Basic NeuralNet -2

```r
library(neuralnet)
```

```r
## Below chunks of code - SOURCE --- CRAN Examples - Package - library(neuralnet)
#
# Set Seed -- ensure reproducible results

set.seed(123)
#

AND <- c(rep(0,7),1)
OR <- c(0,rep(1,7))

print(AND)
```

```
## [1] 0 0 0 0 0 0 0 1
```

```r
print(OR)
```

```
## [1] 0 1 1 1 1 1 1 1
```

```r
#binary_df <- data.frame(expand.grid(c(0,1), c(0,1), c(0,1),c(0,1)), AND, OR) # 16 OBS of 6 Variables
binary_df <- data.frame(expand.grid(c(0,1), c(0,1), c(0,1)), AND, OR) # Original - 8 Obs of 5 Variables

print(binary_df)
```

```
##   Var1 Var2 Var3 AND OR
## 1    0    0    0   0  0
## 2    1    0    0   0  1
## 3    0    1    0   0  1
## 4    1    1    0   0  1
## 5    0    0    1   0  1
## 6    1    0    1   0  1
## 7    0    1    1   0  1
## 8    1    1    1   1  1
```

```r
# Numeric inputs prefeered - ANN does not like FACTOR INPUT
# Features , thus we look at the STRUCTURE of DF.

str(binary_df)
```

```
## 'data.frame':    8 obs. of  5 variables:
##  $ Var1: num  0 1 0 1 0 1 0 1
##  $ Var2: num  0 0 1 1 0 0 1 1
##  $ Var3: num  0 0 0 0 1 1 1 1
##  $ AND : num  0 0 0 0 0 0 0 1
##  $ OR  : num  0 1 1 1 1 1 1 1
```

```r
# https://stat.ethz.ch/R-manual/R-devel/library/base/html/expand.grid.html

print(net <- neuralnet(AND+OR~Var1+Var2+Var3, binary_df, hidden=0,rep=10, err.fct="ce", linear.output=F
```

```
## $call
## neuralnet(formula = AND + OR ~ Var1 + Var2 + Var3, data = binary_df,
##     hidden = 0, rep = 10, err.fct = "ce", linear.output = FALSE)
```

```
## 
## $response
##   AND OR
## 1   0  0
## 2   0  1
## 3   0  1
## 4   0  1
## 5   0  1
## 6   0  1
## 7   0  1
## 8   1  1
## 
## $covariate
##      [,1] [,2] [,3]
## [1,]    0    0    0
## [2,]    1    0    0
## [3,]    0    1    0
## [4,]    1    1    0
## [5,]    0    0    1
## [6,]    1    0    1
## [7,]    0    1    1
## [8,]    1    1    1
## 
## $model.list
## $model.list$response
## [1] "AND" "OR"
## 
## $model.list$variables
## [1] "Var1" "Var2" "Var3"
## 
## 
## $err.fct
## function (x, y)
## {
##     -(y * log(x) + (1 - y) * log(1 - x))
## }
## <environment: 0x491ef68>
## attr(,"type")
## [1] "ce"
## 
## $act.fct
## function (x)
## {
##     1/(1 + exp(-x))
## }
## <environment: 0x491ef68>
## attr(,"type")
## [1] "logistic"
## 
## $linear.output
## [1] FALSE
## 
## $data
##   Var1 Var2 Var3 AND OR
```

```
## 1     0     0     0    0   0
## 2     1     0     0    0   1
## 3     0     1     0    0   1
## 4     1     1     0    0   1
## 5     0     0     1    0   1
## 6     1     0     1    0   1
## 7     0     1     1    0   1
## 8     1     1     1    1   1
##
## $net.result
## $net.result[[1]]
##                  [,1]              [,2]
## 1 0.00000001045614851 0.00007220621224
## 2 0.00001426236484049 0.99999769205959
## 3 0.00001409371095155 0.99999191105328
## 4 0.01886199255844006 1.00000000000000
## 5 0.00001228339436300 0.99995455791699
## 6 0.01647909336278272 0.99999999999999
## 7 0.01628739761101993 0.99999999999997
## 8 0.95759917455105847 1.00000000000000
##
## $net.result[[2]]
##                   [,1]              [,2]
## 1 0.000000007173638431 0.00003195248819
## 2 0.000010814856467627 0.99998945084415
## 3 0.000010922716155212 0.99997945618961
## 4 0.016200483154920703 0.99999999999999
## 5 0.000010848651844279 0.99999802646965
## 6 0.016092398178241846 1.00000000000000
## 7 0.016250285962768875 1.00000000000000
## 8 0.961395346683050045 1.00000000000000
##
## $net.result[[3]]
##                   [,1]              [,2]
## 1 0.000000005333012683 0.00004312244937
## 2 0.000009562204353127 0.99999341428708
## 3 0.000009106900339693 0.99998522518655
## 4 0.016066811684344717 1.00000000000000
## 5 0.000008585413564565 0.99998902286453
## 6 0.015160721326876830 1.00000000000000
## 7 0.014449268248922965 0.99999999999999
## 8 0.963353763941207086 1.00000000000000
##
## $net.result[[4]]
##                   [,1]              [,2]
## 1 0.000000004091970198 0.00001471046154
## 2 0.000008480857714007 0.99999800901283
## 3 0.000008481087593698 0.99999544612409
## 4 0.017274225124824214 1.00000000000000
## 5 0.000006463493392352 0.99999063003269
## 6 0.013219098780546246 1.00000000000000
## 7 0.013219452359933416 1.00000000000000
## 8 0.965236008559654413 1.00000000000000
##
```

```
## $net.result[[5]]
##                   [,1]              [,2]
## 1 0.000000009050241921 0.00002758854423
## 2 0.000012256372553209 0.99999278979485
## 3 0.000011567129876383 0.99999079684495
## 4 0.015423648522194305 1.00000000000000
## 5 0.000013223423308926 0.99999008494816
## 6 0.017593329260302059 1.00000000000000
## 7 0.016620392844302469 1.00000000000000
## 8 0.958139762073664358 1.00000000000000
##
## $net.result[[6]]
##                   [,1]              [,2]
## 1 0.00000001032490407 0.00005894551891
## 2 0.00001350662756587 0.99997070467793
## 3 0.00001388425719369 0.99998574341168
## 4 0.01783930742918135 0.99999999999998
## 5 0.00001298582113977 0.99998480466128
## 6 0.01670421211710922 0.99999999999997
## 7 0.01716323311899804 0.99999999999999
## 8 0.95806186752122480 1.00000000000000
##
## $net.result[[7]]
##                   [,1]              [,2]
## 1 0.000000005609328131 0.00002338785131
## 2 0.000008282371110421 0.99999725391576
## 3 0.000009767196574095 0.99998647501824
## 4 0.014216837554307976 1.00000000000000
## 5 0.000010190447015549 0.99999763137873
## 6 0.014823781854983750 1.00000000000000
## 7 0.017435012670399978 1.00000000000000
## 8 0.963235875211893799 1.00000000000000
##
## $net.result[[8]]
##                   [,1]              [,2]
## 1 0.000000004395199965 0.00006269535384
## 2 0.000008022055538113 0.99998519478146
## 3 0.000008112057614921 0.99998749828347
## 4 0.014590222818044141 0.99999999999999
## 5 0.000007978269076099 0.99997519062394
## 6 0.014353044678497417 0.99999999999998
## 7 0.014511740642217486 0.99999999999998
## 8 0.964127956700623345 1.00000000000000
##
## $net.result[[9]]
##                   [,1]             [,2]
## 1 0.000000008464446292 0.0001355367037
## 2 0.000011617951359184 0.9999988128479
## 3 0.000011894194165248 0.9999849307056
## 4 0.016063613743268392 1.0000000000000
## 5 0.000011942972950986 0.9999071747089
## 6 0.016128429830798447 1.0000000000000
## 7 0.016505594124972114 0.9999999999998
## 8 0.958394659990260300 1.0000000000000
```

```
##
## $net.result[[10]]
##                   [,1]                [,2]
## 1 0.00000001322097189 0.00004239774396
## 2 0.00001546911925454 0.99997276306273
## 3 0.00001499666648046 0.99999329687804
## 4 0.01724469670047139 0.99999999999999
## 5 0.00001617981464788 0.99999076716922
## 6 0.01857994464518476 0.99999999999999
## 7 0.01802270091247184 1.00000000000000
## 8 0.95550554751222927 1.00000000000000
##
##
## $weights
## $weights[[1]]
## $weights[[1]][[1]]
##                [,1]          [,2]
## [1,] -18.376075647 -9.535912265
## [2,]   7.218203590 22.515064987
## [3,]   7.206307848 21.260916206
## [4,]   7.068825671 19.534938765
##
##
## $weights[[2]]
## $weights[[2]][[1]]
##                [,1]          [,2]
## [1,] -18.752852852 -10.35122855
## [2,]   7.318273897  21.81068272
## [3,]   7.328197888  21.14415887
## [4,]   7.321393961  23.48691314
##
##
## $weights[[3]]
## $weights[[3]][[1]]
##                [,1]          [,2]
## [1,] -19.049349522 -10.05142371
## [2,]   7.491666807  21.98202509
## [3,]   7.442880476  21.17399555
## [4,]   7.383912215  21.47110877
##
##
## $weights[[4]]
## $weights[[4]][[1]]
##                [,1]          [,2]
## [1,] -19.314239268 -11.12693694
## [2,]   7.636548781  24.25381492
## [3,]   7.636575887  23.42646422
## [4,]   7.364905118  22.70492852
##
##
## $weights[[5]]
## $weights[[5]][[1]]
##                [,1]          [,2]
## [1,] -18.520474339 -10.49808235
```

```
## [2,]   7.211022048  22.33808829
## [3,]   7.153142793  22.09403734
## [4,]   7.286966755  22.01952900
##
##
## $weights[[6]]
## $weights[[6]][[1]]
##                  [,1]          [,2]
## [1,] -18.388706979 -9.738838002
## [2,]   7.176390423 20.176891417
## [3,]   7.203965928 20.897115165
## [4,]   7.137067488 20.833344646
##
##
## $weights[[7]]
## $weights[[7]][[1]]
##                  [,1]          [,2]
## [1,] -18.998834882 -10.66327046
## [2,]   7.297461899  23.46860228
## [3,]   7.462363574  21.87422901
## [4,]   7.504785229  23.61647060
##
##
## $weights[[8]]
## $weights[[8]][[1]]
##                  [,1]          [,2]
## [1,] -19.242752804 -9.677160517
## [2,]   7.509444959 20.797676547
## [3,]   7.520601908 20.966792616
## [4,]   7.503971705 20.281424617
##
##
## $weights[[9]]
## $weights[[9]][[1]]
##                  [,1]          [,2]
## [1,] -18.587391226 -8.906132532
## [2,]   7.224443719 22.550084686
## [3,]   7.247942959 20.008968834
## [4,]   7.252035679 18.190831124
##
##
## $weights[[10]]
## $weights[[10]][[1]]
##                  [,1]          [,2]
## [1,] -18.141461476 -10.06837301
## [2,]   7.064812117  20.57928229
## [3,]   7.033793856  21.98130348
## [4,]   7.109731553  21.66110864
##
##
##
## $startweights
## $startweights[[1]]
## $startweights[[1]][[1]]
```

```
##                    [,1]          [,2]
## [1,] -0.56047564655  0.1292877352
## [2,] -0.23017748948  1.7150649869
## [3,]  1.55870831415  0.4609162060
## [4,]  0.07050839142 -1.2650612346
##
##
## $startweights[[2]]
## $startweights[[2]][[1]]
##                 [,1]          [,2]
## [1,] -0.6868528519  0.4007714506
## [2,] -0.4456619701  0.1106827159
## [3,]  1.2240817974 -0.5558411348
## [4,]  0.3598138271  1.7869131368
##
##
## $startweights[[3]]
## $startweights[[3]][[1]]
##                 [,1]          [,2]
## [1,]  0.4978504782 -1.0678237060
## [2,] -1.9666171566 -0.2179749147
## [3,]  0.7013559016 -1.0260044483
## [4,] -0.4727914077 -0.7288912293
##
##
## $startweights[[4]]
## $startweights[[4]][[1]]
##                 [,1]          [,2]
## [1,] -0.6250392678 -1.1381369370
## [2,] -1.6866933107  1.2538149211
## [3,]  0.8377870445  0.4264642215
## [4,]  0.1533731178 -0.2950714830
##
##
## $startweights[[5]]
## $startweights[[5]][[1]]
##                [,1]          [,2]
## [1,] 0.8951256610  0.55391765354
## [2,] 0.8781334875 -0.06191171058
## [3,] 0.8215810816 -0.30596266374
## [4,] 0.6886402541 -0.38047100101
##
##
## $startweights[[6]]
## $startweights[[6]][[1]]
##                 [,1]          [,2]
## [1,] -0.6947069789  1.2079619983
## [2,] -0.2079172780 -1.1231085832
## [3,] -1.2653963516 -0.4028848353
## [4,]  2.1689559653 -0.4666553536
##
##
## $startweights[[7]]
## $startweights[[7]][[1]]
```

```
##                [,1]            [,2]
## [1,]  0.77996511834 -0.04287045729
## [2,] -0.08336906647  1.36860228401
## [3,]  0.25331851399 -0.22577098566
## [4,] -0.02854675535  1.51647060443
##
##
## $startweights[[8]]
## $startweights[[8]][[1]]
##               [,1]          [,2]
## [1,] -1.5487528042  0.3796394828
## [2,]  0.5846137496 -0.5023234531
## [3,]  0.1238542438 -0.3332073837
## [4,]  0.2159415687 -1.0185753831
##
##
## $startweights[[9]]
## $startweights[[9]][[1]]
##                [,1]         [,2]
## [1,] -1.07179122648  0.9222674679
## [2,]  0.30352864140  2.0500846856
## [3,]  0.44820977863 -0.4910311661
## [4,]  0.05300422673 -2.3091688756
##
##
## $startweights[[10]]
## $startweights[[10]][[1]]
##              [,1]          [,2]
## [1,]  1.0057385245 -0.2847730071
## [2,] -0.7092007626 -1.2207177123
## [3,] -0.6880086165  0.1813034797
## [4,]  1.0255713697 -0.1388913624
##
##
##
## $generalized.weights
## $generalized.weights[[1]]
##            [,1]         [,2]         [,3]         [,4]         [,5]
## [1,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [2,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [3,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [4,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [5,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [6,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [7,] 7.21820359 7.206307848 7.068825671 22.51506499 21.26091621
## [8,] 7.21820359 7.206307848 7.068825671         NaN         NaN
##            [,6]
## [1,] 19.53493877
## [2,] 19.53493877
## [3,] 19.53493877
## [4,] 19.53493877
## [5,] 19.53493877
## [6,] 19.53493877
## [7,] 19.53493877
```

```
## [8,]          NaN
##
## $generalized.weights[[2]]
##                [,1]         [,2]         [,3]         [,4]         [,5]
## [1,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [2,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [3,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [4,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [5,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [6,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [7,] 7.318273897 7.328197888 7.321393961 21.81068272 21.14415887
## [8,] 7.318273897 7.328197888 7.321393961         NaN         NaN
##              [,6]
## [1,] 23.48691314
## [2,] 23.48691314
## [3,] 23.48691314
## [4,] 23.48691314
## [5,] 23.48691314
## [6,] 23.48691314
## [7,] 23.48691314
## [8,]          NaN
##
## $generalized.weights[[3]]
##                [,1]         [,2]         [,3]         [,4]         [,5]
## [1,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [2,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [3,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [4,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [5,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [6,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [7,] 7.491666807 7.442880476 7.383912215 21.98202509 21.17399555
## [8,] 7.491666807 7.442880476 7.383912215         NaN         NaN
##              [,6]
## [1,] 21.47110877
## [2,] 21.47110877
## [3,] 21.47110877
## [4,] 21.47110877
## [5,] 21.47110877
## [6,] 21.47110877
## [7,] 21.47110877
## [8,]          NaN
##
## $generalized.weights[[4]]
##                [,1]         [,2]         [,3]         [,4]         [,5]
## [1,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [2,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [3,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [4,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [5,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [6,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [7,] 7.636548781 7.636575887 7.364905118 24.25381492 23.42646422
## [8,] 7.636548781 7.636575887 7.364905118         NaN         NaN
##              [,6]
## [1,] 22.70492852
```

```
## [2,] 22.70492852
## [3,] 22.70492852
## [4,] 22.70492852
## [5,] 22.70492852
## [6,] 22.70492852
## [7,] 22.70492852
## [8,]         NaN
##
## $generalized.weights[[5]]
##              [,1]        [,2]        [,3]        [,4]        [,5]       [,6]
## [1,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [2,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [3,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [4,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [5,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [6,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [7,] 7.211022048 7.153142793 7.286966755 22.33808829 22.09403734 22.019529
## [8,] 7.211022048 7.153142793 7.286966755         NaN         NaN        NaN
##
## $generalized.weights[[6]]
##              [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [2,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [3,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [4,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [5,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [6,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [7,] 7.176390423 7.203965928 7.137067488 20.17689142 20.89711516
## [8,] 7.176390423 7.203965928 7.137067488         NaN         NaN
##            [,6]
## [1,] 20.83334465
## [2,] 20.83334465
## [3,] 20.83334465
## [4,] 20.83334465
## [5,] 20.83334465
## [6,] 20.83334465
## [7,] 20.83334465
## [8,]         NaN
##
## $generalized.weights[[7]]
##              [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [2,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [3,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [4,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [5,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [6,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [7,] 7.297461899 7.462363574 7.504785229 23.46860228 21.87422901
## [8,] 7.297461899 7.462363574 7.504785229         NaN         NaN
##            [,6]
## [1,] 23.6164706
## [2,] 23.6164706
## [3,] 23.6164706
## [4,] 23.6164706
```

```
## [5,] 23.6164706
## [6,] 23.6164706
## [7,] 23.6164706
## [8,]        NaN
##
## $generalized.weights[[8]]
##             [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [2,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [3,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [4,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [5,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [6,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [7,] 7.509444959 7.520601908 7.503971705 20.79767655 20.96679262
## [8,] 7.509444959 7.520601908 7.503971705         NaN         NaN
##             [,6]
## [1,] 20.28142462
## [2,] 20.28142462
## [3,] 20.28142462
## [4,] 20.28142462
## [5,] 20.28142462
## [6,] 20.28142462
## [7,] 20.28142462
## [8,]         NaN
##
## $generalized.weights[[9]]
##             [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [2,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [3,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [4,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [5,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [6,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [7,] 7.224443719 7.247942959 7.252035679 22.55008469 20.00896883
## [8,] 7.224443719 7.247942959 7.252035679         NaN         NaN
##             [,6]
## [1,] 18.19083112
## [2,] 18.19083112
## [3,] 18.19083112
## [4,] 18.19083112
## [5,] 18.19083112
## [6,] 18.19083112
## [7,] 18.19083112
## [8,]         NaN
##
## $generalized.weights[[10]]
##             [,1]        [,2]        [,3]        [,4]        [,5]
## [1,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
## [2,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
## [3,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
## [4,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
## [5,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
## [6,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
## [7,] 7.064812117 7.033793856 7.109731553 20.57928229 21.98130348
```

```
## [8,] 7.064812117 7.033793856 7.109731553          NaN         NaN
##             [,6]
## [1,] 21.66110864
## [2,] 21.66110864
## [3,] 21.66110864
## [4,] 21.66110864
## [5,] 21.66110864
## [6,] 21.66110864
## [7,] 21.66110864
## [8,]         NaN
##
##
## $result.matrix
##                               1               2               3
## error              0.095574714068   0.088407379615   0.083466077534
## reached.threshold  0.009622051081   0.009971107377   0.009057825053
## steps            209.000000000000 218.000000000000 223.000000000000
## Intercept.to.AND -18.376075646552 -18.752852851894 -19.049349521771
## Var1.to.AND         7.218203589632   7.318273896559   7.491666807411
## Var2.to.AND         7.206307848475   7.328197888255   7.442880476010
## Var3.to.AND         7.068825670506   7.321393960923   7.383912215372
## Intercept.to.OR    -9.535912264839 -10.351228549406 -10.051423705987
## Var1.to.OR         22.515064986883  21.810682715945  21.982025085342
## Var2.to.OR         21.260916205989  21.144158865246  21.173995551693
## Var3.to.OR         19.534938765393  23.486913136803  21.471108770709
##                               4               5               6
## error              0.079476715355   0.09290641890   0.095158881189
## reached.threshold  0.008972214356   0.00980462943   0.009809007217
## steps            231.000000000000 225.00000000000 214.000000000000
## Intercept.to.AND -19.314239267849 -18.52047433895 -18.388706978920
## Var1.to.AND         7.636548780987   7.21102204759   7.176390423458
## Var2.to.AND         7.636575886562   7.15314279262   7.203965927604
## Var3.to.AND         7.364905117839   7.28696675464   7.137067487541
## Intercept.to.OR   -11.126936937012 -10.49808234646  -9.738838001695
## Var1.to.OR         24.253814921070  22.33808828942  20.176891416797
## Var2.to.OR         23.426464221477  22.09403733626  20.897115164701
## Var3.to.OR         22.704928517008  22.01952899899  20.833344646377
##                               7               8               9
## error              0.084369642581   0.080443007719   0.091872989123
## reached.threshold  0.009739752916   0.007607081617   0.009401678484
## steps            222.000000000000 214.000000000000 206.000000000000
## Intercept.to.AND -18.998834881664 -19.242752804230 -18.587391226476
## Var1.to.AND         7.297461899500   7.509444958903   7.224443719414
## Var2.to.AND         7.462363573560   7.520601907611   7.247942958566
## Var3.to.AND         7.504785228532   7.503971704744   7.252035679397
## Intercept.to.OR   -10.663270457291  -9.677160517240  -8.906132532120
## Var1.to.OR         23.468602284015  20.797676546891  22.550084685627
## Var2.to.OR         21.874229014341  20.966792616331  20.008968833943
## Var3.to.OR         23.616470604430  20.281424616893  18.190831124359
##                              10
## error              0.099983866900
## reached.threshold  0.009399548592
## steps            219.000000000000
## Intercept.to.AND -18.141461475538
```

```
## Var1.to.AND         7.064812117297
## Var2.to.AND         7.033793856121
## Var3.to.AND         7.109731553452
## Intercept.to.OR    -10.068373007051
## Var1.to.OR          20.579282287745
## Var2.to.OR          21.981303479749
## Var3.to.OR          21.661108637561
##
## attr(,"class")
## [1] "nn"
```

```
# Calling help on - ?neuralnet()
# "AND+OR~Var1+Var2+Var3," ==> FORMULA - a symbolic description of the model to be fitted.x
# AND + OR        ==> RESPONSE or DEPENDENT VARIABLES (BINOMIAL Classification)
# Var1+Var2+Var3  ==> INDEPENDENT VARIABLES
# DATAFRAME       ==> binary_df
# hidden ( # of Hidden Neurons in each Layer) ==> ZERO in this case.
# rep ( Repetitions of ANN) ==> TEN.
# act.fct ==>
# err.fct ==> Differentiable FUNC used for Calculating ERROR. Usually - "ce" or "sse"
# Where -- "sse" == Sum of Squared Errors - Similar to Linear Regression .
# "sse" Used for ANN for REGRESSION Tasks , Not Classification.
# "ce" == "cross-entropy" , used for Classification tasks.
#
# Plotting Functions ---
## plot.nn for plotting of the neural network.
## gwplot for plotting of the generalized weights.
#


#
```