Jurik Research Limited Use Software License Agreement

CONCERNING THE SOFTWARE AND DOCUMENTATION, THIS LICENSE AGREEMENT IS THE ENTIRE AGREEMENT BETWEEN JURIK RESEARCH AND YOU. IN ORDER TO HAVE COMPLETED INSTALLATION OF THIS SOFTWARE, YOU GAVE CONSENT TO BE BOUND BY THE FOLLOWING TERMS AND CONDITIONS. KEEP THIS AGREEMENT WITH YOUR PERMANENT RECORDS.

PREFACE -- This manual (the "Documentation") refers to commercial software products (the "Software") provided by Jurik Research ("JR"). This Software will not operate unless you purchase or already own a fully paid license from JR. JR licenses its use under the terms set forth herein.

LICENSE GRANT -- If you are a fully paid license holder, Jurik Research, as licensor, grants to you, and you accept, a non-exclusive license to use the enclosed program Software and accompanying Documentation, only as authorized in this agreement. You acquire no right, title or interest in or to the Documentation or Software, whose copyrights are owned by Jurik Research (JR). All rights are reserved. You agree to respect and to not remove or conceal from view any copyright notices appearing on the Software or Documentation. You may not sublicense this license. You may not rent, lease, modify, translate, disassemble, decompile, or reverse engineer the software, nor create derivative works based on the software without written permission from JR. The software may be used only on a single computer at a single location at any one time. JR permits you to make one archival copy of the software. No other copies or any portions thereof may be made by you or by any persons under your control. No part of this manual may be transmitted or reproduced in any form, by any means, for any purpose other than the purchaser's personal use without written permission of JR.

TERM -- This license is effective until terminated. You may terminate it at any time. It will also terminate upon conditions set forth elsewhere in this Agreement if you fail to comply with any term or condition of this Agreement. You agree upon such termination to destroy the Software and Documentation together with all copies, modifications and merged portions of the software expressed in any media form, including archival copies.

LIMITED WARRANTY -- The information in the user guide and on the diskette is subject to change without notice and does not represent a commitment on the part of JR. JR warrants the diskette and physical document to be free of defects in materials and workmanship. The user's sole remedy, in the event a defect is found, is that JR will replace the defective diskette or documentation. JR warrants that the Software, if properly installed and operated on software for which it is designed, will perform substantially as described in the Documentation. JR also warrants the software to be operationally compatible with the software platforms and operating systems as specified on the JR website, whose software version numbers for each relevant software product are also specified at said website. You recognize and accept that there is the possibility that a software platform developer or operating system developer may significantly change their product so as be incompatible with Jurik tools. Although JR may create a revised version of its tools to re-establish compatibility, no warranty is expressed or implied to that effect. In the case said incompatibility does occur, JR is under no obligation to provide a refund, product exchange, revision or upgrade. The above express warranty is the only warranty made by JR. It is in lieu of any other warranties, whether expressed or implied, including, but not limited to, any implied warranty of merchantability of fitness for a particular purpose. This warranty commences on the date of delivery to the Licensee and expires sixty (60) days thereafter. Any misuse or unauthorized modification of the Software will void this limited warranty. No JR dealer, distributor, agent or employee is authorized to make any modification or addition to this warranty. This warranty gives you specific legal rights, and you may have other rights that vary from state to state. Product may not be returned for a refund after warranty has expired.

LIMITATION OF LIABILITY -- Because computer software is inherently complex and may not be completely free of errors, you are advised to test the software thoroughly before relying upon it. JR will not be responsible for your failure to do so. You assume full responsibility and risk for Software installation, application and results. Do not use the Software in any case where an error may cause significant damage or injury to persons, property or business. In no event shall JR be liable for any indirect, special, incidental, tort, economic, cover, consequential, exemplary damages or other damages, regardless of type, including, without limitation, damages or costs relating to the loss of profits, business, goodwill, data, or computer programs, arising out of the use of or inability to use JR products or services, even if the company or its agent has been advised of the possibility of such damages or of any claim by any other party. JR's total liability to you or any other party for any loss or damages resulting from any claims, demands or actions arising out of or related to this agreement shall not exceed the license fee paid to JR for use of this software. Some states or provinces do not allow the exclusion or limitation of implied warranties or limitation of liability for incidental or consequential damages, so the above exclusion or limitation may not apply to you.

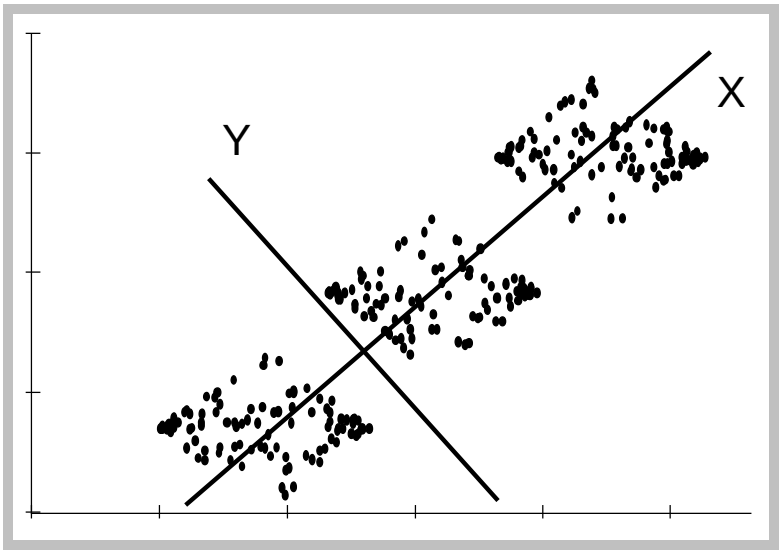
GOVERNING LAW and COST OF LITIGATION -- The license agreement shall be construed and governed in accordance with the laws of California. In any legal action regarding the subject matter hereof, venue shall be in the state of California, and the prevailing party shall be entitled to recover, in addition to any other relief granted, reasonable attorney fees and expenses of litigation. The export of JR products is governed by the U.S. Department of Commerce under the export administration regulations. It is your responsibility to comply with all such regulations.

NO WAIVER -- The failure of either party to enforce any rights granted hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights in the event of future breaches.

FEES -- A new password is required for installing Software into each additional computer. This license entitles you up to two passwords, one for each computer that you own. There is a fee for each additional password beyond the first two. Violation of this restriction is a direct copyright infringement to which Jurik Research shall seek legal remedy. Future upgrades may require a fee. Prices may change without notice.

DDR 2.2

Decorrelator and Dimension Reducer
DLL module
for Windows® Application Developers



USER'S GUIDE

Requirements

- Windows 98, 2000, NT4 or XP.
- Application software that can access DLL functions.

 Jurik Research & Consulting PO 460669, Aurora, CO 80046 303-680-4409 fax: 303-680-4605

Installing the 32 bit DLL module

1. Execute the Installer, JRS_DLL.EXE. It will analyze your computer and give you a computer identification number. Write it down.
2. Get your access PASSWORD from Jurik Research Software. You can do so by calling 323-258-4860 (USA), faxing 323-258-0598 (USA), e-mailing support@nfsmith.net, or writing Jurik Research Software at 686 South Arroyo Parkway, Suite 237, Pasadena, California 91105. Be sure to give your full name, mailing address and computer identification number. You will then be given a password.
3. Rerun the installer JRS_DLL.EXE, this time entering the password when asked. Also enter **all the Jurik Research modules that you currently are licensed to run**. It will copy the latest version of these modules to any directory you specify.

You may now code your software to access the DLL as described on the following pages. First, read the important notices below.

!! IMPORTANT !!

ABOUT PASSWORDS

And what to do when they become invalid

If you upgrade to a new computer, or significantly upgrade your existing computer (such as flash a new BIOS), you should reinstall DDR and all other Jurik tools that are licensed for your computer. The installer will let you know if your current password is no longer valid. Also, if you want to run DDR on additional computers, you will need additional passwords. For new or replacement passwords, call 323-258-4860

ABOUT DATA VALIDITY

And what to do when DDR encounters an error

When DDR encounters a problem, (e.g. the password used during installation has become invalid), DDR will continue to run but the data produced will not be valid. To let you know this is the case, DDR will return an appropriate error code, bit it will NOT post any warning message on your monitor. Therefore …

Do not assume DDR will always smooth your data. You must validate DDR's output by CHECKING THE RETURN ERROR CODE immediately after each call to DDR.

Why use **DDR ?**

The DATA DECORRELATOR by Jurik Research

Brief Description

If you are building a model whereby each data record contains numerous input (independent) variables and you can arrange the records as rows in a spreadsheet, then **DDR** is for you. On the same or another spreadsheet, DDR creates a new data set, arranged in the same number of rows and columns as the original data set, but with two important differences:

- All the columns are decorrelated.
- All the columns are ranked according to the strength of their information content.

This helps models in two ways:

- Models learn faster with decorrelated variables than correlated ones.
- Models learn faster when uninformative input variables are deleted.

Why Decorrelate and Reduce?

Knowing the future sure has its advantages, especially where making a profit is concerned. This is understood most clearly in financial exchanges where competing traders speculate on the rise and fall of market prices. Successful traders have several traits in common, and probably most important is knowing where to look for good information. They know that even the best forecast models are useless if the chosen indicators are not relevant.

Collecting Relevant Indicators - When an aspiring forecaster has no idea which indicators to use, he usually constructs models by feeding them lots of data, data that might have any relation to the desired forecast. For example, a model intended to forecast gold prices might be fed historical precious metal prices as well as estimates of its future supply and demand. Since gold is used a lot in jewelry, and its demand is a function of the public's perceived ability to buy jewelry, then additional indicators for the model may include estimates of the consumer confidence index and related indices. This collection of indicators could swell very quickly.

A Well Kept Secret - Suppose your model's input consists of 100 different indicators. Most beginners think that regression models receiving a large number of indicators will perform better than models receiving a small number. Surprisingly, smaller regression models frequently outperform larger ones! The statistical world refers to this counter-intuitive behavior as the "phenomenon of multi-colinearity". It says that models prefer uncorrelated indicators, and that feeding a large number of *mutually correlated* indicators to a model typically DEGRADES its performance.

The Secret Explained - To understand the "phenomenon of multi-colinearity", let's suppose we have some data records arranged as rows, with each record containing a few input variables. For each record, we also have the target output value. As an example, the input variables could be a person's height, weight, and shoe size; the target value could be the person's life expectancy. We would like a regression model that provides us with coefficients for calculating target values (life expectancy) from the corresponding input variables (height, weight and shoe size).

Recalling high school algebra, a model with fewer records than variables is "**under**constrained", resulting in not one but an infinite number of sets of coefficients. Although each set would correctly calculate the target values, they may all produce different answers on new input data! This would be unacceptable.

In contrast, the more likely case in the real world is to have more records than variables. Models based on such data are *typically* "**over**constrained" whereby no set of coefficients can deliver a perfect answer for every record. In such a case, we must simply accept a set of coefficients that offer performance with low overall error, usually a set delivering least mean square error. Standard regression, like the one embedded into Microsoft Excel, is designed to deliver least mean square error between a model's output and true target values.

The second sentence in the preceding paragraph is very important. The key word is "typically" because databases with lots of records can still be **under**constrained, or very nearly so. This situation occurs when at least one input variable can be closely approximated by other input variables. For example, suppose the illustrated table is a collection of five records (rows), each with three input variables and one target value. Now suppose that for any record in this database, a regression model can determine the target by multiplying the three input variables with coefficients (1, 3, -2) respect-ively.

A	B	C	Target
1.2	3.4	4.6	2.2
0.9	2.2	3.1	1.3
1.8	1.5	3.3	-0.3
2.5	2.7	5.2	0.2
2.1	1.9	4	-0.2

Let's see if this is true. In the first row, input data A=1.2, B=3.4 and C=4.6.

Model's Output	= 1 x A	+	3 x B	+	-2 x C
	= 1 x 1.2	+	3 x 3.4	+	-2 x 4.6
	= 1.2	+	10.2	+	-9.2
	= 2.2				

The model's output matches the target value of 2.2. The coefficients (1, 3, -2) work just as flawlessly for the other four records. One might believe, then, that these are the best coefficients for the model. They are not! Amazing at it may seem, there are an infinite number of equally good coefficient sets to this modeling problem. Some other equally good sets are (-1, 1, 0) and (0, 2, -1) and (3, 5, -4) and (7000, 7002, -7001)!

This is bad news. To see why, let's compare the performance of a model using coefficients (7000, 7002, -7001) and a model using (-1, 1, 0). The input data to both models will be a slightly modified version of record #1 in the example database: A=1.2, B=3.4, C=5. Multiplying the input data by coefficients (-1, 1, 0) produces the output value 2.2. However, multiplying the input data by coefficients (7000, 7002, -7001) produces the output -2798.2!! Although both coefficient sets produced identical results with the original database, they also produced drastically different results with new data. This is simply unacceptable.

The reason why this amazing experiment was possible is because column C of the database does not represent a truly "independent" variable. In fact, each value in column C could be calculated by adding the corresponding values in columns A and B. Simply put, C = A + B. As a rule of thumb, interdependence among input variables seriously degrades the ability of regression models (including neural nets) to perform reliably with new data.

What is even more disheartening is that similar damaging effects would occur even if column C was simply *correlated* to the sum of A+B! The greater the correlation, the more pronounced the effects. This is why you should consider giving models decorrelated input variables. It minimizes a model's divergent response to new data.

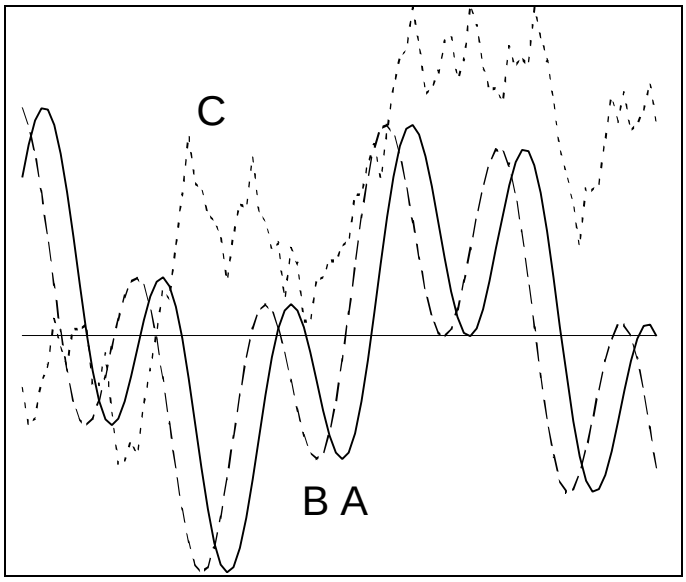
The Bad News - Unfortunately, financial indicators are highly correlated with each other, causing much frustration among those trying to model market behavior. This phenomenon forces all modelers to consider trying various combinations of two or more input variables until the best combination is found. Do you know how many possible combinations you can have with 100 indicators? About 10^{30}, equivalent to 100,000 times the number of atoms in a liter of water! Even with just ten indicators, there are over one thousand combinations to try! Yes, over ONE THOUSAND. Examining the effectiveness of all these combinations could take you a very, very long time!

Cutting Corners - Some modeling tools try to get around this problem by performing correlation analysis between pairs of input variables. This practice is based on the assumption that if two variables are correlated, then you do not need both, and so one of them can be eliminated. This popular practice can easily lead to a dead end. Here's a simple example to illustrate why. Suppose your input consists of three time-series:

A) the daily high tide level near San Francisco,
B) the daily high tide level near Los Angeles,
C) the price of apples in China.

Since signals A and B are very similar, (and therefore highly correlated), one might be tempted to eliminate either one from the set of inputs to the model. But if you do, then the model could never create desired output signal D if its formula is D = A - B. In other words, a model can only calculate (A minus B) when both A and B are present! Therefore removing inputs on the basis of correlation can leave you with insufficient data and a non-working model.

Is there a better way to reduce the number of inputs to a model? YES! Professional forecasters have better ways to reduce the number of input variables and large companies can afford to pay their fees.



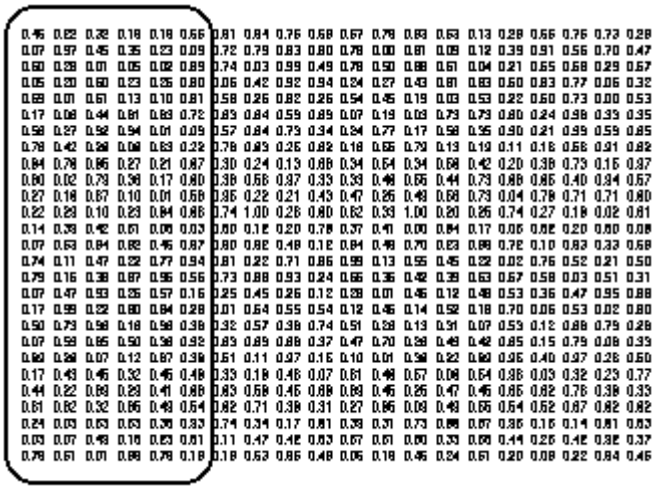
This put individuals at a disadvantage. Until now, that is. With DDR, you now have access to the same powerful technique used by professional forecasters.

Suppose you arrange your model's data so that each indicator fills a separate column and each data case fills a separate row. DDR will take your data, and produce a new data array the same size as the old but with two important differences. (See illustration on the right.)

First, ***all the new columns will be completely uncorrelated with each other!*** This will very likely enhance a model's performance.

Secondly, DDR ranks the new columns according to how well they explain all the input data. DDR typically ***boils down 50 correlated indicators to only 14 with very little loss of information!*** This ranking helps you decide which columns to throw away, giving you additional room to employ more of your favorite indicators!

20 Columns of Data, Ranked and Decorrelated:

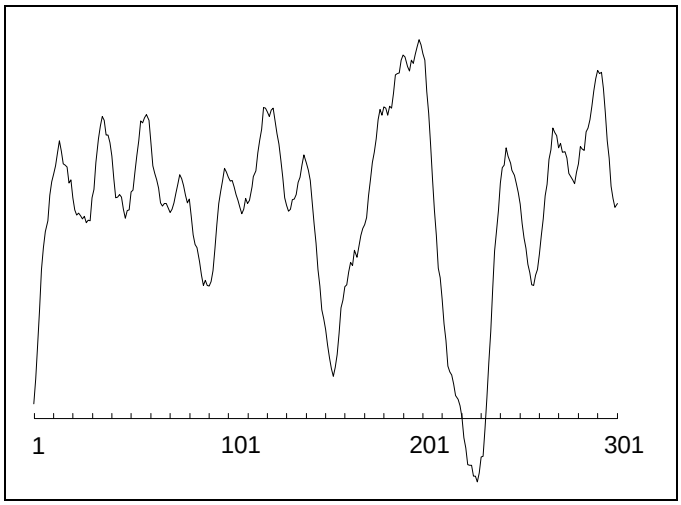


You may keep these 5 columns

and discard these 15 columns

As depicted in the sample spreadsheet, the user may discover that the first five decorrelated columns contain almost all the information offered by the entire array, allowing the other 15 columns to be discarded.

To demonstrate the power of DDR, we prepared three models to forecast future values of a simulated financial time series. This time series consisted of three kinds of market forces: periodic cycles, aperiodic chaos, and random impulses. It is a composite of sinusoidal curves, the famous Mackey-Glass chaotic time series and Brownian noise. A small portion is illustrated on the left.



For all three models, data consisted of 1500 cases (rows) wherein each case contained 21 independent variables (columns) and a single forecast 10 bars into the future. The variables included past values of the time series as well as moving average values and other relevant indicators. The first model utilized the popular linear regression method. The second model was a neural network trained on the same data. For the third model, we had DDR decorrelate the data. We then trained the neural net on o*nly the first **five** columns* of DDR's output.

The results were astounding: the table on the right shows each model's average forecast error. Standard regression on all 21 variables gave an average percentage error more than twice as large as a neural net using the same data. However, after using DDR, the neural net only needed the first 5 columns to produce equivalent performance! DDR puts the secret of professional forecasting in your hands!

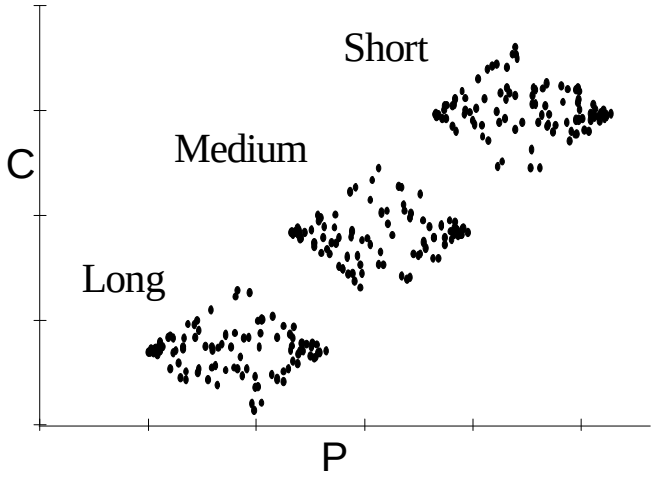
	Error
Model #1	
Simple Regression on 21 columns of original data	15.0%
Model #2	
Neural Net on 21 columns of original data	6.4%
Model #3	
Neural Net on 5 columns produced by DDR	6.4%

(The following section is optional. You may skip this section and proceed to "Installing the 32 bit modules")

The Theoretical Basis of DDR

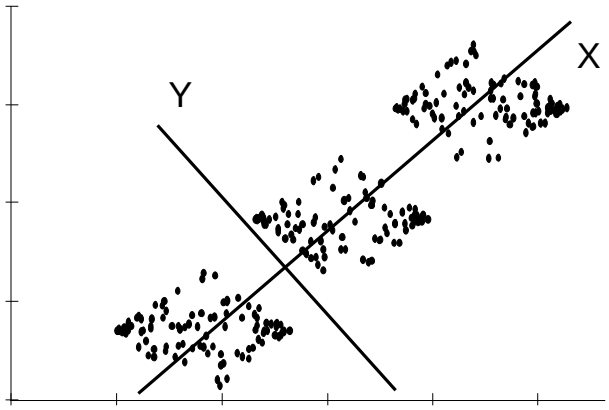
It may seem like magic that in most cases, models based on just a few of the new columns created by DDR perform just as well as models using all the original data! This is not an illusion; it is based on sound principles in mathematics. Consider the following example.

Suppose a long term medical research study measured blood pressure and cholesterol levels on 1,000 people and later recorded their age at death. Points in the figure represent data records, with axis P for pressure and C for cholesterol. The plot reveals three distinct groups, each group having a unique life expectancy.



The plot also shows that you can not use just blood pressure readings or just cholesterol readings to distinguish which group any point would belong. This is because some neighboring groups overlap and share similar blood pressure measurements. Other points overlap and share similar cholesterol measurements. Therefore both are required to determine which group a point belongs.

We might also conclude that if an insurance company built a complex model that needed estimates on life expectancy, the model would also need both measurements. However, models typically perform better with a few key variables than a broad spectrum of many variables. So would it be possible to combine the measurements of blood pressure and cholesterol into one variable that can successfully discriminate among the three life expectancy groups?



The adjacent figure shows one way to do this is. Two new axes are made: X and Y. Axis X travels through the centers of the three groups and axis Y lies perpendicular to X. We can now represent each point in the graph by giving either its P-C coordinates or its X-Y coordinates. The advantage to using these X-Y coordinates is that only the X axis serves to determine which life expectancy group a point belongs. The Y axis value serves no purpose. Therefore, concerning the life insurance model, we can represent information on forecasted life expectancy with only one variable, X, instead of both P and C.

In summary, DDR views each column of the original data as a separate axis, so that 21 columns represent 21 axes. DDR then creates a new set of axes and uses them to evaluate each point's new set of coordinates. DDR chooses the new axes so as to attain all the desirable properties mentioned in the beginning of this manual.

Coding Applications

The DLL file contains two versions of DDR.

The **BATCH MODE** version accepts an entire array of input data and returns results into another array. This method requires ther user provide the DLL function with pointers to two arrays. This version is ideal when an entire array is available for processing with only one call to DDR.

The **REAL TIME** version accepts one record (eg. spreadsheet row) of input data returns one same size record as a result. DDR is called for each successive record in some arbitrary time series. This approach is ideal for processing real time data, whereby the user wants an instant DDR update as each new data record arrives.

The following pages cover the following applications of DDR:

- C code -- instructions and example for batch mode and real-time update
- Visual Basic -- instructions and example for batch mode and real-time update

---

Dynamic Linking

Load Time Dynamic Linking (Microsoft Compilers)

For load-time dynamic linking, you must use the LIB file JRS_32.LIB, located at C:\JRS_DLL\LIB (or on whichever drive you specified during installation). With load-time dynamic linking, the Jurik DLL is loaded into memory when the user's EXE is loaded.

Load Time Dynamic Linking (non-Microsoft Compilers)

The LIB file we provide will only work with the MS Visual C/C++ compiler. For C/C++ users with non-Microsoft compilers, you will probably not be able to use the LIB file we have provided for Load Time Dynamic Linking with our DLL functions. You have two choices. 1) Consult your compilers' documentation to determine how to construct a LIB file from a DLL. For instance, Borland's compiler includes the IMPLIB.EXE utility to accomplish this. 2) Use run-time dynamic linking (described below). A LIB file is not required for this method.

Run Time Dynamic Linking

You may prefer to use run-time dynamic linking instead of load-time. For example, users of Microsoft Visual C may wish to prevent the Jurik DLL from automatically loading along with the user's EXE. With run-time, the DLL is loaded only when the user's EXE specifically calls for it to be loaded with the LoadLibrary function. Another reason for prefering run-time is that the user has a non-Microsoft compiler, and therefore, cannot use the LIB file provided.

For new C/C++ users, we provide sample C files which demonstrate how to accomplish run-time dynamic linking. The sample files are located in the folder C:\JRS_DLL\RUNTIME (or on whichever drive you specified during installation).

C Programming the 32 bit DDR DLL

The file **JRS_32.DLL** contains the functions “DDR” and “DDRUpdate”. In your C code, you should declare both functions as externally defined and, if using MS VC++, use the _declspec(dllimport) keywords. The function is exported as a C function, so if you are using C++, you should insert "C" (with the quotes) between the words "extern" and "_declspec". Also, you should link with JRS_32.LIB, which we provide.

DDR module

```
extern _declspec(dllimport) int WINAPI DDR( double * pDataRef, double * pOutRef,
      DWORD dwRows, DWORD dwCols, double * pdContrib, LPSTR szFileName ) ;
```

PARAMETERS

pDataRef, a pointer to double indicating memory space containing the matrix of raw data to be processed.

pOutRef, a pointer to double indicating memory space in which the matrix of decorrelated data will be placed. The memory space must be allocated by the caller, and it must be exactly the same size as the memory space containing the input data.

dwRows is a DWORD indicating the number of rows of data in the input matrix.

dwCols is a DWORD indicating the number of columns of data in the input matrix.

pdContrib is a pointer to an array of doubles which will hold values indicating the relative contribution of each output column. This memory space must be allocated by the caller and it should be large enough to hold as many double precision numbers as there are columns of output data (same number of columns as the input data).

szFileName is a pointer to a string indicating the name for the coefficient file required to obtain update values. If the user does not wish to create a coefficient file, he may pass a NULL instead.

NOTES

Both DDR and DDRUpdate can encounter problems. They will return error values indicating the nature of the error. The error codes are defined for both functions on the next page.

Note that DDR must be called with at least 2 columns of data with at least 3 rows.

The input and output arrays must be the same size.

DDRUpdate module

```
extern __declspec(dllimport) int WINAPI DDRUpdate( LPSTR szFileName,
     double * pdResult, double * pdNewData, DWORD dwColumn, DWORD dwCols ) ;
```

PARAMETERS

szFileName a pointer to a string consisting of the path and name of the coefficient file to be opened for updates.

pdResult a pointer to a double value into which the update result will be placed.

pdNewData a pointer to an array of double values which contain the row of data required to create an update.

dwColumn a DWORD indicating which column of DDR's output is being updated. The first column is column 0.

dwCols a DWORD indicating how many columns there are in a row of data.

RETURN VALUES - Error Codes

Both **DDR** and **DDRUpdate** can encounter problems. They will return error values indicating the nature of the error; the following error codes are defined for both functions:

0	NO errors
1	Out of memory condition
2	DLL Not properly installed
3	DDR called with NULL data pointer
4	DDR called with NULL output pointer
5	DDR called with NULL contribution pointer
6	There must be more than one column of data to be decorrelated
7	There must be at least 3 rows of data to be decorrelated
8	Couldn't create coefficient file
9	DDR could not converge, data already decorrelated
10	DDR could not write coefficient file
11	DDR could not open coefficient file
12	DDR could not read coefficient file
13	Number of columns in coefficient file don't match update request

C Programming example

```
rows   = 2500;
cols   = 15;
InPtr  = (double *) GlobalAllocPtr( GHND, sizeof(double) * length * width);
OutPtr = (double *) GlobalAllocPtr( GHND, sizeof(double) * length * width);
ValPtr = (double *) GlobalAllocPtr( GHND, sizeof(double) * width);

/* At this location, check that memory was actually allocated,
     and then put your data into the input array. */

err_code = DDR( Inptr, OutPtr, rows, cols, ValPtr, "C:\MyDir\MyFile.ddr" );

// check value of err_code and handle errors

/* To use your new decorrelation matrix, provide DDRUpdate with a
     row of data and it will return user-selected elements from the
     decorrelated version of that row. */

InRowPtr  = (double *) GlobalAllocPtr( GHND, sizeof(double) * width);
OutRowPtr = (double *) GlobalAllocPtr( GHND, sizeof(double) * width);

/* To use your new decorrelation matrix, provide DDRUpdate with a
     row of data pointed to by InRowPtr.  DDRUpdate will decorrelate the  row
and return one row element, specified by OutColNum. */

for( OutColNum=0; OutColNum < cols; OutColNum++ )
{
     err_code = DDRUpdate( "C:\MyDir\MyFile.ddr", OutRowPtr + OutColNum,
                InRowPtr,  OutColNum, cols) ;
     // check value of err_code and handle errors
}
```

Visual Basic example of DDR and DDRupdate

INTRODUCTION

In your Jurik Research DLL installation directory (e.g., C:\JRS_DLL) the workbook DDR_DLL.XLS contains a programming example using Excel's VBA to call functions **DDR** and **DDRupdate**. The workbook includes a worksheet where you can run the macro **DDR_Test** to run both functions.

In this example, run the VBA macro called "**DDR_Test**". It will produce a decorrelated matrix two ways: The entire matrix all at once, and then row-by-row.

VBA MACRO DESCRIPTION

The macro **DDR_Test** calls the functions **DDR** and **DDRupdate**, which are declared as shown below. Note that the input and output arrays (pDataRef and pOutRef) are called by reference using "ByRef". This enables the calling statement to send to **DDR** a pointer to the first element of each data array.

```
Declare Function DDR Lib "JRS_32.dll" (   ByRef pDataRef As Double, _
                                          ByRef pOutRef As Double, _
                                          ByVal dwRows As Long, _
                                          ByVal dwCols As Long, _
                                          ByRef pdContrib As Double, _
                                          ByVal szFileName As String) As Long


Declare Function DDRUpdate Lib "JRS_32.dll" (   ByVal szCofsFileName As String, _
                                                ByRef pdResult As Double, _
                                                ByRef pdNewData As Double, _
                                                ByVal dwColumn As Long, _
                                                ByVal dwCols As Long) As Long
```

The VBA subroutine **DDR_Test** is shown on the next page. This code will read data an array of data, rearrange the data into 1-dimensional arrays, call the DLL function **DDR**, and output its results back to the worksheet in the form of another array. Also, now that **DDR** has created the translation coefficient file, **DDRupdate** is called on the same data, to produce the same results, iteratively, row by row.

Note that the code calls a local subroutine "**Error_handler**". If an error condition exists, the subroutine posts a message on the screen (because DDR itself does not) and then halts the program.

```
Sub DDR_test()

    Dim error_val As Long
    Dim CoefFile As String
    Dim calctype As Long

   ' In this example, input array has 15 rows, 3 columns.

    Const TotalRows = 15
    Const TotalCols = 3

    CoefFile = "C:\MyDir\My File.ddr"

   'disable automatic calculation and screen update
    calctype = Application.Calculation
    Application.Calculation = xlManual
    Application.ScreenUpdating = False

    ' The data must be rearranged as one-dimensional arrays,
    ' because VBA stores arrays in memory in column order, while
    ' programs written in C store them in row order.

    Dim InputData(1 To TotalRows * TotalCols) As Double
    Dim OutputData(1 To TotalRows * TotalCols) As Double
    Dim Contrib(1 To TotalCols) As Double

    ' Place values from spreadsheet into InputData array.
    ' Data begins in row 3 column 1

    For j = 1 To TotalCols
        For k = 1 To TotalRows
            InputData((k - 1) * TotalCols + j) = Cells(k + 2, j)
        Next k
    Next j

    ' Create DDR coefficient matrix file and process data in the
    ' entire input array, placing results into output array.

    error_val = DDR(InputData(1), OutputData(1), TotalRows, _
        TotalCols, Contrib(1), CoefFile)

    If (error_val) Then
        Call Error_handler(error_val, calctype)
    End If

    ' Put DDR's contribution row into worksheet beginning at row 2 column 5

    For k = 1 To TotalCols
        Cells(2, k + 4).FormulaR1C1 = Contrib(k)
    Next k

    ' Put DDR's output array into worksheet beginning at row 3 column 5
    For j = 1 To TotalCols
        For k = 1 To TotalRows
            Cells(k + 2, j + 4).FormulaR1C1 = OutputData((k - 1) * TotalCols + j)
        Next k
    Next j

    Dim InputRow(1 To TotalCols) As Double
    Dim OutputVal As Double
```

```
 ' The test below feeds DDRUpdate() the input data array, InputData, one row at a time
 ' and calculates the decorrelated values, putting them into the spreadsheet so that
 ' they may be compared with the values calculated by DDR(). They should be equal.

    For j = 1 To TotalRows

        ' First, copy a row of elements from the array InputData to InputRow.

        For k = 1 To TotalCols
            InputRow(k) = InputData((j - 1) * TotalCols + k)
        Next k

        ' Next, feed the row to DDRUpdate.
        '
        ' Note that the fourth input parameter to DDRUpdate uses k-1 instead
        ' of k because DDRUpdate uses array indices that start at zero.
        ' Cells indices are adjusted for proper placement on the spreadsheet.

        ' Normally, new data not used in generating the coefficient file would be
        ' fed to DDRUpdate.  This permits DDRUpdate to decorrelate new rows in real
        ' time.

        For k = 1 To TotalCols
            error_val = DDRUpdate(CoefFile, OutputVal, InputRow(1), k - 1, TotalCols)
            If (error_val) Then
                Call Error_handler(error_val, calctype)
            End If
            Cells(j + 2, k + 8).FormulaR1C1 = OutputVal
        Next k
    Next j

    Application.ScreenUpdating = True
    Application.Calculation = calctype

End Sub
```

```
' The following subroutine is a simple way to handle run-time errors that may occur
' It's good practice to handle each error type mentioned in the user manual.

Private Sub Error_handler(ByVal error_code As Long, ByVal calctype As Long)
    Dim result As Long
    result = MsgBox("Error number " & Str(error_code) &
                    " was returned by DDR.", , "DDR Error")
    Application.Calculation = calctype
    End   ' this END command will halt execution of the VBA code.
End Sub
```

IF YOU FIND A BUG . . . YOU WIN

If you discover a legitimate bug in any of our preprocessing tools, please let us know! We will try to verify it on the spot. If you are the first to report it to us, you will receive the following two coupons redeemable toward your acquisition of any of our preprocessing tools:

- a $50 discount coupon
- a free upgrade coupon

You may collect as many coupons as you can.
You may apply more than one discount coupon toward the purchase of your next tool.

$$$ Anti-Piracy Reward Policy $$$

Jurik tools are world renown for excellence and value. We manage to keep costs down with large sales volume, maintained in part by protecting our copyrights with the following anti-piracy policy…

1. We have on permanent retainer one of the best intellectual property law firms in the U.S.
2. We do not perform cost-benefit analysis when it comes to litigation. We prosecute all offenders.
3. We register portions of our software with the U.S. Copyright office, entitling us to demand the offender compensate Jurik Research for all legal costs, which is typically over $10,000 per lawsuit.
4. We offer up to $5000 reward for information leading to the prosecution of any offender(s).

Risk & Liability

Hypothetical or simulated performance results have certain inherent limitations. Simulated performance is subject to the fact that they are designed with the benefit of hindsight.

We must also state here that, due to the frequently unpredictable nature of the marketplace, past performance of any trading system is never a guarantee of future performance. In addition, all trading systems have risk and commodities trading leverages that risk. We advise you never to place at risk more than you can afford to lose. It's only common sense.

The user is advised to test the software thoroughly before relying upon it. The user agrees to assume the entire risk of using the software. In no event shall JRC be responsible for any special, consequential, actual or other damages, regardless of type, and any lost profit resulting from the use of this software.