<-array(0,
                  dim=c(10,4,14),
                  dimnames=list(1:10,names_state,names_population))
for (i in 1:14){
  lifeyear_m[1,,i]<-m_M[1,,i]*year
}
qaly_m
```

```
## , , m_40
##
##     s1 s2 s3 s4
## 1  229  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_45
##
##     s1 s2 s3 s4
## 1  444  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
```

```
##
## , , m_50
##
##     s1 s2 s3 s4
## 1  422  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_55
##
##     s1 s2 s3 s4
## 1  410  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_60
##
##     s1 s2 s3 s4
## 1  322  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_65
##
##     s1 s2 s3 s4
## 1  160  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
```

```
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_70
##
##     s1 s2 s3 s4
## 1  116  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_40
##
##     s1 s2 s3 s4
## 1  498  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_45
##
##     s1 s2 s3 s4
## 1  856  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_50
##
##     s1 s2 s3 s4
## 1  822  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
```

```
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_55
##
##     s1 s2 s3 s4
## 1  842  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_60
##
##     s1 s2 s3 s4
## 1  519  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_65
##
##     s1 s2 s3 s4
## 1  394  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_70
##
##     s1 s2 s3 s4
## 1  187  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
```

```
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
```

```
lifeyear_m
```

```
## , , m_40
##
##     s1 s2 s3 s4
## 1  229  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_45
##
##     s1 s2 s3 s4
## 1  444  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_50
##
##     s1 s2 s3 s4
## 1  422  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_55
##
##     s1 s2 s3 s4
```

```
## 1  410  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_60
##
##     s1 s2 s3 s4
## 1  322  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_65
##
##     s1 s2 s3 s4
## 1  160  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , m_70
##
##     s1 s2 s3 s4
## 1  116  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_40
```

```
##
##     s1 s2 s3 s4
## 1  498  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_45
##
##     s1 s2 s3 s4
## 1  856  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_50
##
##     s1 s2 s3 s4
## 1  822  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_55
##
##     s1 s2 s3 s4
## 1  842  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
```

```
##
## , , f_60
##
##     s1 s2 s3 s4
## 1  519  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_65
##
##     s1 s2 s3 s4
## 1  394  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
##
## , , f_70
##
##     s1 s2 s3 s4
## 1  187  0  0  0
## 2    0  0  0  0
## 3    0  0  0  0
## 4    0  0  0  0
## 5    0  0  0  0
## 6    0  0  0  0
## 7    0  0  0  0
## 8    0  0  0  0
## 9    0  0  0  0
## 10   0  0  0  0
```

```r
#### addtional transition probability
#### probability of recurring CVD

p9 <- array(NA,
            dim=c(10,n_population),
            dimnames=list(1:10,names_population))
for (i in 1:14){
  if (i==7 | i==14){
    for (j in 1:10)
      p9[j,i]<-p7[i]*(1-p8[j,i])
  }
```

```
  else {
    for (j in 1:5){
      p9[j,i]<-p7[i]*(1-p8[j,i])
    }
    for (j in 6:10){
      p9[j,i]<-p7[i+1]*p8[j,i]
    }
  }
}
p9
```

```
##            m_40         m_45         m_50         m_55         m_60        m_65
## 1  0.0050896665 0.0088307191 0.0129815809 0.0194624896 0.0271331668 0.038919928
## 2  0.0050443883 0.0088522883 0.0138105480 0.0192681847 0.0275459814 0.037651766
## 3  0.0049591409 0.0084780129 0.0133062915 0.0194435344 0.0272234129 0.039050591
## 4  0.0048167200 0.0087001142 0.0139098862 0.0199518047 0.0277691990 0.039689648
## 5  0.0051167729 0.0084172901 0.0137473590 0.0188914230 0.0278245541 0.040265289
## 6  0.0008420031 0.0008578052 0.0010520435 0.0021804877 0.0034361505 0.001608279
## 7  0.0008759398 0.0011101097 0.0004356107 0.0024790796 0.0009036431 0.002606041
## 8  0.0006677999 0.0014247887 0.0010458810 0.0008497767 0.0024042497 0.003537334
## 9  0.0006445693 0.0007228139 0.0018518117 0.0023116403 0.0032475658 0.004197141
## 10 0.0002286027 0.0011787464 0.0009763545 0.0015698998 0.0031167057 0.003022800
##           m_70         f_40         f_45         f_50         f_55         f_60
## 1  0.05217461 0.0059098354 0.0091300685 0.0132217665 0.0172473946 0.0222232043
## 2  0.05502457 0.0056615685 0.0089153615 0.0134206869 0.0176959004 0.0227049276
## 3  0.05426309 0.0059060592 0.0091568553 0.0127784945 0.0178192653 0.0234442646
## 4  0.05484605 0.0059124641 0.0092145336 0.0125209137 0.0167446958 0.0232969222
## 5  0.05338039 0.0058417221 0.0088809190 0.0126280876 0.0172789741 0.0238552943
## 6  0.05518834 0.0008826110 0.0004983519 0.0015578196 0.0009130854 0.0006707309
## 7  0.05417345 0.0008610836 0.0010580623 0.0010490606 0.0007478266 0.0024617645
## 8  0.05284912 0.0004945391 0.0004091817 0.0009818421 0.0014352812 0.0009004629
## 9  0.05598805 0.0007938416 0.0005454647 0.0015779916 0.0023143597 0.0017752158
## 10 0.05234744 0.0009354809 0.0004329740 0.0012716706 0.0016730951 0.0022693622
##           f_65       f_70
## 1  0.028703310 0.04214006
## 2  0.029968514 0.04393684
## 3  0.029997182 0.04408672
## 4  0.030789857 0.04189490
## 5  0.029307600 0.04086327
## 6  0.002540632 0.04205625
## 7  0.002747357 0.04219049
## 8  0.001651458 0.04231636
## 9  0.001727663 0.04065941
## 10 0.003052503 0.04238272
```

```
############################################################

#### addtional transition probability
#### probability of first time CVD
p10 <- array(NA,
             dim=c(10,n_population),
             dimnames=list(1:10,names_population))
for (i in 1:14){
```

```
  if (i==7 | i==14){
    for (j in 1:10)
      p10[j,i]<-p1_0[i]
  }
  else {
    for (j in 1:5){
      p10[j,i]<-p1_0[i]
    }
    for (j in 6:10){
      p10[j,i]<-p1_0[i+1]
    }
  }
}
p10
```

```
##           m_40        m_45       m_50       m_55       m_60       m_65
## 1  0.003880452 0.006706411 0.01050840 0.01517469 0.02183606 0.03050504
## 2  0.003880452 0.006706411 0.01050840 0.01517469 0.02183606 0.03050504
## 3  0.003880452 0.006706411 0.01050840 0.01517469 0.02183606 0.03050504
## 4  0.003880452 0.006706411 0.01050840 0.01517469 0.02183606 0.03050504
## 5  0.003880452 0.006706411 0.01050840 0.01517469 0.02183606 0.03050504
## 6  0.006706411 0.010508397 0.01517469 0.02183606 0.03050504 0.04265265
## 7  0.006706411 0.010508397 0.01517469 0.02183606 0.03050504 0.04265265
## 8  0.006706411 0.010508397 0.01517469 0.02183606 0.03050504 0.04265265
## 9  0.006706411 0.010508397 0.01517469 0.02183606 0.03050504 0.04265265
## 10 0.006706411 0.010508397 0.01517469 0.02183606 0.03050504 0.04265265
##           m_70        f_40        f_45       f_50       f_55       f_60
## 1  0.04265265 0.004534687 0.007068897 0.01008183 0.01364012 0.01810608
## 2  0.04265265 0.004534687 0.007068897 0.01008183 0.01364012 0.01810608
## 3  0.04265265 0.004534687 0.007068897 0.01008183 0.01364012 0.01810608
## 4  0.04265265 0.004534687 0.007068897 0.01008183 0.01364012 0.01810608
## 5  0.04265265 0.004534687 0.007068897 0.01008183 0.01364012 0.01810608
## 6  0.04265265 0.007068897 0.010081834 0.01364012 0.01810608 0.02346433
## 7  0.04265265 0.007068897 0.010081834 0.01364012 0.01810608 0.02346433
## 8  0.04265265 0.007068897 0.010081834 0.01364012 0.01810608 0.02346433
## 9  0.04265265 0.007068897 0.010081834 0.01364012 0.01810608 0.02346433
## 10 0.04265265 0.007068897 0.010081834 0.01364012 0.01810608 0.02346433
##           f_65      f_70
## 1  0.02346433 0.0333386
## 2  0.02346433 0.0333386
## 3  0.02346433 0.0333386
## 4  0.02346433 0.0333386
## 5  0.02346433 0.0333386
## 6  0.03333860 0.0333386
## 7  0.03333860 0.0333386
## 8  0.03333860 0.0333386
## 9  0.03333860 0.0333386
## 10 0.03333860 0.0333386
```

```
#####################################################


for (i in 1:14){
```

```
  for (j in 1:9){
    m_M[j+1,,i]<-m_M[j,,i] %*% a_P[,,j,i]
    n_cnew[j+1,1,i]<-m_M[j,1,i] * p10[j,i]   ## new occurence = S1*p9
    n_clive[j+1,1,i]<-m_M[j,1,i]*a_P["s1","s2",j,i] +m_M[j,2,i]*p9[j,i]
    ## new/recur cvd = S1*p1 + S2*p9
    qaly_m[j+1,,i]<-m_M[j+1,,i] * uti+n_clive[j+1,1,i]*uti2
    ## qaly = qaly (under 4 states) + the lose of qaly
    lifeyear_m[j+1,,i]<-m_M[j+1,,i]*year
  }
  n_cvd[i]<-sum(n_cnew[1:10,,i])
  n_cd[i]<-m_M[10,4,i]
  n_nd[i]<- m_M[10,3,i]
  n_d[i]<-n_cd[i]+n_nd[i]
  qaly[i]<-sum(qaly_m[1:10,,i])
  lifeyear[i]<-sum(lifeyear_m[1:10,,i])
}

m_M
```

```
## , , m_40
##
##          s1        s2        s3        s4
## 1  229.0000 0.0000000 0.0000000 0.0000000
## 2  227.3535 0.8884289 0.5704144 0.1876688
## 3  225.7188 1.7573138 1.1389405 0.3849313
## 4  224.0959 2.6068050 1.7055591 0.5917417
## 5  222.4846 3.4368919 2.2702512 0.8082142
## 6  220.8850 4.2495760 2.8329974 1.0324504
## 7  218.3583 5.6278391 3.5969307 1.4207351
## 8  215.8606 6.9559029 4.3569673 1.8354579
## 9  213.3914 8.2371094 5.1130349 2.2736343
## 10 210.9505 9.4715131 5.8650714 2.7355563
##
## , , m_45
##
##          s1        s2        s3       s4
## 1  444.0000  0.000000  0.000000 0.000000
## 2  438.9212  2.976651  1.506594 0.595557
## 3  433.9005  5.846875  3.006055 1.246579
## 4  428.9372  8.610309  4.498219 1.954258
## 5  424.0307 11.274744  5.982918 2.711626
## 6  419.1803 13.837048  7.460010 3.522609
## 7  411.7413 17.735583  9.598581 4.945879
## 8  404.4344 21.408841 11.719666 6.485919
## 9  397.2571 24.862976 13.822805 8.139033
## 10 390.2071 28.134759 15.907556 9.870854
##
## , , m_50
##
##          s1        s2        s3        s4
## 1  422.0000  0.000000  0.000000  0.000000
## 2  414.5110  4.428516  2.084158  0.976354
## 3  407.1548  8.615803  4.153202  2.076148
```

```
## 4  399.9293 12.562134  6.206595  3.302003
## 5  392.8319 16.292596  8.243792  4.631694
## 6  385.8605 19.805516 10.264362  6.069601
## 7  375.7940 24.627550 13.207692  8.416655
## 8  365.9901 29.065613 16.112971 10.934282
## 9  356.4419 33.106420 18.979317 13.642610
## 10 347.1429 36.761916 21.805705 16.536473
##
## , , m_55
##
##          s1        s2        s3        s4
## 1  410.0000  0.000000  0.000000  0.000000
## 2  399.3037  6.214088  2.974776  1.507433
## 3  388.8865 11.926029  5.917031  3.270484
## 4  378.7410 17.171767  8.825146  5.262106
## 5  368.8602 21.990259 11.697711  7.451844
## 6  359.2372 26.370209 14.533546  9.859078
## 7  345.1132 32.231524 18.812619 13.943963
## 8  331.5445 37.336264 23.000002 18.344323
## 9  318.5093 41.835995 27.093461 22.929752
## 10 305.9866 45.650536 31.092202 27.799874
##
## , , m_60
##
##          s1        s2        s3        s4
## 1  322.0000  0.000000  0.000000  0.000000
## 2  309.3401  7.013336  3.573224  2.073376
## 3  297.1779 13.204290  7.083788  4.534050
## 4  285.4939 18.638877 10.528089  7.339176
## 5  274.2692 23.405029 13.903041 10.422712
## 6  263.4859 27.555853 17.206323 13.751931
## 7  248.0980 32.702067 22.096763 19.260431
## 8  233.6087 36.947636 26.815109 24.972360
## 9  219.9657 40.254992 31.361328 30.972666
## 10 207.1194 42.767248 35.733875 37.163846
##
## , , m_65
##
##           s1        s2        s3        s4
## 1  160.00000  0.000000  0.000000  0.000000
## 2  150.65580  4.869065  2.688516  1.786623
## 3  141.85731  8.912971  5.301835  3.927889
## 4  133.57266 12.263676  7.835262  6.328404
## 5  125.77184 15.009214 10.285782  8.933160
## 6  118.42661 17.231964 12.651358 11.690070
## 7  107.95835 19.854779 16.173331 16.171362
## 8   98.41543 21.639027 19.491620 20.793590
## 9   89.71606 22.740862 22.608479 25.472463
## 10  81.78565 23.298547 25.528089 30.133848
##
## , , m_70
##
##           s1        s2        s3        s4
## 1  116.00000  0.000000  0.000000  0.000000
```

```
## 2  105.74624  4.921229  3.011596  2.320931
## 3   96.39886  8.679636  5.884749  5.036753
## 4   87.87774 11.464951  8.612801  8.044510
## 5   80.10983 13.475548 11.191940 11.222679
## 6   73.02857 14.827990 13.621607 14.521835
## 7   66.57325 15.706317 15.902542 17.817893
## 8   60.68854 16.159080 18.038687 21.113690
## 9   55.32401 16.268331 20.033808 24.373850
## 10  50.43368 16.191631 21.892491 27.482202
##
## , , f_40
##
##          s1        s2        s3        s4
## 1  498.0000  0.000000 0.0000000 0.0000000
## 2  495.0011  2.257614 0.5659042 0.1754274
## 3  492.0202  4.465653 1.1309660 0.3832130
## 4  489.0572  6.627174 1.6951496 0.6204439
## 5  486.1121  8.741933 2.2584225 0.8875047
## 6  483.1848 10.809915 2.8207518 1.1845502
## 7  478.6765 13.965767 3.6203754 1.7425859
## 8  474.2103 17.015206 4.4178097 2.3686819
## 9  469.7857 19.968212 5.2129507 3.0533024
## 10 465.4024 22.814005 6.0057097 3.8076611
##
## , , f_45
##
##          s1        s2        s3         s4
## 1  856.0000  0.000000  0.000000  0.0000000
## 2  848.0132  6.047775  1.385597  0.5534324
## 3  840.1009 11.892132  2.768056  1.2389003
## 4  832.2625 17.544106  4.147167  2.0462753
## 5  824.4971 23.007248  5.522739  2.9728852
## 6  816.8043 28.275919  6.894585  4.0252383
## 7  805.5658 35.576024  8.983572  5.8987215
## 8  794.4820 42.498145 11.062824  8.0115208
## 9  783.5507 49.109704 13.131789 10.2985743
## 10 772.7698 55.386307 15.190075 12.7864990
##
## , , f_50
##
##          s1        s2        s3         s4
## 1  822.0000  0.000000  0.000000  0.0000000
## 2  810.6901  8.282801  2.031934  0.9952014
## 3  799.5357 16.174886  4.056386  2.2329870
## 4  788.5349 23.673744  6.072773  3.7185916
## 5  777.6854 30.796810  8.080504  5.4372828
## 6  766.9852 37.568962 10.079024  7.3668222
## 7  752.1438 46.309145 13.054381 10.5386938
## 8  737.5897 54.479261 16.007176 14.0267293
## 9  723.3172 62.088710 18.936362 17.8274320
## 10 709.3208 69.119759 21.840907 21.9643300
##
## , , f_55
##
```

```
##          s1       s2        s3        s4
## 1  842.0000  0.00000  0.000000  0.000000
## 2  825.7071 11.46952  3.113838  1.709537
## 3  809.7295 22.19506  6.209839  3.865626
## 4  794.0610 32.21405  9.286416  6.438516
## 5  778.6957 41.51403 12.342101  9.448121
## 6  763.6278 50.19643 15.375356 12.800418
## 7  742.3963 61.04782 20.122329 18.540748
## 8  721.7550 70.88707 24.808756 24.786622
## 9  701.6877 79.71612 29.432175 31.552803
## 10 682.1783 87.57546 33.990043 38.815154
##
## , , f_60
##
##          s1        s2        s3        s4
## 1  519.0000  0.000000  0.000000  0.000000
## 2  504.5700  9.374342  3.027287  2.028396
## 3  490.5412 17.909633  6.025084  4.524126
## 4  476.9024 25.680569  8.990838  7.426204
## 5  463.6428 32.722419 11.922365 10.712390
## 6  450.7519 39.113841 14.817625 14.316608
## 7  432.9675 46.701174 19.235764 20.220174
## 8  415.8848 53.191166 23.561935 26.635540
## 9  399.4760 58.873151 27.792570 33.301128
## 10 383.7147 63.676246 31.926458 40.313049
##
## , , f_65
##
##          s1        s2        s3        s4
## 1  394.0000  0.000000  0.000000  0.000000
## 2  378.4547  9.215675  3.553518  2.776075
## 3  363.5228 17.335648  7.049949  6.091601
## 4  349.1800 24.451708 10.484943  9.883338
## 5  335.4031 30.683956 13.854758 14.058171
## 6  322.1698 36.038569 17.156527 18.635117
## 7  302.3745 42.834226 22.456736 26.542759
## 8  283.7955 48.221918 27.564596 34.873679
## 9  266.3580 52.468320 32.477272 43.430637
## 10 249.9920 55.671818 37.194767 52.178792
##
## , , f_70
##
##          s1        s2        s3        s4
## 1  187.0000  0.000000  0.000000  0.000000
## 2  175.5100  6.215757  2.766934  2.507278
## 3  164.7260 11.356938  5.455829  5.461185
## 4  154.6047 15.559940  8.061231  8.774158
## 5  145.1052 18.905611 10.579061 12.410137
## 6  136.1894 21.525792 13.005837 16.278978
## 7  127.8214 23.576628 15.339461 20.262497
## 8  119.9676 25.117215 17.579613 24.335576
## 9  112.5963 26.223427 19.726352 28.453878
## 10 105.6780 26.907973 21.780390 32.633627
```

```
n_cnew  ## new events of CVD
```

```
## , , m_40
##
##          num
## 1  0.0000000
## 2  0.8886234
## 3  0.8822342
## 4  0.8758909
## 5  0.8695933
## 6  0.8633409
## 7  1.4813454
## 8  1.4644007
## 9  1.4476498
## 10 1.4310905
##
## , , m_45
##
##         num
## 1  0.000000
## 2  2.977646
## 3  2.943586
## 4  2.909915
## 5  2.876629
## 6  2.843724
## 7  4.404913
## 8  4.326741
## 9  4.249957
## 10 4.174535
##
## , , m_50
##
##         num
## 1  0.000000
## 2  4.434544
## 3  4.355846
## 4  4.278545
## 5  4.202615
## 6  4.128034
## 7  5.855312
## 8  5.702556
## 9  5.553785
## 10 5.408895
##
## , , m_55
##
##         num
## 1  0.000000
## 2  6.221621
## 3  6.059308
## 4  5.901230
## 5  5.747276
## 6  5.597338
```

```
## 7  7.844326
## 8  7.535914
## 9  7.239628
## 10 6.954990
##
## , , m_60
##
##         num
## 1  0.000000
## 2  7.031213
## 3  6.754770
## 4  6.489195
## 5  6.234062
## 6  5.988960
## 7  8.037647
## 8  7.568238
## 9  7.126243
## 10 6.710062
##
## , , m_65
##
##         num
## 1  0.000000
## 2  4.880806
## 3  4.595761
## 4  4.327362
## 5  4.074639
## 6  3.836675
## 7  5.051209
## 8  4.604710
## 9  4.197679
## 10 3.826628
##
## , , m_70
##
##         num
## 1  0.000000
## 2  4.947708
## 3  4.510358
## 4  4.111667
## 5  3.748219
## 6  3.416897
## 7  3.114862
## 8  2.839526
## 9  2.588527
## 10 2.359716
##
## , , f_40
##
##         num
## 1  0.000000
## 2  2.258274
## 3  2.244675
## 4  2.231158
```

```
## 5  2.217722
## 6  2.204366
## 7  3.415583
## 8  3.383715
## 9  3.352143
## 10 3.320867
##
## , , f_45
##
##         num
## 1  0.000000
## 2  6.050976
## 3  5.994518
## 4  5.938587
## 5  5.883178
## 6  5.828285
## 7  8.234885
## 8  8.121581
## 9  8.009836
## 10 7.899628
##
## , , f_50
##
##          num
## 1   0.000000
## 2   8.287268
## 3   8.173243
## 4   8.060787
## 5   7.949878
## 6   7.840495
## 7  10.461769
## 8  10.259332
## 9  10.060811
## 10  9.866132
##
## , , f_55
##
##         num
## 1   0.00000
## 2  11.48498
## 3  11.26274
## 4  11.04481
## 5  10.83109
## 6  10.62150
## 7  13.82631
## 8  13.44189
## 9  13.06815
## 10 12.70481
##
## , , f_60
##
##          num
## 1   0.000000
## 2   9.397055
```

```
## 3   9.135784
## 4   8.881777
## 5   8.634832
## 6   8.394754
## 7  10.576592
## 8  10.159292
## 9   9.758457
## 10  9.373437
##
## , , f_65
##
##          num
## 1   0.000000
## 2   9.244946
## 3   8.880186
## 4   8.529819
## 5   8.193275
## 6   7.870009
## 7  10.740690
## 8  10.080742
## 9   9.461344
## 10  8.880004
##
## , , f_70
##
##         num
## 1  0.000000
## 2  6.234318
## 3  5.851259
## 4  5.491736
## 5  5.154303
## 6  4.837604
## 7  4.540364
## 8  4.261387
## 9  3.999552
## 10 3.753804
```

```
n_clive
```

```
## , , m_40
##
##          num
## 1  0.0000000
## 2  0.8884289
## 3  0.8864827
## 4  0.8842996
## 5  0.8817218
## 6  0.8807611
## 7  1.4836763
## 8  1.4680476
## 9  1.4513282
## 10 1.4354775
##
## , , m_45
```

```
##
##         num
## 1  0.000000
## 2  2.976651
## 3  2.969015
## 4  2.957486
## 5  2.950202
## 6  2.936501
## 7  4.413004
## 8  4.341627
## 9  4.274405
## 10 4.189489
##
## , , m_50
##
##         num
## 1  0.000000
## 2  4.428516
## 3  4.414697
## 4  4.388763
## 5  4.375543
## 6  4.349564
## 7  5.869989
## 8  5.710800
## 9  5.578375
## 10 5.460185
##
## , , m_55
##
##         num
## 1  0.000000
## 2  6.214088
## 3  6.170529
## 4  6.125857
## 5  6.085737
## 6  6.002791
## 7  7.884721
## 8  7.597136
## 9  7.265203
## 10 7.035623
##
## , , m_60
##
##         num
## 1  0.000000
## 2  7.013336
## 3  6.933573
## 4  6.832748
## 5  6.739764
## 6  6.629109
## 7  8.104714
## 8  7.590950
## 9  7.197941
## 10 6.819001
```

```
##
## , , m_65
##
##         num
## 1  0.000000
## 2  4.869065
## 3  4.762206
## 4  4.665575
## 5  4.554715
## 6  4.436958
## 7  5.070799
## 8  4.644453
## 9  4.259375
## 10 3.906014
##
## , , m_70
##
##         num
## 1  0.000000
## 2  4.921229
## 3  4.769863
## 4  4.569234
## 5  4.366980
## 6  4.122061
## 7  3.925912
## 8  3.680870
## 9  3.430414
## 10 3.266918
##
## , , f_40
##
##         num
## 1  0.000000
## 2  2.257614
## 3  2.256243
## 4  2.256871
## 5  2.256262
## 6  2.254640
## 7  3.422110
## 8  3.392827
## 9  3.358900
## 10 3.334082
##
## , , f_45
##
##         num
## 1  0.000000
## 2  6.047775
## 3  6.043978
## 4  6.044499
## 5  6.042223
## 6  6.028075
## 7  8.244873
## 8  8.150629
```

```
## 9  8.023948
## 10 7.922107
##
## , , f_50
##
##          num
## 1   0.000000
## 2   8.282801
## 3   8.281624
## 4   8.259559
## 5   8.236438
## 6   8.220519
## 7  10.503997
## 8  10.297150
## 9  10.104423
## 10  9.948539
##
## , , f_55
##
##         num
## 1   0.00000
## 2  11.46952
## 3  11.45560
## 4  11.43176
## 5  11.35048
## 6  11.32486
## 7  13.85951
## 8  13.47749
## 9  13.15114
## 10 12.85990
##
## , , f_60
##
##          num
## 1   0.000000
## 2   9.374342
## 3   9.330947
## 4   9.291033
## 5   9.221511
## 6   9.168767
## 7  10.595732
## 8  10.249250
## 9   9.797567
## 10  9.461310
##
## , , f_65
##
##          num
## 1   0.000000
## 2   9.215675
## 3   9.139486
## 4   9.033869
## 5   8.937294
## 6   8.749120
```

```
## 7  10.804962
## 8  10.170728
## 9   9.525356
## 10  8.955310
##
## , , f_70
##
##         num
## 1  0.000000
## 2  6.215757
## 3  6.117452
## 4  5.986766
## 5  5.789576
## 6  5.589569
## 7  5.431759
## 8  5.243624
## 9  5.051218
## 10 4.803299
```

```
n_cvd
```

```
##  [1]  10.20417  31.70765  43.92013  59.10163  61.94039  39.39547  31.63748
##  [8]  24.62850  61.96147  80.95971 108.28628  84.31198  81.88101  44.12433
```

```
n_cd
```

```
##  [1]  2.735556  9.870854 16.536473 27.799874 37.163846 30.133848 27.482202
##  [8]  3.807661 12.786499 21.964330 38.815154 40.313049 52.178792 32.633627
```

```
n_nd
```

```
##  [1]  5.865071 15.907556 21.805705 31.092202 35.733875 25.528089 21.892491
##  [8]  6.005710 15.190075 21.840907 33.990043 31.926458 37.194767 21.780390
```

```
n_d
```

```
##  [1]  8.600628 25.778410 38.342179 58.892075 72.897721 55.661937 49.374693
##  [8]  9.813371 27.976574 43.805237 72.805197 72.239508 89.373560 54.414017
```

```
qaly
```

```
##  [1] 2245.4473 4308.9636 4027.6202 3813.6582 2869.0922 1333.1401  892.4738
##  [8] 4923.6811 8406.9425 7988.9629 8056.1947 4836.8231 3517.6313 1579.4142
```

```
lifeyear
```

```
##  [1] 2251.3300 4327.2977 4052.9225 3846.9089 2903.0481 1353.9798  909.8754
##  [8] 4938.1157 8443.3835 8036.2968 8118.6540 4884.6939 3562.1723 1604.5880
```

```r
N_cvd<-sum(n_cvd)
N_cd<-sum(n_cd)
N_nd<-sum(n_nd)
N_d<-sum(n_d)
QALY<-sum(qaly)
LIFEYEAR<-sum(lifeyear)

N_cvd
```

```
## [1] 764.0602
```

```r
N_cd
```

```
## [1] 354.2218
```

```r
N_nd
```

```
## [1] 325.7533
```

```r
N_d
```

```
## [1] 679.9751
```

```r
QALY
```

```
## [1] 58800.05
```

```r
LIFEYEAR
```

```
## [1] 59233.27
```