16.1 Character-based Graphics — One or More XY Graphs

A. Purpose

These subroutines produce an image in a character array that the user can print to produce a printer plot of one or more *xy* data sets with titles and numeric grid-line labels. The size of the image is user-specified. SPRPL1/DPRPL1 will process a single *xy* data set, whereas SPRPL2/DPRPL2 will process multiple *xy* data sets.

B. Usage

B.1 Usage to plot a single *xy* data set

B.1.a Program Prototype, Single Precision

INTEGER NP, NLINES, NCHARS, IERR

REAL X(≥NP), **Y**(≥NP)

CHARACTER*n_1 **TITLE** [$1 \le n_1 \le$ NCHARS]

CHARACTER*n_2 **XNAME** [$1 \le n_2 \le$ NCHARS]

CHARACTER*n_3 **YNAME** [$1 \le n_3 \le$ NLINES]

CHARACTER*n_4 **IMAGE**(≥NLINES) [$n_4 \ge$ NCHARS]

Assign values to all arguments except IMAGE() and IERR.

CALL SPRPL1 (X, Y, NP, TITLE, XNAME, YNAME, NLINES, NCHARS, IMAGE, IERR)

The printer plot image is returned in IMAGE() and the termination status in IERR.

B.1.b Argument Definitions

X(), Y() [in] Arrays of (x, y) coordinate pairs defining the curve to be plotted.

NP [in] Number of (x, y) points to be plotted.

TITLE [in] Character string to be placed above the plot frame as a title for the graph.

XNAME [in] Character string to be placed below the plot frame to identify the abscissa variable.

YNAME [in] Character string to be placed in a vertical column to the left of the plot frame to identify the ordinate variable.

NLINES [in] Number of lines of a plot image to be built in IMAGE(). The array IMAGE() must be dimensioned at least NLINES.

NCHARS [in] Number of character positions to be used in each line in building the plot image in IMAGE(). The declared character length of each element of IMAGE() must be at least NCHARS.

IMAGE() [out] Character array in which the printer plot image is built. The image will use NLINES positions in the vertical direction and NCHARS positions in the horizontal direction.

IERR [out] Termination status indicator.

- 0 No errors.
- 1 NCHARS is too small.
- 2 NLINES is too small.

B.2 Usage to plot multiple *xy* data sets

B.2.a Program Prototype, Single Precision

INTEGER IDIM, KC, NR, JX(≥KC), **JY**(≥KC), **NP**(≥KC)

INTEGER NLINES, NCHARS, IERR

REAL XY(IDIM, m) [$m \ge \max_{1 \le k \le \mathrm{KC}} \{\mathrm{JX}(k), \mathrm{JY}(k)\}$]

CHARACTER*1 SYMBOL(≥KC)

CHARACTER*n_1 **TITLE** [$1 \le n_1 \le$ NCHARS]

CHARACTER*n_2 **XNAME** [$1 \le n_2 \le$ NCHARS]

CHARACTER*n_3 **YNAME** [$1 \le n_3 \le$ NLINES]

CHARACTER*n_4 **IMAGE**(≥NLINES) [$n_4 \ge$ NCHARS]

Assign values to all arguments except IMAGE() and IERR.

CALL SPRPL2 (XY, IDIM, KC, JX, JY, NP, SYMBOL, TITLE, XNAME, YNAME, NLINES, NCHARS, IMAGE, IERR)

The printer plot image is returned in IMAGE() and the termination status in IERR.

B.2.b Argument Definitions

XY(,) [in] Array of values from which (x, y) coordinates of points to be placed will be obtained under control of the parameters JX(), JY(), and NP().

IDIM [in] Dimension of the first subscript in the XY array. Require IDIM $\ge \max_{1 \le k \le \mathrm{KC}} \{\mathrm{NP}(k)\}$.

KC [in] Number of *xy* sets to be plotted. If KC ≤ 0 the subroutine will return taking no action.

JX() [in] JX(k) specifies the column (second subscript) of XY(,) to be used as the x coordinates for the k^{th} *xy* set.

JY() [in] JY(k) specifies the column (second subscript) of XY(,) to be used as the y coordinates for the k^{th} xy set.

NP() [in] NP(k) specifies the number of xy pairs from XY(,) in the k^{th} set to be plotted.

SYMBOL() [in] SYMBOL(k) is the single character to be used for point-plotting the k^{th} data set.

TITLE, XNAME, YNAME, NLINES, NCHARS,
IMAGE, IERR Same as in Section B.1 above.

B.3 Modifications for Double Precision

Change the names SPRPL1 and SPRPL2 to DPRPL1 and DPRPL2, respectively, and change the REAL declarations to DOUBLE PRECISION.

C. Examples and Remarks

It is permissible, and generally most convenient, to give the arguments TITLE, XNAME, and YNAME as character literals directly in the CALL statement. We suggest that no leading or trailing blanks be included in these strings, since each of these strings will be centered in the image based on its length.

The program DRSPRPL1 and its output ODSPRPL1 illustrate the use of SPRPL1 to obtain printer-plots in two different resolutions. The first plot uses NLINES = 45 and NCHARS = 110, producing a plot that can be displayed on 8.5 inch wide paper using compressed printing, *i.e.*, 16.67 characters per inch. The second plot uses NLINES = 22 and NCHARS = 79, producing a plot that can be displayed on the 25×80 character display frequently used with personal computers. Similarly the use of SPRPL2 is illustrated by the program DRSPRPL2 and its output ODSPRPL2.

D. Functional Description

The subroutine first scans the given xy data to determine maximum and minimum values. It then determines end-values for the x-axis and a subdivision of the x-axis into 3 to 10 equal-length subintervals, such that the values at the ends and subdivision points will be representable in decimal with a small number of nonzero digits, and the span of the x-axis will encompass the given x data. This same process is applied to the y data.

The subroutine establishes integer values, *top*, *bottom*, *left*, and *right*, such that the plot grid will extend vertically from index *top* to index *bottom* in the IMAGE() array, inclusive of the top and bottom grid lines, and horizontally from character position *left* to *right*, inclusive of the left and right grid lines. These values will satisfy $1 \le top < bottom \le \text{NLINES} - 1$, and $1 < left < right = \text{NCHARS} - 1$. If TITLE is nonblank, it will be copied into IMAGE(1) and *top* is set to 2, otherwise $top = 1$. If XNAME is nonblank, it will be copied into IMAGE(NLINES) and *bottom* is set to NLINES − 2, otherwise *bottom* = NLINES − 1. *left* is set large enough to allow for YNAME, if nonblank, to be placed vertically at the left edge of the plot image, for the numeric y-axis labels to be positioned to the left of the plot grid, and for the leftmost numeric x-axis label to extend partially to the left of the plot grid. The width of the numeric x-axis labels, and y-axis labels are data-dependent.

For minimal useful resolution one should probably arrange to have $(bottom - top) \ge 20$ and $(right - left) \ge 20$, however the subroutine imposes the less stringent requirement that these extents each be at least 10. The subroutine abandons the effort and returns with IERR $\neq 0$ if either of these extents is less than 10.

It is possible that there will not be enough space to place a numeric label below each subdivision point of the x-axis. The subroutine first places one centered under the left end of the x-axis. This is assured to be possible by the way *left* is defined. It next attempts to place one for the right end of the x-axis, right justified in the available space. It then sequentially tries to place labels centered under the second, third, etc., x-axis subdivision points. It is acceptable if not all x-axis labels can be placed.

E. Error Procedures and Restrictions

If the character variable TITLE or XNAME has length greater than NCHARS, only the first NCHARS characters are placed in the image. If YNAME has length greater than NLINES, only the first NLINES characters are placed in the image.

This subroutine requires at least enough space for the plot grid boundary indices, defined above in Section D, to satisfy $(bottom - top) \ge 10$ and $(right - left) \ge 10$. If this is not satisfied the subroutine abandons the image-building effort, issues an error message using the error message package of Chapter 19.2 at error level 0, and returns with IERR = 1 or 2.

F. Supporting Information

The source language is ANSI Fortran 77. At Release 4.0 of MATH77 the subroutines of this Chapter were introduced and previous similar but less general subroutines PRPL1 and PRPL2 were deleted.

Based on 1967 code by C. L. Lawson, and J. Hatfield, JPL.

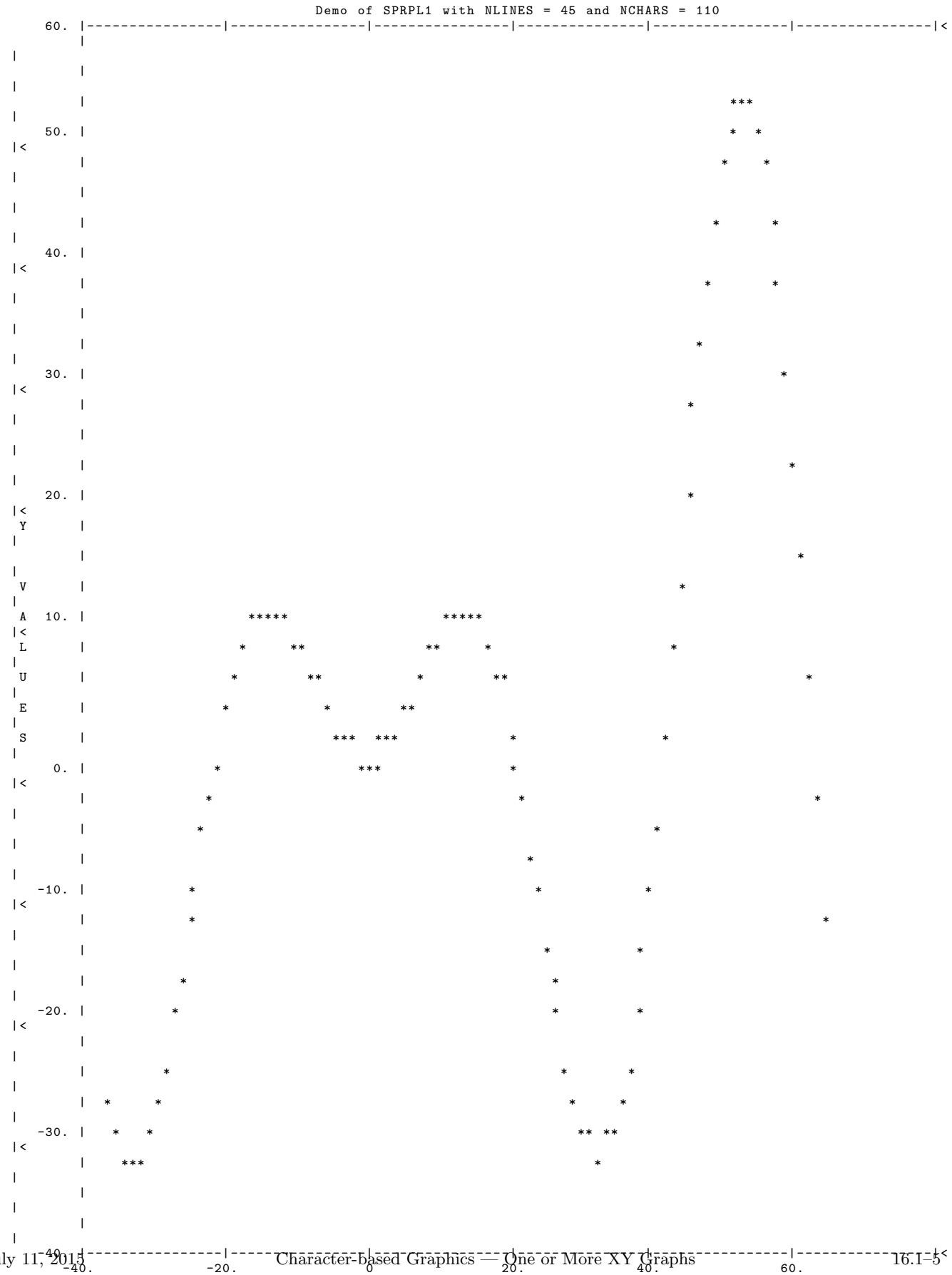
Current version by C. L. Lawson, 1992.

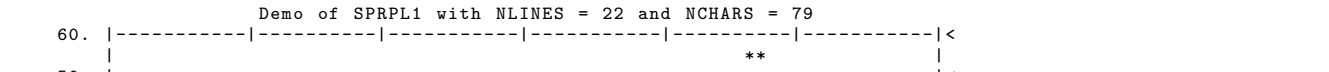
Entry	Required Files	Entry	Required Files
DPRPL1	DPRPL1, DPRPL3, ERFIN, ERMSG, IERM1, IERV1	**SPRPL1**	ERFIN, ERMSG, IERM1, IERV1, SPRPL1, SPRPL3
DPRPL2	DPRPL2, DPRPL3, ERFIN, ERMSG, IERM1, IERV1	**SPRPL2**	ERFIN, ERMSG, IERM1, IERV1, SPRPL2, SPRPL3

DRSPRPL1

```
catc      program DRSPRPL1
c>> 1996-06-27 DRSPRPL1  Krogh  Special code for C conversion.
c>> 1994-10-19 DRSPRPL1  Krogh  Changes to use M77CON
c>> 1992-02-14 DRSPRPL1  CLL
c     ------------------------------------------------------------------
c--S replaces "?": DR?PRPL1, ?PRPL1
c     ------------------------------------------------------------------
      integer I, IERR, LINE, NLMAX, NCMAX, NP
      parameter(NLMAX = 45, NCMAX = 110, NP = 101)
      real              ALPHA, BETA, DX, X(NP),XT, Y(NP)
      parameter(ALPHA = 0.15e0, BETA = 0.015e0, DX = 1.0e0)
c%%    long int ierr, line;
c%%    char image[45][111], image2[45][80];
      character IMAGE(NLMAX)*(NCMAX)
c     ------------------------------------------------------------------
      XT= -36.0e0
      do 10 I=1,NP
        X(I)=XT
        Y(I)=X(I)*SIN(ALPHA*X(I)+BETA)
        XT=XT+DX
   10 continue
c
c++ Code for ~.C. is active
      call SPRPL1(X,Y,NP,
     *    'Demo of SPRPL1 with NLINES = 45 and NCHARS = 110',
     *    'X VALUES','Y VALUES', 45, 110, IMAGE, IERR)
      print'(1x,a)',IMAGE
      print'(1x/1x)'
c
      call SPRPL1(X,Y,NP,
     *    'Demo of SPRPL1 with NLINES = 22 and NCHARS = 79',
     *    'X VALUES','Y VALUES', 22, 79, IMAGE, IERR)
      print'(1x,a)',(IMAGE(LINE)(1:79), LINE = 1,22)
c++ Code for .C. is inactive
c%%   sprpl1( x,y,NP,"Demo of SPRPL1 with NLINES = 45 and NCHARS = 110",
c%%    "X VALUES","Y VALUES",45,111,(byte*)image,&ierr );
c%%   for(line=0; line < 45; line++)
c%%           printf( "\n%111.111s", image[line]);
c%%   printf( "\n" );
c%%   printf( " \n \n" );
c%%   sprpl1( x,y,NP,"Demo of SPRPL1 with NLINES = 22 and NCHARS = 79",
c%%    "X VALUES","Y VALUES",22,80,(byte*)image2,&ierr );
c%%   printf( " " );
c%%   for (line = 0; line < 22; line++)
c%%     printf( "\n%80.80s", image2[line] );
c%%   printf( "\n" );
c++ End
      stop
      end
```

ODSPRPL1


Demo of SPRPL1 with NLINES = 45 and NCHARS = 110
60.
50.
40.
30.
20.
10.
0.
-10.
-20.
-30.
-40.
Y VALUES
-40.
-20.
0
20.
40.
60.
80.
X VALUES

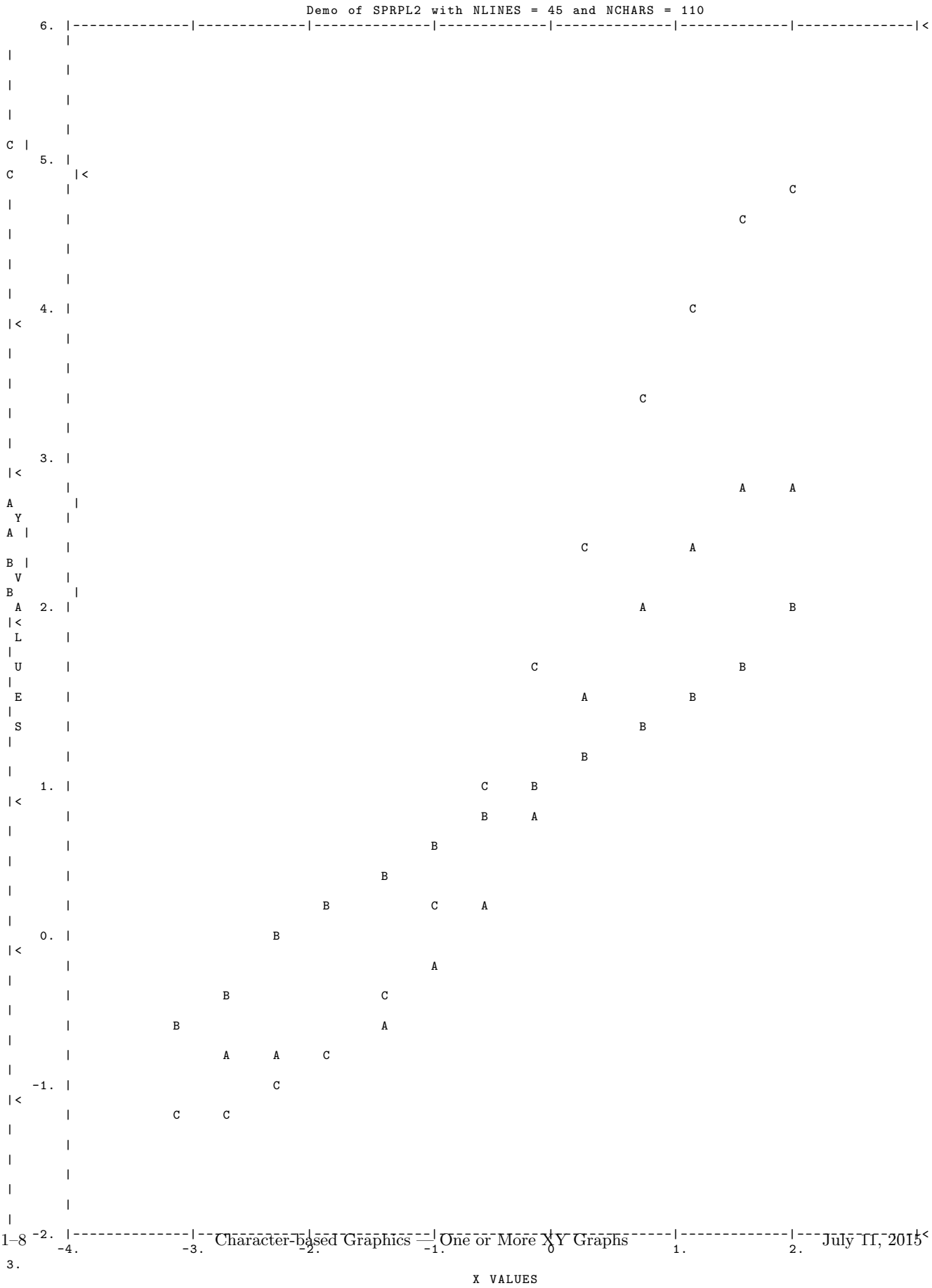

Demo of SPRPL1 with NLINES = 22 and NCHARS = 79
60.

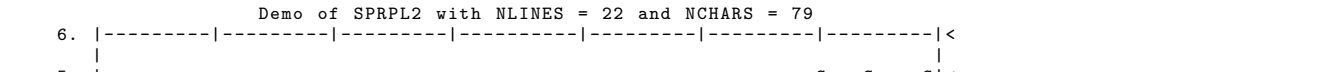
DRSPRPL2

```
c      program DRSPRPL2
c>> 1996-06-27 DRSPRPL2  Krogh  Special code for C conversion.
c>> 1994-10-19 DRSPRPL2  Krogh  Changes to use M77CON
c>> 1992-02-14 DRSPRPL2  CLL
c     ------------------------------------------------------------------
c--S replaces "?": DR?PRPL2, ?PRPL2
c     ------------------------------------------------------------------
      integer I, IERR, KC, LINE, NCMAX, NLMAX
      parameter(KC = 3, NLMAX = 45, NCMAX = 110)
      integer JX(KC), JY(KC), NP(KC)
      real              DX, S, X, XY(15,4)
      character SYMBOL(KC)
c%%    long int ierr, line;
c%%    char image[45][111], image2[45][80];
      character IMAGE(NLMAX)*(NCMAX)
      data JX/1,1,1/
      data JY/2,3,4/
      data NP/15,15,15/
      data SYMBOL/'A','B','C'/
c     ------------------------------------------------------------------
      X = -3.14e0
      DX = 21.0e0/49.0e0
      do 10 I=1,15
        S = sin(X)
        XY(I,1) = X
        XY(I,2) = S+1.0e0 + 0.5e0*X
        XY(I,3) = 1.0e0 + 0.5e0*X
        XY(I,4) = S + 2.0e0 +X
        X = X+DX
   10 continue

c++ Code for ~.C. is active
      call SPRPL2(XY,15,KC,JX,JY,NP,SYMBOL,
     *    'Demo of SPRPL2 with NLINES = 45 and NCHARS = 110',
     *    'X VALUES','Y VALUES', 45, 110, IMAGE, IERR)
      print'(1x,a)',IMAGE
      print'(1x/1x)'
c
      call SPRPL2(XY,15,KC,JX,JY,NP,SYMBOL,
     *    'Demo of SPRPL2 with NLINES = 22 and NCHARS = 79',
     *    'X VALUES','Y VALUES', 22, 79, IMAGE, IERR)
      print'(1x,a)',(IMAGE(LINE)(1:79), LINE = 1,22)
c++ Code for .C. is inactive
c%%   sprpl2( (float *)xy, 15, KC, jx, jy, np, symbol,
c%%      "Demo of SPRPL2 with NLINES = 45 and NCHARS = 110",
c%%      "X VALUES", "Y VALUES", 45, 111, (byte*)image, &ierr );
c%%   for(line=0; line < 45; line++)
c%%      printf( "\n%111.111s", image[line] );
c%%   printf( " \n\n" );
c%%   sprpl2( (float *)xy, 15, KC, jx, jy, np, symbol,
c%%   "Demo of SPRPL2 with NLINES = 22 and NCHARS = 79",
c%%   "X VALUES", "Y VALUES", 22, 80, (byte*)image2, &ierr );
c%%   for (line = 0; line < 22; line++)
c%%      printf( "\n%80.80s", image2[line]);
c%%   printf( "\n" );
c++ End
      stop
      end
```

ODSPRPL2


Demo of SPRPL2 with NLINES = 45 and NCHARS = 110
6.
5.
4.
3.
2.
1.
0.
-1.
-2.
-4.
-3.
-2.
-1.
0
1.
2.
3.
X VALUES


Demo of SPRPL2 with NLINES = 22 and NCHARS = 79
6.