neural_networks.R

Fiona

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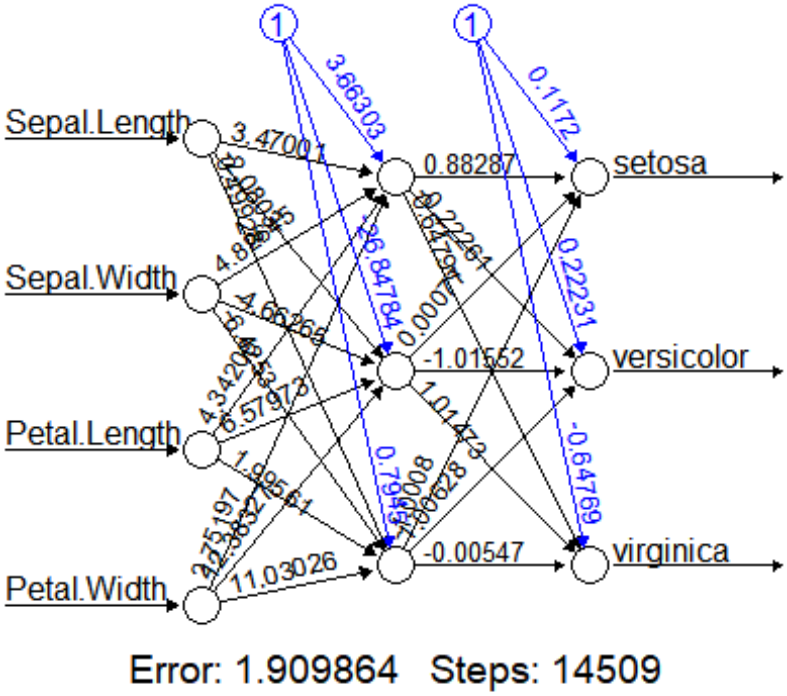
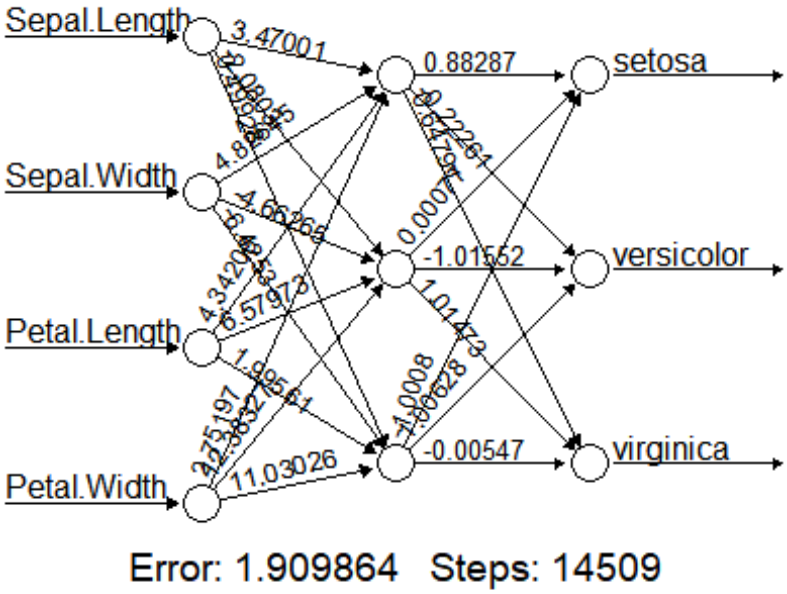
```
# Install Packages
#install.packages("neuralnet")
library("neuralnet")

## Warning: package 'neuralnet' was built under R version 3.3.3

# Get data ready for analysis - add 3 columns with TRUE/FALSE for different
flower species (3 output nodes)
itrain <- iris
itrain$setosa <- c(itrain$Species == 'setosa')
itrain$versicolor <- c(itrain$Species == 'versicolor')
itrain$virginica <- c(itrain$Species == 'virginica')
itrain$Species <- NULL

# Train the neural network
inet <- neuralnet(setosa + versicolor + virginica ~ Sepal.Length +
Sepal.Width + Petal.Length + Petal.Width, itrain, hidden=3, lifesign="full")

## hidden: 3    thresh: 0.01    rep: 1/1    steps:    1000  min thresh:
0.533209933
##                                                    2000  min thresh:
0.383854816
##                                                    3000  min thresh:
0.2709086099
##                                                    4000  min thresh:
0.1682186743
##                                                    5000  min thresh:
0.1577655008
##                                                    6000  min thresh:
0.11110708
##                                                    7000  min thresh:
0.1017465333
##                                                    8000  min thresh:
0.09138648775
##                                                    9000  min thresh:
0.08896441489
##                                                   10000  min thresh:
0.08819161954
##                                                   11000  min thresh:
0.05478473085
##                                                   12000  min thresh:
0.03135207115
```

```
##                                                          13000  min thresh:
0.01782033234
##                                                          14000  min thresh:
0.01073336712
##                                                          14509  error: 1.90986
time: 2.95 secs
```

```
# Plot network
plot(inet, rep="best")
```




```
# Plot without bias nodes
plot(inet, rep="best", intercept=FALSE)
```




```
# Make predictions on origional data
predict <- compute(inet, iris[1:4])

# Look at predictions (see which has the higher value)
predict$net.result
```

```
##                       [,1]             [,2]             [,3]
##   [1,]  1.000070940080609 -0.0002956757139  0.0002199213681
##   [2,]  1.000055518405831 -0.0002801696324  0.0002198370790
##   [3,]  1.000068348386617 -0.0002930698349  0.0002199072029
##   [4,]  1.000062735869982 -0.0002874265996  0.0002198765270
##   [5,]  1.000071298753504 -0.0002960363499  0.0002199233285
##   [6,]  1.000070603605603 -0.0002953373973  0.0002199195290
##   [7,]  1.000068453896811 -0.0002931759226  0.0002199077795
##   [8,]  1.000070072809593 -0.0002948036961  0.0002199166279
##   [9,]  1.000047751338644 -0.0002723600541  0.0002197946271
##  [10,]  1.000068218551049 -0.0002929392888  0.0002199064932
##  [11,]  1.000071376308954 -0.0002961143299  0.0002199237524
##  [12,]  1.000069906618076 -0.0002946365950  0.0002199157196
##  [13,]  1.000066562574278 -0.0002912742484  0.0002198974423
##  [14,]  1.000069476429351 -0.0002942040517  0.0002199133683
##  [15,]  1.000071630427838 -0.0002963698396  0.0002199251413
##  [16,]  1.000071624850819 -0.0002963642321  0.0002199251108
##  [17,]  1.000071183354084 -0.0002959203189  0.0002199226977
##  [18,]  1.000069494874772 -0.0002942225981  0.0002199134691
##  [19,]  1.000070885187947 -0.0002956205208  0.0002199210681
##  [20,]  1.000071273689803 -0.0002960111491  0.0002199231915
```

```
##  [21,]  1.000068773031810 -0.0002934968043  0.0002199095238
##  [22,]  1.000069456627371 -0.0002941841414  0.0002199132601
##  [23,]  1.000071525520732 -0.0002962643583  0.0002199245679
##  [24,]  0.999942480699953 -0.0001665132428  0.0002192192574
##  [25,]  1.000068471043337 -0.0002931931630  0.0002199078733
##  [26,]  1.000046370398242 -0.0002709715555  0.0002197870794
##  [27,]  1.000054086876276 -0.0002787302678  0.0002198292548
##  [28,]  1.000070736666786 -0.0002954711868  0.0002199202563
##  [29,]  1.000070223230243 -0.0002949549401  0.0002199174501
##  [30,]  1.000065635509727 -0.0002903421098  0.0002198923753
##  [31,]  1.000059621475421 -0.0002842951592  0.0002198595049
##  [32,]  1.000054084240031 -0.0002787276171  0.0002198292404
##  [33,]  1.000071651449676 -0.0002963909765  0.0002199252562
##  [34,]  1.000071648162379 -0.0002963876712  0.0002199252382
##  [35,]  1.000061294238309 -0.0002859770775  0.0002198686475
##  [36,]  1.000068509094193 -0.0002932314221  0.0002199080812
##  [37,]  1.000070939972907 -0.0002956756056  0.0002199213675
##  [38,]  1.000071544531444 -0.0002962834731  0.0002199246718
##  [39,]  1.000061358612043 -0.0002860418036  0.0002198689994
##  [40,]  1.000069991659688 -0.0002947221021  0.0002199161844
##  [41,]  1.000069972476718 -0.0002947028141  0.0002199160795
##  [42,]  0.997150237705497  0.0026410124005  0.0002039579068
##  [43,]  1.000068808759600 -0.0002935327277  0.0002199097191
##  [44,]  0.999987750956684 -0.0002120312750  0.0002194666876
##  [45,]  1.000069085727673 -0.0002938112117  0.0002199112329
##  [46,]  1.000025395088008 -0.0002498814421  0.0002196724363
##  [47,]  1.000071502245184 -0.0002962409554  0.0002199244407
##  [48,]  1.000067814202688 -0.0002925327273  0.0002199042832
##  [49,]  1.000071390024023 -0.0002961281200  0.0002199238273
##  [50,]  1.000069189391204 -0.0002939154426  0.0002199117995
##  [51,] -0.000533994085967  1.0054682307409 -0.0049314260108
##  [52,] -0.000597846639744  1.0048268886355 -0.0042262471388
##  [53,] -0.000698001152853  0.9979940126608  0.0027066241817
##  [54,] -0.000711441297275  1.0045807005533 -0.0038664718458
##  [55,] -0.000712388596299  0.9957004573776  0.0050145137807
##  [56,] -0.000598692240868  1.0034731418425 -0.0028716859836
##  [57,] -0.000662727525313  0.9958414247283  0.0048238893837
##  [58,]  0.003613500173845  1.0016148895700 -0.0052256034266
##  [59,] -0.000600963848328  1.0054094120773 -0.0048056399839
##  [60,] -0.000632819283290  1.0051700714189 -0.0045344499071
##  [61,] -0.000514924127631  1.0057522379151 -0.0052344962955
##  [62,] -0.000643574158660  1.0048741344978 -0.0042277651041
##  [63,] -0.000555592444332  1.0057885293345 -0.0052301191941
##  [64,] -0.000677421744585  0.9976307432401  0.0030493061352
##  [65,]  0.000803875807770  1.0044356942640 -0.0052367624206
##  [66,] -0.000512502393941  1.0056329255095 -0.0051176083380
##  [67,] -0.000664298085693  0.9923558989082  0.0083109053418
##  [68,]  0.003131203652093  1.0020951563500 -0.0052235701137
##  [69,] -0.000620674032900  0.8643596375435  0.1362605909456
##  [70,] -0.000142408178605  1.0053728218008 -0.0052275990838
```

```
##  [71,] -0.000373488923626  0.5411384518602  0.4592271398830
##  [72,] -0.000444954079275  1.0056576562499 -0.0052098857712
##  [73,] -0.000488553353774  0.6899994271629  0.3104846608763
##  [74,] -0.000516154653170  1.0046483762530 -0.0041294295889
##  [75,] -0.000473338947432  1.0056313550826 -0.0051552007843
##  [76,] -0.000608637243471  1.0056032361650 -0.0049917863251
##  [77,] -0.000709929080665  0.9999941213102  0.0007184894094
##  [78,] -0.000492694830565  0.6962364155721  0.3042519577430
##  [79,] -0.000697753298911  0.9965058895500  0.0041944651171
##  [80,]  0.006314813898388  0.9988993231579 -0.0052113713313
##  [81,] -0.000332597037907  1.0055637345254 -0.0052283215058
##  [82,]  0.000724626697086  1.0045173710673 -0.0052391894627
##  [83,] -0.000092300155909  1.0053244513048 -0.0052293369463
##  [84,] -0.000105907120188  0.1832381178659  0.8168516408387
##  [85,] -0.000653519009848  0.9854887227095  0.0151671442328
##  [86,] -0.000536151264704  1.0026023517364 -0.0020634559661
##  [87,] -0.000686133956409  1.0026883456063 -0.0019994674952
##  [88,] -0.000720468380174  1.0023402513369 -0.0016170473656
##  [89,]  0.000346410986630  1.0048175198720 -0.0051611215205
##  [90,] -0.000671896393117  1.0053795259978 -0.0047048231530
##  [91,] -0.000583588097890  1.0044593516155 -0.0038729769164
##  [92,] -0.000623306870017  1.0031642121651 -0.0025381491860
##  [93,] -0.000453917700139  1.0056521892184 -0.0051954553845
##  [94,]  0.001449040104877  1.0037909791110 -0.0052372163940
##  [95,] -0.000599221702529  1.0052020487168 -0.0046000235252
##  [96,]  0.001790689516884  1.0034106469818 -0.0051985371318
##  [97,] -0.000287179628591  1.0053300047017 -0.0050400137757
##  [98,] -0.000446590584168  1.0055562341322 -0.0051068295136
##  [99,]  0.003782373546615  1.0014456827861 -0.0052252712899
## [100,] -0.000444811292155  1.0055247182939 -0.0050770936665
## [101,]  0.000039038418421 -0.0095418179714  1.0094821866932
## [102,]  0.000036187965311 -0.0057334848355  1.0056767918098
## [103,]  0.000038964491254 -0.0094414742738  1.0093819192361
## [104,]  0.000036460048142 -0.0060213536110  1.0059643818667
## [105,]  0.000039027339260 -0.0095259339739  1.0094663141411
## [106,]  0.000039036669721 -0.0095392544951  1.0094796250247
## [107,] -0.000055110457904  0.1155739731333  0.8844634289451
## [108,]  0.000038837067778 -0.0092594840091  1.0092000605907
## [109,]  0.000038787153448 -0.0092048929663  1.0091455207207
## [110,]  0.000039036268376 -0.0095382514211  1.0094786223752
## [111,]  0.000003941228521  0.0371316100302  0.9628449319138
## [112,]  0.000036362830624 -0.0059821476031  1.0059252739791
## [113,]  0.000038478200081 -0.0087932148650  1.0087341610638
## [114,]  0.000038525307084 -0.0088586216710  1.0087995192549
## [115,]  0.000039029200839 -0.0095296291806  1.0094700074010
## [116,]  0.000038846304168 -0.0092825985237  1.0092231653359
## [117,]  0.000026957115225  0.0066796510057  0.9932731729989
## [118,]  0.000039039396880 -0.0095201912451  1.0094605594872
## [119,]  0.000039038418706 -0.0095420936108  1.0094824623260
## [120,] -0.000061858129027  0.1241905086843  0.8758538397109
```

```
## [121,]  0.000038999870966 -0.0094892629662  1.0094296714471
## [122,]  0.000035798469274 -0.0052163769093  1.0051600853013
## [123,]  0.000039036819043 -0.0095396363758  1.0094800067472
## [124,] -0.000053281823391  0.1128280229286  0.8872074872050
## [125,]  0.000038565157109 -0.0088812957539  1.0088221529654
## [126,]  0.000034174581902 -0.0028912587158  1.0028366446016
## [127,] -0.000156390039340  0.2495360341127  0.7506057359661
## [128,] -0.000165778296119  0.2625816629078  0.7375697961947
## [129,]  0.000038989702203 -0.0094756385574  1.0094160575212
## [130,] -0.000039539726710  0.0952982309769  0.9047231329284
## [131,]  0.000038863239051 -0.0093061664714  1.0092467158054
## [132,]  0.000037155943463 -0.0067024118045  1.0066447284663
## [133,]  0.000039024360575 -0.0095228340290  1.0094632172463
## [134,] -0.000499494869799  0.7077419389755  0.2927534996617
## [135,] -0.000016870234489  0.0659034591465  0.9340945575937
## [136,]  0.000039032567338 -0.0095341981982  1.0094745729467
## [137,]  0.000039024803401 -0.0095205334769  1.0094609163044
## [138,]  0.000023590707314  0.0113607674052  0.9885955309304
## [139,] -0.000239768784360  0.3608165529615  0.6394111613831
## [140,]  0.000036911381480 -0.0067099228522  1.0066524838989
## [141,]  0.000039029497644 -0.0095298616124  1.0094702395306
## [142,]  0.000037745653115 -0.0078270935105  1.0077687945296
## [143,]  0.000036187965311 -0.0057334848355  1.0056767918098
## [144,]  0.000039030681880 -0.0095305899207  1.0094709666379
## [145,]  0.000039035208869 -0.0095374317691  1.0094778038015
## [146,]  0.000038761606101 -0.0091740565744  1.0091147105871
## [147,]  0.000032887214852 -0.0013876793663  1.0013343872809
## [148,]  0.000031615331940  0.0003324181096  0.9996156013442
## [149,]  0.000038880909388 -0.0093168409704  1.0092573723881
## [150,] -0.000007102175095  0.0522278600187  0.9477600733701
```

```
# Identify which values are max then change numbers to name of the species
result<-0
for (i in 1:150) { result[i] <- which.max(predict$net.result[i,]) }
for (i in 1:150) { if (result[i]==1) {result[i] = "setosa"} }
for (i in 1:150) { if (result[i]==2) {result[i] = "versicolor"} }
for (i in 1:150) { if (result[i]==3) {result[i] = "virginica"} }

# Combine and view results against actual data
data.frame(actual = iris[5], results = result)

##        Species    results
## 1       setosa     setosa
## 2       setosa     setosa
## 3       setosa     setosa
## 4       setosa     setosa
## 5       setosa     setosa
## 6       setosa     setosa
## 7       setosa     setosa
## 8       setosa     setosa
```

```
## 9       setosa     setosa
## 10      setosa     setosa
## 11      setosa     setosa
## 12      setosa     setosa
## 13      setosa     setosa
## 14      setosa     setosa
## 15      setosa     setosa
## 16      setosa     setosa
## 17      setosa     setosa
## 18      setosa     setosa
## 19      setosa     setosa
## 20      setosa     setosa
## 21      setosa     setosa
## 22      setosa     setosa
## 23      setosa     setosa
## 24      setosa     setosa
## 25      setosa     setosa
## 26      setosa     setosa
## 27      setosa     setosa
## 28      setosa     setosa
## 29      setosa     setosa
## 30      setosa     setosa
## 31      setosa     setosa
## 32      setosa     setosa
## 33      setosa     setosa
## 34      setosa     setosa
## 35      setosa     setosa
## 36      setosa     setosa
## 37      setosa     setosa
## 38      setosa     setosa
## 39      setosa     setosa
## 40      setosa     setosa
## 41      setosa     setosa
## 42      setosa     setosa
## 43      setosa     setosa
## 44      setosa     setosa
## 45      setosa     setosa
## 46      setosa     setosa
## 47      setosa     setosa
## 48      setosa     setosa
## 49      setosa     setosa
## 50      setosa     setosa
## 51  versicolor versicolor
## 52  versicolor versicolor
## 53  versicolor versicolor
## 54  versicolor versicolor
## 55  versicolor versicolor
## 56  versicolor versicolor
## 57  versicolor versicolor
## 58  versicolor versicolor
```

```
## 59  versicolor versicolor
## 60  versicolor versicolor
## 61  versicolor versicolor
## 62  versicolor versicolor
## 63  versicolor versicolor
## 64  versicolor versicolor
## 65  versicolor versicolor
## 66  versicolor versicolor
## 67  versicolor versicolor
## 68  versicolor versicolor
## 69  versicolor versicolor
## 70  versicolor versicolor
## 71  versicolor versicolor
## 72  versicolor versicolor
## 73  versicolor versicolor
## 74  versicolor versicolor
## 75  versicolor versicolor
## 76  versicolor versicolor
## 77  versicolor versicolor
## 78  versicolor versicolor
## 79  versicolor versicolor
## 80  versicolor versicolor
## 81  versicolor versicolor
## 82  versicolor versicolor
## 83  versicolor versicolor
## 84  versicolor  virginica
## 85  versicolor versicolor
## 86  versicolor versicolor
## 87  versicolor versicolor
## 88  versicolor versicolor
## 89  versicolor versicolor
## 90  versicolor versicolor
## 91  versicolor versicolor
## 92  versicolor versicolor
## 93  versicolor versicolor
## 94  versicolor versicolor
## 95  versicolor versicolor
## 96  versicolor versicolor
## 97  versicolor versicolor
## 98  versicolor versicolor
## 99  versicolor versicolor
## 100 versicolor versicolor
## 101  virginica  virginica
## 102  virginica  virginica
## 103  virginica  virginica
## 104  virginica  virginica
## 105  virginica  virginica
## 106  virginica  virginica
## 107  virginica  virginica
## 108  virginica  virginica
```

```
## 109  virginica  virginica
## 110  virginica  virginica
## 111  virginica  virginica
## 112  virginica  virginica
## 113  virginica  virginica
## 114  virginica  virginica
## 115  virginica  virginica
## 116  virginica  virginica
## 117  virginica  virginica
## 118  virginica  virginica
## 119  virginica  virginica
## 120  virginica  virginica
## 121  virginica  virginica
## 122  virginica  virginica
## 123  virginica  virginica
## 124  virginica  virginica
## 125  virginica  virginica
## 126  virginica  virginica
## 127  virginica  virginica
## 128  virginica  virginica
## 129  virginica  virginica
## 130  virginica  virginica
## 131  virginica  virginica
## 132  virginica  virginica
## 133  virginica  virginica
## 134  virginica versicolor
## 135  virginica  virginica
## 136  virginica  virginica
## 137  virginica  virginica
## 138  virginica  virginica
## 139  virginica  virginica
## 140  virginica  virginica
## 141  virginica  virginica
## 142  virginica  virginica
## 143  virginica  virginica
## 144  virginica  virginica
## 145  virginica  virginica
## 146  virginica  virginica
## 147  virginica  virginica
## 148  virginica  virginica
## 149  virginica  virginica
## 150  virginica  virginica
```