

Appendix A

Help Me!

Some of the more common difficulties that you may experience have been listed here. If you have a problem, please review this section and see if the solution or answer has been provided. If there is an Error Message associated with your problem, please check Appendix B for a list of Error Messages and their causes. If you still experience difficulties, then please consult with Cheshire Customer Service, as discussed in Appendix C.

A.1 Installation Problems

A.1.1 Windows Problems

I tried to run the install program but I got an error saying “This program requires Microsoft Windows.”

The install software can only be run from within Windows. Start up Windows and then follow the install instructions in Chapter 2 of the Neuralyst User’s Guide.

When I ran the install program I got an error saying “Unable to copy file to destination directory. Check your free disk space.”

The Neuralyst software requires about 300K bytes of free disk space. If the install fails due to lack of space, try specifying a different disk drive than C: in the box holding the directory to install to, or else clear some room on your disk and try again.

The install program fails with the message “Unable to create directory to copy to.” What’s happening?

The install program allows you to specify the directory to install the Neuralyst software to. The default is C:\NEURLYST, which is fine for most systems. If you get this message it indicates that the directory that you have specified cannot be created. Make sure you have given a drive letter and destination directory that would be legal on your system. If you have no drive C, for example, edit the default to a drive appropriate for your system before continuing.

The Neuralyst installer will create the destination directory to hold the files, but it won’t create a whole chain of directories. If you specify C:\X\Y\NEURLYST for your destination, C:\X\Y must already exist. The install program will then create the NEURLYST subdirectory within the \X\Y directory. However, it won’t create \X and \X\Y for you. You would have to do that before running the install program.

I reinstalled the software and then when I ran Neuralyst, I got an error message saying “Change Disk. Cannot find NEUR14.DLL. Please insert in Drive A:.” What’s happening?

This message can only appear in a situation where you are doing a second or later install of Neuralyst. It will not occur on a normal first installation. If you reinstall Neuralyst you must exit Windows *after* the installation and then restart Windows. That will prevent this message from occurring.

The problem occurs because of the way Windows handles program libraries like the NEUR14.DLL file included with Neuralyst. If an old version of NEUR14.DLL has been running and a new version is installed, Windows gets confused about whether you want the old version or the new one to be running. Restarting Windows clears the old version from memory, eliminating the confusion.

The install program still isn't working for me even after following all this advice. What can I do?

Please contact Cheshire Customer Service for assistance. We are committed to getting you up and running with Neuralyst as soon as possible!

A.1.2 Macintosh Problems

Something went wrong with my install.

You should first make sure Excel has been properly installed. Then clear the Neuralyst folder from your hard disk. Re-drag the Neuralyst folder from the installation disk to your hard disk. Be sure to launch Neuralyst from the Excel macro file named Neuralyst, NOT from the Cheshire icon labeled Neuralyst Lib. If you still have problems, call Cheshire Customer Service.

I installed Neuralyst on my small screen Macintosh running with System 7; but when I tried to run Neuralyst, I couldn't find the Neural and Config menus; the N might have been there, but that was all.

On small screens (those with horizontal resolution of 512 pixels), the combination of the Excel menus and the System 7 Multifinder menu leaves no room for any additional menu items. After installing Neuralyst, you should copy the contents of the folder Small Screen I/F into the Neuralyst folder. This will replace the standard menu interface with a special menu interface that is called on command. See the documentation in the folder for further details.

A.2 Neuralyst Problems

Whenever I give a command I get the error “Initialize or Reload the worksheet.”

You have to tell Neuralyst that you want to use a particular worksheet before you can give any Neuralyst commands. If it is a new worksheet that you haven't run Neuralyst on before, use the **Init Working Area** command to set it up. If it's a worksheet that you have used Neuralyst on in the past, use the **Reload Network** command. After one of these two commands is given Neuralyst will know that you want it to use this worksheet for its operations.

I try to give a command but I get an error telling me to “Select worksheet XYZ first.”

After you tell Neuralyst which worksheet to use with either the **Init Working Area** or **Reload Network** commands, it remembers that worksheet name. Then when you give another Neuralyst command it checks to make sure that worksheet is still the active one (the one in front of all others). If it isn't, you get this message telling you to bring your worksheet to the front.

If you actually want to start using a different worksheet than the one you were using before, bring that one to the front and give the **Reload Network** command. Then if you want to switch back to the first one, bring it back to the front and do **Reload Network** again. It's always safe to do **Reload Network** in order to make sure that the worksheet in the front is the one that Neuralyst is working with.

When I give the Reload Network command, I get a message saying “Worksheet XYZ must be initialized.”

This message means that Neuralyst does not think that your worksheet ever got initialized with the **Init Working Area** command. Neuralyst remembers this fact by creating a named cell in the top left corner of the Working Area, the cell which has the Neuralyst program name and version number. This cell must have the name **_NWTL**.

If you have accidentally deleted that name from your worksheet, you can re-create it by selecting the cell with the Neuralyst program name, and giving Excel's **Define Name** command. Type **_NWTL** in the box labeled **Name:** and hit **OK**. Neuralyst will now be able to find the Working Area on your sheet when you give the **Reload Network** command.

After I set the network size, I got a message saying "Input Column C is bad."

Neuralyst checks your columns to make sure that they hold valid numeric data. This message indicates that your column **C** has some invalid data in the rows that Neuralyst is looking at. Take a look at the Row Information block in the Working Area; it's just to the right of the Network Run Statistics block. Look at the entries for First Row and Last Row to see what range of rows Neuralyst is working with. Then look carefully at your column **C** in that range of rows. Find the non-numeric data and replace it. Blank cells will be treated as zeros, which may be OK for your particular application, but any cells with text or error values will not be acceptable.

I made a change to the values in one of my target columns, but Neuralyst seems to be training to the old value, ignoring the change.

After any change to the values in your Input, Target, or Mode Flag columns, you need to give the **Reload Network** command to force Neuralyst to re-read your columns and pick up the changed data. Neuralyst will also re-read your column data after the **Set Network Size** command, or if you have changed the set of rows and columns in use by giving the **Set Rows** or one of the column commands.

A.2.1 Windows Problems

I ran two Neuralysts at the same time so I could have two different Neuralyst worksheets running, but I am seeing strange behavior and getting bad results.

You can't run two Neuralysts at the same time. Windows is only able to load one instance of the Neuralyst program library NEUR14.DLL at one time. When two instances of Excel running with Neuralyst both try to interface with the single instance of NEUR14.DLL that is available, then data transfers and other communications gets confused and errors will result.

If you want to run two or more instances of Excel at the same time, that is OK so long as only one of them is running with Neuralyst. Within a single instance of Excel running with Neuralyst, you may open as many worksheets as Excel will allow and switch between them using **Reload Network** as described in the previous problem.

I got an error message which the manual said represents an internal problem in the Neuralyst software. What should I do?

The Neuralyst design team has made every effort to provide you with reliable, bug-free software. However, errors may still exist. Should you encounter such a problem, please inform Cheshire Customer Service of the error message and the conditions under which it occurred. We will work with you to resolve the problem as quickly as possible.

Neuralyst keeps a great deal of its data in the Working Area. Any accidental alteration you might make to this data could cause Neuralyst to behave incorrectly or to abort with an error message. Also, much of the Neuralyst functionality resides in a program library which is loaded with Excel. If that library should become corrupted, it will be necessary to exit and then re-start Windows to load a fresh copy of the program. Cheshire Customer Service can provide more information in these situations.

A.2.2 Macintosh Problems

I got an error message which the manual said represents an internal problem in the Neuralyst software. What should I do?

The Neuralyst design team has made every effort to provide you with reliable, bug-free software. However, errors may still exist. Should you encounter such a problem, please inform Cheshire Customer Service of the error message and the conditions under which it occurred. We will work with you to resolve the problem as quickly as possible.

Neuralyst keeps a great deal of its data in the Working Area. Any accidental alteration you might make to this data could cause Neuralyst to behave incorrectly or to abort with an error message. Also, much of the Neuralyst functionality resides in a program library which is loaded with Excel. If that library should become corrupted, it may be necessary to Restart the Macintosh and re-load Neuralyst and Excel to load a fresh copy of the program. Cheshire Customer Service can provide more information in these situations.

Appendix B

Error Messages

Neuralyst Error Messages have been included here in alphabetical order. If the Error Message you see is not listed here, then it is likely that the message is being given by DOS, Windows, or Excel. In that case, you may have to refer to their respective manuals for help.

Bad arg to GenNextPop
Bad arg to Init
Bad arg to InitPop
Bad arg to SetParams
Bad arg to SetEnhanced
Bad arg to SetCutoffs
Bad arg to SetWeights
Bad arg to SetColumn
Bad arg to SetColumn for blanks
Bad arg to TrainNextSchema

These messages should never appear; they represent an internal problem in the Neuralyst software. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area.

Bad column in SelectDataMode

This message should never appear; it represents an internal problem in Neuralyst and indicates that an invalid column was created.

Bad column string in GetSchema
Bad selector in GetSchema

These messages should never appear; they represent an internal problem in Neuralyst and indicate that an invalid value was passed to the Genetic Supervisor. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area.

Bad data in ReloadPop

This message should never appear; it represents an internal problem in Neuralyst and indicates that an invalid value was passed to the Genetic Supervisor. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area.

Bad parameter in InitSuper
Bad parameter in InitPop
Bad parameter in TrainNextSchema
Bad parameter in GenNextPop
Bad parameter in ReloadPop

This message should never appear; it represents an internal problem in Neuralyst and indicates that an invalid value was passed to the Genetic Supervisor. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area.

Blank flag column invalid

This message should never appear; it represents an internal problem in Neuralyst and indicates that an invalid column was created.

Call Init before InitSuper
Call InitSuper before InitPop
Call InitPop before TrainNextSchema
Call InitPop before GenNextPop

This message should never appear; it represents an internal problem in Neuralyst and indicates that the neural network was not set up before the Genetic Supervisor was called or that the Genetic Supervisor was not called in the proper sequence.

Can't have more than one MIN row
Can't have more than one MAX row
Can't have more than one SYMBOL row

These messages will appear if more than one row of that type was marked in the Mode Flag column.

Can't set symbols before Init

This message should never appear; it represents an internal problem in Neuralyst and indicates that a column was transferred before a network was initialized.

Changing the activation function or calculation method will reinitialize the network, causing any learning done so far to be forgotten. Proceed?

This warning appears if you are changing the activation function type or gain or the calculation method when using the **Set Enhanced Parameters command. It allows you to confirm your intentions.**

Cheshire Engineering Corporation prefers that this file be called NEURLYST.XLM. *Windows only*

This message appears when Neuralyst is loaded if the NEURLYST.XLM file has been copied or renamed.

Cheshire Engineering Corporation prefers that this file be called Neuralyst. *Macintosh only*

This message appears when Neuralyst is loaded if the Neuralyst file has been copied or renamed.

Do Set Genetic Parameters first.

This message appears if an attempt is made to execute **Run Genetic Supervisor** before **Set Genetic Parameters** has initialized the Genetic Supervisor state.

Do Set Mode Flag Column first.

This message appears if an attempt is made to execute **Set Mode Rows** before **Set Mode Flag Column** has initialized the location of the Mode Flag column.

Do Set Rows first.

This message appears if an attempt is made to execute **Set Mode Rows** before **Set Rows** has initialized the range of defined rows.

Establish input columns before InitSuper.

Establish gap column before InitSuper.

Establish mode flag column before InitSuper.

Establish target columns before InitSuper.

This message should never appear; it represents an internal problem in Neuralyst and indicates that the neural network was not set up before the Genetic Supervisor was called.

Failed to translate in SetColumnEx.

This message appears if the symbol translator failed to identify or parse the symbols present in a column.

Generate Min values for currently defined Input and Target columns?

Generate Max values for currently defined Input and Target columns?

These messages appear after a **Set Mode Rows** command has established a Min or Max row. It allows you to confirm an operation to automatically generate Min or Max values based on data defined previously with **Set Rows**, **Add Input Columns**, and **Add Target Columns**. These values will overwrite any data currently in the Min or Max fields of the applicable columns.

Genetic Supervisor data may not be compatible with data saved on the worksheet. Do Set Genetic Parameters to reinitialize.

This message appears if an attempt is made to execute **Run Genetic Supervisor** and an event has occurred which makes the Genetic Supervisor state inconsistent with the neural network model. Such events include retrieving an optimized neural network configuration from a prior Genetic Supervisor run, as well as the following commands:

Set Rows,
Add Input Column,
Add Target Column,
Add Output Column,
Set Mode Flag Column, and
Set Network Size.

Hyperbolic activation function can only be used with Floating Point calculation mode.

This message appears after the **Set Enhanced Parameters** dialog box if the Hyperbolic activation function and Fixed Point calculation method were chosen at the same time.

Illegal value. All values must be > 0 .

This message appears after the second **Set Network Size** dialog box if one or more of the layers has been given a number of neurons which is negative or zero.

Illegal value. Crossovers must be between 0 and 10 and Mutation Rate must be between 0 and 1.

This message appears after the **Set Genetic Parameters** dialog box if you have an illegal value for the Crossovers or Mutation Rate fields.

Illegal value. Gain and Threshold values must be ≥ 0 .

This message appears after the **Set Enhanced Parameters** dialog box if you have an illegal value for the function gain or zero threshold fields.

Illegal value. Input Inclusion Rate must be > 0 and ≤ 1 .

This message appears after the **Set Genetic Parameters** dialog box if you have an illegal value for the input column Inclusion Rate field.

Illegal value. Learning Rate and Momentum must be between 0 and 1 and Input Noise must be between 0 and 0.1.

This message appears after the **Set Genetic Parameters** dialog box if you have an illegal value for Learning Rate, Momentum or Input Noise fields.

Illegal value. Mode Flag type not recognized.

This message appears if an invalid entry was made in a Mode Flag field.

Illegal value. Network structure must be between 2 and 6 layers.

This message appears after the **Set Genetic Parameters** dialog box if you have an illegal value for the network Max Layers field.

Illegal value. Number of hidden layer neurons must be > 0 for the layers specified and $= 0$ for the layers above the number of max layers specified. Remember, hidden layers plus 2 (input and output layers) equals max layers.

This message appears after the **Set Genetic Parameters** dialog box if you have an illegal value for a Layer n Neuron Limit field.

Illegal value. Number of rows per pattern must be at least 1 and less than the total number of rows.

This message appears after the **Set Rows** dialog box if you have an illegal value for the number of rows per pattern.

Illegal value. % (percent) must be between 0 and 100.

This message appears after the **Select Data Mode** dialog box if you have an illegal value for the % field.

Illegal value. Population Pool Size must be > 0 and < 380 .

This message appears after the **Set Genetic Parameters** dialog box if you have an illegal value for the Pool Size field.

Illegal value. Rows to shift per pattern must be at least 1.

This message appears after the **Set Rows** dialog box if you have an illegal value for the number of rows to shift.

Illegal value. The first five values must be in the range from 0 to 1; Epochs per Update must be > 0 ; and Epoch Limit, Time Limit, and Error Limit must be ≥ 0 .

This message appears after the dialog box of the **Set Network Parameters** command, if one or more entries is out of the legal range.

Inconsistent input column count in Genetic Supervisor data.

This message should never appear; it represents an internal problem in the Neuralyst software. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area.

Incorrect index
Incorrect type
Incorrect column size
Incorrect column width
Incorrect weight array size
Incorrect network size

These messages should never appear; they represent an internal problem in the Neuralyst software. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area.

Initial limit must range from 0 to 16.

This message appears after the **Reset Weights** dialog box if the value for the initial weight limit is out of range.

Initialize or Reload the worksheet.

You have given a Neuralyst command before any worksheet has been specified with the **Init Working Area** or **Reload Network** commands. Use one of those commands and then try again.

Input column <column name> is bad.

This message indicates that Neuralyst has found bad data in the specified column. Check that column and check the rows that have been set (look in the Working Area to see the row limits). Make sure there is only numeric or valid symbolic data in that area.

Input column list is invalid. Please re-enter.

This message appears after the **Edit Column Lists** dialog box if Neuralyst wasn't able to interpret the Input column list entry. A legal entry looks like a series of one or two letter column names separated by spaces and/or commas.

Insufficient memory (N).

N is a number in the range 1 through 11 which is used internally by Neuralyst development teams for debugging. This message means that your system doesn't have enough memory to handle the network and data sizes that you have chosen.

Insufficient memory in Genetic Supervisor (N).

N is a number in the range 1 through 12 which is used internally by Neuralyst development teams for debugging. This message means that your system doesn't have enough memory to handle the data structures needed to manage the Genetic Supervisor.

Invalid Column Type

This message should never appear; it represents an internal problem in Neuralyst and indicates that a column was incorrectly specified.

Invalid column list, please re-enter.

This message may appear after the **Edit Column Lists** dialog box if Neuralyst wasn't able to interpret one of the column list entries. A legal entry looks like a series of one or two letter column names separated by spaces and/or commas.

Library file Neuralyst Lib is bad. *Macintosh only.*

This message should never appear. It indicates that the library file Neuralyst Lib has been corrupted in some way. Try re-installing the software from the distribution diskette.

Macro error at cell: NEURLYST.XLM!<Cell ID> *Windows only.*

This message should never appear; it represents an internal problem in the Neuralyst software. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area. Press the button labeled "Halt" to remove this message.

Macro error at cell: Neuralyst!<Cell ID> *Macintosh only.*

This message should never appear; it represents an internal problem in the Neuralyst software. Other causes could include accidental changes made to the data Neuralyst stores in the Working Area. Press the button labeled "Halt" to remove this message.

Maximum number of rows is 6550.

Some currently supported versions of Excel allow arrays of only 6550 elements. This limits Neuralyst to allowing only 6550 rows in the **Set Rows** command. Future versions of Excel and/or Neuralyst may overcome this restriction.

Min or Max symbols must be in the Symbol List.

This message indicates that a Min and/or Max symbol was defined which was not also defined in the Symbol List.

Min cannot be >= Max.

This message indicates that a Min value was entered which was greater than the entered Max value.

Min symbol must precede Max symbol and Min and Max symbols must be different.

This message indicates that a Min symbol was entered which has higher or equal precedence to the Max symbol as defined by order of entry in the Symbol List.

Missing Symbol

This message indicates that an incorrectly structured symbol list was passed to symbol initialization.

Mode Flag column field is invalid. Please re-enter.

This message appears after the **Edit Column Lists** dialog box if Neuralyst wasn't able to interpret the Mode Flag column entry. A legal entry is a one or two letter column name.

Mode Flag column is bad.

This message indicates that Neuralyst has found bad data in the Mode Flag column. Check that column and check the rows that have been set (look in the Working Area to see the row limits). Make sure there are only blanks or TRAIN, TEST, MIN, MAX, or SYMBOL values in that area.

Mode is set to optimize epoch count. Fitness limit represents RMS error and should be between 0 and 1.

This message appears after the **Set Genetic Parameters** dialog box if the range of the Fitness Limit field does not match the Fitness Criteria selected.

Mode is set to optimize RMS error. Fitness limit represents epochs and should be an integer ≥ 1 .

This message appears after the **Set Genetic Parameters** dialog box if the range of the Fitness Limit field does not match the Fitness Criteria selected.

Network must be completely set up before Genetic Supervisor data can be initialized.

This message appears after the **Set Genetic Parameters** dialog box if a neural network model has not been set up in all normal respects first.

No data is available to create a Training Error Plot.

No training error history is available for plotting. This can occur if: a worksheet has just been initialized with an **Init Working Area** command and no training has occurred yet; a **Set Network Size** or **Reset Weights** command was issued and no training has occurred yet; or if a worksheet has just been reloaded with a **Reload Network** command (there is no training error history saved between reloads).

Non-blank value in a "blank" row for input column <name>

Non-blank value in a "blank" row for target column <name>

Non-blank value in a "blank" row for Mode Flag column <name>

Neuralyst skips blank rows in your data area. The determination of whether a row is blank or not is done based on values in the first input column. This message indicates that it found a partially blank row, one where the first input column was blank but some other column was not. The message tells you which column had the non-blank value.

Not a single column array.

This message should never appear; it represents an internal problem in Neuralyst and indicates that a column was incorrectly specified.

Not enough room to save weights. Try reducing the size of your network or relocating the Working Area higher on the worksheet.

This message appears after a **Set Network Size** command if the space from the Working Area to the bottom of the worksheet has insufficient room to save all the weights.

Number of layers must be 2-6.

This message appears after the first **Set Network Size** dialog box if the number of layers entered is outside of the range supported by Neuralyst. Two layers is the minimum and six is the maximum currently supported.

Number of target columns must equal number of output columns.

This message appears after the dialog box of the **Edit Column Lists** command, if the number of columns in the Target column list is different from the number in the Output column list.

Number of weights exceeds Neuralyst limit of 131,008. Try reducing the size of your network, especially the size of the largest layer.

This warning appears if you are changing the network size using the **Set Network Size** command. The total number of weights in the network is limited to 131,008 in this version of Neuralyst. The number of weights in a network is calculated by taking each layer except the last, and multiplying one plus the number of neurons in that layer times the number of neurons in the next layer, then adding those products. For example, a 4 layer network with sizes of 15, 20, 10, 5 would have $16*20 + 21*10 + 11*5$ or 585 weights.

Only one column may be selected.

This message appears after the **Edit Mode Lists** command if more than one column was entered as a selection.

Only one row may be selected.

This message appears after the **Set Mode Row** command if more than one row was entered as a selection.

Output column too large.

This message should never appear; it represents an internal problem in Neuralyst and indicates that a column was incorrectly specified.

Output column list is invalid. Please re-enter.

This message appears after the **Edit Column Lists** dialog box if Neuralyst wasn't able to interpret the Output column list entry. A legal entry looks like a series of one or two letter column names separated by spaces and/or commas.

Randomization setting must be greater than zero.

This message occurs after the **Reset Weights** dialog box if User Set randomization has been selected, and the User Set value is invalid.

Reload macro sheet NEURLYST.XLM. *Windows only.*

This message indicates that something went wrong when Neuralyst originally loaded. Try exiting Excel and re-starting Neuralyst.

Reload macro sheet Neuralyst. *Macintosh only.*

This message indicates that something went wrong when Neuralyst originally loaded. Try exiting Excel and re-starting Neuralyst.

Select worksheet <your worksheet name> first.

The worksheet which is currently selected is not the one you have specified for Neuralyst. Bring that worksheet to the front, or else use the **Reload Network** command on the front worksheet if you want Neuralyst to change over to using that one.

Selected column has not been defined as an Input or Target column.

This message indicates that the column selected for Symbol and/or Min/Max entry with **Edit Mode Lists** is not currently defined as an Input or Target column.

Selected row not in current row range. Include this row with Set Rows later.

This message indicates that the row defined by a **Set Mode Rows** command is not currently in the range of rows defined by the **Set Rows** command. It will not be used until a **Set Rows** is done with the row included in the row range.

Selection must be at least two rows high.

This message appears if you have selected just one row for the **Set Rows** command. Neuralyst requires at least two rows to be specified.

Set the network size. That will randomize the weights, too.

This message appears if you give the **Reset Weights** command at a time when the network size still needs to be specified. What you should do is to give the **Set Network Size** command, which will also randomize the weights.

Symbol is neither blank nor a string.

This message appears if non-blank or non-string data is present in the SYMBOL row.

Symbol List must have at least two symbols, separated by a comma.

This message appears if a Symbol List was entered that has less than two symbols.

Set up all rows and columns first.

This message appears if you give the **Select Data Mode** or **Set Network Size** commands before you have finished setting up the rows and columns. Either the number of rows is zero, or the number of Input or Output columns is zero, or the number of Target columns is not equal to the number of Output columns, or the Mode Flag column has not been set. Fix things with the **Set Rows** and/or the column commands, and try again.

Target column <column name> is bad.

This message indicates that Neuralyst has found bad data in the specified column. Check that column and check the rows that have been set (look in the Working Area to see the row limits). Make sure there is only numeric data in that area.

Target column list is invalid. Please re-enter.

This message appears after the **Edit Column Lists** dialog box if Neuralyst wasn't able to interpret the Target column list entry. A legal entry looks like a series of one or two letter column names separated by spaces and/or commas.

The network size must be set before training can begin

The network size must be set before running

The network size must be set before histogramming

The network size must be set before unpacking

This message appears if you give the **Train Network, Run/Predict with Network, Histogram Weights, or Unpack Weights** commands at a time when the network size still needs to be set. Use the **Set Network Size** command and then try again.

This mode row was previously defined. Change to new row?

This warning appears if **Set Mode Rows** is used to set a row type that was already set. It allows you to confirm your intentions.

This will cause any genetic training state to be lost! Proceed?

This warning appears if you are initializing the supervisor state with the **Set Genetic Parameter** command. It allows you to confirm your intentions.

This will cause any learning done so far to be forgotten. Proceed?

This warning appears when you give the **Reset Weights** command. It allows you to confirm your intentions.

This will clear a large area to the right and down from the cell you have selected. Are you sure you have chosen an area that it's OK to clear?

This warning appears whenever you give the `Init Working Area` command. It allows you to confirm your intentions.

This will overwrite your current network structure and other parameters. Proceed?

This warning appears if you confirm retrieval of an optimized neural network configuration after a `Run Genetic Supervisor` command. It allows you to confirm your intentions.

This will randomize the network weights, causing any learning done so far to be forgotten. Proceed?

This warning appears if you are changing the network size using the `Set Network Size` command. It allows you to confirm your intentions.

This will require you to change the network size, forgetting any learning done so far. Proceed with the change? [Proceed with the column addition?, Proceed with the column changes?]

This warning appears when you are about to make a change which will require the network size to change. You are being warned that proceeding with that change will cause any learning done so far to be forgotten. Changes which will lead to this message are: changing the number of rows per pattern in the `Set Rows` command, or changing the set of Input, Output, or Target columns with the column commands.

This worksheet is set up for an old version of Neuralyst. Should it be updated for the new version?

This message occurs when you give the **Reload Network** command for a worksheet which was set up under a previous version of Neuralyst. In order for your worksheet to be used with the new version, Neuralyst will automatically update the worksheet, preserving your data. Confirm with OK if you want this to be done; use Cancel if you don't want the worksheet changed (which will mean that it can't be used with this version of Neuralyst).

Total weights exceeded 131,008 limit.

This warning appears if you are changing the network size using the **Set Network Size** command. The total number of weights in the network is limited to 131,008 in this version of Neuralyst. The number of weights in a network is calculated by taking each layer except the last, and multiplying one plus the number of neurons in that layer times the number of neurons in the next layer, then adding those products. For example, a 4 layer network with sizes of 15, 20, 10, 5 would have $16*20 + 21*10 + 11*5$ or 585 weights.

Unable to find macro sheet NEURXTRA.XLM [TML.XLM]. Please make sure it is installed in the Neuralyst directory and try again.
Windows only.

Neuralyst keeps some of its functions in separate Excel macro sheets which should be in the same directory as NEURLYST.XLM. This message indicates that it was not able to find one of these macro sheets there. Check to see that the file named in the message was properly installed into the Neuralyst directory.

Unable to find macro sheet Neuralyst_Inits [TML]. Please make sure it is installed in the Neuralyst folder and try again. *Macintosh only.*

Neuralyst keeps some of its functions in separate Excel macro sheets which should be in the same folder as Neuralyst. This message indicates that it was not able to find one of these macro sheets there. Check to see that the file named in the message was properly installed into the Neuralyst folder.

Unable to load library file NEUR14.DLL. You must either copy that file into a directory on your search path, or start Excel by using the Neuralyst icon in Program Manager. *Windows only.*

Neuralyst relies on the external library file NEUR14.DLL. This message appears if it was unable to locate that file. Make sure you start Neuralyst from a directory which includes both the NEURLYST.XLM macro sheet and the NEUR14.DLL file, which can be done by using the Neuralyst icon in the Program Manager. Alternatively, you can put NEUR14.DLL into your Windows home directory or any directory on your search path, which will guarantee that Neuralyst will be able to find it.

Unable to load library file Neuralyst Lib. Be sure it is in the Neuralyst folder. *Macintosh only.*

Neuralyst relies on the external library file Neuralyst Lib. This message appears if it was unable to locate that file. Make sure you start Neuralyst from a folder which includes both the Neuralyst macro sheet and the Neuralyst Lib file.

Value greater than Max in input column
Value greater than Max in target column
Value less than Min in input column
Value less than Min in target column

This message indicates that a value in the designated column exceeded the set Min or Max values, modified by Scaling Margin, for that column.

Value out of range in input column

Value of of range in target column

This message should never appear; it represents an internal error in Neuralyst and indicates that numeric representation of an input, target or output exceeds the range of defined symbols.

When optimizing epoch count, it is generally necessary to set a Time Limit in Set Network Parameters to prevent untrainable networks from tying up testing. Proceed?

This message appears if you give the **Run Genetic Supervisor** command with no Time Limit set and Fitness Criteria set to Train Epochs or Test Epochs. It allows you to confirm your intentions.

Worksheet <your worksheet name> must be initialized.

This message appears if you give the **Reload Network** command for a worksheet which has never been prepared for Neuralyst with the **Init Working Area** command. Use **Init Working Area** to set up the worksheet for Neuralyst.

You must first name this worksheet (by saving it).

This message appears if you give the **Init Working Area** command for a worksheet which has never been saved (such as SHEET1). Neuralyst can't work on such a worksheet. Save the worksheet and give it a name and then you will be able to use the **Init Working Area** command.

You must make a continuous selection before using this function.

This message appears for the **Set Rows** command, or any of the **Add Columns** commands, if you have selected a region that is not continuous before giving the command. Neuralyst can only work with continuous regions for these commands.

Appendix C

Cheshire Customer Service

If you have problems installing or running Neuralyst, please review the procedures and error messages discussed in this guide, particularly Appendices A and B.

If you are still not able to get Neuralyst to work, please note down all information relating to the failure and have it ready at hand. Then call Cheshire Customer Service at (626)351-5493 (or FAX (626)351-8645). Cheshire Customer Service is available Monday to Friday between the hours of 0900 to 1700 Pacific Time.

Due to the highly involved and widely varying nature of individual neural network models, Cheshire Customer Service can only answer questions on general usage, incorrect operation and Neuralyst generated faults and errors. Cheshire Customer Service cannot answer specific questions on developing neural network models nor will it be able to debug neural network models that you may have developed.

If you need help in developing or debugging neural network models then please write Cheshire at:

Cheshire Engineering Corporation
650 Sierra Madre Villa Avenue, Suite 201
Pasadena, CA 91107

Cheshire can provide full tutorial and design services for Neuralyst and development of custom neural network designs. These services are provided independently of its Customer Service operations for Neuralyst.

Appendix D

Neuralyst Specifications

D.1 Windows Specifications

Windows Version

3.1 or later.

Excel Version

4.0 or later.

CPU or Memory Requirements

Any system able to run Windows with Excel. More memory will allow larger neural networks to run.

Maximum Network Size

Greater than 131,000 weights.

Maximum Number of Neural Network Layers

Six.

Maximum Number of Neurons per Layer

Limited by Maximum Network Size.

Maximum Number of Input Columns

Limited only by memory and worksheet size.

Maximum Number of Output Columns

Limited only by memory and worksheet size.

Maximum Number of Rows

6550 per Input or Output Column.

Maximum Number of Rows per Pattern Window

Limited by Maximum Number of Rows.

Neural Network Computation Rate

Sample performance (in *Connections per Second*):

	386DX-40 (est.)	486DX-33	486DX2-66	Pentium-60
Fixed/Small Training	71,000	149,000	262,000	440,000
Fixed/Small Testing	221,000	465,000	836,000	1,363,000
Fixed/Huge Training	63,000	133,000	234,000	370,000
Fixed/Huge Testing	201,000	423,000	749,000	1,147,000
Float/Small Training	22,000	48,000	92,000	166,000
Float/Small Testing	69,000	145,000	269,000	489,000
Float/Huge Training	22,000	47,000	87,000	153,000
Float/Huge Testing	66,000	142,000	265,000	462,000

Connections per second is equivalent to a single weight/input computation for a neuron. Computation rates listed are examples only. Other computers will be slower or faster in proportion to their clock rates, processor type and other system characteristics.

Small applies to fixed-point networks having 10,920 or fewer connections (weights) and to floating-point networks having 4096 or fewer weights; larger networks are *huge*.

D.2 Macintosh Specifications

Maximum Network Size

Greater than 131,000 weights.

Maximum Number of Neural Network Layers

Six.

Maximum Number of Neurons per Layer

Limited by Maximum Network Size.

Maximum Number of Input Columns

Limited only by memory and worksheet size.

Maximum Number of Output Columns

Limited only by memory and worksheet size.

Maximum Number of Rows

6550 per Input or Output Column.

Maximum Number of Rows per Pattern Window

Limited by Maximum Number of Rows.

Excel Version

4.0 or later.

CPU or Memory Requirements

Any system able to run Excel. More memory will allow larger neural networks to run.

Neural Network Computation Rate

Sample performance (in *Connections per Second*):

	68030-33 (est.)	68040-25 (est.)	PowerPC-60 Emulated (est.)	PowerPC-60 Native (est.)
Fixed-point Training	82,000	209,000	104,000	682,000
Fixed-point Testing	256,000	650,000	325,000	2,112,000
Floating-point Training	31,000	79,000	39,000	257,000
Floating-point Testing	91,000	232,000	116,000	757,000

Connections per second is equivalent to a single weight/input computation for a neuron. Computation rates listed are examples only. Other computers will be slower or faster in proportion to their clock rates, processor type, and other system characteristics.

Appendix E

Macro Interface Specifications

E.1 Neuralyst/Excel Macro Interface

Neuralyst can be controlled by Excel macros on Windows or Macintosh. The list of accessible Neuralyst menu items and corresponding macro names are:

<u>Menu Item</u>	<u>Macro Name</u>
Reload Network	MacroReloadNetwork
Train Network	MacroTrainNetwork
Run/Predict with Network	MacroRunNetwork
Plot Training Error	MacroPlotError
Histogram Weights	MacroHistChart
Unpack Weights	MacroUnpackWeights

Note: When using these macro commands, prepend the macro name with “NEURLYST.XLM!” on Windows and “Neuralyst!” on Macintosh.

Other Neuralyst menu items do not have a correspondence through the macro interface since they use dialog boxes to interface and capture settings and parameters and there is no way to set dialog boxes from macros. However, many menu items can be simulated by writing directly to the Working Area and then using the MacroReloadNetwork command to get Neuralyst to accept the new settings.

For example, to change the row limits, write directly to the First Row and or Last Row cells in the Working Area. Let's say the First Row cell is in "R7C16" and you wish to set the value to 12, then use:

```
FORMULA(12, "R7C16")
```

Then give the MacroReloadNetwork command. (A more convenient method to reference Working Area cells is described in the next section.)

Most other parameters can be changed by this method. A useful command that is not accessible in this way is the **Set Network Size** command. **Set Network Size** opens a dialog box, fills in values, and then executes a Neuralyst DLL function to generate values to initialize the Working Area. There is no way to force this to happen from the macro interface. Fortunately, this command does not have to be given frequently. It is also not possible to call the Genetic Supervisor from the macro interface.

E.2 Referencing the Working Area

It is not convenient to count cells on each worksheet and generate "RC" references for the Neuralyst Working Area when setting parameters. Fortunately, Neuralyst provides a reference mechanism for dealing with this. The top-left corner cell of the Neuralyst Working Area is referenced by the name _NWTL as follows:

```
SET.NAME("_NWTL",TEXTREF("NETSHEET.XLS!_NWTL"))
```

Where NETSHEET.XLS is replaced by the name of your worksheet. This sets the local name, NWTL, on your macro sheet to point to the Working Area of your worksheet.

The other cells can be referenced from this location. Here is a list of offsets:

<u>Parameter</u>	<u>Offset</u>
RMS Error	OFFSET(NWTL,4,0)
Number of Data Items	OFFSET(NWTL,5,0)
Number Right	OFFSET(NWTL,6,0)

<u>Parameter</u>	<u>Offset</u>
Number Wrong	OFFSET(NWTL,7,0)
Training Epochs	OFFSET(NWTL,10,0)
Learning Rate	OFFSET(NWTL,13,0)
Momentum	OFFSET(NWTL,14,0)
Input Noise	OFFSET(NWTL,15,0)
Training Tolerance	OFFSET(NWTL,16,0)
Testing Tolerance	OFFSET(NWTL,17,0)
Epochs per Update	OFFSET(NWTL,18,0)
Epoch Limit	OFFSET(NWTL,19,0)
Time Limit	OFFSET(NWTL,20,0)
Error Limit	OFFSET(NWTL,21,0)
First Row	OFFSET(NWTL,5,4)
Last Row	OFFSET(NWTL,6,4)
Number, Of Rows	OFFSET(NWTL,7,4)
Rows/Pattern	OFFSET(NWTL,8,4)
Row, Offset	OFFSET(NWTL,9,4)
Function	OFFSET(NWTL,13,4)
Function Gain	OFFSET(NWTL,14,4)
Force Zero	OFFSET(NWTL,15,4)
FZ Threshold	OFFSET(NWTL,16,4)
Adaptive LR	OFFSET(NWTL,17,4)
Calculation Method	OFFSET(NWTL,18,4)
Scaling Margin	OFFSET(NWTL,19,4)
#Input Columns	OFFSET(NWTL,6,7)
Input Columns (list)	OFFSET(NWTL,8,7)
#Target Columns	OFFSET(NWTL,6,9)
Target Columns (list)	OFFSET(NWTL,8,9)
#Output Columns	OFFSET(NWTL,6,11)
Output Columns (list)	OFFSET(NWTL,8,11)
Mode Flag Column	OFFSET(NWTL,6,13)
Min Scale Row	OFFSET(NWTL,8,13)
Max Scale Row	OFFSET(NWTL,10,13)
Symbol Row	OFFSET(NWTL,12,13)
Generation Count	OFFSET(NWTL,24,0)
Structure Count	OFFSET(NWTL,25,0)
Least RMS Error	OFFSET(NWTL,26,0)
Least Epochs	OFFSET(NWTL,27,0)
Inclusion Rate	OFFSET(NWTL,24,4)
Max Layers	OFFSET(NWTL,25,4)

<u>Parameter</u>	<u>Offset</u>
L2 Neuron Limit	OFFSET(NWTL,26,4)
L3 Neuron Limit	OFFSET(NWTL,27,4)
L4 Neuron Limit	OFFSET(NWTL,28,4)
L5 Neuron Limit	OFFSET(NWTL,29,4)
Min Learning Rate	OFFSET(NWTL,30,4)
Max Momentum	OFFSET(NWTL,31,4)
Max Input Noise	OFFSET(NWTL,32,4)
Population Size	OFFSET(NWTL,33,4)
Population Mode	OFFSET(NWTL,34,4)
Crossovers	OFFSET(NWTL,35,4)
Mutation Rate	OFFSET(NWTL,36,4)
Fitness Criteria	OFFSET(NWTL,37,4)
Fitness Limit	OFFSET(NWTL,38,4)
Genetic State Information	OFFSET(NWTL,24,13)

By using OFFSET(NWTL,R,C) in a macro function, a reference will be returned pointing to the desired cell.

E.3 Windows DDE Interface

Neuralyst can also be controlled through external programs via DDE (Dynamic Data Exchange) on Windows. The technique is similar to using DDE to control basic Excel functions. In each case, the DDE Execute function is used. The format of a string sent using an Execute function is always:

[<Command Name>(<Arguments>)]

<Command Name> should be the name of a command to run and <Arguments> should be the arguments, separated by commas, to the command. If there are no arguments, you still need a pair of parentheses after the command name. For example:

[BEEP()]

[COLUMN.WIDTH(15)]

Neuralyst commands may be executed by using Excel's RUN function. The format is like this:

```
[RUN("NEURLYST.XLM!<Neuralyst Macro Name>")]
```

<Neuralyst Macro Name> should be replaced by one of the documented commands listed in Section E.1. As with Excel macros, not all Neuralyst commands are accessible through this interface since Neuralyst uses many dialog boxes to interface with the user. However, most functions can be simulated by writing directly to the Working Area and then using MacroReloadNetwork to get Neuralyst to accept the new values. The technique can be used with DDE just as was described above for an Excel macro.

Note that some Neuralyst commands can take a long time, particularly the MacroTrainNetwork command. Excel will not return the DDE "Acknowledge" message until the command has finished. Code which expects to receive the Acknowledge within a short time will therefore not work. However, waiting for the Acknowledge is safer since it guarantees that the command has finished.

E.4 Macintosh Apple Events Interface

It is also possible to control Neuralyst through Excel 4.0's Apple Events Interface on the Macintosh with System 7.0. For details, reference the *Microsoft Excel 4.0 Software Development Kit*.

Appendix F

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Appendix G

Trader's Macro Library

G.1 Support for Technical Analysis

One of the more popular applications for Neuralyst is investment analysis; in particular, the kind of investment analysis known as technical analysis as demonstrated in the example `DJIA.XLS` {DJIA}. Cheshire has included a Trader's Macro Library (TML) specifically designed to help you set up your Neuralyst worksheet to integrate neural network analysis and technical analysis.

[There is a vast literature on technical analysis and we will not attempt to duplicate or summarize that information here; see Section G.6 for some introductory references.]

The goal of technical analysis is to predict the future price movement of equities, futures, or other investment instruments based solely on historical price and volume data. TML recognizes and deals specifically with data designated as one of the following types: Open, High, Low, Close, Volume, and Open Interest. The first four are price-related and the last two are volume-related.

You must obtain this data for the kind of equity, future, or investment that you wish to analyze. This data may be obtained from the business section of your daily paper, computer news services (such as CompuServe or Dow Jones News Retrieval), or specialized investment data services.

Once this data is obtained, it must be entered into an Excel worksheet, organized so that the data are headed by columns labeled by one or more of the names just listed, and with the respective data for each

new day appended in succeeding rows. TML can then be used to add and format additional columns that contain technical analysis indicators selected by you and derived from the basic data.

G.2 Enabling and Disabling the Library

G.2.1 Enabling and Disabling in Windows

TML is an optional feature which can be enabled or disabled prior to the execution of Neuralyst and Excel. To use TML the first time, it must be enabled.

In order to enable TML, execute the command:

```
TMLON.EXE
```

from the Neuralyst directory while in DOS or Windows. The next time Neuralyst is loaded, there will be a new command in the **Neural** menu, **Trader's Macro Library**.

In order to disable TML, execute the command:

```
TMLOFF.EXE
```

from the Neuralyst directory while in DOS or Windows. The next time Neuralyst is loaded, the **Trader's Macro Library** command in the **Neural** menu will no longer be present.

Alternatively, renaming, moving, or deleting TML.XLM from the Neuralyst directory will disable TML. Restoring it will enable TML.

If you have re-installed Neuralyst or have installed an updated version of Neuralyst, you must give the TMLON.EXE command in order for the new version of TML to be enabled.

G.2.2 Enabling and Disabling in Macintosh

TML is an optional feature which can be enabled or disabled prior to the execution of Neuralyst and Excel. To use TML the first time, it must be enabled.

In order to enable TML change the name of the file called NoTML to TML. The next time Neuralyst is loaded, there will be a new command in the **Neural** menu, **Trader's Macro Library**.

In order to disable TML, change the name of the file called TML to NoTML. The next time Neuralyst is loaded, the **Trader's Macro Library** command in the **Neural** menu will no longer be present.

If you have re-installed Neuralyst or have installed an updated version of Neuralyst, you must be sure to remove your old TML file before you change the name of the new NoTML file to TML. This will ensure that Neuralyst uses the new version of TML.

G.3 Using the Library

All TML operations are accessed through the **Trader's Macro Library** command in the **Neural** menu.

G.3.1 Initializing the Library

If you use TML, the location of the Neuralyst Working Area is more restricted than usual. When you use TML, the Neuralyst Working Area must be to the right of your data, indicators, targets, outputs, and Mode Flag column. When TML is in operation, it will make use of some of the information kept in the Working Area and store some of its internal data there. Because of this, after you create a new worksheet that contains price data, you should perform an **Init Working Area** command prior to executing **Trader's Macro Library**.

Once the Working Area has been defined, you may add columns for indicators, targets, outputs, and Mode Flag column by using the **Edit Insert** operation from Excel if you need to make additional space. As with Neuralyst, if you insert columns after the column configuration operations have been executed, you will need to use **Edit Column Lists** to revise the column configuration.

TML requires that the data to be operated on and transformed into indicators must be in columns headed by one of the following labels: Open, High, Low, Close, Volume, or Open Interest (OI for Open

Interest also works). The values in such columns must be numeric and positive, but there is no restriction on the magnitude. Price data quoted in points ($\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$, and so on) must be converted to decimal representations first.

One or more of these columns may be designated as inputs to TML by selecting the cells containing the labels and then executing **Trader's Macro Library**. The TML dialog box will appear providing a list of TML operations; each operation is preceded by a "pushbutton" indicator. Select the **Set TML Columns** command and confirm **OK**. This will cause TML to record the column or columns and associated names for future operations.

After the columns have been set, select the rows containing price data, excluding the label for the data, and then execute **Trader's Macro Library**. The TML dialog box will appear. Select the **Set TML Rows** command and confirm **OK**. This will cause TML to record the rows containing price data for future operations.

To summarize:

1. Start by creating a new worksheet.
2. Set aside columns to be used for price data and head them with the proper labels.
3. Enter the price data in the respective columns.
4. Set aside as many other columns as may be needed to store the desired number of indicators, targets, outputs, and so on.
5. Select a blank column to the right of this area and perform an **Init Working Area** command.
6. Select the cells containing the labels for the columns containing the price data, call the **Trader's Macro Library**, and perform a **Set TML Columns** command.
7. Select the rows containing the price data, call the **Trader's Macro Library**, and perform a **Set TML Rows** command.

The worksheet is now ready for technical indicator creation by TML.

G.3.2 Creating a Technical Indicator

There are fourteen technical “indicators” supported (strictly speaking Log, Delta, and Log-Delta are not indicators). These supported indicators do not constitute a complete toolbox of technical analysis indicators; however, they are some of the most popular and useful.

All TML indicators use one or more of the price data columns defined previously. Eight of the fourteen indicators supported may derive their inputs from any valid price data column. These indicators are: Log, Delta, Log-Delta, Moving Average, Exponential Average, Moving Average Oscillator, Momentum, and Rate-of-Change (ROC). Six of the indicators supported have fixed inputs (fixed subset of Open, High, Low, Close, and Volume) required by the definition of the indicator. These are: Moving Average Convergence-Divergence (MACD), On Balance Volume, Relative Strength Index (RSI), Stochastic Oscillator, Volatility, and Williams’ Ultimate Oscillator.

Some indicators also allow the setting of one or more additional parameters. These are: Moving Average, Exponential Average, Moving Average Oscillator, Momentum, MACD, ROC, RSI, Stochastic Oscillator, Volatility, and Ultimate Oscillator. The parameters are described in the next section.

To create a technical indicator, select the column or columns that will contain the results of the technical indicator computation. Then execute **Trader’s Macro Library**. A dialog box will appear showing the available TML operations. Select one of the items from the Indicators section. If the indicator allows an input type to be selected, then a dialog box listing the possible inputs will appear; select one of these. If parameters are required to complete the definition of the indicator, then the dialog box will contain fields allowing these parameters to be set; enter the desired parameter values. If both an input type may be selected and parameters may be set, then the dialog box will have fields allowing both operations to be performed. When the necessary entries have been made, confirm **OK** to complete the operation.

TML will then create the indicator and store both the formulas and the values in the designated column or columns.

G.3.3 Technical Indicators

These indicators are described below.

Log — calculates the logarithm of each value in the column selected and places the results in the designated column.

Delta — calculates the difference between the current value and the previous value in the column selected and places the results in the designated column. The first row is blank since there is no previous value.

Log-Delta — calculates the difference between the logarithms of the current value and the previous value in the column selected and places the results in the designated column. The first row is blank since there is no previous value.

Moving Average — calculates moving average of the current and preceding values for n rows in the column selected and places the results in the designated column. The first $n-1$ rows are blank since the moving average is not defined for these rows.

Exponential Average — calculates the exponential average places the results in the designated column. The decay factor is entered as an integer so that, when the formula for the exponential average is created, it is calculated to be the corresponding fractional value which approximates the smoothing characteristics of the moving average value n . The initial value of the exponential average is set to the initial value of the input data; this causes the first $n-1$ rows to be weighted more than usual by that initial value. Because of this, you may wish to skip the first $n-1$ rows when performing your analysis.

Moving Average Convergence-Divergence (MACD) — calculates the exponential average of the difference between a fast and slow moving average using the Close column and places the results in the three designated columns. The first column contains the fast exponential average, with period f , of the Close (traditionally a period of 12 days). The second column contains the slow exponential average, with period s , of the Close (traditionally a period of 26 days). The third column contains a smoothed (another fast exponential, traditionally 9 days), with period k , difference of the first two columns. Since all

three columns are generated using exponential averages, all rows contain values in each column, however, as with all exponential averages, the initial data is more heavily weighted by early values, so it may be desirable to skip a number of rows, corresponding to the sum of the slow exponential average period and the smoothing period, $s + k$, when performing your analysis.

Moving Average Oscillator — calculates the difference between the moving average of m rows and n rows of the column selected and places the results in the designated column. The first $m-1$ or $n-1$ (whichever is greater) rows are blank since the Moving Average Oscillator is not defined for these rows.

Momentum — calculates the difference between the current value and the value n rows previous in the column selected and places the results in the designated column. The first n rows are blank since Momentum is not defined for these rows.

On Balance Volume (OBV) — calculates the accumulation or distribution of volume by adding the day's volume if it was an up day or subtracting the day's volume if it was a down day from a running total. OBV is calculated using the Close and Volume columns and the results are placed in the designated column. The first row is blank since there is no previous value.

Rate-of-Change (ROC) — calculates the ratio as a percentage of the current value and the value n rows previous in the column selected and places the results in the designated column. The first n rows are blank since the ROC is not defined for these rows.

Relative Strength Index (RSI) — calculates the RSI for period n using the High, Low and Close columns and places the results in the three designated columns. The RSI is an index computed from the ratio of the total points in up movement on closing prices divided by the total points of down movement on closing prices over the period n . The values of the up closes are copied in the first column. The values of the down closes are copied in the second column. The third column contains the computed RSI. The first $n-1$ rows of the third column are blank since the RSI is not defined for these rows.

Stochastic Oscillator — calculates the two Stochastic Oscillator values %K, of period m , and %D, of period n , using the High, Low and Close

columns and places the results in the two designated columns. The %K Stochastic Oscillator is computed by taking the difference of the most recent close from the lowest low of the last m days divided by the difference between the highest high and the lowest low of the last m days. The %D Stochastic Oscillator is the n day moving average of %K. The first $m-1$ rows of the %K column are blank since the %K Stochastic Oscillator is not defined for these rows. The first $m+n-1$ rows of the %D column are blank since the %D Stochastic Oscillator is not defined for these rows.

Volatility— calculates the Volatility for period n using the High, Low and Close columns and places the results in the two designated columns. The Volatility is an index computed from the moving average of the “true range” over the period n . The true range is defined as the greater of the difference between the High and Low of a day, the High of the day and the Close of the previous day, or the Low of the day and the Close of the previous day. The values of the true ranges are in the first column. The moving average of the true ranges are in the second column. The first row of the first column is blank since there is no previous day. The first n rows of the second column are blank since the Volatility is not defined for these rows.

Williams’ Ultimate Oscillator — calculates a weighted three period average using the High, Low, and Close columns and places the results in the three designated columns. The Ultimate Oscillator is an index computed from the difference of the day’s Close and the “true low”, this difference is then divided by the “true range”. The true low is defined as the lesser of the Low of the day or the Close of the previous day. The true range is defined as the greater of the difference between the High and Low of a day, the High of the day and the Close of the previous day, or the Low of the day and the Close of the previous day. Finally, a fast, an intermediate, and a slow period moving averages, with periods f , i , and s , are calculated from this ratio and recombined with weighting inversely proportional to the three periods. The weighting of the fast moving average is s/f , the weighting for the intermediate moving average is s/i , and the weighting of the slow moving average is 1. The first column contains the difference between the Close and the true low. The second column contains the true range. The third column contains the sum of the weighted moving averages. The first row of the first two columns is blank since there is no previous

day. The first s rows of the third column are blank since the slow moving average is not defined for those rows.

G.4 Updating Technical Indicators

Once a technical analysis application has been created and Neuralyst has been trained on the data, it will be necessary to update the price data on a regular, usually daily or weekly, basis.

One more command has been provided in TML to facilitate these operations. **Extend TML Rows** will copy the last data row, including price data, technical indicators, target formulas, output area, and Mode Flag value, into the row below it. The row information in Neuralyst and in TML will be updated to reflect this change. Once you have entered the new price data, the indicators and other formulas will be updated automatically. You can then perform a **Reload Network** to update Neuralyst and train, test, or run with the new data.

G.5 TML Error Messages

Close and Volume columns must be defined for this function.

This message appears for the **OBV** (On Balance Volume) indicator. This indicator always works with Close and Volume data. This message indicates that one or both of those columns are not yet defined. Use the **Set TML Columns** command to define the needed data columns.

Column "Open" has not been set. Please try again.
Column "High" has not been set. Please try again.
Column "Low" has not been set. Please try again.
Column "Close" has not been set. Please try again.
Column "Volume" has not been set. Please try again.
Column "Open Interest" has not been set. Please try again.

You have tried to apply an indicator to a column type which has not been defined with the **Set TML Columns** command. Try applying the indicator to a different column, or give the **Set TML Columns** command again for the column type you want.

Column heading "XXX" is not recognized, please try again.

This message appears for the **Set TML Columns** command, when one of the column headings you have selected is not in the list of headings that are recognized. Re-check your selected column headings to make sure they correspond to those allowed for this command.

High, Low, and Close columns must be defined for this function.

This message appears for the **Stochastic Oscillator, Volatility, and Williams' Ultimate Oscillator** indicators. These indicators need to have High, Low, and Close data to work with. This message indicates that one or more of those columns are not yet defined. Use the **Set TML Columns** command to define the needed data columns.

Interval must be ≥ 1 . Please try again.

This message appears for the **Momentum** and **ROC (Rate-of-change)** indicators. It indicates that the value for the Interval is invalid.

Multiple-row selection is not allowed here.

This message appears for the **Set TML Columns** command. The selection needs to be one row high and to include only the column headings. Make sure your selection is of this format, and try the command again.

Number of rows selected < longest period. Please try again.

This message appears for the **Williams' Ultimate Oscillator**. There are fewer rows selected than the longest period of the oscillator. No data can be generated under these conditions. Increase the row selection or decrease the longest period.

Only a single column may be selected here.

This message appears for several of the indicators. Most indicators produce only one column of output, and so only one column should be selected before using them.

Period [Periods] must be ≥ 1 . Please try again.

Several indicators produce this message. It indicates that one or more values specified for the periods are invalid.

Periods must be increasing. Please try again.

The **Williams' Ultimate Oscillator** indicator produces this message. It indicates that the sequence of periods set does not have increasing values.

Set TML columns first.

Set TML rows first.

These messages appear if you try to use a TML indicator before you have done both the **Set TML Columns** and the **Set TML Rows** commands. Make sure both of those commands have been given before trying to use indicators. The TML information is saved in the Working Area, so future uses of the library will re-use any row and column information you have set previously.

The Close column must be defined for this function.

This message appears for the **MACD** (Moving Average Convergence-Divergence) and **RSI** (Relative Strength Indicator). They always works with Close data. This message indicates that the Close column has not yet been defined. Use the **Set TML Columns** command to define this data column.

Three columns must be selected here.

This message appears for the **MACD** (Moving Average Convergence-Divergence), **RSI** (Relative Strength Indicator), and **Williams' Ultimate Oscillator**. These indicators use three columns for output. Make sure your selection is three columns wide and then try again.

Two columns must be selected here.

This message appears for the **Stochastic Oscillator** and **Volatility**. These indicators use two columns for output. Make sure your selection is two columns wide and then try again.

Unimplemented indicator

This message should not occur and indicates an internal problem with the TML software.

You must make a continuous selection before using this function.

This message can appear for any TML command or indicator, if you have selected a region that is not continuous before giving the command. TML can only work with continuous regions for its commands.

G.6 Technical Analysis Literature

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