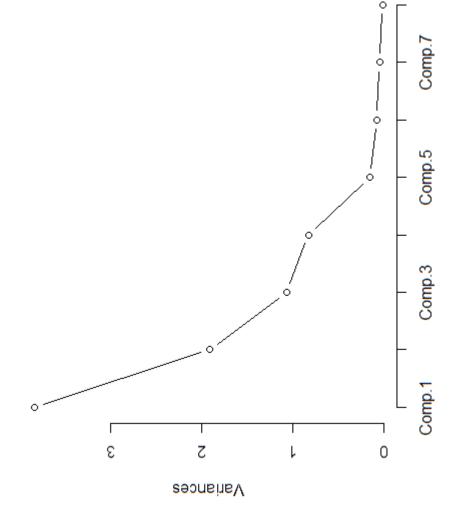
```
setwd("C:/Users/TonyLaptop/Desktop/rowan/DM1/lecture11/lecture11")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       houses$MedianHomeVal2 <- sapply(houses$MedianHomeVal,function(b)
                                               Copyright (C) 2015 The R Foundation for Statistical Computing
                                                                                                                                                                                                                                                           You are welcome to redistribute it under certain conditions.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   'citation()' on how to cite R or R packages in publications.
                                                                                                                                                                                                                                                                                                                                                                                                                       Natural language support but running in an English locale
                                                                                                                                                                                                           R is free software and comes with ABSOLUTELY NO WARRANTY.
                                                                                                                                                                                                                                                                                                                   details
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Type 'demo()' for some demos, 'help()' for on-line help,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       'help.start()' for an HTML browser interface to help.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       houses$zMedHomeVal<-(houses$MedianHomeVal-m)/sigma
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        houses$zMedHomeAge<-(houses$MedianHomeAge-m)/sigma
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            R is a collaborative project with many contributors.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                houses=read.csv("Houses.csv",header=TRUE,sep=",")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 houses$zBedrooms<- (houses$TotalBedRooms-m)/sigma
                                                                                                                                                                                                                                                                                                             Type 'license()' or 'licence()' for distribution
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 houses$zMedInc<- (houses$MedianIncome-m)/sigma
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Type 'contributors()' for more information and
R version 3.2.2 (2015-08-14) -- "Fire Safety"
                                                                                                    Platform: x86_64-w64-mingw32/x64 (64-bit)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return ((b-minn)/(maxx-minn)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     minn = min(houses$MedianHomeVal)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          maxx = max(houses$MedianHomeVal)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           siqma<-sd(houses$MedianHomeVal)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        sigma<-sd(houses$MedianHomeAge)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  siqma<-sd(houses$TotalBedRooms)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 sigma<-sd(houses$MedianIncome)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      m<-mean (houses$MedianHomeVal)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      m<-mean (houses$MedianHomeAge)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             m<-mean (houses$TotalBedRooms)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            m<-mean(houses$MedianIncome)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      m<-mean(houses$TotalRooms)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Type 'q()' to quit
```

```
"zMedInc", "zMedHomeAge", "zBedrooms", "zTotRooms", "zPop", "zHouseholds", "zLatitude",
                                                                                                                                                                                                                                                                                                                                                                                             0.8614180
                                                                                                                                                                                                                                                                                                                                                                                                               -0.8207575
                                                                                                                                                                                                                                                                                                                                                                                                                                 -0.7660095
                                                                                                                                                                                                                                                                                                                                                                                                                                                   -0.7598283
                                                                                                                                                                                                                                                                                                                                                                           -0.9744050
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      -0.8940491
                                                                                                                                                                                                                                                                                                                                                                          -0.8047996
                                                                                                                                                                                                                                                                                                                                                                                                            -0.5357329
                                                                                                                                                                                                                                                                                                                                                                                                                                 -0.6241995
                                                                                                                                                                                                                                                                                                                                                                                                                                                  -0.4623928
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     -0.7869229
                                                                                                                                                                                                                                                                                                                                                                                            2.0458405
                                                                                                                                                                                                                                                                                                                                                         zTotRooms
                                                                                                                                                                                                                                                                                                                                                                                                                                                   -0.6122238
                                                                                                                                                                                                                                                                                                                                                                          -0.9706826
                                                                                                                                                                                                                                                                                                                                                                                                                               -0.7190493
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      -0.7712751
                                                                                                                                                                                                                                                                                                                                                         zBedrooms
                                                                                                                                                                                                                                                                                                                                                                                                             -0.8258748
                                                                                                                                                                                                                                                                                                                                                                                             1.3486168
                                                                                                                               houses$zHouseholds<-(houses$Households-m)/sigma
                   houses$zTotRooms<- (houses$TotalRooms-m)/sigma
                                                                                                                                                                                                                                             houses$zLongitude<- (houses$Longitude-m)/sigma
                                                                                                                                                                                      houses$zLatitude<- (houses$Latitude-m)/sigma
                                                                         houses$zPop<- (houses$Population-m)/sigma
                                                                                                                                                                                                                                                                                                                                                                          0.9821189
                                                                                                                                                                                                                                                                                                                                                                                                                               1.8561366
                                                                                                                                                                                                                                                                                                                                                                                                                                                   1.8561366
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      1.8561366
                                                                                                                                                                                                                                                                                                                                                                                                               1.8561366
                                                                                                                                                                                                                                                                                                                                                         zMedHomeAge
                                                                                                                                                                                                                                                                                                                                                                                             -0.6070042
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       zHouseholds zLatitude zLongitude
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                -1.337785
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  -1.337785
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          -1.327803
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            -1.322812
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              -1.332794
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 MASS
                                                                                                             sigma<-sd(houses$Households)
sigma<-sd(houses$TotalRooms)
                                                       sigma<-sd(houses$Population
                                                                                                                                                                                                                          sigma<-sd(houses$Longitude)
                                                                                                                                                                                                                                                                                                                                                         zMedInc
                                                                                                                                                                                                                                                                                                                                                                           2.34470896
                                                                                                                                                                                                                                                                                                                                                                                            2.33218146
                                                                                                                                                                                                                                                                                                                                                                                                                                                   -0.01288068
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      0.08744452
                                                                                                                                                                                                                                                                                                                                                                                                               1.78265622
                                                                                                                                                                                                                                                                                                                                                                                                                               0.93294491
                                                                                            m<-mean (houses$Households)
                                     m<-mean(houses$Population)
                                                                                                                                                                     siqma<-sd(houses$Latitude)
                                                                                                                                                                                                       m<-mean(houses$Longitude)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 package:
                                                                                                                                                 m<-mean(houses$Latitude)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                package:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            1.043159
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1.052523
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              1.038478
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              1.038478
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    1.038478
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  1.038478
                                                                                                                                                                                                                                                                                                                     > houses2<-houses[vars]</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             > library("neuralnet")
                                                                                                                                                                                                                                                                                c("MedianHomeVal2",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0.5251545
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Loading required
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Loading required
                                                                                                                                                                                                                                                                                                                                                                                                                                                  0.6746385
                                                                                                                                                                                                                                                                                                                                                                          0.9022664
                                                                                                                                                                                                                                                                                                                                                                                             0.7082466
                                                                                                                                                                                                                                                                                                                                                                                                                                 0.6727828
                                                                                                                                                                                                                                                                                                                                                         MedianHomeVal2
                                                                                                                                                                                                                                                                                                                                                                                                               0.6950507
                                                                                                                                                                                                                                                                                                                                        head (houses2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         dim(houses2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            1.6699206
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          -0.9770092
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             -0.8436165
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                -0.7337637
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   -0.6291419
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   -0.8017678
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    set.seed(2)
                                                                                                                                                                                                                                                                                                   zLongitude")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          [1] 20640
                                                                                                                                                                                                                                                                  vars<-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   9
                                                                                                                                                                                                                                                                                                                                                                                                              \sim
                                                                                                                                                                                                                                                                                                                                                                                                                                400
```

```
"ZPop"
                                                                                                                                                                                                                                                                                                                                                                                         MedianHomeVal2~zMedInc+zMedHomeAge+zBedrooms+zTotRooms+zPop+zHouseholds+zLatitude+zLongitude
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > testingData\$Actual<-(testingData\$MedianHomeVal2^*(maxx-minn))+minn
                                                                                                                                                                                                                                                                     "zBedrooms"
                                                                                                                                                                                                                                                                                                "zLatitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                "zBedrooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  > testingData$absDiff<-abs(testingData$guess-testingData$Actual)</p>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > nnet<-neuralnet(formula,trainingData, hidden=5, threshold=0.2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              testingData$guess<-(testingData$guess*(maxx-minn))+minn
                                                                                                                                                                                                                                                                                             "zHouseholds"
                                                                                                                                                                                                                                                                     "zMedHomeAge"
                                                                                                                                                                                                                                                                                                                                                                                                                                               "zMedHomeAge"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 > results<-compute(nnet, testingData[,2:9])</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > testingData$quess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           avgHomeVal<-mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               > avgErr<-mean(testingData$absDiff)</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "zLongitude"
                                                                                                                                                                                                                                                                    [1] "MedianHomeVal2" "zMedInc"
                                                                                                                                                                                                                                                                                                                                                                                                                                               [1] "MedianHomeVal2" "zMedInc"
                                                          > trainingData=houses2[train,
train=sample (1:20640, 16000)
                                                                                          testingData=houses2[test,]
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > dim(results$net.result)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 3.33 301.99
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      user system elapsed
                                                                                                                                                                                                                                       > names(trainingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 > ptm <- proc.time()
                                                                                                                                                                                                                                                                                                                                                                                                                     > names(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           proc.time() - ptm
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           avqErr/avqHomeVal
                                                                                                                  > dim(trainingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    > dim(testingData)
                                                                                                                                                                            > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    [1] 0.2007115494
                                                                                                                                                                                                                                                                                                                           [9] "zLongitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          [8] "zLatitude"
                                                                                                                                                                                                                                                                                                [5] "zTotRooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               "zHouseholds"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     [1] 4640 11
                               test=-train
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         [1] 4640
                                                                                                                                                                                                                                                                                                                                                            > formula=
                                                                                                                                                [1] 16000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   [1] 4640
                                                                                                                                                                                                          [1] 4640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 152.46
```

```
"ZPop"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "ZPop"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           "ZTotRooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "ZTotRooms"
                                                                                                                                                                                                                                                            testingData$Actual<-(testingData$MedianHomeVal2*(maxx-minn))+minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "zBedrooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "zBedrooms"
                           > nnet<-neuralnet(formula,trainingData, hidden=8, threshold=0.15)
                                                                                                                                                                                                                                                                                                                  > testingData$absDiff<-abs(testingData$guess-testingData$Actual)</p>
                                                                                                                                                                                                                                                                                      testingData$guess<- (testingData$guess* (maxx-minn)) +minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "zMedHomeAge"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "zMedHomeAge"
                                                                                                                                             > results<-compute(nnet, testingData[,2:9])</pre>
                                                                                                                                                                                                                               > testingData$quess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                            avgHomeVal<-mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                               avgErr<-mean(testingData$absDiff)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      > PCA<-princomp(trainingData[,2:9])</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  "zLongitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 "zLongitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          [1] "MedianHomeVal2" "zMedInc"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        [1] "MedianHomeVal2" "zMedInc"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                screeplot (PCA, type="lines")
                                                                                                                                                                       > dim(results$net.result)
                                                                                   system elapsed
                                                                                                                458.57
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                > names(trainingData)
ptm <- proc.time()</pre>
                                                        proc.time() - ptm
                                                                                                                                                                                                                                                                                                                                                                                                        avgErr/avgHomeVal
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           > dim(trainingData)
                                                                                                             23.34
                                                                                                                                                                                                                                                                                                                                                                                                                               [1] 0.1898130528
                                                                                                                                                                                                                                                                                                                                                                                                                                                               > names(houses2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 [8] "zLatitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  [8] "zLatitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     "zHouseholds"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       "zHouseholds"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         [1] 16000
                                                                                                                                                                                                    [1] 4640
                                                                                                             435.18
```



```
Loadings:
```

```
trainingData$zTotRooms[i]*.479-trainingData$zHouseholds[i]*.493-trainingData$zPop[i]*.475
                                                                                                                                                                                                                                                                                                                                         trainingData$C1[i]<-trainingData$zMedHomeAge[i]*.219-trainingData$zBedrooms[i]*.49-
                                                                                                                                                                                                                                                                                                                                                                                                           trainingData$zBedrooms[i]*.114-trainingData$zPop[i]*.113-trainingData$zHouseholds[i]*
                                                                                                                                                                                                                                                                                                                                                                         trainingData$C2[i]<-trainingData$zLatitude[i]*.701-trainingData$zLongitude[i]*.701
                                                                                                                                                                                                                                                                                                                                                                                          trainingData$C3[i]<-trainingData$zMedInc[i]*.897-trainingData$zMedHomeAge[i]*.381-
                                                                                                                                                                                                                                                                                                                                                                                                                            + trainingData$C4[i]<-trainingData$zLatitude[i]*.109-trainingData$zMedInc[i]*.395-
                                                                                                                                                                     Comp.8
                                                                                                                                                                                     1.000
                                                                                                                                                                                                     0.125
                                                                                                                                                                                                                     1.000
                                                                                 -0.123
                                                                                                 0.679
Comp.5 Comp.6 Comp.7 Comp.8
                                                                 0.144
                                                                                                                                                                    Comp.6 Comp.7
                                                                                                                                                                                     1.000
                                                                                                                                                                                                    0.125
                                                                                                                                                                                                                     0.875
                                                                                                                                                                                                                                                                                                                                                                                                                                             trainingData$zMedHomeAge[i]*.891-trainingData$zTotRooms[i]*.111
                                                0.230
                                                                                                0.308
                                                                                                                 0.505
                                                                -0.574
                                                                                                                                    0.486
                0.171
                                                                                                                                                                                    1.000
                                                                                                                                                                                                    0.125
                                                                                                                                                                                                                     0.750
                                                               0.546
                                                 -0.216
                                                                                  0.117
                                                                                                 -0.388
                                                                                                                  0.482
                                                                                                                                    0.497
                                                                                                                                                                    Comp.3 Comp.4 Comp.5
                                                                                                                                                                                    1.000
                                                                                                                                                                                                    0.125
                                                                                                                                                                                                                     0.625
                                                0.377
                                                                0.307
                                                                                  -0.850
                                                                                                 0.160
                                                                                                                                                                                    1.000
                                                                                                                                                                                                    0.125
                                                                                                                                                                                                                     0.500
Comp.1 Comp.2 Comp.3 Comp.4
               -0.395
                                                                 -0.111
                                                                                                                  0.109
                                -0.891
                                                                                                                                                                                    1.000
                                                                                                                                                                                                   0.125
                                                                                                                                                                                                                     0.375
               0.897
                                -0.381
                                                                                  -0.113
                                                                                                  -0.106
                                                -0.114
                                                                                                                                                                    Comp.2
                                                                                                                                                                                    1.000
                                                                                                                                                                                                     0.125
                                                                                                                                                                                                                     0.250
                                                                                                                0.701
                                                                                                                                  -0.701
                                                                                                                                                                     Comp.1
                                                                                                                                                                                     1.000
                                                                                                                                                                                                    0.125
                                                                                                                                                                                                                     0.125
                                                                                                                                                                                                                                       > trainingData$C1<-0
                                                                                                                                                                                                                                                      trainingData$C2<-0
                                                                                                                                                                                                                                                                       trainingData$C3<-0
                                                                                                                                                                                                                                                                                        trainingData$C4<-0
                                                                                                                                                                                                                                                                                                         trainingData$C5<-0
                                                                                                                                                                                                                                                                                                                         for (i in 1:16000)
                                               -0.490
                                                                -0.479
                                                                                  -0.475
                                0.219
                                                                                                  -0.493
                                                                                                                                                                                                                      Cumulative Var
                                                                                                                                                                                                      Proportion Var
                                zMedHomeAge
                                                                                                   zHouseholds
                                                                                                                                                                                     SS loadings
                                                                                                                                     zLongitude
                                                   zBedrooms
                                                                 zTotRooms
                                                                                                                    zLatitude
                 zMedInc
                                                                                  zPop
```

ZTotRooms zBedrooms zMedHomeAge zLongitude zMedInc zLatitude MedianHomeVal2 > head(trainingData) zHouseholds

zPop

.106

+ trainingData\$C5[i]<-trainingData\$zBedrooms[i]*.377+trainingData\$zTotRooms[i]*.307-

trainingData\$zPop[i]*.85+trainingData\$zHouseholds[i]*.16

```
-0.2308922649
0.4329899671 -1.3233720718 -0.2891795935 -0.21103490916 -0.6897472321 -0.599995330
                                                                                                                          -0.8103001114 -1.2198878158
                                                                                                                                                                                       0.3245368060 -0.4582908989 0.1875573287 -0.66919742410 -0.7080822708 -0.4710768987
                                                                                                                                                                                                                                                                                                                     0.3360141134
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          testingData$zTotRooms[i]*.479-testingData$zHouseholds[i]*.493-testingData$zPop[i]*.475
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           .106
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               testingData$C1[i]<-testingData$zMedHomeAge[i]*.219-testingData$zBedrooms[i]*.49-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       testingData$zBedrooms[i]*.114-testingData$zPop[i]*.113-testingData$zHouseholds[i]*
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          testingData$C2[i]<-testingData$zLatitude[i]*.701-testingData$zLongitude[i]*.701
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     + testingData$C5[i]<-testingData$zBedrooms[i]*.377+testingData$zTotRooms[i]*.307-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          testingData$C3[i]<-testingData$zMedInc[i]*.897-testingData$zMedHomeAge[i]*.381
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        + testingData$C4[i]<-testingData$zLatitude[i]*.109-testingData$zMedInc[i]*.395-
                                                           0.1188279732
                                                                                                                                                                                                                                                  -0.4527668573
                                                                                                                                                                                                                                                                                                                   0.6280836722
                                                                                                                                                                                                                                                                                                                                                                                                                0.18540072636
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            -0.17870425692
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           0.03128405822
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.19919477694
                                                                                                                                                                                                                                                                                                                                                                                                                                            0.17337037261
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              0.26578560911
                                                                                                                            -0.85436154931
                                                                                                                                                                                                                                                    0.2195887852 -0.7741100068 0.1875573287 -0.58136315958
                                                           -0.09471385615
                                                                                                                                                                                                                                                                                                                     0.53199549071
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.02505241448
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           0.29292544656
                                                                                                                                                                                                                                                                                                                                                                                                               0.78439377615
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.29347198030
                                                                                                                                                                                                                                                                                                                                                                                                                                               0.55445115371
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              1.35297527704
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      testingData$zMedHomeAge[i]*.891-testingData$zTotRooms[i]*.111
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  testingData$zPop[i]*.85+testingData$zHouseholds[i]*.16
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1.1656175511 -0.4333865370
                                                           0.8298955468 0.6481287088 -1.0837411305
                                                                                                                          0.3298976087 -0.4582908989 -1.0042849768
                                                                                                                                                                                                                                                                                                                                                                                                               -0.9629772123
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              0.3394641495
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         1.1588368212 -0.5793652902
                                                                                                                                                                                                                                                                                                                                                                                                                                            1.0468405178
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           -0.2805148384
                                                                                                                                                                                                                                                                                                                   0.2016507148 -0.3610186137 -0.1302672861
                                                                                           0.1478819784 -1.3023986103 1.1877548179
                                                                                                                                                                                                                      0.6840683423 -0.6188627779 0.5438917910
                                                                                                                                                                                                                                                                                    0.5375979209 0.9542059871 -0.6989135865
                              0.5389006047
                                                                                                                                                        1.2516412251 1.7173316083 -0.3794776662
                                                                                                                                                                                                                                                                                                                                                  0.9588877394 -0.7039047728
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          > formula=MedianHomeVal2~C1+C2+C3+C4+C5
                                                                                                                                                                                                                                                                                                                                                                                                                -0.8444112147
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            -0.8150909528
                                                                                                                                                                                                                                                                                                                                                                                                                                            -1.7455975532
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              1.4698633014
                              0.2080394728 -0.6656803006
                                                                                                                                                                                                                                                                                                                                                                                                               0.75802893700
                                                                                                                                                                                                                                                                                                                                                                                                                                             -0.06526847607
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            1.78333833910
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           1.26916042014
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         1.07355963748
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        19469 -1.03136156824
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              for (i in 1:4640) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   testingData$C3<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      > names(testingData
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                testingData$C5<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    testingData$C2<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   testingData$C4<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       testingData$C1<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                  0.5713924123
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       [1] 4640
                                                                                                                                                                                                                                                      19478
                                                              14497
                                                                                                                                                                                                                                                                                                                                                                                                                                               14497
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              11833
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           19478
                                                                                                                                                                                                                                                                                                                                                                                                                  3816
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              3469
 3816
```

```
"dummy"
 "ZPop"
"zTotRooms"
                                                             "absDiff"
 "zBedrooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                      > testingData$Actual<-(testingData$MedianHomeVal2*(maxx-minn))+minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        testingData$Actual<-(testingData$MedianHomeVal2*(maxx-minn))+minn
                                                                                                                                                                                   > nnet<-neuralnet(formula,trainingData, hidden=8, threshold=0.15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > nnet<-neuralnet(formula,trainingData, hidden=5, threshold=0.15)
                                                             "Actual"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > testingData$absDiff<-abs(testingData$guess-testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > testingData$absDiff<-abs(testingData$guess-testingData$Actual)</p>
                                                                                                                       "C5"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     testingData$guess<- (testingData$guess* (maxx-minn)) +minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    testingData$guess<- (testingData$guess* (maxx-minn))+minn
"zMedHomeAge"
                                                             "guess"
                                                                                                                                                                                                                                                                                                              > results<-compute(nnet, testingData[,14:18])</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > results<-compute(nnet, testingData[,14:18])</pre>
                                                                                                                         "C4"
                                                                                                                                                                                                                                                                                                                                                                                                        > testingData$quess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          testingData$guess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             avgHomeVal<-mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           avqHomeVal<-mean(testingData$Actual
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             avgErr<-mean (testingData$absDiff)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             avgErr<-mean(testingData$absDiff)
                                                             "zLongitude"
[1] "MedianHomeVal2" "zMedInc"
                                                                                                                         "C3"
                                                                                                                                                                                                                                                                                                                                          > dim(results$net.result)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        > dim(results$net.result)
                                                                                                                                                                                                                                                 user system elapsed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               user system elapsed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             4.89 204.13
                                                                                                                                                                                                                                                                               2.06 285.01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     > ptm <- proc.time()
                                                                                                                                                        > ptm <- proc.time()
                                                                                                                                                                                                                   > proc.time() - ptm
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  proc.time() - ptm
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         avgErr/avgHomeVal
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         > avgErr/avgHomeVal
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       [1] 0.2332437547
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     [1] 0.2495409405
                                                           [8] "zLatitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                [1] 4640 18
                               "zHouseholds"
                                                                                                                      [15] "C2"
                                                                                                                                                                                                                                                                                                                                                                          [1] 4640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 [1] 4640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           199.15
                                                                                                                                                                                                                                                                               282.94
                                                                                         "C1"
```

```
#might be getting over trained; test on training data and see if results are better
                                                                                                                                                                                 "zTotRooms"
                                                                                                                                                                                                                                                      "C3"
                                                                                                                                                                                 "zBedrooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > testingData\$Actual<-(testingData\$MedianHomeVal2*(maxx-minn))+minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              testingData\$Actual<-(testingData\$MedianHomeVal2*(maxx-minn))+minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                > #now turn the last 4640 rows of training data into testing data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > testingData$absDiff<-abs(testingData$quess-testingData$Actual)</p>
                                                                                                                                                                                                                                                      "C2"
                                   > #if results are much better then the model is overtrained
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           #use the first 4640 rows of training data as testing data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > testingData$guess<- (testingData$guess* (maxx-minn)) +minn</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     testingData$guess<- (testingData$guess* (maxx-minn))+minn
                                                                                                                                                                               "zMedHomeAge"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         > results<-compute(nnet, testingData[,10:14])</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > results<-compute(nnet, testingData[,10:14])</pre>
                                                                                                                                                                                                                                                      "C1"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > testingData<-trainingData[11360:16000,]</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > testingData$guess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            testingData$quess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     avqHomeVal<-mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              > testingData<-trainingData[1:4640,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 avgErr<-mean (testingData$absDiff)
                                                                                                                                                                                                                                                        "zLongitude"
                                                                                                                                                                                 "ZMedInc"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      > dim(results$net.result)
                                                                                                                                                                             [1] "MedianHomeVal2"
                                                                                                                                            > names(trainingData)
                                                                                                                                                                                                                                                                                                                                                                                                  > #save testing data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          avgErr/avgHomeVal
                                                                      > dim(trainingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > dim(trainingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      > dim(testingData)
                                                                                                                                                                                                                                                                                                                          > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                         > t2<-testingData
                                                                                                                                                                                                                                                        "zLatitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       [1] 0.2474397734
                                                                                                                                                                                                                  "zHouseholds"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        > 16000-4640
                                                                                                       [1] 16000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    [1] 16000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         [1] 11360
                                                                                                                                                                                                                                                                                                                                                               [1] 4640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    [1] 4640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         [1] 4640
```

"ZPop"

"C4"

```
> testingData$absDiff<-abs(testingData$guess-testingData$Actual)</p>
> dim(testingData)
                                     [1] 4641
```

avgHomeVal<-mean(testingData\$Actual) avgErr<-mean(testingData\$absDiff)

Λ

avgErr/avgHomeVal Λ

[1] 0.2475267321

> #apparently not overtrained

data > #go back to original training

testingData<-t2

> dim(testingData)

[1] 4640

> PCA\$loadings

Loadings:

```
Comp.8
                                                   0.679
                         -0.705
                                  0.144
                                          -0.123
Comp.5 Comp.6 Comp.7
                         0.230
                                                                   0.486
                                 -0.574
                                                   0.308
                                                           0.505
        0.171
                                 0.546
                         -0.216
                                                  -0.388
                                          0.117
                                                           0.482
                                                                   0.497
                         0.377
                                                   0.160
                                 0.307
                                          -0.850
Comp.3 Comp.4
        -0.395
                                  -0.111
                                                           0.109
                -0.891
        0.897
                -0.381
                                                  -0.106
                                          -0.113
                        -0.114
Comp.1 Comp.2
                                                           0.701
                                                                   -0.701
                0.219
                                 -0.479
                                          -0.475
                                                  -0.493
                zMedHomeAge
                                                   zHouseholds
                                                                    zLongitude
                         zBedrooms
                                  zTotRooms
                                                            zLatitude
        zMedInc
                                          zPop
```

0.125 Comp.8 1.000 1.000 1.000 0.125 Comp.6 Comp.7 0.875 1.000 0.125 0.750 1.000 Comp.4 Comp.5 0.125 0.625 1.000 0.500 Comp. 3 0.125 1.000 0.375 0.125 Comp.2 1.000 0.250 1.000 Comp.1 0.125 0.125 Proportion Var Cumulative Var SS loadings

```
Comp.6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.11714898519
                                                                                                                                                                                                                                      0.89697310056 -0.39498145961 -0.05292607283 -0.05069985665
                                                                                                                                                                                                                                                                                                                   0.09428586745
                                                                                                                                                                                                                                                                                                                                                                                                0.37677755094 -0.21583563847
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 0.54639593644
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           0.15979221377 -0.38785615930
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   0.48199697936
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0.49691929364
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    trainingData$C2[i]<-trainingData$zLatitude[i]*.70066739522-trainingData$zLongitude[i]*.70093813570
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             trainingData$C5[i]<-trainingData$zBedrooms[i]*.37677755094+trainingData$zTotRooms[i]*.30680339698-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                + trainingData$C4[i]<-trainingData$zLatitude[i]*.10881449345-trainingData$zMedInc[i]*.39498145961-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.04618716232
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               0.30680339698
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          -0.47516370568 0.03234963325 -0.11344625820 -0.08755608656 -0.85042459610
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0.09449106267
                                                                                                                                                                                                                                                                                                                 0.03594194492
#perhaps the issue is that we only have 3 digits of accuracy from the loadings above
                                                                                                                                                           Comp.5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 trainingData$zMedHomeAge[i]*.38093625978-trainingData$zBedrooms[i]*.11350576403-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      trainingData$zMedHomeAge[i]*.89131163277-trainingData$zTotRooms[i]*.11149814146
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       trainingData$zBedrooms[i]*.48986944891-trainingData$zTotRooms[i]*.47921520638-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                trainingData$zHouseholds[i]*.49270345689-trainingData$zPop[i]*.47516370568
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         trainingData$zPop[i]*.11344625820-trainingData$zHouseholds[i]*.10571681754
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   trainingData$zPop[i]*.85042459610+trainingData$zHouseholds[i]*.15979221377
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             zTotRooms -0.47921520638 0.07697382345 0.09619023484 -0.11149814146
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.10881449345
                                                                                                                                                                                                                                                                                                                                                         Δυσυτυομης -0.48986944891 0.06379535786 -0.11350576403 -0.06462876723 0.22999775707 -0.705303002500
                                                                                                                                                                                                                                                                                                                   -0.38093625978 -0.89131163277
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           zHouseholds -0.49270345689 0.06718850658 -0.10571681754 -0.09795929987
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0.06198241721
                                                                                                                                                              Comp.4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   trainingData$C1[i]<-trainingData$zMedHomeAge[i]*.21904336969-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             trainingData$C3[i]<-trainingData$zMedInc[i]*.89697310056
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  zLongitude -0.07861713696 -0.70093813570 -0.06240090409
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   zLatitude 0.07662414023 0.70066739522 0.01583449593
                                                                                                                                                           Comp.3
                                        #let's see if we can get a few more digits
                                                                                                                                                                                                                                                                                                                 0.02846998302
                                                                                                                                                                                                                                        -0.04256235977 -0.03721263091
                                                                                                                                                           Comp.2
                                                                               load <- with(PCA, unclass(loadings))</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       -0.57384888422 0.144097307274
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  0.02520026393 -0.122702487969
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               0.30838107295 0.678890344726
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.50506157980 0.039510450552
                                                                                                                                                                                                                                                                               0.17132239177 -0.038853088520
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.48596413567 0.052448988161
                                                                                                                                                                                                                                                                                                                   zMedHomeAge 0.21904336969
                                                                                                                                                              Comp.1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            for (i in 1:16000)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > trainingData$C1<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             trainingData$C4<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    trainingData$C5<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                trainingData$C2<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       trainingData$C3<-0
                                                                                                                                                                                                                                          zMedInc
                                                                                                                     load
                                                                                                                                                                                                    Comp. 7
                                          Λ
                                                                                 Λ
      Λ
```

```
testingData$C1[i]<-testingData$zMedHomeAge[i]*.21904336969-testingData$zBedrooms[i]*.48986944891
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    testingData$C3[i]<-testingData$zMedInc[i]*.89697310056 -testingData$zMedHomeAge[i]*.38093625978-
                                                                                                                                                                                                                                                                                                                                                                                                                                        testingData$C2[i]<-testingData$zLatitude[i]*.70066739522-testingData$zLongitude[i]*.70093813570
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 testingData$C5[i]<-testingData$zBedrooms[i]*.37677755094+testingData$zTotRooms[i]*.30680339698
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              testingData$C4[i]<-testingData$zLatitude[i]*.10881449345-testingData$zMedInc[i]*.39498145961-
                                                                                                                                                                                                                                                                                                                                     testingData$zTotRooms[i]*.47921520638-testingData$zHouseholds[i]*.49270345689-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               testingData$zMedHomeAge[i]*.89131163277-testingData$zTotRooms[i]*.11149814146
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                testingData$zPop[i]*.85042459610+testingData$zHouseholds[i]*.15979221377
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   testingData$zBedrooms[i]*.11350576403-testingData$zPop[i]*.11344625820-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       testingData$Actual<-(testingData$MedianHomeVal2*(maxx-minn))+minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           > nnet<-neuralnet(formula,trainingData, hidden=8, threshold=0.15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  > testingData$absDiff<-abs(testingData$guess-testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        testingData$guess<- (testingData$guess* (maxx-minn))+minn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         results<-compute (nnet, testingData[,14:18])
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  testingData$zHouseholds[i]*.10571681754
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              C2 + C3 + C4 + C5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           testingData$quess<-results$net.result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     avqHomeVal<-mean(testinqData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       but not much
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    avqErr<-mean(testinqData$absDiff)
                                                                                                                                                                                                                                                                                                                                                                                    testingData$zPop[i] *.47516370568
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             #a little bit better,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            system elapsed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        295.53
                                                                                                                                                                                                                                          for (i in 1:4640) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           MedianHomeVal2 ~ C1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ptm <- proc.time()</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ptm <- proc.time()</pre>
                                                                                        testingData$C3<-0
                                                                                                                                                                                        testingData$C5<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             proc.time() - ptm
                                            testingData$C2<-0
                                                                                                                                            testingData$C4<-0
testingData$C1<-0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  avgErr/avgHomeVal
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        8.14
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                [1] 0.2344961167
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    formula
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 [1] 4640
```

```
> nnet<-neuralnet(formula,trainingData, hidden=10, threshold=0.1)
```

> proc.time() - ptm
user system elapsed

769.07 28.44 797.63

> results<-compute(nnet, testingData[,14:18])</pre>

> dim(results\$net.result)

[1] 4640 1

> testingData\$guess<-results\$net.result

> testingData\$Actual<-(testingData\$MedianHomeVal2*(maxx-minn))+minn

> testingData\$guess<- (testingData\$guess* (maxx-minn))+minn

> dim(testingData)

[1] 4640 18

> testingData\$absDiff<-abs(testingData\$guess-testingData\$Actual)

> avgErr<-mean(testingData\$absDiff)</pre>

> avgHomeVal<-mean(testingData\$Actual)</pre>

avgErr/avgHomeVal

[1] 0.2349090405

> #no improvement

```
#A common trick is to change the target variable to log of that variable
```

#this has the affect of making non-linear data mostly linear

> trainingData\$LogHomeVal<-log(trainingData\$Actual)</pre>

> head(trainingData)

zPop -0.2308922649 -0.5999995330 -0.6897472321 0.1188279732 **z**TotRooms 3816 0.4329899671 -1.3233720718 -0.2891795935 -0.21103490916 0.8298955468 0.6481287088 -1.0837411305 -0.09471385615 zBedrooms zMedHomeAge 0.1478819784 -1.3023986103 1.1877548179 0.5389006047 zLongitude zMedInc 0.2080394728 -0.6656803006 zLatitude MedianHomeVal2 14497

-0.8103001114 -1.2198878158-0.854361549310.3298976087 -0.4582908989 -1.0042849768 1.2516412251 1.7173316083 -0.3794776662

0.3245368060 -0.4582908989 0.1875573287 -0.66919742410 -0.7080822708 -0.4710768987 0.6840683423 -0.6188627779 0.5438917910

-0.4527668573-0.58136315958 0.2195887852 -0.7741100068 0.1875573287 0.5375979209 0.9542059871 -0.6989135865 19478

0.3360141134 0.6280836722 0.53199549071 0.2016507148 -0.3610186137 -0.1302672861 0.9588877394 -0.7039047728 0.5713924123

12.32385568 12.94203982 175000 12.07254125 LogHomeVal 0.17349684347 417500 225000 Actual C2 0.26691300191 0.18588126247 0.78492643791 0.55498330985 1.35336481608 0.75817381320 -0.8441564675 -0.9628555061 1.0467683546 0.3391801498 -0.06535947012 -1.74509088951.4692686326 1.78318616447 14497 11833 3816

12.05757264 11.70766954 121500 172400 0.03185161328 -0.17807402608 0.29290117573 0.02545299681 1.1584762099 -0.5795224531 -0.2808047913 -0.8148514686 1.26910783603 1.07352146524 19478 3469

0.19869155414 112800

0.29301512796

-0.4331103385

1.1652550738

-1.03131849785

19469

> max2<-max(trainingData\$LogHomeVal)

> min2<-min(trainingData\$LogHomeVal

> max2

[1] 13.12236538

> min2

[1] 9.615738811

traininqData\$MedianHomeVal3<- (traininqData\$LoqHomeVal-min2)/(max2-min2)

head(trainingData)

zTotRooms	0.6897472321 -0.5999995330 -	0.1188279732 -0.2308922649 -	0.8103001114 -1.2198878158 -	0.7080822708 -0.4710768987 -	0.4527668573 -0.5593800729 -	0.6280836722 0.3360141134	C5 Actual LogHomeVal	.18588126247 225000 12.32385568	.17349684347 417500 12.94203982	.26691300191 175000 12.07254125	.17807402608 172400 12.05757264	.03185161328 121500 11.70766954	.19869155414 112800 11.63337162				ian home val		
zBedrooms	-0.21103490916 -	-0.09471385615	-0.85436154931 -	-0.66919742410 -	-0.58136315958 -	0.53199549071	C4	0.78492643791 0	0.55498330985 0	1.35336481608 0	0.02545299681 -0	0.29290117573 0	0.29301512796 0		or		alized Log of medi	threshold=0.1)	
<u>-</u>	gituae 8 -0.2891795935 9006047	-1. 5481	-1.0 -1.0 77666	0.1	13787 13786	-0.1 -0.1 04772	2 C3	5 -0.9628555061	5 1.0467683546	6 0.3391801498	6 -0.2808047913	9 -0.5795224531	8 -0.4331103385		about .01% erro	-	4 + C5 3 which is norme 3+C4+C5	yData, hidden=8,	
zMedIn	itude zbon -1.323372071 803006 0 538	0.648128708 986103 1.187	-0.458290898 316083 -0 379	-0.458290898 -0.458290898	-0.774110006	-0.361018613 77394 -0.703	O	0 -0.8441564675	2 -1.7450908895	7 1.4692686320	3 -0.8148514686	4 1.1584762099	5 1.1652550738		s \$25 which is	-	+ CZ + C3 + C MedianHomeVal neVal3~C1+C2+C) ormula,training	psed
MedianHomeVal	Households ZLA 816 0.432989967 2080394728 -0 665	.2000374720 4497 0.829895546 .1478819784 -1.302	1833 0.329897608 2516412251 1.717		0340033423 0.010 9478 0.219588785 5375979209 0 954	469 0.201650714 5713924123 0.958		edianhomevais 816 0.7581738132	.//22855054 4497 -0.0653594701 0405757740	1.7831861644 170732	469 1.2691078360 6963484078		.33030331 9469 -1.0313184978 6762771620	exp(12.322	#rounding costs u	formula	<pre>MedianHomeVal2 ~ Cl + > #rerun model with Me > formula<-MedianHomeV</pre>	<pre>ptm <- proc.time(nnet<-neuralnet(f</pre>	proc.time() - ptm user system ela

```
regmodel=1m(trainingData$MedianHomeVal3~trainingData$C1+trainingData$C2+trainingData$C3+
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * * *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * * *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * * *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           770.51854 < 0.000000000000000222
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.000000000000000222
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.00000000078374
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               < 0.0000000000000000222
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 < 0.000000000000000222
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              0.00000000000000222
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Pr(>|t|)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         F-statistic: 3115.095 on 5 and 15994 DF, p-value: < 0.00000000000000022204
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      trainingData$C2 + trainingData$C3 + trainingData$C4 + trainingData$C5)
                                                                                                                                                                                                                                                                                                                           > #Let's try a regression model to see if we can get a better result
                                                                                                                                                testingData$absDiff<-abs (testingData$guess-testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Residual standard error: 0.1156565 on 15994 degrees of freedom
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Multiple R-squared: 0.4933714, Adjusted R-squared: 0.493213
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       0.05 \'. 0.1 \'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          lm(formula = trainingData$MedianHomeVal3 ~ trainingData$C1 +
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0.68574262
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        #terrible R squared. This is not going to work too well
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         -39.57195
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            21.67850
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    89.11508
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  t value
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 -75.30757
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        -6.15192
                                                         testingData$guess<-testingData$guess*(max2-min2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.07356449
results<-compute(nnet, testingData[,14:18])
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           0.0009144070
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     \***\ 0.001 \**\ 0.01 \*\
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.0004945693
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               0.0010346019
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Std. Error
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      0.0006735235
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   0.0009068346
                                                                                         testingData$guess<-testingData$guess+min2
                                                                                                                    testingData$guess<-exp(testingData$guess)
                               testingData$quess<-results$net.result
                                                                                                                                                                                                                                                                                               > #no improvement with log home values
                                                                                                                                                                                                           avqHomeVal<-mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       0.00272059
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Median
                                                                                                                                                                               avqErr<-mean(testinqData$absDiff)
                                                                                                                                                                                                                                                                                                                                                                                         trainingData$C4+trainingData$C5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             0.7045675482
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           -0.0195710714
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 -0.0779133549
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0.0517195795
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      -0.0041434612
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    0.0808126417
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      -0.77864590 -0.07110792
                                                                                                                                                                                                                                        avgErr/avgHomeVal
                                                                                                                                                                                                                                                                                                                                                                                                                     summary (regmodel)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   dim(testingData)
                                                                                                                                                                                                                                                                    [1] 0.2341468598
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 trainingData$C4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            trainingData$C5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           trainingData$C1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         trainingData$C2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    trainingData$C3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        codes:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Coefficients
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                (Intercept)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Residuals:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Signif.
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zHouseholds
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0.9821188657 -0.9706826023 -0.8047995998 -0.9744049915 -0.9770091850
                                                                                                                                                                                                                                                                                                                                                               MedianHomeVal MedianIncome MedianHomeAge TotalRooms TotalBedRooms Population Households Latitude
                                                                                                                                                                                                                                                                                                                                                                                                                                       37.86
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             37.85
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                37.85
                                                                                                                                                                                                                                                                                                                                                                                                   37.88
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          37.85
                                                                                                                                                                                                                                                                                                                                                                                                   126
                                                                                                                                                                                                                                                                                                                                                                                                                                       1138
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             219
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                259
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   193
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          177
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       zPop
                                                    trainingData\$C4[i]*.0779133549+trainingData\$C3[i]*.0808126417-trainingData\$C2[i]*
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          496
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             558
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                565
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   413
                                                                                                                                                                                                                                                                                                                                                                                                   322
                                                                                                                                                                                                                                                                                                                                                                                                                                       2401
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       zTotRooms
                                                                                                                                                                                                                                                                                                                                                                                                                                       1106
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                280
                                                                                                                                                                                                                                                                                                                                                                                                   129
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             235
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   213
                                                                                                                                                                                                                                                                                                          #next thing to try is the use of user defined composite variable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       zBedrooms
                                   testingData$guess[i]<-testingData$C5[i]*.0517195795-
                                                                    + .0041434612-trainingData$C1[i]*.0195710714+.7045675482
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   919
                                                                                                                                                                                                                                                                                                                                                                                                   880
                                                                                                                                                                                                                                                                                                                                                                                                                                       7099
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             1274
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                1627
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          1467
                                                                                                                                                                                                                                    > mean(testingData$absDiff)/mean(testingData$Actual)
                                                                                                          testingData$quess<-testingData$quess*(max2-min2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      zMedHomeAge
                                                                                                                            > testingData$quess<-testingData$quess+min2</p>
                                                                                                                                            testingData$guess<-exp(testingData$guess)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          52
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             52
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                52
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   52
                                                                                                                                                                                                                                                                                                                                                                                                    41
                                                                                                                                                                                                                                                                                                                                                                                                                                       21
                                                                                                                                                                                                                                                                                                                             #go back to original houses data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2.34470895612
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       zMedInc
                                                                                                                                                                                                                                                                                                                                                                                                   8.3252
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 3.8462
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   4.0368
                                                                                                                                                                                                                                                                                                                                                                                                                                       8.3014
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          .2574
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              5.6431
                                                                                                                                                               mean (testingData$absDiff)
                                                                                                                                                                                                  > mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          1.052522785 -1.327803055
                                                                                                                                                                                                                                                                                                                                                                                 Longitude MedianHomeVal2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0.5251545354
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        zLongitude
                                                                                                                                                                                                                                                                                                                                                                                                                   0.9022663824
                                                                                                                                                                                                                                                                                                                                                                                                                                                       0.7082465639
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              0.6727827926
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           0.6950507421
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                0.6746384551
> for (i in 1:4640)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         352100
                                                                                                                                                                                                                                                                                                                                                                                                                                     358500
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            341300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                342200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   269700
                                                                                                                                                                                                                                                                                                                                                                                                   452600
                                                                                                                                                                               [1] 110002.2071
                                                                                                                                                                                                                    [1] 204041.6976
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1 2.1295798911
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     zMedHomeVal
                                                                                                                                                                                                                                                      [1] 0.53911631
                                                                                                                                                                                                                                                                                                                                               > head (houses)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         zLatitude
                                                                                                                                                                                                                                                                         > #awful
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                -122.25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    -122.25
                                                                                                                                                                                                                                                                                                                                                                                                                    -122.23
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           -122.24
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             -122.25
                                                                                                                                                                                                                                                                                                                                                                                                                                                       -122.22
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[1] 4640

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-0.8436164799
   1.6699205726
                                                                                                                                       1.8561365564 -0.7190493040 -0.6241994689 -0.7660095005 -0.7337636638
                                                                                                                                                                                                        1.8561365564 -0.6122238471 -0.4623927526 -0.7598282783 -0.6291419343
                                                                                                                                                                                                                                                                        1.8561365564 -0.7712750829 -0.7869229371 -0.8940491030 -0.8017677880
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      "medInc"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 "TotalBedRooms"
 0.8614179998
                                                                 -0.8207574685
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    "zLongitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   "zMedInc"
                                                                   -0.8258747608 -0.5357329073
 2.0458405374
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   "MedianHomeVal2" "zMedHomeVal"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 "TotalRooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    "zLatitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            houses$tBedRooms<-(houses$TotalBedRooms-min3)/(max3-min3)
1.3486167609
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       houses$medAge<-(houses$MedianHomeAge-min3)/(max3-min3)
                                                                                                                                                                                                                                                                                                                                                                                                               houses$medInc<- (houses$MedianIncome-min3) / (max3-min3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 "MedianHomeAge"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           houses$tRooms<- (houses$TotalRooms-min3) / (max3-min3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  houses$Hholds<- (houses$Households-min3) / (max3-min3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    "zHouseholds"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              houses$Pop<- (houses$Population-min3) / (max3-min3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         houses$long<-(houses$Longitude-min3)/(max3-min3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     houses$lat<-(houses$Latitude-min3)/(max3-min3)
 2.33218146484 -0.6070042083
                                                                 1.8561365564
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 [1] "MedianHomeVal" "MedianIncome"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     "Longitude"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     > min3<-min(houses$MedianHomeAge)</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           max3<-max(houses$TotalBedRooms)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        max3<-max(houses$MedianHomeAge)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            min3<-min(houses$TotalBedRooms)
                                                                                                                                                                                                                                                                                                                                              min3<-min(houses$MedianIncome)
                                                                                                                                                                                                                                                                                                                                                                           > max3<-max(houses$MedianIncome)</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  max3<-max(houses$Households)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         max3<-max(houses$TotalRooms)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 max3<-max(houses$Population)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   min3<-min(houses$Households)
                                                                                                                                                                                                        5 1.1728711014 -0.01288068384
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            min3<-min(houses$Population)
                                                                   1.78265621721
                                                                                                                                       0.93294490759
                                                                                                                                                                                                                                                                        6 0.5445976662 0.08744451941
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    "Households"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            min3<-min (houses$TotalRooms
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        min3<-min (houses$Longitude)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       max3<-max(houses$Longitude)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     "zBedrooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      max3<-max(houses$Latitude)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   min3<-min(houses$Latitude)
                                  1.043159280 -1.322811868
                                                                                                    1.038477528 -1.332794241
                                                                                                                                                                      1.038477528 -1.337785427
                                                                                                                                                                                                                                         1.038477528 -1.337785427
                                                                                                                                                                                                                                                                                                           .038477528 -1.337785427
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    [15] "zTotRooms"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   [8] "Latitude"
                                                                   3 1.2586629222
                                                                                                                                       4 1.1650718450
                                                                                                                                                                                                                                                                                                                                                                                                                                                  > names (houses)
 1.3141243014
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    "zMedHomeAge"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    "Population"
```

S1		"medInc"	"tBedRooms"	beakooms")	lat	0.5674814028	0.5653560043	0.5642933050	0.5642933050	0.5642933050	0.5642933050			+ (H B D	0.5674814028	0.5653560043	0.5642933050
"TotalBedRooms	"zMedInc"	"zLongitude"	"long"	T. '. Suot'	Hholds	0.02055582963	0.18697582634	0.02894260812	0.03584936688	0.04242723236	0.03157375432		iRooms)/4	7 7 4 1	01111	0.02055582963	0.18697582634	0.02894260812
"TotalRooms"	"zMedHomeVal"	"zLatitude"	"lat"	op.,, "hnolds", "l	Pop	0.008940833544	0.067210403879	0.013817651840	0.015555368704	0.015751562544	0.011491353457		<pre>\$Pop+houses3\$Hholds+houses3\$tBedRooms) /</pre>	С (Н	0.008940833544	0.067210403879	0.013817651840
MedianHomeAge"	MedianHomeVal2"	zHouseholds"	lds"	. 'CKOOMS', 'F	ge tRooms	55 0.02233073910	27 0.18050256880	00 0.03726028791	00 0.03235159469	00 0.04132967089	00 0.02332265120		\$Pop+houses3\$Hho	; ; ; ; ; ; ; ; ; ;		55 0.02233073910	27 0.18050256880	00 0.03726028791
anIncome" "s"	itude" "	=	= 7	medinc", "meo	Inc medAg	84 0.78431372	17 0.39215686	48 1.00000000	59 1.00000000	72 1.00000000	35 1.00000000		e Rooms+houses3	() }	C C C C C C C C C C C C C C C C C C C	84 0.78431372	17 0.39215686	48 1.00000000
น	7	=		lanhomevalz ses[vars] 9	2 med	824 0.53966841	39 0.538027	0.1/14//3432 421 0.466028	293296089	.0363128491 51 0.230776	0.04329608939 354 0.24392077 0.03289882061	\$long)	site var <- (house	3)	ms	824 0.53966841	39 0.538027	421 0.466028 0.0293296089
[1] "MedianHomeVal" "Population" "Ho	ud e	[15] "ZTotRooms	JE TERO	vars<-c houses3 dim(hou	> head(houses3) MedianHomeVal	0.90226 0.90226 11155378	0.7082465	121313944	101593625 0.6727827	1633466 .6746384	091633466 0.5251545 091633466	houses3	<pre>> #make a compo > houses3\$comp1</pre>	> head (houses3)	ond tB	0.90226	0.7082465	0.6950507

> names (houses)

```
0.6727827926 0.3546985559 1.0000000000 0.03235159469 0.015555368704 0.03584936688 0.5642933050
                                                                                                                                    0.5251545354 0.2439207735 1.000000000 0.02332265120 0.011491353457 0.03157375432 0.5642933050
                                                                1.0000000000 0.04132967089 0.015751562544 0.04242723236 0.5642933050
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > nnet<-neuralnet(formula,trainingData, hidden=5, threshold=0.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               formula<-MedianHomeVal2~comp1+comp2+medInc+medAge
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   MedianHomeVal2 ~ comp1 + comp2 + medInc + medAge
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         > houses3$comp2<-(houses3$lat-houses3$long)/2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > vars<-c("comp1","comp2","medInc","medAge")</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                0
to
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > #add .5 so min and max go back to
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               > houses3$comp2<-houses3$comp2+.5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    trainingData<-houses3[train,]
                                                                0.6746384551 0.2307761272
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   > testingData<-houses3[test,]</pre>
                                 0.2091633466 0.03631284916
                                                                                                   0.2091633466 0.04329608939
                                                                                                                                                                   0.2091633466 0.03289882061
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       test2<-testingData[vars]
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                system elapsed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               23.70 423.45
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    > min(houses3$comp1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > min(houses3$comp2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            > ptm <- proc.time()</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               proc.time() - ptm
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          > max(houses3$comp2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                    > max(houses3$comp1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    [1] 0.0001009282068
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      > dim(trainingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      > dim(testingData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           [1] -0.4742327184
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 [1] 0.9075818929
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         [1] 0.4916651143
                                                                                                                                                                                                                                                                                                                                             0.03001729486
                                                                                                                                                                                                                                                                                                                                                                              0.03570113880
                                                                                                                                                                                                                                         0.01792271028
                                                                                                                                                                                                                                                                         0.15154153557
                                                                                                                                                                                                                                                                                                            0.02733753920
                                                                                                                                                                                                                                                                                                                                                                                                                 0.02482164490
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        [1] 4640 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       [1] 16000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  > formula
```

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0.05689506079 0.02766333137 0.06873869429 0.5632306057
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   33 0.1967022816 0.08944704211 0.9215686275 0.04883259576 0.02867232826 0.05492517678 0.5632306057
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      0.1746405169 0.11590874609 1.0000000000 0.04288112315 0.02382353766 0.05328071041
                                                                                                                                                                                                                                                  0.10623252754
                                                                                                                                                                                                                                                                                                                0.11725045223
                                                                                                                                                                                                                                                                                                                                                                                                                                         0.01904979907 0.01137924269 0.02713369512
                                                                                                                                                                                                                                                  0.4668042606 0.18069405939 1.0000000000 0.07889516252 0.03234395583
                                                                                                                                                                                                                                                                                                                0.5074226498 0.22008661949 1.0000000000 0.09021313393 0.04338686622
                                                                                                                                                                                       Pop
                                                                                                                         testingData$Actual<-(testingData$MedianHomeVal2*(max3-min3))+min3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         > nnet<-neuralnet(formula,trainingData, hidden=8, threshold=0.05)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   testingData$absDiff<-abs(testingData$Actual-testingData$guess)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          147500
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               241400
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             261100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            158700
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 absDiff Actual
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     > testingData$guess<- (testingData$guess*(max3-min3))+min3</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       0.04893620304 0.6780296455 0.2177137461 0.02101146446
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.04185950463
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.03062025157
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.1293202291 0.14387658241
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             0.11083944768
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0.11791628710
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  > mean(testingData$absDiff)/mean(testingData$Actual)
                                                                                                                                                                                                                                                                                                                                                                                                                                         21 0.2731968116 0.05916470118 0.7647058824
                                                                                                                                                                                                                                                                                                                                                                         19 0.2962894998 0.10283996083 0.9607843137
                                                                                                                                                                                       medAge
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  vars<-c("comp1","comp2","medInc","medAge")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.2925568040
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             0.5086637652
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.6182620975
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0.2656692483
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      guess
                              testingData$quess<-results$net.result
                                                            min3<-min(houses$MedianHomeVal)
                                                                                          max3<-max(houses$MedianHomeVal
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 comp2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.6770336296
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0.6775316375
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0.6785609951
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.6780296455
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               0.6770336296
results <- compute (nnet, test2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   mean (testingData$absDiff)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 0.2071713147 0.06331471136
                                                                                                                                                                                                                                                                                                                                             0.2091633466 0.10955927995
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    0.2071713147 0.05214152700
                                                                                                                                                                                                                                                                                0.2091633466 0.10645561763
                                                                                                                                                                                                                                                                                                                                                                                                         0.2081673307 0.07045313470
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.2071713147 0.02839851024
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      45.05 774.56
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         system elapsed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           proc.time()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         proc.time() - ptm
                                                                                                                                                         head(testingData)
                                                                                                                                                                                       MedianHomeVal2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              #worse than PCA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               0.08098181588
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.09010243308
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            0.05593755529
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.02149031178
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       0.04303172455
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            [1] 0.2696501748
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      comp1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  [1] 55019.87943
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ptm <-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       33
```

lat

Hholds

0.5632306057

0.5632306057

0.5642933050

0.5632306057

```
test2<-testingData[vars]
```

- results<-compute(nnet, test2)
- testingData\$guess<-results\$net.result
- testingData\$absDiff<-abs (testingData\$Actual-testingData\$guess) testingData\$guess<- (testingData\$guess* (max3-min3)) +min3
 - testingData\$percErr<-testingData\$absDiff/testingData\$Actual
- mean(testingData\$absDiff)/mean(testingData\$Actual)

[1] 0.2687390437

- > #let's see if we improve if we undo the lat and longitude composite
- formula<-MedianHomeVal2~comp1+medInc+medAge+lat+long
- > ptm <- proc.time()
- > nnet<-neuralnet(formula,trainingData, hidden=8, threshold=0.05)

Warning message:

algorithm did not converge in 1 of 1 repetition(s) within the stepmax

> proc.time() - ptm

143.58 2541.89 user system elapsed 2394.73

> #took forever and didn't work

#try again with more layers and higher threshold

> ptm <- proc.time()

> nnet<-neuralnet(formula,trainingData, hidden=10, threshold=0.09)

Warning message:

algorithm did not converge in 1 of 1 repetition(s) within the stepmax

system elapsed > proc.time() - ptm

Give up 152.79 2992.83 > #still doesn't work. 2835.84