Problem Set 2

Tony Lashley

April 13, 2015

1 Machinery for the Schelling Model

1.1 Write a function that calculates distances between coordinate points

```
an_individual <- c(0,0)

neighbors = matrix(1:8, ncol = 2, byrow = T)
print(neighbors)

##      [,1] [,2]
## [1,]    1    2
## [2,]    3    4
## [3,]    5    6
## [4,]    7    8

colnames(neighbors) <- c("X","Y")
dstances = matrix(ncol = 3, byrow = T)
colnames(dstances) <- c("X","Y", "Pythgorean")

f1 <- function(an_individual, neighbors){

  for (i in 1:nrow(neighbors)){

    neighbor_longitude = neighbors[i,1]
    ## Find your neighbor's longitude
    neighbor_latitude =  neighbors[i,2]
    ## Find your neighbor's latitude
    individual_longitude = an_individual[1]
    ## Find your own longitude
    individual_latitude =  an_individual[2]
    ## Find your own latitude

    lftrghtdstance = abs(neighbor_longitude - individual_longitude)
```

```
    ## Find east/west distance between indiv. and neighbor
    updowndstance = abs(neighbor_latitude - individual_latitude)
    ## Find north/south distance between indiv. and neighbor
    pyth = sqrt(((lftrghtdstance)^2) + ((updowndstance)^2))
    ## Find Euclidian distance
    currentdistance = c(lftrghtdstance,updowndstance,pyth)
    ## Make vector with Manhattan and Euclidian distances


    dstances <- rbind(dstances, currentdistance)
    ## Add vector as row in matrix of distances
  }

  return(dstances)
}

f1(an_individual, neighbors)

##                  X  Y Pythgorean
##                 NA NA         NA
## currentdistance  1  2   2.236068
## currentdistance  3  4   5.000000
## currentdistance  5  6   7.810250
## currentdistance  7  8  10.630146
```

1.2 Write a function that simulates Schelling's Segregation model

```
library(RANN)
library(FNN)
library(ggplot2)
library(reshape2)

library(foreach)
library(doParallel)

## Loading required package:  iterators
## Loading required package:  parallel

library(parallel)

require(foreach)
require(doParallel)
require(parallel)
```

```r
require(ggplot2)

numCores <- detectCores()
cl <- makeCluster(numCores)
registerDoParallel(cl)

testv = 100

testRacialPreferenceTable <- matrix(1:15, ncol = 5, nrow = 3)
testRacialPreferenceTable[1,] <- c("R",1, 50, 5, 2)
testRacialPreferenceTable[2,] <- c("G", 0, 50, 5, 2)
testRacialPreferenceTable[3,] <- c("B", -1, 50, 5, 2)
colnames(testRacialPreferenceTable) <- c("Color", "Value", "Pop.", "Test Pool Size", "Racial
print(testRacialPreferenceTable)
```

```
##      Color Value Pop. Test Pool Size Racial Threshold
## [1,] "R"   "1"   "50" "5"            "2"
## [2,] "G"   "0"   "50" "5"            "2"
## [3,] "B"   "-1"  "50" "5"            "2"
```

```r
nR <- as.numeric(testRacialPreferenceTable[1,"Pop."])
nG <- as.numeric(testRacialPreferenceTable[2,"Pop."])
nB <- as.numeric(testRacialPreferenceTable[3,"Pop."])

n <- sum(nR + nG + nB)
## Find total population from summing each racial population

inputs <- testRacialPreferenceTable

stop.val <- .95
happy_counter <- 0


Schelling <- function(racialPreferenceTable = testRacialPreferenceTable, cyclemax = testv){
  set.seed(20016)
  library(ggplot2)
  LocationTable <- matrix(ncol = 3)
  ## Initalizing table for initial neighborhood coordinates

  for (i in 1:nR){
    x <- runif(1, min=0, max=1)
    ## Generate random X coordinate between 0 and 1 for point
    y <- runif(1, min=0, max=1)
    ## Generate random Y coordinate between 0 and 1 for point
    R = c(1,x,y)
    ## Create vector with point coordinates, labeling point as red
```

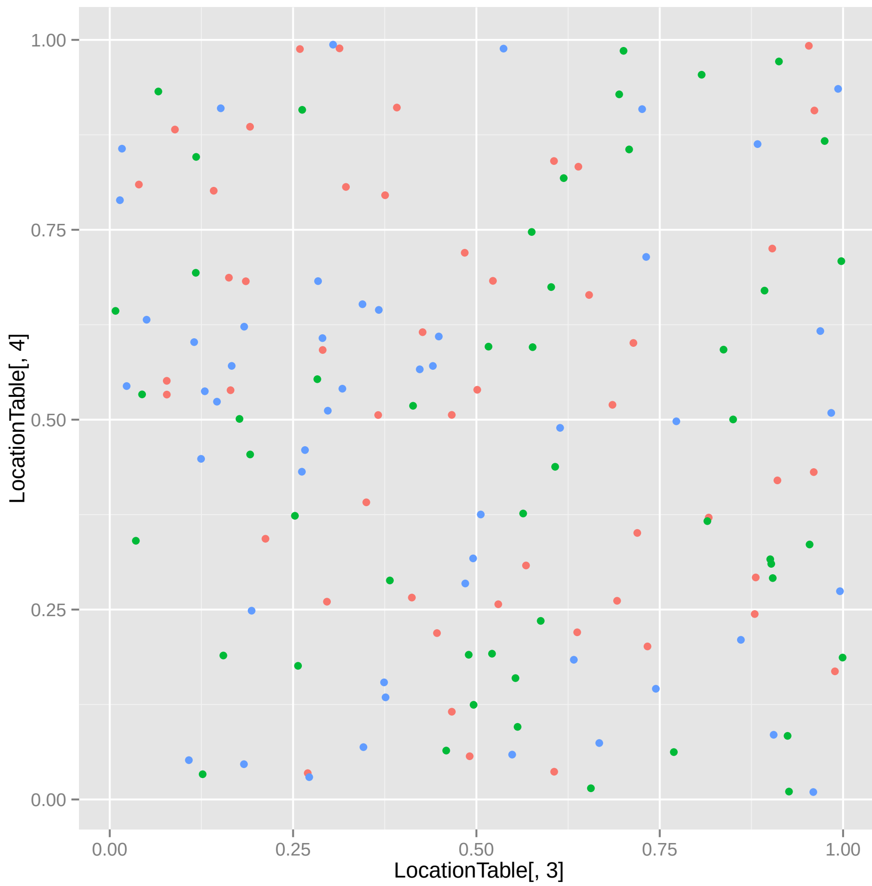
```
  LocationTable <- rbind(LocationTable, R)
  ## Add red point to table of all neighborhood coordinates
}

for (i in 1:nG){
  x <- runif(1, min=0, max=1)
  y <- runif(1, min=0, max=1)

  G = c(0,x,y)

  LocationTable <- rbind(LocationTable, G)
}

for (i in 1:nB){
  x <- runif(1, min=0, max=1)
  y <- runif(1, min=0, max=1)
  B = c(-1,x,y)

  LocationTable <- rbind(LocationTable, B)
}

LocationTable <- LocationTable[-1,]
Count <- c(1:nrow(LocationTable))
## Create column counting number of points or people

Happy <- c(rep(0, nrow(LocationTable)))
## Create column to keep track of if person is happy

Testpool <- c(rep(0, nrow(LocationTable)))
## Create column for indvidual's testpool

Threshold <- c(rep(0, nrow(LocationTable)))
## Create column for indvidual's threshold

LocationTable <- cbind(Count, LocationTable, Happy, Testpool, Threshold)
## Add columns to Location Table


p <- qplot(x = LocationTable[,3], y = LocationTable [,4], col = ifelse(LocationTable[,2] <

print(p)

testpoolR <- as.numeric(racialPreferenceTable[1,4])
## Pull m value for given race
thresholdR <- as.numeric(racialPreferenceTable[1,5])
```

```
##Pull j value for given race

testpoolG <- as.numeric(racialPreferenceTable[2,4])
thresholdG <- as.numeric(racialPreferenceTable[2,5])

testpoolB <- as.numeric(racialPreferenceTable[3,4])
thresholdB <- as.numeric(racialPreferenceTable[3,5])

for (individual in 1:nrow(LocationTable)){

  own_race <- LocationTable[individual,2]

  if(own_race == 1){
  ##If the point is red...

      testpool <- testpoolR
      ## Pull m value for individual given race
      threshold <- thresholdR
      ##Pull j value for indvidual given race

      LocationTable[individual,6] <- testpool
      LocationTable[individual,7] <- threshold

    }

    if(own_race == 0){
    ##If the point is green...

      testpool <- testpoolG
      threshold <- thresholdG

      LocationTable[individual,6] <- testpool
      LocationTable[individual,7] <- threshold

    }

    if(own_race == -1){
    ##If the point is blue...

      testpool <- testpoolB
      threshold <- thresholdB

      LocationTable[individual,6] <- testpool
      LocationTable[individual,7] <- threshold
```

```
    }
  }

  print(LocationTable)

  maxtestnumb <- max(testpoolR, testpoolG, testpoolB)
  #Finding max testpool value so we can create neighborlist outside loop

  LoopUnhappyLocationTable <- LocationTable

  justXYtable = LocationTable[,3:4]
  #Make seperate table with just X & Y coordinate for
  #nearest neighbor function

  neighborList <- get.knn(data = justXYtable, k = maxtestnumb)$nn.index
  ## Create matrix of m closest neighbors for each point

  print(neighborList)



  ##Initialize value for total number of neighbors evaluate

  cycles <- 0


while (((happy_counter/n) < stop.val) & (cycles < cyclemax)){

     NumUnhappy <- nrow(LoopUnhappyLocationTable)

     cycles <- cycles + 1
     happy_counter<- n - NumUnhappy


     for (individual in (1:NumUnhappy)){
     ##For a point in the location table...

       neighborracevector <- matrix(, ncol = testpool, nrow = 1 )

       for (neighbor in (1:testpool)){
       ## For each closest neighbor of the given point

         neighborList <- neighborList[,1:testpool]
         ##Get rid of extraneous neighbors who are ranked lower than
         ## k closest
```

```
        a_neighbor <- neighborList[individual,neighbor]
        ## Find numerical value of neighboor in Location matrix

        a_neighbors_race <- LocationTable[a_neighbor,2]
        ## Find neighbor's race

        if (own_race == a_neighbors_race){
          neighborracevector[1,neighbor] = 1
        }

        else{
          neighborracevector[1,neighbor] = 0
        }
      }


      totalownraceneighbors = sum(neighborracevector[1,])



      if (totalownraceneighbors >= (threshold)){
          LocationTable[individual,5] = 1
          LoopUnhappyLocationTable = LoopUnhappyLocationTable[-individual,]
        }

      else {

          xstar <- runif(1, min=0, max=1)
          ystar <- runif(1, min=0, max=1)

          LocationTable[individual,3] <- xstar
          LocationTable[individual,4] <- ystar

      }
     }

   p <- qplot(x = LocationTable[,3], y = LocationTable [,4], col = ifelse(LocationTable[,2]

    if (cycles %% 5 == 0) {print(p)}
 }

out <- c(cycles, happy_counter)
return(out)
print(p)
```

```
}

Schelling(testRacialPreferenceTable)
```




```
##   Count                                Happy Testpool Threshold
## R     1  1 0.88087670 0.292274361     0        5         2
## R     2  1 0.50111460 0.539329507     0        5         2
## R     3  1 0.34984375 0.391174800     0        5         2
## R     4  1 0.71935381 0.350873383     0        5         2
## R     5  1 0.46636470 0.506259974     0        5         2
## R     6  1 0.37548038 0.795474492     0        5         2
## R     7  1 0.48403496 0.719710088     0        5         2
## R     8  1 0.16247257 0.686906370     0        5         2
## R     9  1 0.19127365 0.885605896     0        5         2
## R    10  1 0.71405276 0.600972072     0        5         2
## R    11  1 0.60577097 0.840487010     0        5         2
```

```
## R    12  1 0.63742605 0.220050183     0        5          2
## R    13  1 0.03969718 0.809529376     0        5          2
## R    14  1 0.69181073 0.261534572     0        5          2
## R    15  1 0.65363839 0.664152477     0        5          2
## R    16  1 0.63901260 0.833021256     0        5          2
## R    17  1 0.52979992 0.257004289     0        5          2
## R    18  1 0.98889149 0.168652831     0        5          2
## R    19  1 0.42661108 0.615167781     0        5          2
## R    20  1 0.87949560 0.244099568     0        5          2
## R    21  1 0.31329813 0.988823090     0        5          2
## R    22  1 0.41195102 0.265774416     0        5          2
## R    23  1 0.25931412 0.987915983     0        5          2
## R    24  1 0.73325532 0.201447914     0        5          2
## R    25  1 0.07781230 0.533021456     0        5          2
## R    26  1 0.96087329 0.906998900     0        5          2
## R    27  1 0.56762140 0.308037600     0        5          2
## R    28  1 0.81676286 0.371100862     0        5          2
## R    29  1 0.46643300 0.115485445     0        5          2
## R    30  1 0.91045513 0.420044321     0        5          2
## R    31  1 0.95330606 0.992173342     0        5          2
## R    32  1 0.21233086 0.343192349     0        5          2
## R    33  1 0.60603245 0.036496113     0        5          2
## R    34  1 0.49077000 0.056881471     0        5          2
## R    35  1 0.07772721 0.551119528     0        5          2
## R    36  1 0.52250407 0.682729156     0        5          2
## R    37  1 0.44620386 0.219016305     0        5          2
## R    38  1 0.26996361 0.034623944     0        5          2
## R    39  1 0.16472249 0.538759632     0        5          2
## R    40  1 0.29034521 0.591719521     0        5          2
## R    41  1 0.36602488 0.506071298     0        5          2
## R    42  1 0.95998975 0.430965685     0        5          2
## R    43  1 0.18552025 0.682198081     0        5          2
## R    44  1 0.29617673 0.260350465     0        5          2
## R    45  1 0.08887899 0.881948053     0        5          2
## R    46  1 0.14174181 0.801370089     0        5          2
## R    47  1 0.32205100 0.806377763     0        5          2
## R    48  1 0.68550996 0.519523249     0        5          2
## R    49  1 0.39148476 0.910894458     0        5          2
## R    50  1 0.90343921 0.725260953     0        5          2
## G    51  0 0.38196612 0.288304984     0        5          2
## G    52  0 0.60736101 0.437951637     0        5          2
## G    53  0 0.28304754 0.553282319     0        5          2
## G    54  0 0.95431985 0.335656283     0        5          2
## G    55  0 0.76918250 0.062349494     0        5          2
## G    56  0 0.70062206 0.985571126     0        5          2
```

```
## G    57  0 0.90407563 0.291436276     0        5          2
## G    58  0 0.97487034 0.866844861     0        5          2
## G    59  0 0.57538006 0.747099884     0        5          2
## G    60  0 0.56372344 0.376455617     0        5          2
## G    61  0 0.51646822 0.596139638     0        5          2
## G    62  0 0.25671389 0.175912370     0        5          2
## G    63  0 0.85005458 0.500281350     0        5          2
## G    64  0 0.52127557 0.191887318     0        5          2
## G    65  0 0.99933825 0.186784270     0        5          2
## G    66  0 0.90205565 0.310173962     0        5          2
## G    67  0 0.11732077 0.693351585     0        5          2
## G    68  0 0.15488647 0.189495955     0        5          2
## G    69  0 0.90067305 0.316219866     0        5          2
## G    70  0 0.45880769 0.064337363     0        5          2
## G    71  0 0.92430297 0.083698585     0        5          2
## G    72  0 0.41358364 0.518244113     0        5          2
## G    73  0 0.81491619 0.366424271     0        5          2
## G    74  0 0.89288318 0.669900519     0        5          2
## G    75  0 0.83698380 0.592185493     0        5          2
## G    76  0 0.91252799 0.971544161     0        5          2
## G    77  0 0.49615943 0.124587787     0        5          2
## G    78  0 0.06626001 0.932025275     0        5          2
## G    79  0 0.19143956 0.454173630     0        5          2
## G    80  0 0.12666432 0.033178403     0        5          2
## G    81  0 0.55324639 0.159727750     0        5          2
## G    82  0 0.69469408 0.928274332     0        5          2
## G    83  0 0.60196479 0.674556291     0        5          2
## G    84  0 0.55610809 0.095542465     0        5          2
## G    85  0 0.17690371 0.500974125     0        5          2
## G    86  0 0.58767244 0.235076410     0        5          2
## G    87  0 0.57664420 0.595454185     0        5          2
## G    88  0 0.25248506 0.373429720     0        5          2
## G    89  0 0.80710407 0.954102898     0        5          2
## G    90  0 0.11780056 0.845909939     0        5          2
## G    91  0 0.03558219 0.340554802     0        5          2
## G    92  0 0.92623339 0.010365395     0        5          2
## G    93  0 0.00783140 0.643187550     0        5          2
## G    94  0 0.48946651 0.190491560     0        5          2
## G    95  0 0.26242574 0.907880367     0        5          2
## G    96  0 0.61903045 0.817983840     0        5          2
## G    97  0 0.04407600 0.533258923     0        5          2
## G    98  0 0.65611025 0.014729884     0        5          2
## G    99  0 0.99759068 0.708671428     0        5          2
## G   100  0 0.70825015 0.855745154     0        5          2
## B   101 -1 0.28403739 0.682381599     0        5          2
```

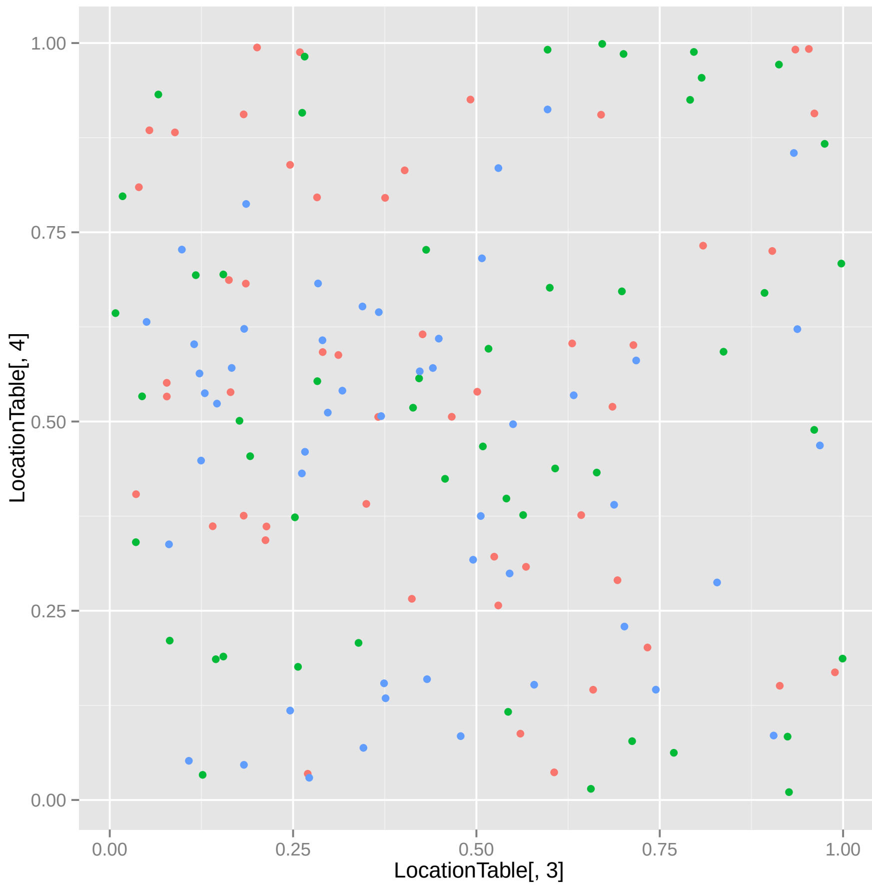
```
## B   102 -1 0.49549380 0.317354294     0        5          2
## B   103 -1 0.01665007 0.856748833     0        5          2
## B   104 -1 0.36686837 0.644468423     0        5          2
## B   105 -1 0.15136172 0.909936710     0        5          2
## B   106 -1 0.99574788 0.274148161     0        5          2
## B   107 -1 0.34591864 0.068874221     0        5          2
## B   108 -1 0.73146704 0.714227306     0        5          2
## B   109 -1 0.86064525 0.210119003     0        5          2
## B   110 -1 0.96896713 0.616654244     0        5          2
## B   111 -1 0.37609992 0.134423233     0        5          2
## B   112 -1 0.53699035 0.988473766     0        5          2
## B   113 -1 0.26198562 0.431435353     0        5          2
## B   114 -1 0.44866089 0.609484812     0        5          2
## B   115 -1 0.61410004 0.489205373     0        5          2
## B   116 -1 0.48478954 0.284334196     0        5          2
## B   117 -1 0.54874250 0.059020051     0        5          2
## B   118 -1 0.12959936 0.537379685     0        5          2
## B   119 -1 0.01384381 0.788933858     0        5          2
## B   120 -1 0.14618622 0.523666771     0        5          2
## B   121 -1 0.88337735 0.862787974     0        5          2
## B   122 -1 0.26621716 0.459968218     0        5          2
## B   123 -1 0.44061894 0.570699342     0        5          2
## B   124 -1 0.77261437 0.497840131     0        5          2
## B   125 -1 0.27200541 0.029366484     0        5          2
## B   126 -1 0.34462786 0.651964305     0        5          2
## B   127 -1 0.42271211 0.566269456     0        5          2
## B   128 -1 0.11508901 0.602072069     0        5          2
## B   129 -1 0.30451388 0.993687095     0        5          2
## B   130 -1 0.16626382 0.570786456     0        5          2
## B   131 -1 0.29007546 0.607338065     0        5          2
## B   132 -1 0.37406760 0.154123175     0        5          2
## B   133 -1 0.50591913 0.375157764     0        5          2
## B   134 -1 0.18329200 0.622406428     0        5          2
## B   135 -1 0.12450300 0.448399968     0        5          2
## B   136 -1 0.99320260 0.935470444     0        5          2
## B   137 -1 0.90531437 0.085126241     0        5          2
## B   138 -1 0.10787591 0.051739027     0        5          2
## B   139 -1 0.31719869 0.540758874     0        5          2
## B   140 -1 0.74466186 0.145718680     0        5          2
## B   141 -1 0.95939913 0.009733661     0        5          2
## B   142 -1 0.98383691 0.508911631     0        5          2
## B   143 -1 0.19343030 0.248508668     0        5          2
## B   144 -1 0.02300792 0.544214905     0        5          2
## B   145 -1 0.05023313 0.631581234     0        5          2
## B   146 -1 0.18296334 0.046411481     0        5          2
```

```
## B   147 -1 0.29731931 0.511776394     0        5         2
## B   148 -1 0.72596524 0.908810235     0        5         2
## B   149 -1 0.66749887 0.074263743     0        5         2
## B   150 -1 0.63282073 0.183889588     0        5         2
##        [,1] [,2] [,3] [,4] [,5]
##   [1,]   57   66   69   20  109
##   [2,]    5   61  123  127  114
##   [3,]  113   88   51  122   41
##   [4,]   14   73   28   52   24
##   [5,]    2   72  123  127   41
##   [6,]   47   49    7  101  126
##   [7,]   36   59  114   19   83
##   [8,]   43   67  134  128  130
##   [9,]  105   95   90   46   45
##  [10,]   48   15  108  124   75
##  [11,]   96   16   59  100   82
##  [12,]  150   86   14   24   81
##  [13,]  119  103   90   45   46
##  [14,]   12   24    4  150   86
##  [15,]   83   10  108   87   59
##  [16,]   96   11  100   59   82
##  [17,]  116   86   27   64  102
##  [18,]   65  106   71  137   20
##  [19,]  114  123  127  104  126
##  [20,]  109    1   57   66   69
##  [21,]  129   23   95   49    9
##  [22,]   51   37  116  102   94
##  [23,]  129   21   95    9  105
##  [24,]  140   14   12  150  109
##  [25,]   35   97  118  144  120
##  [26,]   58  136   76   31  121
##  [27,]   17   60  102   86  116
##  [28,]   73    4   69    1   66
##  [29,]   77   70   34   94   84
##  [30,]   42   54   63   69   28
##  [31,]   76  136   26   58  121
##  [32,]   88  143  113   79   44
##  [33,]   98  117  149   84   34
##  [34,]   70  117   29   77   84
##  [35,]   25   97  118  144  128
##  [36,]    7   83   59   61   87
##  [37,]   94   22  116   64   17
##  [38,]  125  107  146   62   80
##  [39,]  120  130  118   85  128
##  [40,]  131   53  139  147  126
```

```
##  [41,]   72  139  147  127   53
##  [42,]   30  142   54   69   63
##  [43,]    8  134   67  101  128
##  [44,]   51   62  143   22   32
##  [45,]   90   78  105  103   13
##  [46,]   90   45    9   13  105
##  [47,]    6   95   49  101    9
##  [48,]  115   10  124   52   87
##  [49,]   21    6  129   47   95
##  [50,]   74   99  110  121   75
##  [51,]   22   44   37  116    3
##  [52,]  115   60   48  133   27
##  [53,]  139   40  147  131  122
##  [54,]   69   66   57  106    1
##  [55,]  140  149   98  137   24
##  [56,]   82  148   89  100  112
##  [57,]   66    1   69   20   54
##  [58,]   26  136  121   76   31
##  [59,]   83   96   36    7   11
##  [60,]  133   27   52  102  116
##  [61,]    2   87  114  123   36
##  [62,]   44  143   68  132  111
##  [63,]  124   75   30   42   28
##  [64,]   94   81   17   77   86
##  [65,]   18  106   71   20  137
##  [66,]   69   57    1   54   20
##  [67,]    8   43  145  128  134
##  [68,]  143   62  138  146   44
##  [69,]   66   57    1   54   20
##  [70,]   34   29   77  117   84
##  [71,]  137   92  141   18   65
##  [72,]  127   41    5  123    2
##  [73,]   28    4    1   69   66
##  [74,]   50  110   75   99  108
##  [75,]   63   74  124   10  110
##  [76,]   31   26  136   89  121
##  [77,]   29   94   84   81   34
##  [78,]   45  105  103   90   13
##  [79,]   85  135  113  122  120
##  [80,]  138  146   38  125   68
##  [81,]   64   84   77   94   86
##  [82,]  148   56  100   16   89
##  [83,]   15   59   36   87   61
##  [84,]  117   81   77   34   33
##  [85,]  120   39   79  118  130
```

```
##  [86,]   12   17  150   27   64
##  [87,]   61   83    2   36   15
##  [88,]   32  113  122    3   79
##  [89,]  148   76   56   82  121
##  [90,]   45   46  105    9   13
##  [91,]  135   32  143   68   79
##  [92,]  141   71  137   55   18
##  [93,]  145  144  128   35   97
##  [94,]   64   37   77   81   17
##  [95,]    9   23  129   21  105
##  [96,]   16   11   59  100   82
##  [97,]  144   25   35  118  145
##  [98,]   33  149  117   55   84
##  [99,]   50  110   74   58  121
## [100,]  148   16   82   96   11
## [101,]  126  131   40  104   43
## [102,]  116  133   17   27   60
## [103,]   13  119   45   78   90
## [104,]  126   19  131  114  101
## [105,]    9   45   90   78   46
## [106,]   54   65   57   66   69
## [107,]  111   38  125  132   70
## [108,]   15   10   83  100   16
## [109,]   20    1   57   66   69
## [110,]   74   99  142   50   75
## [111,]  132  107   29   70   37
## [112,]   11   56   49   82   16
## [113,]  122   88   79  147    3
## [114,]   19  123  127   61    2
## [115,]   52   48   87   60    2
## [116,]  102   17   22   37   27
## [117,]   84   34   33   77   70
## [118,]  120   39  130   25   35
## [119,]   13  103   90   45   46
## [120,]  118   39   85  130   25
## [121,]   26   58   76   89  136
## [122,]  113  147   79   88   53
## [123,]  127  114   19   72    2
## [124,]   63   48   75   10   28
## [125,]   38  107  146   80   62
## [126,]  104  101  131   40   19
## [127,]  123   72   19  114    5
## [128,]  130   35  118  134  145
## [129,]   21   23   95   49    9
## [130,]   39  118  120  134  128
```

```
## [131,]   40   53  126  139  101
## [132,]  111  107   37   29   22
## [133,]   60  102   27  116   52
## [134,]  130   43    8  128   39
## [135,]   79   85  120  118   25
## [136,]   26   31   58   76  121
## [137,]   71   92  141   18  109
## [138,]   80  146   68   38  125
## [139,]  147   53   40   41  131
## [140,]   24   55  149  150   14
## [141,]   92   71  137   18   65
## [142,]   42  110   30   63   75
## [143,]   68   62   32   44   88
## [144,]   97   35   25  145   93
## [145,]   93  128   35   67  144
## [146,]   80  138   38  125   68
## [147,]  139   53  122   41   40
## [148,]   82  100   56   89   16
## [149,]   98   33   55  140   84
## [150,]   12   86   81   14   24
```




```
## [1]   8 143
```

```
# print(system.time(Schelling(testRacialPreferenceTable)))
```

2 Code Review

2.1 Sketch model that code is based on