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Appendix B – User Manual

User manual for IDENT, a parametric and nonparametric linear systems identification package

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INTRODUCTION

This document is intended to provide a first time user of IDENT with tutorials on the usage of the program. The user should be familiar with the theoretical aspects of linear system identification. The Box and Jenkins (1976) Time Series Analysis is probably the best first reference. Following are explanations of each command (generated by IDENT), and examples of each command.

IDENT uses 2 types of input files. One type contains the input and output data to be analyzed. The other type contains commands with which the program may be run automatically. It has been the experience of this laboratory that the automatic mode of running IDENT is the only one used. Usually, one wants to estimate and evaulate several models before choosing a model structure. On an LSI-11, the time involved in such an effort is considerable, so that modeling was often done in an overnight run of IDENT.

COMMAND NUMBER 1

IDENTIFICATION OF THE OUTPUT ARRAY

FUNCTION OF THE COMMAND:

This command results in a univariate analysis of some fraction of the possibly detrended or differenced output data array.

See the comments about command 8 for details concerning the establishment of the data case range, for setting up the differencing factor, and for control over whether the data are detrended.

UNIVARIATE ANALYSIS:

The following statistics are calculated in a univariate analysis:

1 Mean

2 Variance

3 Normalized Autocovariance function lags

4 Partial Autocorrelaation lags

5 Durbin Watson Statistic

6 Q10 Statistic = sum of the first 10 squared normalized autocovariance function lags

7 Q20 Statistic = sum of the first 20 squared normalized autocovariance function lags

8 Q35 Statistic = sum of the first 35 squared normalized autocovariance function lags

9 Univariate spectrum

COMMAND OUTPUT

The output has the following appearance:

1 The mean and variance are printed.

2 A plot of a specified number (see below) of normalized autocovariance function lags is next. These values fall in the range of -1 to 1. The actual values are also printed on the left.

3 A plot of a specified number (see below) of partial autocorrelation function lags follows. These values also fit in the range of -1 to 1. The actual values are printed on the left.

4 The Durbin Watson statistic is printed.

5 The degrees of freedom for the Q statistics are shown.

6 The p = .05 levels for the Q statistics are next.

7 The p = .10 levels for the Q statistics follow.

8 The actual Q statistics follow.

9 A plot of the univariate spectrum is shown with the actual values on the left side.

USER CONTROL OVER THE COMMAND

The user is not required to enter any input.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The NA operation parameter controls the number of normalized autocovariance lags plotted. It has a default value of 10.

The NP operation parameter controls the number of partial autocorrelation lags plotted. It has a default value of 10.

The KSAMP operation parameter is the resampling factor. The user can control the upper frequency of the spectral plots with this parameter. It can take on the values 1, 2, 4, or 8 corresponding to the entire, half, fourth, or eighth of the Nyquist frequency (1/2 the sampling rate. It has a default value of 8.

The lag window operation parameter, LAG, controls the size of the lag window used in the smoothing of the spectrum. It may take on the values 1 or 2, corresponding to a window length of 1/2 or 1/4 the array size. A smoother spectral estimate will result with a value of 2. It has a default value of 1.

Example of command 1

```
1

 *********IDENTIFICATION OF OUTPUT ARRAY**********


MEAN=    -0.00000 VARIANCE=     4.36856


-AUTOCORRELATIONS-


LAG     VALUE    -1                     0                    +1
                  ---------------------+---------------------
  1     0.9596                         I                    *
  2     0.9429                         I                    *
  3     0.9130                         I                   *
  4     0.8809                         I                   *
  5     0.8490                         I                  *
  6     0.8062                         I                 *
  7     0.7598                         I                *
  8     0.7139                         I               *
  9     0.6654                         I              *
 10     0.6212                         I             *
-PARTIAL AUTOCORRELATIONS-


LAG     VALUE    -1                     0                    +1
                  ---------------------+---------------------
  1     0.9596                         I                    *
  2     0.2787                         I      *
  3    -0.0983                       * I
  4    -0.1197                       * I
  5    -0.0378                        *I
  6    -0.1533                      *  I
  7    -0.1515                      *  I
  8    -0.0358                        *I
  9    -0.0228                         *
 10     0.0363                         I*

DURBIN-WATSON STATISTIC =         0.07492

              Q10           Q20          Q35

DEG. FREED.    7            17            32
.05 LEVELS 14.1           27.6          46.2
.10 LEVELS 12.0           24.8          42.6
ACTUAL   2098.9         2628.6        2751.9


SPECTRUM

J    DENSITY
                ---------------------+--------------------
  0   148.0702  ******************************************
  1   140.1490  ****************************************
  2   118.9074  **********************************
  3    92.2721  **************************
  4    70.7658  ********************
  5    60.1605  *****************
  6    58.2954  ****************
  7    60.7174  *****************
  8    65.2456  ******************
  9    68.5665  *******************
 10    63.9055  ******************
 11    48.1959  *************
 12    28.4962  ********
 13    15.6953  ****
 14    13.0051  ****
 15    15.2466  ****
 16    17.0362  *****
 17    17.0806  *****
 18    15.1837  ****
 19    11.0299  ***
 20     5.9746  **
 21     2.7434  *
 22     1.6728  *
 23     1.3726  *
 24     0.5123  *
 25     0.6057  *
 26     0.4505  *
 27     0.8177  *
 28     0.3887  *
 29     0.7360  *
 30     0.8169  *
 31     1.1737  *

    1.56250 HZ


COMMAND:
```

COMMAND NUMBER 2

PARAMETER ESTIMATION

FUNCTION OF THE COMMAND:

This command results in the estimation of parameters of a specified model structure based on some fraction of the possibly detrended or differenced output and input data.

See the comments about command 8 for details concerning the establishment of the data case range, for setting up the differencing factor, and for control over whether the data are detrended.

In order to be able later to do a complete evaluation of a transfer function model, a 6 command should be done prior to a parameter estimation so that a prewhitened input series is available .(see comments under command 6 and command 3.) A prewhitened input cannot be obtained after a parameter estimation without destroying the parameter estimates.

COMMAND OUTPUT

The output has the following appearance:

1 The deadtime factor (the number of data points the output is assumed to be lagging the input) is printed.

2 The model orders are printed with abbreviated labels:
a) TFN = transfer function numerator
b) TFD = transfer function denominator = noise
c) NN noise model numerator
d) ND = noise model denominator

3 For each iteration, the parameter estimates are written in the order: TFN, TFD, NN, ND.

4 At the last iteration, standard deviations of the parameter estimates and the stochastic approximation estimate of the residual variance are written.

USER CONTROL OVER THE COMMAND

The model orders (transfer function poles, transfer function zeros, noise model poles, noise model zeros) and deadtime factor must be supplied from a command file or in response to the queries:

ENTER ORDERS: TFP, TFZ, NP, NZ

ENTER DEADTIME FACTOR:

Positive integers should be entered. Any of these orders may be zero to result in the estimation of a subset of a transfer function plus noise model. If TFP is 0 and TFZ is -1, then the parameters of a univariate ARIMA model are estimated.

Example of command 2

```
2

     **********MODEL PARAMETER ESTIMATION**********

 ENTER ORDERS: TFP,TFZ,NP,NZ 1,0,1,2
 ENTER DELAY FACTOR4
THE DEADTIME FACTOR =  4

 NUMBER OF PARAMETERS:TFN: 1 TFD: 0 NN: 2 ND: 1

ITERATION          PARAMETERS

       0 -0.11414  -0.23169  -0.06846   0.09905   0.97256
       1 -0.03937  -0.46698   0.19644   0.04431   0.97729
       2 -0.02809  -0.19657  -0.09644   0.11396   0.97763
       3 -0.00855   0.03256  -0.33474   0.18244   0.97814
       4  0.00780   0.25573  -0.56264   0.24232   0.97842
       5  0.02352   0.52625  -0.83591   0.31313   0.97737
       6  0.04611   0.73623  -1.05175   0.36893   0.97442
       7  0.06599   0.85461  -1.17670   0.39213   0.96910
       8  0.07748   0.89334  -1.22098   0.39637   0.96329
       9  0.08316   0.90675  -1.23752   0.39711   0.95752
      10  0.08620   0.91248  -1.24473   0.39723   0.95200

ESTIMATED STANDARD DEVIATIONS:
STD DEV.     0.01154    0.01994    0.02549    0.01893    0.00737

THE RECURSIVELY ESTIMATED RESIDUAL VARIANCE=     0.24715

 COMMAND:
```

COMMAND NUMBER 3

MODEL EVALUATION

FUNCTION OF THE COMMAND:

In the evaluation of a general transfer function plus noise model, the following computations are performed:

1 Calculation of residual series

2 Univariate analysis of the residuals

3 A specified number of cross correlation lags between the residual and prewhitened input are calculated.

4 S11 statistic = the first 11 squared normalized cross correlations summed

5 S21 statistic = the sum of the first 21 squared normalized cross correlations

6 S36 statistic = the sum of the first 36 squared normalized cross correlations

7 The parametric transfer function

8 The signal variance = variance of the parametric transfer functtion

9 The noise variance = variance of the parametric noise model

10 The signal variance to noise variance ratio

11 Poles and zeros of the parametric transfer function and noise model

If the model being evaluated is a univariate one (noise model only), then steps 3,4,5,6, 7,8,9, and 10 above are omitted.

The following statistics are calculated in a univariate analysis:

1 Mean

2 Variance

3 Normalized Autocovariance function lags

4 Partial Autocorrelaation lags

5 Durbin Watson Statistic

6 Q10 Statistic = sum of the first 10 squared normalized autocovariance function lags

7 Q20 Statistic = sum of the first 20 squared normalized autocovariance function lags

8 Q35 Statistic = sum of the first 35 squared normalized autocovariance function lags

9 Univariate spectrum

COMMAND OUTPUT

For the univariate residual analysis:

The output has the following appearance:

1 The mean and variance are printed.

2 A plot of a specified number (see below) of normalized autocovariance function lags is next. These values fall in the range of -1 to 1. The actual values are also printed on the left.

3 A plot of a specified number (see below) of partial autocorrelation function lags follows. These values also fit in the range of -1 to 1. The actual values are printed on the left.

4 The Durbin Watson statistic is printed.

5 The degrees of freedom for the Q statistics are shown.

6 The p = .05 levels for the Q statistics are next.

7 The p = .10 levels for the Q statistics follow.

8 The actual Q statistics follow.

9 A plot of the univariate spectrum is shown with the actual values on the left side.

For the residual analysis, the spectrum is not plotted.

The output from the bivariate analysis between the residuals and the prewhitened input has the following appearance:

1 The mean and variance of the residuals are printed.

2 The mean and variance of the prewhitened input are next.

3 The cross correlation coefficient (normalized cross correlation at lag 0) is printed.

4 A plot of a specified number (see below) of normalized cross correlation lags is next. These values fall in the range of -1 to 1. The actual values are printed on the left.

5 The degrees of freedom for the S statistics are shown.

6 The p = .05 levels for the S statistics are next.

7 The p = .10 levels for the S statistics follow.

8 The actual S statistics (labeled Q) follow.

In the case of a transfer function model, the results of the evaluation of the parametric transfer function are typed:

1 The noise variance, signal variance, and signal to noise ratio, labeled N, S, SNR are printed.

2 Sixteen values from 0 Hz up to some fraction of the Nyquist frequency (see below) of the gain and phase of the parametric transfer function are plotted with the actual values printed on the left.

For all models, the values of the magnitudes and frequencies of the poles and zeros derived from the parameter polynomials are listed.

USER CONTROL OVER THE COMMAND

The user is not required to enter any input for a model evaluation.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The NA operation parameter controls the number of normalized autocovariance lags plotted. It has a default value of 10.

The NA operation parameter controls the number of normalized cross correlation lags plotted. It has a default value of 10.

The NP operation parameter controls the number of partial autocorrelation lags plotted. It has a default value of 10.

The KSAMP operation parameter is the resampling factor. The user can control the upper frequency of the spectral plots with this parameter. It can take on the values 1, 2, 4, or 8 corresponding to the entire, half, fourth, or eighth of the Nyquist frequency (1/2 the sampling rate. It has a default value of 8.

Example of command 3

```
3

               **********DIAGNOSTICS**********

 THE CURRENT CASE RANGE =    24 508

                    -----RESIDUAL STATISTICS-----

MEAN=     0.00224 VARIANCE=     0.21741


-AUTOCORRELATIONS-


LAG     VALUE     -1                    0                    +1
                   ---------------------+---------------------
  1     -0.0496                        *|
  2      0.0275                         |*
  3     -0.0094                         *
  4     -0.0689                        *|
  5      0.0631                         |*
  6     -0.0051                         *
  7     -0.0735                        *|
  8     -0.0687                        *|
  9     -0.0914                       * |
 10     -0.0091                         *

-PARTIAL AUTOCORRELATIONS-


LAG     VALUE     -1                    0                    +1
                   ---------------------+---------------------
  1     -0.0496                        *|
  2      0.0251                         |*
  3     -0.0068                         *
  4     -0.0705                        *|
  5      0.0572                         |*
  6      0.0042                         *
  7     -0.0792                       * |
  8     -0.0803                       * |
  9     -0.0877                       * |
 10     -0.0205                         *

DURBIN-WATSON STATISTIC =          2.09915

             Q10            Q20            Q35

DEG. FREED.    7             17             32
.05 LEVELS 14.1            27.6           46.2
.10 LEVELS 12.0            24.8           42.6
ACTUAL      14.8           28.7           42.4

                    -----S TEST-----


MEAN=     0.00224 VARIANCE=     0.21741


MEAN=     0.00046 VARIANCE=     0.06410


THE CROSS- CORRELATION COEFFICIENT        -0.047739
```

```
 -CROSS CORRELATIONS-

LAG      VALUE     -1                    0                    +1
                    ---------------------+---------------------
  1     -0.0691                         *|
  2     -0.0423                         *|
  3     -0.0289                         *|
  4      0.0117                          *
  5      0.0481                          |*
  6      0.0546                          |*
  7      0.0141                          *
  8      0.0999                          | *
  9      0.0510                          |*
 10      0.0531                          |*
            Q10          Q20             Q35

DEG. FREED.    9          19              34
.05 LEVELS 16.9          30.1            48.6
.10 LEVELS 14.7          27.2            44.9
ACTUAL      14.9          28.3            53.7

N=  5.3753128 S=  3.8744307 SNR=  0.7207823

PARAMETRIC TRANSFER FUNCTION SPECTRUM


GAIN

J     DENSITY
                    ---------------------+---------------------
  0      0.9763    *****************************************
  1      0.9140    **************************************
  2      0.8185    ********************************
  3      0.7187    ***************************
  4      0.6291    **********************
  5      0.5534    ******************
  6      0.4909    **************
  7      0.4394    ***********
  8      0.3967    *********
  9      0.3609    *******
 10      0.3308    *****
 11      0.3050    ****
 12      0.2829    ***
 13      0.2636    **
 14      0.2468    *
 15      0.2319    *

    1.56250 HZ


PHASE

J     DENSITY
                    ---------------------+---------------------
  0     -0.1272    ************************************
  1     -0.3641    ****************************
  2     -0.5601    *********************
  3     -0.7111    ****************
  4     -0.8241    ************
  5     -0.9082    *********
  6     -0.9711    ******
  7     -1.0185    *****
  8     -1.0544    ***
  9     -1.0817    **
 10     -1.1025    **
 11     -1.1181    *
 12     -1.1296    *
 13     -1.1380    *
 14     -1.1437    *
 15     -1.1472    *

    1.56250 HZ



              MAG            FREQ(HZ)
TRANSFER FUNCTION ZEROS
TRANSFER FUNTION POLES
 1            0.91248            0.00000
NOISE ZEROS
 1            0.63026            0.63065
 2            0.63026           -0.63065
NOISE POLES

 1            0.95200            0.00000

 COMMAND:
```

COMMAND NUMBER 4

IDENTIFICATION OF THE INPUT ARRAY

FUNCTION OF THE COMMAND:

This command results in a univariate analysis of some fraction of the possibly detrended or differenced output data array.

See the comments about command 8 for details concerning the establishment of the data case range, for setting up the differencing factor, and for control over whether the data are detrended.

UNIVARIATE ANALYSIS:

The following statistics are calculated in a univariate analysis:

1 Mean

2 Variance

3 Normalized Autocovariance function lags

4 Partial Autocorrelaation lags

5 Durbin Watson Statistic

6 Q10 Statistic = sum of the first 10 squared normalized autocovariance function lags

7 Q20 Statistic = sum of the first 20 squared normalized autocovariance function lags

8 Q35 Statistic = sum of the first 35 squared normalized autocovariance function lags

9 Univariate spectrum

COMMAND OUTPUT

The output has the following appearance:

1 The mean and variance are printed.

2 A plot of a specified number (see below) of normalized autocovariance function lags is next. These values fall in the range of -1 to 1. The actual values are also printed on the left.

3 A plot of a specified number (see below) of partial autocorrelation function lags follows. These values also fit in the range of -1 to 1. The actual values are printed on the left.

4 The Durbin Watson statistic is printed.

5 The degrees of freedom for the Q statistics are shown.

6 The p = .05 levels for the Q statistics are next.

7 The p = .10 levels for the Q statistics follow.

8 The actual Q statistics follow.

9 A plot of the univariate spectrum is shown with the actual values on the left side.

USER CONTROL OVER THE COMMAND

The user is not required to enter any input.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The NA operation parameter controls the number of normalized autocovariance lags plotted. It has a default value of 10.

The NP operation parameter controls the number of partial autocorrelation lags plotted. It has a default value of 10.

The KSAMP operation parameter is the resampling factor. The user can control the upper frequency of the spectral plots with this parameter. It can take on the values 1, 2, 4, or 8 corresponding to the entire, half, fourth, or eighth of the Nyquist frequency (1/2 the sampling rate. It has a default value of 8.

The lag window operation parameter, LAG, controls the size of the lag window used in the smoothing of the spectrum. It may take on the values 1 or 2, corresponding to a window length of 1/2 or 1/4 the array size. A smoother spectral estimate will result with a value of 2. It has a default value of 1.

Example of command 4

```
4

**********IDENTIFICATION OF INPUT ARRAY**********

MEAN=     0.00000 VARIANCE=     3.71093


-AUTOCORRELATIONS-


LAG    VALUE   -1                    0                   +1
               --------------------+--------------------
  1    0.9806                      I                   *
  2    0.9530                      I                  *
  3    0.9151                      I                 *
  4    0.8696                      I                *
  5    0.8201                      I               *
  6    0.7684                      I              *
  7    0.7158                      I             *
  8    0.6642                      I            *
  9    0.6159                      I           *
 10    0.5696                      I          *

-PARTIAL AUTOCORRELATIONS-

LAG    VALUE   -1                    0                   +1
               --------------------+--------------------
  1    0.9806                      I                   *
  2   -0.2233                  *   I
  3   -0.2510                 *    I
  4   -0.1411                   *  I
  5   -0.0305                     *I
  6    0.0036                      *
  7   -0.0050                      *
  8    0.0161                      *
  9    0.0575                      I*
 10   -0.0135                      *

DURBIN-WATSON STATISTIC =      0.02354

               Q10        Q20        Q35

DEG. FREED.   7         17          32
.05 LEVELS 14.1        27.6        46.2
.10 LEVELS 12.0        24.8        42.6
ACTUAL   1998.2      2474.1      2684.8

SPECTRUM

J    DENSITY
               --------------------+--------------------
 0   152.3907  ****************************************
 1   144.5988  **************************************
 2   122.4483  ********************************
 3    91.5422  ************************
 4    62.2404  ****************
 5    43.3132  ***********
 6    35.5546  *********
 7    33.7180  *********
 8    32.7623  ********
 9    30.1453  ********
10    24.7476  ******
11    17.6455  ****
12    12.6789  ***
13    13.0939  ***
14    17.7431  ****
15    22.8164  ******
16    25.7877  *******
17    25.9008  *******
18    22.4872  ******
19    16.1068  ****
20    10.0388  **
21     7.6930  **
22     8.5377  **
23     9.2544  **
```

```
24      8.0104  **
25      5.9195  *
26      4.2875  *
27      3.2764  *
28      2.5239  *
29      2.1555  *
30      1.8422  *
31      1.5495  *

   1.56250 HZ

COMMAND:
```

COMMAND NUMBER 5

IDENTIFICATION OF THE NOISE ARRAY

FUNCTION OF THE COMMAND:

This command results in the estimation of a correlated noise series. A truncated version of the impulse response obtained nonparametrically from command 7 is used to compute estimates of the transfer function output, which are subtracted from the actual output to get an estimate of the noise component. A univariate analysis is done on the estimated noise series. A prerequisite for this command is a command 7.

UNIVARIATE ANALYSIS:

The following statistics are calculated in a univariate analysis:

1 Mean

2 Variance

3 Normalized Autocovariance function lags

4 Partial Autocorrelaation lags

5 Durbin Watson Statistic

6 Q10 Statistic = sum of the first 10 squared normalized autocovariance function lags

7 Q20 Statistic = sum of the first 20 squared normalized autocovariance function lags

8 Q35 Statistic = sum of the first 35 squared normalized autocovariance function lags

9 Univariate spectrum

COMMAND OUTPUT

The output has the following appearance:

1 The mean and variance are printed.

2 A plot of a specified number (see below) of normalized autocovariance function lags is next. These values fall in the range of -1 to 1. The actual values are also printed on the left.

3 A plot of a specified number (see below) of partial autocorrelation function lags follows. These values also fit in the range of -1 to 1. The actual values are printed on the left.

4 The Durbin Watson statistic is printed.

5 The degrees of freedom for the Q statistics are shown.

6 The p = .05 levels for the Q statistics are next.

7 The p = .10 levels for the Q statistics follow.

8 The actual Q statistics follow.

9 A plot of the univariate spectrum is shown with the actual values on the left side.

USER CONTROL OVER THE COMMAND

The user is not required to enter any input.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The KSAMP operation parameter is the resampling factor. The upper frequency present in the nonparametrically derived impulse response is controlled by this parameter. It can take on the values 1, 2, 4, or 8 corresponding to the entire, half, fourth, or eighth of the Nyquist frequency (1/2 the sampling rate. The input and output data are resampled according to KSAMP before estimation of the noise series. It has a default value of 8.

The length of the estimated impulse response used to calculate the noise series is controlled by the operation parameter, IMP. It has a default value of 30. It should be large enough so that significant values of the impulse response are not missed.

The NA operation parameter controls the number of normalized autocovariance lags plotted. It has a default value of 10.

The NP operation parameter controls the number of partial autocorrelation lags plotted. It has a default value of 10.

The lag window operation parameter, LAG, controls the size of the lag window used in the smoothing of the spectrum. It may take on the values 1 or 2, corresponding to a window length of 1/2 or 1/4 the array size. A smoother spectral estimate will result with a value of 2. It has a default value of 1.

Example of command 5

```
5

     **********ESTIMATION OF NOISE ARRAY**********


**********IDENTIFICATION OF NOISE ARRAY**********


MEAN=   -0.03532 VARIANCE=    5.76799


-AUTOCORRELATIONS-


LAG     VALUE    -1                     0                    +1
                 ----------------------+---------------------
 1      0.8614                         I                *
 2      0.7157                         I            *
 3      0.7079                         I            *
 4      0.6914                         I            *
 5      0.6034                         I          *
 6      0.5137                         I        *
 7      0.4555                         I       *
 8      0.3799                         I      *
 9      0.2811                         I    *
10      0.2022                         I  *

-PARTIAL AUTOCORRELATIONS-


LAG     VALUE    -1                     0                    +1
                 ----------------------+---------------------
 1      0.8614                         I                *
 2     -0.1020                       * I
 3      0.4560                         I       *
 4     -0.1164                       * I
 5     -0.0407                        *I
 6     -0.0976                       * I
 7     -0.0591                        *I
 8     -0.1517                      *  I
 9     -0.0882                       * I
10     -0.0498                        *I


DURBIN-WATSON STATISTIC =        0.26926

                Q10          Q20           Q35

DEG. FREED.  10           20            35
.05 LEVELS 18.3         31.4          49.8
.10 LEVELS 16.0         28.4          46.1
ACTUAL    753.3        770.5        1208.1


SPECTRUM
```

COMMAND NUMBER 6

PREWHITEN THE INPUT

FUNCTION OF THE COMMAND:

This command results in the estimation of a specified number (see below) of autoregressive parameters with which to approximate the input series. The resulting model of the input is evaluated (as a univariate model). The residuals are set aside as the prewhitened input to be used in future transfer function model evaluations. The input may be detrended or differenced. Any fraction of the input array may be used.

See the comments about command 8 for details concerning the establishment of the data case range, for setting up the differencing factor, and for control over whether the data are detrended.

In the evaluation of a univariate model, the following computations are performed:

1 Calculation of the residual series

2 Univariate analysis of the residuals

3 Poles and zeros of the model

For the univariate residual analysis:

The following statistics are calculated in a univariate analysis:

1 Mean

2 Variance

3 Normalized Autocovariance function lags

4 Partial Autocorrelaation lags

5 Durbin Watson Statistic

6 Q10 Statistic = sum of the first 10 squared normalized autocovariance function lags

7 Q20 Statistic = sum of the first 20 squared normalized autocovariance function lags

8 Q35 Statistic = sum of the first 35 squared normalized autocovariance function lags

9 Univariate spectrum

For the residual analysis, the spectrum is not plotted.

COMMAND OUTPUT

Since the autoregressive parameters of the input model are found using the same algorithm for the determination of the partial autocorrelation coefficents in a univariate analysis, the output from this command looks like 2 univariate analyses without spectra: 1) a univariate analysis of the input series followed by a univariate analysis of the residuals. The univariate analysis output is listed below.

The output has the following appearance:

1 The mean and variance are printed.

2 A plot of a specified number (see below) of normalized autocovariance function lags is next. These values fall in the range of -1 to 1. The actual values are also printed on the left.

3 A plot of a specified number (see below) of partial autocorrelation function lags follows. These values also fit in the range of -1 to 1. The actual values are printed on the left.

4 The Durbin Watson statistic is printed.

5 The degrees of freedom for the Q statistics are shown.

6 The p = .05 levels for the Q statistics are next.

7 The p = .10 levels for the Q statistics follow.

8 The actual Q statistics follow.

9 A plot of the univariate spectrum is shown with the actual values on the left side.

USER CONTROL OVER THE COMMAND

The user is not required to enter any input.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The NA operation parameter controls the number of normalized autocovariance lags plotted. It has a default value of 10.

For the residual analysis:

The NP operation parameter controls the number of partial autocorrelation lags plotted. It has a default value of 10.

For the input univariate analysis:

The NPW parameter controls the number of partial autocorrelation lags plotted. It has a default value of 17. NPW is the number of autoregressive parameters with which the input is approximated.

COMMAND OUTPUT

The command output consists of 3 plots with actual values printed on the left:

1 Sixteen values from 0 Hz up to some fraction of Nyquist freqency (see below) of transfer function gain

2 Sixteen values from 0 Hz up to the same frequency above of transfer function phase lags in radians

3 Fifty values of the impulse response

Example of command 6

```
6

*******ESTIMATION OF PREWHITENING PARAMETERS*******

MEAN=     0.00012 VARIANCE=     0.08078

-AUTOCORRELATIONS-

LAG    VALUE    -1                    0                    +1
                 --------------------+--------------------
 1     0.3157                        I     *
 2     0.3805                        I       *
 3     0.2741                        I    *
 4     0.1455                        I  *
 5     0.1095                        I *
 6    -0.0251                       *I
 7    -0.0561                       *I
 8    -0.0984                      * I
 9    -0.1113                      * I
10    -0.0926                      * I

-PARTIAL AUTOCORRELATIONS-

LAG    VALUE    -1                    0                    +1
                 --------------------+--------------------
 1     0.3157                        I     *
 2     0.3119                        I     *
 3     0.1144                        I *
 4    -0.0619                       *I
 5    -0.0372                       *I
 6    -0.1196                      * I
 7    -0.0746                       *I
 8    -0.0448                       *I
 9    -0.0135                        *
10     0.0166                        *
```

```
11    -0.0218                      *
12    -0.0293                     *I
13     0.0151                      *
14    -0.0136                      *
15    -0.0248                      *
16     0.0170                      *
17    -0.0722                     *I


DURBIN-WATSON STATISTIC =       1.36759

              Q10           Q20          Q35

DEG. FREED.  10             20           35
.05 LEVELS 18.3           31.4         49.8
.10 LEVELS 16.0           28.4         46.1
ACTUAL     197.8         221.9        248.0


           **********DIAGNOSTICS**********

 THE CURRENT CASE RANGE =    19 512

                 -----RESIDUAL STATISTICS-----

MEAN=     0.00107 VARIANCE=     0.06390


-AUTOCORRELATIONS-

LAG     VALUE     -1                    0                    +1
                  ---------------------+---------------------
 1    -0.0066                          *
 2     0.0020                          *
 3     0.0006                          *
 4    -0.0007                          *
 5     0.0118                          *
 6     0.0020                          *
 7     0.0065                          *
 8    -0.0005                          *
 9    -0.0214                          *
10     0.0014                          *

-PARTIAL AUTOCORRELATIONS-

LAG     VALUE     -1                    0                    +1
                  ---------------------+---------------------
 1    -0.0066                          *
 2     0.0019                          *
 3     0.0006                          *
 4    -0.0007                          *
 5     0.0118                          *
 6     0.0022                          *
 7     0.0065                          *
 8    -0.0004                          *
 9    -0.0215                          *
10     0.0010                          *

DURBIN-WATSON STATISTIC =       2.01268

              Q10           Q20          Q35

DEG. FREED.    0             3           18
.05 LEVELS   0.0           7.8         28.9
.10 LEVELS   0.0           6.2         26.0
ACTUAL       0.3           3.0         21.3



               MAG           FREQ(HZ)
TRANSFER FUNCTION ZEROS
TRANSFER FUNTION POLES
NOISE ZEROS
NOISE POLES

 1            0.88502          9.60281
 2            0.88502         -9.60281
 3            0.87100         10.99081
 4            0.87100        -10.99081
 5            0.86045         12.50001
 6            0.86343          7.97997
 7            0.86343         -7.97997
 8            0.82252          6.51420
 9            0.82252         -6.51420
10            0.84768          5.11226
11            0.84768         -5.11226
12            0.89091          0.83008
13            0.89091         -0.83008
14            0.85657          1.80676
15            0.85657         -1.80676
16            0.81777          3.48803
17            0.81777         -3.48803

COMMAND:
```

COMMAND NUMBER 7

NONPARAMETRIC ESTIMATION OF THE TRANSFER FUNCTION AND IMPULSE RESPONSE

This command results in a nonparametric estimation (via FFTs and spectral smoothing techniques) of the transfer function between the input and output arrays. From the nonparametric frequency response, an inverse FFT results in an estimate of the impulse response.

This impulse response estimate is accurate only if 256 or fewer points of the input and output series were used.

USER CONTROL OVER THE COMMAND

The user is not required to enter any input.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The lag window operation parameter, LAG, controls the size of the lag window used in the smoothing of the spectrum. It may take on the values 1 or 2, corresponding to a window length of 1/2 or 1/4 the array size. A smoother spectral estimate will result with a value of 2. It has a default value of 1.

The KSAMP operation parameter is the resampling factor. The user can control the upper frequency of the spectral plots with this parameter. It can take on the values 1, 2, 4, or 8 corresponding to the entire, half, fourth, or eighth of the Nyquist frequency (1/2 the sampling rate. It has a default value of 8.

Example of command 7

```
7

EST. OF TRANSFER FUNCTION AND IMPULSE RESPONSE


 WARNING: SOME POINTS OF THE IMPULSE RESPONSE
WILL BE ALIASED.

GAIN

J     DENSITY
                 ---------------------+---------------------
 0      0.9724   *******
 1      1.1414   ********
 2      1.0235   *******
 3      1.2953   **********
 4      1.4155   ***********
 5      1.0709   ********
 6      0.8279   *****
 7      0.5229   ***
 8      0.7643   *****
 9      0.9099   ******
10      0.4993   **
11      0.3950   *
12      0.4442   **
13      0.3447   *
14      0.2283   *
15      4.8154   ******************************************

    1.56250 HZ


PHASE

J     DENSITY
                 ---------------------+---------------------
 0     -0.0762   ********************
 1     -0.1126   ********************
 2     -0.4327   ******************
 3     -0.9504   **************
 4     -0.8461   ***************
```

```
  5    -1.0805  *************
  6    -1.7555  ********
  7    -2.1754  *****
  8    -2.6554  **
  9    -2.9197  *
 10    -2.3265  ****
 11     1.2001  ******************************
 12     2.7791  *****************************************
 13     2.4688  ***************************************
 14     0.9136  ****************************
 15     1.5334  ********************************

   1.56250 HZ


IMPULSE RESPONSE

J     DENSITY
                --------------------+--------------------
  0    -0.0968  ***
  1     0.7084  *****************************************
  2     0.3699  *************************
  3     0.0268  *********
  4    -0.1707  *
  5    -0.0335  ******
  6     0.0074  ********
  7    -0.0694  *****
  8     0.0772  ************
  9    -0.0565  *****
 10    -0.0190  *******
 11    -0.0293  *******
 12     0.0512  **********
 13    -0.0078  ********
 14     0.0393  **********
 15    -0.0291  *******
 16     0.0072  ********
 17    -0.0067  ********
 18     0.0126  *********
 19    -0.0073  ********
 20    -0.0067  ********
 21     0.0052  ********
 22    -0.0117  *******
 23     0.0169  *********
 24    -0.0119  *******
 25     0.0132  *********
 26    -0.0186  *******
 27     0.0209  *********
 28    -0.0200  *******
 29     0.0213  *********
 30    -0.0233  *******
 31     0.0249  *********
 32    -0.0317  ******
 33     0.0361  **********
 34    -0.0320  ******
 35     0.0333  **********
 36    -0.0414  ******
 37     0.0513  **********
 38    -0.0594  *****
 39     0.0635  ***********

COMMAND:
```

COMMAND NUMBER 8

SPECIFICATION OF DIFFERENCE PARAMETERS AND THE CASE RANGE

FUNCTION OF THE COMMAND:

This command results in the specification of of the case range and difference parameters for the input and output arrays. The case range can specify any starting and stopping point within the array size. Differencing parameters of 0, 1, or 2 may be specified separately for the input and output arrays.

COMMAND OUTPUT

If the detrending factor is set to detrend, then the slope, intercept, and variance of the possibly differenced data within the specified case range are shown for both the input and output arrays.

USER CONTROL OVER THE COMMAND

Specification of the case range and the difference parameters must be done by the user interactively or from a command file.

The program types:

THE CURRENT CASE RANGE (IX IY)

If the endpoints IX and IY are those desired, the user can type in 0s in response and IX and IY will not be changed. If not, the appropriate numbers should be entered. IY must be greater than IX and less than the maximum array size. Both must be greater than 0.

For the difference parameters, the program types:

THE CURRENT INPUT DIFFERENCE PARAMETER (IX)

THE CURRENT OUTPUT DIFFERENCE PARAMETER (IX)

Again, if the numbers in parentheses are those desired, a 0 response causes no change. Otherwise, type a 0, 1, or 2.

Certain details of the command are controlled by operation parameters. Any operation parameters may be changed by the command 9.

The operation parameter, ITREND, controls whether the input and output arrays are detrended within the case range. If ITREND equals 1, then detrending is done. The default value is 1.

Example of command 8

```
8
 THE CURRENT CASE RANGE(      1    512)23,512
 THE CURRENT INPUT DIFFERENCE PARAMETER(    0)0
 THE CURRENT OUTPUT DIFFERENCE PARAMETER(    0)0

          SLOPE        INTERCEPT     SIGNAL VARIANCE

 INPUT    -0.00148      0.39598        4.58565

OUTPUT    -0.00261      0.69719        5.13450

 COMMAND:
```

COMMAND NUMBER 9

CHANGING OPERATION PARAMETERS

FUNCTION OF THE COMMAND:

This command allows the user to change any of the 8 operation parameters either directly or via a a command file.

The operation parameters are described below:

The NA operation parameter controls the number of normalized autocovariance lags plotted. It has a default value of 10.

The NP operation parameter controls the number of partial autocorrelation lags plotted. It has a default value of 10.

The KSAMP operation parameter is the resampling factor. The user can control the upper frequency of the spectral plots with this parameter. It can take on the values 1, 2, 4, or 8 corresponding to the entire, half, fourth, or eighth of the Nyquist frequency (1/2 the sampling rate. It has a default value of 8.

The lag window operation parameter, LAG, controls the size of the lag window used in the smoothing of the spectrum. It may take on the values 1 or 2, corresponding to a window length of 1/2 or 1/4 the array size. A smoother spectral estimate will result with a value of 2. It has a default value of 1.

The length of the estimated impulse response used to calculate the noise series is controlled by the operation parameter, IMP. It has a default value of 30. It should be large enough so that significant values of the impulse response are not missed.

For the input univariate analysis:

The NPW parameter controls the number of partial autocorrelation lags plotted. It has a default value of 17. NPW is the number of autoregressive parameters with which the input is approximated.

The operation parameter, ITREND, controls whether the input and output arrays are detrended within the case range. If ITREND equals 1, then detrending is done. The default value is 1.

The operation parameter, IDEV, controls the device from which the commands are read. If it equals 5, the command device is the terminal. If it is a 3, commands are read from a command file.

COMMAND OUTPUT

The list of operation parameters and their allowable range are listed.

USER CONTROL OVER THE COMMAND

Each operation parameter is printed with the current value in parentheses. If the user desires to change the value, he types in the desired value. Typing a 0 results in no change to the parameter.

Example:

NUMBER OF AUTOCORRELATIONS (IX) 0

The number of autocorrelation lags printed will remain IX.

Example of command 9

```
9

LIST OF OPERATION PARAMETERS
NO. AUTOCORRELATION LAGS (UP TO 50)
NO. PARTIAL AUTOCORRELATION LAGS (UP TO 50)
LAG WINDOW FACTOR = 1/2 TO THE FACTORTH
RESAMPLING FACTOR = 1,2,4,8
       1 IS BEST FOR OBTAINING A NOISE ESTIMATE.
IMPULSE RESPONSE LENGTH FOR ESTIMATING NOISE (UP TO 50)
NO. PREWHITENING POLES (UP TO 50)
DETRENDING FACTOR = 1 FOR DETRENDING, -1 FOR NOT
COMMAND INPUT DEVICE = 5 FOR TERMINAL, 3 FOR FILE

 NUMBER OF AUTOCORRELATIONS( 10)0
 NUMBER OF PARTIAL AUTOCORRELATIONS( 10)0
 THE LAG WINDOW( 1)0
 THE IMPULSE RESPONSE LENGTH(30)0
 THE CURRENT RESAMPLING FACTOR( 8)4
 THE NUMBER OF PREWHITENING POLES(17)0
 THE DETRENDING FACTOR( 1)0
 THE COMMAND INPUT DEVICE( 5)0

 COMMAND:
```

COMMAND NUMBER 10

STOPPING THE ANALYSIS

FUNCTION OF THE COMMAND:

This command stops analysis on the current data set. If other data sets have been included in the data list, then the new data are read in.

Example of command 10

```
10

******* CAMERA 2 *******

 COMMAND:10
TYPE 1 FOR NEW FILE, 0 TO STOP, -1 FOR MORE
TO DO IN CURRENT FILE
0

STOP --
```