The Program CONTEXT.PAS for Plotting
the Contours of a Criterion Function

1. Introduction

The purpose of this program is to plot the contours of bivariate criterion function for estimating the parameters of a linear stochastic differential equation with a pair of conjugate complex poles and a single zero, which is described as a LSDE(2, 1) model. The function in question is the sum of squares of differences between the leading autocovariances of a discrete-time autoregressive moving-average ARMA(2, 1) model with complex poles and those of its continuous-time LSDE(2, 1) counterpart.

The poles of the ARMA model are translated directly to the poles of the LSDE. The variance of the forcing function is set to unity. The two real-valued parameters (a, b), which are the arguments of the criterion function, determine the two moving-average coefficients of the LSDE.

The user is asked to specify the ARMA model. Then, they are asked to place bounds on the values of (a, b) and to specify the number of elements in a matrix of the values of the criterion function. A specified number of contours is plotted on an approximation of the surface of the criterion function, which is formed from the rectangular panes that are determined by four adjacent elements of the matrix of function values.

The procedures of the program are either self-explanatory or else they are explained in the appropriate places by short texts displayed on the computer screen. The inputs to the program are protected. Thus, for example, if the procedure to plot the contours is activated before any data has been provided and before the parameters of the graph have been declared, then the program will ask the user to provide these items.

The program is also protected again inappropriate inputs. Thus, if a non-numeric symbol is typed when a bounded integer has been called for, then the program will persist in asking for the integer until one that satisfies the bounds has been provided.

The graphs that are generated by the program are written to the screen in accordance with the chosen dimensions or page parameters. There are options to generate the *PostScript* code of the graphs. This is provided either as an encapsulated *PostScript* code or as a code that is compatible with the *Textures* typesetting program.

2. The Menus of the Program

The following is a summary of the menus of the program. Most of the items of the main menu of CONTEXT.PAS subsume a sub-menu:

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

1. *Page Parameters*
2. *Specify the Parameters of the ARMA Model*
3. *Test a Specific Point in the Function Space*
4. *Specify the Parameters of the Contour Plot*
5. *Generate a Matrix of the Criterion Function Values*
6. *Locate Local Minima amongst the Function Values*
7. *Plot the Contour Lines*
8. *SAVE and EXIT*

Subsumed under the sub-menus are various requests for information and various function that can be performed:

1. SPECIFY THE PAGE PARAMETERS

Do you want to output in PostScript, y/N?

Do you want a TeXtures Format, Y/N?

Specify the frame surrounding the graph.
  (5cm $\times$ 3cm) <= (width $\times$ height) <= (13.5cm $\times$ 9.5cm)

For two diagrams per page use 9cm times 6cm
For three diagrams per page use 9cm times 3.75cm

2. SPECIFY AN ARMA MODEL

1. Specify roots of the polynomial operator in polar form
2. Specify roots of the polynomial operator in Cartesian form
3. Specify the coefficients of the polynomial operator

3. TEST A SPECIFIC POINT

Specify a value of the parameter a

Specify a value of the parameter b

Do you wish to interchange the values of a and b, Y/N?

4. PARAMETERS OF THE CONTOUR PLOT

Specify the lower bound for the parameter a
Specify the upper bound for the parameter a
Specify the lower bound for the parameter b
Specify the upper bound for the parameter b

Specify the limit iMax for the row index of the data matrix

Specify the limit jMax for the column index of the data matrix

How many contour levels do you require?

PLOT MINIMUM VALUES ON THE CONTOUR MAP

Do you wish to plot the known minimising values, Y/N?

If there already exists a Contour Matrix, then

1. Respecify the contour parameters
2. Invert the z-values
3. Skip the procedure and EXIT

5. GENERATE A MATRIX OF THE CRITERION FUNCTION VALUES

6. SEARCH FOR LOCAL MINIMA

1. Search within quadrants
2. Search within 9 cells
3. Search within 16 cells
4. Skip the procedure and EXIT

7. PLOT THE CONTOUR LINES

8. EXIT THE PROGRAM OR RETURN

Do you wish to Save the Data Matrix Y/N?

Do you wish to EXIT the program Y/N?

The Program in Use

The following listing demonstrates the use of the program in creating a contour map of the criterion function of the indirect procedure for estimating the parameters of an LSDE(2, 1) model, given the parameters of an ARMA(2, 1) model that has been fitted to data. Only a limited subset of the available procedures of the program are used in this example.

The inputs required of the user are indicated by the longrightarrows: $\longrightarrow$.

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

1. Page Parameters
$\longrightarrow$ 1

SPECIFY THE PAGE PARAMETERS

3

Do you want to output in PostScript, Y/N?
⟶ N

Specify the width
⟶ 99   {*for maximum width*}

Specify the height
⟶ 99   {*for maximum height*}

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

2. Specify the Parameters of the ARMA Model
⟶ 2

SPECIFY A DISCRETE-TIME AUTOREGRESSIVE MOVING-AVERAGE MODEL

Specify the Autoregressive Parameters

Do you wish to specify the auxiliary polynomial in polar form, Y/N?
⟶ Y

Complex Conjugate Roots

Specify the argument theta[1] in degrees
⟶45

Specify the modulus rho[1]
⟶0.9

Specify the Moving-Averge Parameters

Specify coeff[0] ⟶1.0

Specify coeff[10] ⟶ −0.5

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

4. Specify the Parameters of the Contour Plot
⟶ 4

PARAMETERS OF THE CONTOUR PLOT

Specify the lower bound for the parameter a
⟶ −0.6

Specify the upper bound for the parameter a
⟶ 0.6

Specify the lower bound for the parameter b
⟶ −0.6

Specify the upper bound for the parameter b

4

$\longrightarrow$ 0.6

Specify the limit iMax for the row index of the data matrix
$\longrightarrow$ 64

Specify the limit jMax for the column index of the data matrix
$\longrightarrow$ 64

How many contour levels do you require?
$\longrightarrow$ 8

Do you wish to plot the known minimising values, Y/N?
$\longrightarrow$ N

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

7. Plot the Contour Lines
$\longrightarrow$ 7

The result is a contour map plotted on the screen. To dismiss the graphic, click on the close box in the top right corner of the screen and press ⟨RETURN⟩

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

4. Specify the Parameters of the Contour Plot
$\longrightarrow$4

PARAMETERS OF THE CONTOUR PLOT

2. Invert the z-values
$\longrightarrow$ 2

INVERT THE DATA VALUES

What six the vale of R?
$\longrightarrow$ 60

3. EXIT this Procedure
$\longrightarrow$ 3

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

7. Plot the Contour Lines
$\longrightarrow$ 7

The result is a contour map of the inverse function values which is intended to highlight the vicinities of the four minimising values. To dismiss the graphic, click on the close box in the top right corner of the screen and press ⟨RETURN⟩

CONTEXT.PAS: The Contour Map for CONCRETE.PAS

8. SAVE and EXIT

$\longrightarrow 8$

EXIT THE PROGRAM OR RETURN

Do you wish to save the data matrix, Y/N?
$\longrightarrow$ N

Do you wish to EXIT the program, Y/N?
$\longrightarrow$ Y

Compiling the Program

The Program has been compiled with the *Free Pascal* compiler on a *Windows* platform. *Free Pascal* compilers exist for a wide variety of platforms. The instruction *FPC MAIN* is sufficient for compiling the code that has been provided in the current folder. The code of the program is contained in 12 units, which are compiled in the following order:

1. GLOBALS
2. MATHS
3. UTILS
4. ROOTS
5. ACQUIRE
6. CACOVARS
7. DACOVARS
8. POST
9. SCREEN
10. CONTOURS
11. ORGANISE
12. MAIN

The resulted program will be named *MAIN.EXE*.