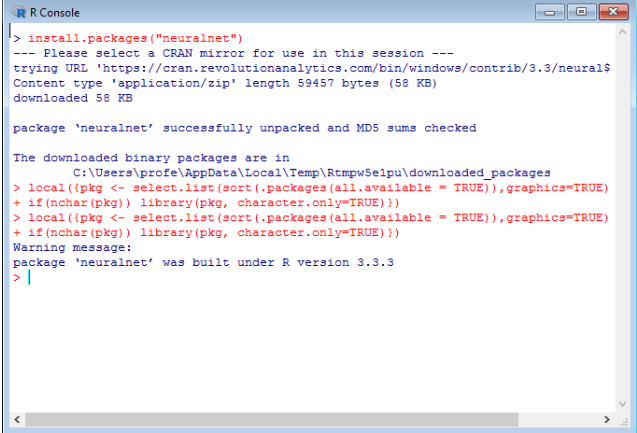
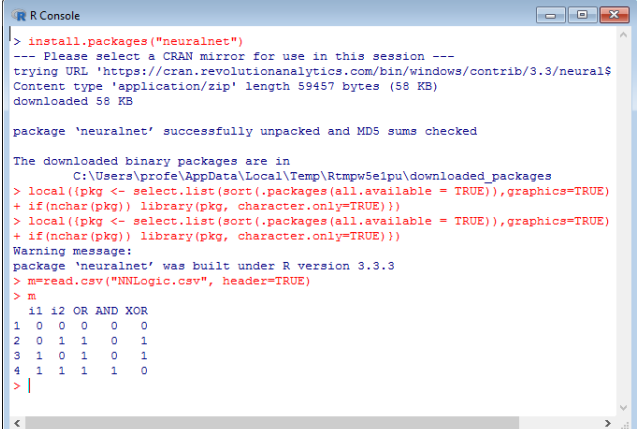


R Programming Fundamentals for Business Students— Neural Networks

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ACTION	REACTION																																				
<ul style="list-style-type: none"> Start up R and File > Change dir... to your scripts folder (mine is MyRScripts) Type install.packages("neuralnet") and select an HTTPS Cran mirror in the popup (not shown) Select the menu item Packages > Load Package... > neural net, then press the OK button <p>Note: You should upgrade to R version 3.3.3, I obviously have not, but it should still work.</p>	 <pre> R Console > install.packages("neuralnet") --- Please select a CRAN mirror for use in this session --- trying URL 'https://cran.revolutionanalytics.com/bin/windows/contrib/3.3/neuralnet' Content type 'application/zip' length 59457 bytes (58 KB) downloaded 58 KB package 'neuralnet' successfully unpacked and MD5 sums checked The downloaded binary packages are in C:\Users\profe\AppData\Local\Temp\Rtmpw5e1pu\downloaded_packages > local({pkg <- select.list(sort(.packages(all.available = TRUE)),graphics=TRUE) + if(nchar(pkg)) library(pkg, character.only=TRUE)}) > local({pkg <- select.list(sort(.packages(all.available = TRUE)),graphics=TRUE) + if(nchar(pkg)) library(pkg, character.only=TRUE)}) Warning message: package 'neuralnet' was built under R version 3.3.3 > </pre>																																				
<ul style="list-style-type: none"> Create the following spreadsheet in Excel Export the table into your R script folder as NNLogic.csv (not shown, see tutorial on exporting csv files) 	<table border="1"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>i1</td> <td>i2</td> <td>OR</td> <td>AND</td> <td>XOR</td> </tr> <tr> <td>2</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>3</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>4</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>5</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>		A	B	C	D	E	1	i1	i2	OR	AND	XOR	2	0	0	0	0	0	3	0	1	1	0	1	4	1	0	1	0	1	5	1	1	1	1	0
	A	B	C	D	E																																
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5	1	1	1	1	0																																
<ul style="list-style-type: none"> Import this table into R inside the variable m. Type m just to be sure you have the right data. 	 <pre> R Console > install.packages("neuralnet") --- Please select a CRAN mirror for use in this session --- trying URL 'https://cran.revolutionanalytics.com/bin/windows/contrib/3.3/neuralnet' Content type 'application/zip' length 59457 bytes (58 KB) downloaded 58 KB package 'neuralnet' successfully unpacked and MD5 sums checked The downloaded binary packages are in C:\Users\profe\AppData\Local\Temp\Rtmpw5e1pu\downloaded_packages > local({pkg <- select.list(sort(.packages(all.available = TRUE)),graphics=TRUE) + if(nchar(pkg)) library(pkg, character.only=TRUE)}) > local({pkg <- select.list(sort(.packages(all.available = TRUE)),graphics=TRUE) + if(nchar(pkg)) library(pkg, character.only=TRUE)}) Warning message: package 'neuralnet' was built under R version 3.3.3 > m=read.csv("NNLogic.csv", header=TRUE) > m i1 i2 OR AND XOR 1 0 0 0 0 0 2 0 1 1 0 1 3 1 0 1 0 1 4 1 1 1 1 0 > </pre>																																				

TRAINING A NEURAL NETWORK

- Type `net=neuralnet(AND+OR+XOR~i1+i2, m, hidden=2)`

Explanation: This command creates a 2x2x3 neural network (2 inputs, 2 hidden units, 3 output units).

The first parameter describes the network, the second parameter is the data frame, and the last parameter specifies the number of hidden units.

```
R Console
> install.packages("neuralnet")
--- Please select a CRAN mirror for use in this session ---
trying URL 'https://cran.revolutionanalytics.com/bin/windows/contrib/3.3/neuralnet'
Content type 'application/zip' length 59457 bytes (58 KB)
downloaded 58 KB

package 'neuralnet' successfully unpacked and MD5 sums checked

The downloaded binary packages are in
C:\Users\profe\AppData\Local\Temp\Rtmpw5e1pu\downloaded_packages
> local((pkg <- select.list(sort(.packages(all.available = TRUE)), graphics=TRUE)
+ if(nchar(pkg)) library(pkg, character.only=TRUE)))
> local((pkg <- select.list(sort(.packages(all.available = TRUE)), graphics=TRUE)
+ if(nchar(pkg)) library(pkg, character.only=TRUE)))
Warning message:
package 'neuralnet' was built under R version 3.3.3
> m=read.csv("NNLogic.csv", header=TRUE)
> m
  i1 i2 OR AND XOR
1  0  0  0  0  0
2  0  1  1  0  1
3  1  0  1  0  1
4  1  1  1  1  0
> net = neuralnet(OR+AND+XOR~i1+i2,m,hidden=2)
> |
<
```

CHECKING THE ERROR & RESULTS

- Type `net` to see the results

Explanation. The error should be close to zero if the network learned. The `$Results.matrix` also contains the weightings between all layers.

```
R Console
$Result.matrix
              1
error          0.0006420892032
reached.threshold 0.0086556820280
steps          205.000000000000000
Intercept.to.l1ayhid1 -0.0331712674031
i1.to.l1ayhid1 -18.9855455504291
i2.to.l1ayhid1 -19.9095943010137
Intercept.to.l1ayhid2 -2.8074673839230
i1.to.l1ayhid2  1.7279127923285
i2.to.l1ayhid2  1.7252134648477
Intercept.to.OR  0.9640725283718
l1ayhid.1.to.OR -1.9661868210150
l1ayhid.2.to.OR  0.0900098580711
Intercept.to.AND -0.6084634950638
l1ayhid.1.to.AND  0.9501973631820
l1ayhid.2.to.AND  2.4329892372006
Intercept.to.XOR  1.6154364058916
l1ayhid.1.to.XOR -3.0019212171527
l1ayhid.2.to.XOR -2.4519708668982

attr(,"class")
[1] "nn"
> |
<
```