FinalProject

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R Markdown

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
library(keras)
library(tensorflow)
library(ggplot2)


#Loading a csv file
WineQualityDataFrame <- read.csv("WineQT.csv")


#WineQualityDataFrame <- subset(WineQualityDataFrame, select = -c(Id))
WineQualityDataFrame <-
  subset(
    WineQualityDataFrame,
    select = c(
      fixed.acidity,
      volatile.acidity,
      citric.acid,
      free.sulfur.dioxide,
      total.sulfur.dioxide,
      pH,
      sulphates,
      alcohol,
      quality
    )
  )

# Various syntax for R dataframes
summary(WineQualityDataFrame)
```

```
##  fixed.acidity    volatile.acidity  citric.acid     free.sulfur.dioxide
##  Min.   : 4.600   Min.   :0.1200   Min.   :0.0000   Min.   : 1.00
##  1st Qu.: 7.100   1st Qu.:0.3925   1st Qu.:0.0900   1st Qu.: 7.00
##  Median : 7.900   Median :0.5200   Median :0.2500   Median :13.00
##  Mean   : 8.311   Mean   :0.5313   Mean   :0.2684   Mean   :15.62
##  3rd Qu.: 9.100   3rd Qu.:0.6400   3rd Qu.:0.4200   3rd Qu.:21.00
```

```
##  Max.   :15.900   Max.   :1.5800   Max.   :1.0000   Max.   :68.00
##  total.sulfur.dioxide       pH          sulphates         alcohol
##  Min.   :  6.00       Min.   :2.740   Min.   :0.3300   Min.   : 8.40
##  1st Qu.: 21.00       1st Qu.:3.205   1st Qu.:0.5500   1st Qu.: 9.50
##  Median : 37.00       Median :3.310   Median :0.6200   Median :10.20
##  Mean   : 45.91       Mean   :3.311   Mean   :0.6577   Mean   :10.44
##  3rd Qu.: 61.00       3rd Qu.:3.400   3rd Qu.:0.7300   3rd Qu.:11.10
##  Max.   :289.00       Max.   :4.010   Max.   :2.0000   Max.   :14.90
##     quality
##  Min.   :3.000
##  1st Qu.:5.000
##  Median :6.000
##  Mean   :5.657
##  3rd Qu.:6.000
##  Max.   :8.000
```

```
head(WineQualityDataFrame)
```

```
##   fixed.acidity volatile.acidity citric.acid free.sulfur.dioxide
## 1           7.4             0.70        0.00                  11
## 2           7.8             0.88        0.00                  25
## 3           7.8             0.76        0.04                  15
## 4          11.2             0.28        0.56                  17
## 5           7.4             0.70        0.00                  11
## 6           7.4             0.66        0.00                  13
##   total.sulfur.dioxide   pH sulphates alcohol quality
## 1                   34 3.51      0.56     9.4       5
## 2                   67 3.20      0.68     9.8       5
## 3                   54 3.26      0.65     9.8       5
## 4                   60 3.16      0.58     9.8       6
## 5                   34 3.51      0.56     9.4       5
## 6                   40 3.51      0.56     9.4       5
```

```
head(WineQualityDataFrame$quality)
```

```
## [1] 5 5 5 6 5 5
```

Splitting data into training and testing

```
sample_size <- 900
set.seed(1234) # setting random seed to make results repeatable


# Subtract three to so quality levels start at zero
WineQualityDataFrame$quality <- WineQualityDataFrame$quality -3

picked <- sample(seq_len(nrow(WineQualityDataFrame)),size = sample_size)
training <- WineQualityDataFrame[picked,]
testing <- WineQualityDataFrame[-picked,]


# Changing y into categorical data (performing one-hot encoding)

yTr <- to_categorical(training$quality, num_classes = 6)
```

```
## Loaded Tensorflow version 2.0.0
```

```
yTest <- to_categorical(testing$quality, num_classes = 6)
```

Neural network for the iris example

This is where we tried to improve our accuracy. One way we found that was somewhat successful was to increase the number of epochs. We think Elena chose 20 epochs because she had a smaller data set but since ours was larger we needed more. We found that after 300 we got vastly diminishing returns, so we settled on 300 for the time being. We are still looking at ways of improving accuracy.

initial accuracy -> ~43% drop Id feature -> no improvement in accuracy increase epochs to 100 -> accuracy raised to ~53% increase epochs to 1000 -> accuracy raised to ~67% decrease epochs to 300 -> accuracy lowered to ~60% increase units from 64 to 128 in first layer -> ~56% increase input_shape from 4 to 11 -> ~80% increase first layer units from 64 to 128 -> ~81% increase second layer units from 64 to 128 -> ~88%

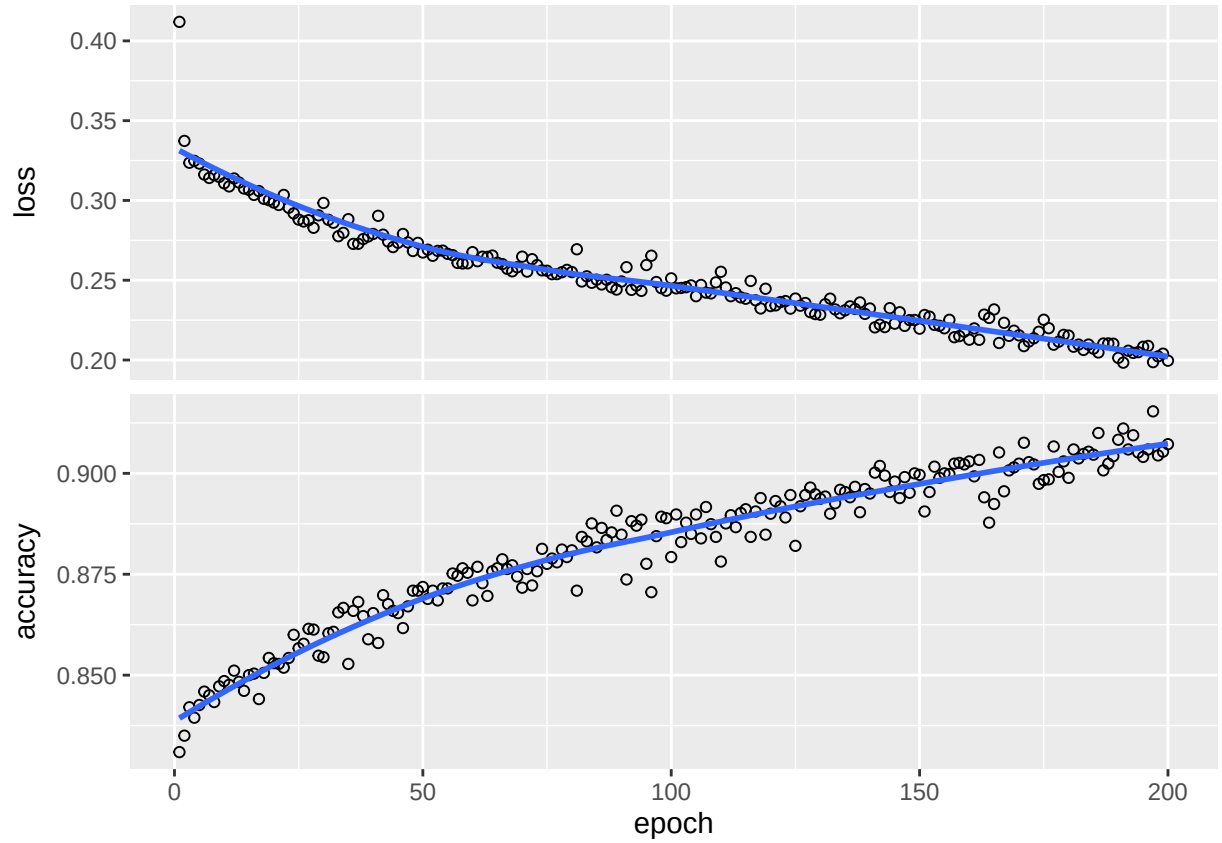
increased the sample_size from 120 to 500 -> increased 43% to 57% accuracy Removed two layers and had only one dropout layer at 25% -> accuracy: 0.5941 Removed two layers, removed dropout rate, now only look at 7 features, added regularization to second hidden layer -> 0.6277056 added third hidden layer, reduced first layer from 128 to 7 nodes, added regularization to three hidden layers -> 0.5844156 removed regularization from middle hidden layer -> 0.5454546 removed regularization from first hidden layer -> 0.5887446 add regularization to middle layer -> 0.5627705 7 hidden layer, layer 1 128 nodes, layers 2-7 64 nodes, regularization on layers 4 and 7 -> 0.5021645 add bias of 2.0 to first layer -> 0.5454546 3 hidden layers, regularization on last 2, bias of 2.0 on first layer -> 0.4935065 same as above but reg on hidden layers 1 and 3 -> 0.5324675 increase nodes in first layer back up from 7 to 128 -> 0.6190476 move bias from input to output node -> 0.5584416 add alcohol col as a parameter -> 100% (not the good 100 tho lol) reduce nodes in input layer to 8 from 128 -> 100% L1 = https://www.analyticssteps.com/blogs/l2-and-l1-regularization-machine-learning

Wow!!! Changed loss to binary_crossentropy -> accuracy: 0.8773 No increase in accuracy by changing epochs to 300

```
wineModel = keras_model_sequential() %>%
  layer_dense(units = 64, activation = "relu",input_shape=(8), regularizer_l1(l = 0.01)) %>%
  layer_dense(units = 64, activation = "relu", regularizer_l1(l = 0.01)) %>%
  layer_dense(units = 64, activation = "relu", regularizer_l1(l = 0.01)) %>%
  layer_dense(units = 64, activation = "relu", regularizer_l1(l = 0.01)) %>%
  layer_dense(units = ncol(yTr), activation = "softmax")


wineModel %>% compile(
  loss = "binary_crossentropy",
  optimizer = "adam", #optimizer_rmsprop(),
  metrics = "accuracy"
)

xTr <- as.matrix(training[,1:8]) # need to convert to a matrix
xTest <- as.matrix(testing[,1:8])

history <- wineModel %>%
  fit(
    x = xTr, # input is the first 4 columns of the dataframe
    y = yTr, # label is the last column
    epochs = 200
  )
```

```
plot(history)
```

```
## `geom_smooth()` using formula 'y ~ x'
```



Evaluate the model

```
wineModel %>% evaluate(xTest, yTest)
```

```
## $loss
## [1] 0.2984036
##
## $accuracy
## [1] 0.866941
```

```
# Predicting likelihood of all categories:
result <- wineModel %>% predict(xTest)

result
```

```
##                [,1]         [,2]         [,3]         [,4]         [,5]
##   [1,] 1.250719e-04 3.065269e-02 7.602438e-01 0.2086793780 2.981217e-04
##   [2,] 9.643565e-05 1.162672e-02 8.222316e-01 0.1659369022 1.082978e-04
##   [3,] 3.228508e-05 6.108828e-03 8.291333e-01 0.1646864414 3.861354e-05
##   [4,] 1.394015e-06 2.364896e-03 3.759445e-01 0.5460895300 7.450278e-02
##   [5,] 6.292862e-04 3.493654e-02 4.413661e-01 0.4989083409 2.405197e-02
```

```
##   [6,] 6.766877e-04 1.671213e-02 5.775388e-01 0.4050074816 5.084343e-05
##   [7,] 1.311249e-03 7.933994e-02 7.334739e-01 0.1842796952 1.590540e-03
##   [8,] 1.870714e-03 2.574529e-02 5.714382e-01 0.4009452164 6.156468e-07
##   [9,] 4.731718e-14 4.653776e-07 1.397718e-03 0.0005827196 9.706031e-01
##  [10,] 9.965002e-06 2.620879e-03 7.226712e-01 0.2742142677 4.794098e-04
##  [11,] 1.072153e-04 8.857442e-03 7.991108e-01 0.1918044984 1.200303e-04
##  [12,] 3.455269e-03 1.013238e-02 9.809326e-01 0.0054795281 2.747193e-07
##  [13,] 3.455269e-03 1.013238e-02 9.809326e-01 0.0054795281 2.747193e-07
##  [14,] 1.879098e-03 1.033037e-02 6.027395e-01 0.3850029111 4.807607e-05
##  [15,] 1.979451e-01 1.125543e-01 5.915164e-01 0.0732565299 2.465541e-02
##  [16,] 1.471224e-07 2.090546e-02 9.494875e-01 0.0216127746 7.992825e-03
##  [17,] 3.941462e-03 1.934718e-02 9.610859e-01 0.0156254824 4.040838e-08
##  [18,] 1.792489e-03 4.691304e-02 5.552422e-01 0.3814809620 1.449902e-02
##  [19,] 5.529612e-04 1.243472e-02 7.101653e-01 0.2767583132 8.845054e-05
##  [20,] 1.089504e-04 9.135569e-03 8.408772e-01 0.1497811377 9.694510e-05
##  [21,] 5.921536e-04 8.861519e-03 6.006667e-01 0.3853575885 4.496242e-03
##  [22,] 3.917253e-04 2.386625e-03 9.093432e-01 0.0878225118 5.517291e-05
##  [23,] 4.753050e-03 2.803696e-03 9.919840e-01 0.0004593024 2.062622e-09
##  [24,] 5.629583e-03 2.059069e-01 7.072334e-01 0.0810984001 1.315891e-04
##  [25,] 8.549501e-14 3.873424e-05 1.260473e-02 0.8259469271 1.406076e-01
##  [26,] 7.635598e-06 1.524448e-03 9.254239e-01 0.0722015575 8.397645e-04
##  [27,] 1.693395e-07 6.288277e-03 7.780314e-01 0.2095018923 6.176134e-03
##  [28,] 9.887830e-04 8.201819e-02 8.857289e-01 0.0310083982 2.554635e-04
##  [29,] 9.565040e-04 6.696877e-03 6.806313e-01 0.3116499484 6.524706e-05
##  [30,] 2.355792e-04 1.060362e-02 9.489631e-01 0.0401977412 4.858685e-09
##  [31,] 2.155593e-05 5.826803e-03 6.819656e-01 0.3073431551 4.811369e-03
##  [32,] 5.231016e-05 2.421208e-03 9.062657e-01 0.0911716595 8.600963e-05
##  [33,] 1.308234e-05 3.753598e-03 5.993598e-01 0.3968314528 4.083180e-05
##  [34,] 9.777950e-08 3.216491e-04 2.810546e-01 0.4644247890 2.460074e-01
##  [35,] 9.628824e-09 4.074213e-05 5.900583e-02 0.2517667115 6.786922e-01
##  [36,] 3.383692e-04 5.489506e-03 4.885939e-01 0.5053610206 2.171012e-04
##  [37,] 3.008743e-03 2.026309e-02 6.853051e-01 0.2892332971 2.188940e-03
##  [38,] 3.637903e-06 2.780762e-03 7.207450e-01 0.2756251097 8.401619e-04
##  [39,] 2.697320e-04 7.101543e-03 7.183867e-01 0.2740539014 1.880145e-04
##  [40,] 3.146757e-05 1.811443e-02 5.882036e-02 0.1208872944 8.010949e-01
##  [41,] 4.592910e-05 9.263169e-03 3.924984e-01 0.5981613398 3.062124e-05
##  [42,] 5.046571e-06 1.871425e-03 9.376306e-01 0.0604139976 7.890469e-05
##  [43,] 2.970560e-04 1.261299e-02 9.036140e-01 0.0834457427 3.002546e-05
##  [44,] 5.348303e-10 1.766605e-05 1.575147e-01 0.8007152081 3.066911e-02
##  [45,] 1.606679e-05 5.548522e-03 2.123713e-01 0.7633094192 1.871332e-02
##  [46,] 2.743233e-05 7.475059e-03 4.808758e-01 0.5115981698 2.296221e-05
##  [47,] 1.814543e-06 3.564622e-04 3.029300e-01 0.6802442670 1.446138e-02
##  [48,] 1.764519e-06 2.166707e-03 1.160769e-01 0.7814518809 9.964588e-02
##  [49,] 9.678838e-05 1.837431e-03 5.366416e-01 0.4586223662 2.791986e-03
##  [50,] 1.776048e-06 4.594490e-04 4.965367e-01 0.5011231899 1.641517e-03
##  [51,] 4.063123e-03 1.496434e-02 5.756563e-01 0.4052837491 3.246591e-05
##  [52,] 9.676187e-05 4.282205e-03 6.746357e-01 0.3209672272 1.777407e-05
##  [53,] 3.449868e-03 1.562250e-02 7.350730e-01 0.2448702157 9.841139e-04
##  [54,] 4.662826e-03 1.361518e-02 8.301688e-01 0.1511813253 3.718667e-04
##  [55,] 3.134559e-04 9.633465e-03 4.163105e-01 0.5554334521 1.824255e-02
##  [56,] 1.623434e-07 3.741916e-04 1.510578e-01 0.8455114961 2.991549e-03
##  [57,] 8.756852e-08 1.426577e-03 1.186199e-01 0.7960832715 8.341620e-02
##  [58,] 1.327177e-09 2.881496e-04 2.572243e-02 0.8831807375 3.868937e-02
##  [59,] 4.536595e-06 1.952405e-03 1.686231e-01 0.7528362870 7.605737e-02
```

```
##  [60,] 3.674177e-03 7.181681e-02 8.313166e-01 0.0924774930 7.120303e-04
##  [61,] 8.050371e-09 1.406700e-04 6.017353e-02 0.8666145802 7.305136e-02
##  [62,] 5.366715e-05 1.764443e-03 6.415134e-01 0.2933799326 6.261399e-02
##  [63,] 1.855711e-03 9.557743e-03 6.019916e-01 0.3864806294 1.142704e-04
##  [64,] 4.921938e-05 6.033971e-03 1.856398e-01 0.7643455863 4.369042e-02
##  [65,] 1.218582e-07 3.987493e-04 2.489986e-01 0.7262007594 2.397792e-02
##  [66,] 1.435233e-12 4.251361e-06 2.471025e-03 0.1031437144 4.236220e-01
##  [67,] 6.660811e-13 3.954612e-06 2.342168e-02 0.7162725925 1.624792e-01
##  [68,] 7.819325e-03 1.038433e-01 8.347571e-01 0.0527439602 8.352691e-04
##  [69,] 1.245413e-09 6.396235e-05 1.096257e-01 0.8479973674 1.951271e-02
##  [70,] 2.999842e-07 1.707594e-02 9.662992e-01 0.0160473324 5.770600e-04
##  [71,] 2.904213e-07 2.991608e-02 4.774919e-01 0.3344445229 1.571326e-01
##  [72,] 2.594896e-06 6.354660e-04 6.322894e-01 0.3670386672 3.178316e-05
##  [73,] 2.334726e-03 9.631333e-03 8.754810e-01 0.1111113653 1.435142e-03
##  [74,] 8.277940e-06 1.145131e-03 7.655672e-01 0.2331036925 1.668490e-04
##  [75,] 3.020834e-07 1.609767e-03 4.711451e-02 0.8463346958 1.038975e-01
##  [76,] 6.287817e-10 3.178270e-05 1.921356e-01 0.7995033264 5.336731e-03
##  [77,] 4.116026e-04 7.588532e-03 4.008543e-01 0.5911426544 2.766169e-06
##  [78,] 1.415355e-07 8.062599e-04 1.108884e-01 0.8184019923 6.918748e-02
##  [79,] 4.466004e-12 2.404926e-05 5.493854e-03 0.2927994430 1.177988e-01
##  [80,] 1.182441e-08 2.443757e-04 9.892636e-01 0.0104855541 6.481289e-06
##  [81,] 8.236273e-07 4.202701e-04 4.940714e-01 0.5053932667 1.003607e-04
##  [82,] 2.654453e-07 2.744369e-04 1.175221e-01 0.7019947767 1.705345e-01
##  [83,] 8.975871e-11 1.713260e-05 2.481485e-02 0.2267601341 7.246078e-01
##  [84,] 1.491830e-05 1.902299e-03 2.931360e-01 0.6799703836 2.485261e-02
##  [85,] 9.456326e-07 3.247943e-04 6.127408e-01 0.3865836859 2.966440e-04
##  [86,] 5.351054e-07 1.318283e-03 1.168500e-01 0.8051545620 7.420826e-02
##  [87,] 6.140305e-12 3.730725e-06 9.212458e-02 0.8465211987 2.663491e-02
##  [88,] 9.677133e-09 1.338580e-04 1.297592e-01 0.8664838076 9.143548e-04
##  [89,] 4.199696e-05 1.838938e-03 1.958184e-01 0.8022912145 9.080608e-06
##  [90,] 1.310302e-06 1.050293e-03 1.410649e-01 0.7828660011 7.480291e-02
##  [91,] 3.341761e-09 5.068485e-05 1.584628e-01 0.8052267432 2.930841e-02
##  [92,] 8.745922e-05 2.092650e-03 4.314016e-01 0.5644454956 1.971805e-03
##  [93,] 3.271946e-06 3.146704e-03 1.341127e-01 0.8509870172 1.173751e-02
##  [94,] 1.042425e-13 6.960902e-07 3.683931e-02 0.5546705127 3.801160e-01
##  [95,] 2.952044e-05 4.922535e-03 2.045902e-01 0.7669999003 2.339841e-02
##  [96,] 2.326145e-08 1.066192e-04 1.381232e-01 0.8614484668 2.352805e-04
##  [97,] 1.428973e-07 3.880842e-04 2.862158e-01 0.4566991031 2.504700e-01
##  [98,] 2.137933e-03 2.553940e-02 7.280250e-01 0.2442968935 6.892440e-07
##  [99,] 9.675967e-05 1.192945e-02 8.960516e-01 0.0911007300 8.214522e-04
## [100,] 1.539251e-02 4.038142e-02 6.142470e-01 0.3274171650 2.559863e-03
## [101,] 2.113903e-02 2.503303e-02 8.469879e-01 0.1066201553 2.199544e-04
## [102,] 4.699245e-02 2.495087e-01 5.532056e-01 0.1502922475 9.380192e-07
## [103,] 2.637895e-03 1.123001e-02 7.076697e-01 0.2783409059 1.215509e-04
## [104,] 7.231809e-05 4.083010e-03 7.077928e-01 0.2878462374 1.989615e-04
## [105,] 1.779811e-05 1.228467e-03 6.456375e-01 0.3530771434 3.898832e-05
## [106,] 2.318104e-08 3.678831e-03 9.920079e-01 0.0042734668 3.990346e-05
## [107,] 1.587077e-07 1.472272e-03 1.306238e-01 0.7879372239 7.725091e-02
## [108,] 3.367895e-05 2.927054e-03 6.907282e-01 0.3056353927 6.529129e-04
## [109,] 4.295047e-05 6.597272e-03 3.865253e-01 0.6064895988 3.350828e-04
## [110,] 2.164916e-05 1.272116e-02 5.454383e-01 0.4409179688 8.881248e-04
## [111,] 2.239235e-02 7.922583e-02 7.959299e-01 0.1008383259 1.612595e-03
## [112,] 1.137287e-05 6.080090e-03 9.072039e-01 0.0866120160 9.257199e-05
## [113,] 4.270543e-04 2.833946e-02 8.486556e-01 0.1225660443 1.185884e-05
```

```
## [114,] 2.668350e-06 6.379658e-03 1.761266e-01 0.7449300289 7.198659e-02
## [115,] 2.659854e-02 3.466821e-02 9.201865e-01 0.0185043775 4.197861e-05
## [116,] 1.156270e-01 1.415541e-01 6.708470e-01 0.0712406561 7.304291e-04
## [117,] 2.832358e-05 1.762794e-03 5.884655e-01 0.4097342491 8.383565e-06
## [118,] 7.254566e-05 2.719786e-03 6.855620e-01 0.3113956153 2.499816e-04
## [119,] 1.528057e-04 3.560625e-03 6.402608e-01 0.3556685746 3.569930e-04
## [120,] 1.280692e-11 1.624197e-05 8.382940e-02 0.8007443547 1.008633e-01
## [121,] 3.260415e-06 4.288816e-03 5.058938e-01 0.4841002822 5.694042e-03
## [122,] 5.961146e-05 3.493172e-03 3.096882e-01 0.6861060858 4.471216e-04
## [123,] 1.756727e-03 1.825422e-02 7.604799e-01 0.2150565088 4.036552e-03
## [124,] 3.897254e-05 1.436707e-01 4.396774e-02 0.2691351771 5.429710e-01
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## [194,] 9.179176e-04
## [195,] 1.173172e-07
## [196,] 3.255544e-05
## [197,] 5.823543e-04
## [198,] 3.211836e-04
## [199,] 2.041831e-10
## [200,] 4.604920e-04
## [201,] 6.428524e-04
## [202,] 1.833283e-05
## [203,] 4.032847e-02
## [204,] 3.018081e-08
## [205,] 3.853525e-08
## [206,] 1.558478e-04
## [207,] 6.105915e-08
## [208,] 1.258781e-08
## [209,] 9.840563e-07
## [210,] 5.984861e-03
## [211,] 1.210512e-05
## [212,] 4.759821e-08
## [213,] 5.534754e-06
## [214,] 8.824108e-07
## [215,] 3.919764e-07
## [216,] 3.304408e-02
## [217,] 1.922943e-06
## [218,] 1.444858e-07
## [219,] 1.029988e-04
## [220,] 4.274552e-04
## [221,] 2.281441e-09
## [222,] 6.802230e-02
## [223,] 2.402638e-04
## [224,] 4.242136e-01
## [225,] 1.088227e-01
## [226,] 5.497186e-03
## [227,] 5.497186e-03
## [228,] 6.708026e-03
## [229,] 7.683866e-05
## [230,] 7.942472e-03
## [231,] 1.591192e-08
## [232,] 9.899915e-06
## [233,] 3.765792e-03
## [234,] 1.355790e-04
## [235,] 3.116336e-05
## [236,] 6.843846e-05
## [237,] 1.950684e-07
## [238,] 1.844994e-05
## [239,] 1.337252e-03
## [240,] 1.727039e-01
## [241,] 5.141585e-02
## [242,] 2.368867e-01
## [243,] 2.098367e-08
```

```
testing[,8]
```

```
##   [1]  9.400000  9.400000  9.500000  9.500000  9.700000  9.500000  9.400000
##   [8]  9.600000 13.100000  9.400000  9.300000 10.900000 10.900000  9.500000
```

```
##  [15]  9.200000  9.500000  9.800000  9.000000  9.200000  9.300000  9.700000
##  [22]  9.000000 10.900000  9.900000 14.000000 10.000000 10.500000  9.300000
##  [29]  9.500000  9.100000  9.500000  9.300000  9.700000 10.300000 10.800000
##  [36]  9.400000 10.100000  9.700000  9.400000  9.200000  9.900000  9.300000
##  [43]  9.400000 10.100000 10.700000  9.400000  9.300000 10.600000  9.500000
##  [50]  9.500000  9.200000  9.400000 10.400000  9.700000  9.200000 11.500000
##  [57] 11.000000 12.500000 10.000000  9.400000 13.000000  9.800000  9.400000
##  [64]  9.900000 11.000000 12.000000 13.300000  9.100000 11.700000  9.300000
##  [71] 12.300000 10.600000 10.400000  9.300000 10.800000 11.200000  9.300000
##  [78] 11.500000 14.000000  9.800000 10.200000  9.400000 12.500000  9.700000
##  [85] 11.900000 10.000000 10.300000 11.000000  9.900000 11.000000 10.700000
##  [92] 10.400000 11.100000 12.700000 10.100000 10.700000 10.400000  9.600000
##  [99]  9.300000  9.200000  9.700000  9.100000  9.300000  9.300000 11.300000
## [106]  9.400000 10.300000  9.500000  9.600000  9.600000  9.700000  9.400000
## [113]  9.900000 10.500000  9.500000  9.300000  9.600000  9.800000  9.700000
## [120] 12.500000  9.600000 10.300000 10.500000 11.000000 11.100000 10.900000
## [127]  9.400000  9.900000 11.800000 10.000000  9.800000 10.800000 10.800000
## [134] 11.000000 11.000000 11.200000 11.300000 10.900000 11.300000 12.900000
## [141] 10.500000 11.300000  9.400000  9.400000  9.100000 10.300000 11.700000
## [148] 10.000000 12.300000 10.600000 12.200000 12.700000  9.100000 11.600000
## [155] 12.500000 11.100000  9.500000 12.000000 11.200000  9.900000  9.400000
## [162] 12.400000 11.300000 10.000000 11.100000 12.300000  9.500000 11.200000
## [169]  9.300000 10.900000 11.200000 10.000000 10.400000  9.500000 10.900000
## [176]  9.200000 12.800000  9.400000  9.500000 10.500000 10.900000 10.300000
## [183] 11.400000 11.200000  9.700000  9.500000 11.500000 10.400000 10.200000
## [190]  9.500000 10.900000  9.800000  9.100000 10.600000  9.800000  9.700000
## [197] 10.500000 11.000000  9.500000 11.800000 10.033333 11.800000 10.500000
## [204]  9.800000 10.000000  9.900000  9.900000  9.500000  9.200000 12.500000
## [211] 11.000000  9.800000 10.200000  9.900000 11.900000 10.900000  9.400000
## [218]  9.900000  9.800000 10.400000 10.300000 11.300000 10.500000 11.900000
## [225] 13.600000 10.600000 10.600000 10.700000 11.950000 11.100000  9.233333
## [232] 10.200000 11.700000 10.100000 10.400000 11.300000  9.900000 10.100000
## [239] 10.900000 12.400000 11.100000 11.600000  9.500000
```