Interpolation program runs on HP41

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A program that can interpolate between points is an obvious asset when you're wading through tables of data. Such a program, for the HP41 calculator, is shown here (**figure**). Based on Lagrange's interpolation polynomial, it provides better accuracy than simple linear interpolation.

The Lagrange interpolation method is a polynomial that uses N given points, represented by (x_i,y_i) for i=1 to N, to generate an interpolated y value for an intermediate x value. The polynomial takes the form

$$P(x) = \sum_{i=1}^{N} y_i \prod_{\substack{k=1 \\ (k\neq i)}}^{N} \frac{(x - x_k)}{(x_i - x_k)}.$$

Each (x_i,y_i) point can represent data from a graph, a table or even a DATA statement in a FORTRAN or BASIC program. The subscript $k\neq i$ merely instructs you not to use the term $(x_i-x_k)/(x_i-x_k)$.

The implementation shown here limits N to five input points—usually more than adequate for accurate interpolation. Indeed, most cases require only three points to obtain good predictions. When the program runs, you enter intermediate x values, and the program returns corresponding interpolated y values.

To use the program, perform the following steps:

- Enter "EXQ LINTP" to start the program.

```
01      LBL LINTP
        LBL 00
        CLRG
        CF 01
05      NO. OF PNTS?      ;input N
        PROMPT
        STO 12
        ENTER
        6
10      X<=Y?
        GTO 06            ;too many points
        0
        STO 15            ;clear temp reg.
        Y1/X1 ?           ;1st pair
15      PROMPT
        XEQ 05            ;store pair
        FS ? 01           ;finished ?
        GTO 04            ;yes
        Y2/X2 ?           ;no
20      PROMPT
        XEQ 05            ;store next pair...
        FS ? 01
        GTO 04
        Y3/X3 ?
25      PROMPT
        XEQ 05
        FS ? 01
        GTO 04
        Y4/X4 ?
30      PROMPT
        XEQ 05
        FS ? 01
        GTO 04
        Y5/X5 ?
35      PROMPT
        XEQ 05
        FS ? 01
        GTO 04
        GTO 06            ;possible error?
```

Use this program on your HP41 calculator *to interpolate (x,y) values on a curve. Interpolated values come from a Lagrange polynomial which the program constructs from as many as five pairs of input points.*

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```
*
*Begin polynomial evaluation
*
40      LBL 04
        CF 01           ;reset complete flag
        X=?             ;prompt for x value
        PROMPT
        STO 13          ;save it
45      0
        STO 16          ;clear result reg.
        1
        STO 10          ;start with i=1
        LBL 03
50      1
        STO 15          ;temp result
        STO 11          ;start with k=1
        LBL 01
        RCL 10          ;i
55      RCL 11          ;k
        X=Y ?           ;i=k ?
        GTO 02          ;yes-so by pass
        XEQ 07          ;evaluate partial product
        ST* R15         ;store result
60      LBL 02
        RCL 12          ;N
        RCL 11          ;k
        1
        +
65      X>Y ?           ;k>N ?
        GTO 08          ;yes
        1               /
        ST+ 11          ;k=k+1
        GTO 01          ;go round
70      LBL 08
        RCL 10          ; 2*(i-1)+1
        2
        *
        1
75      -
        RCL IND X       ;find Yi
        ST* 15          ;complete product
        RCL 15          ;recover it
        ST+ 16          ;and save it in result reg
80      1
        ST+ 10          ;i=i+1
        RCL 12          ;N
        RCL 10
        X>Y ?           ;N<i ?
85      GTO 09          ;yes
        GTO 03          ;work on next term
*
*RESULT PHASE
*
        LBL 09
        Y=
        ARCL 16         ;show as Y=.....
90      PROMPT
        GTO 04          ;next Y(x) if required
*
*ERROR REPORT
*
        LBL 06
        BEEP
        *ERROR N>5*
95      AVIEW
        PSE
        PSE             ;wait a sec
        GTO 00          ;try again
*
*STORE SUBROUTINE FOR Y/X
*
        LBL 05          ;R15 holds the index
100     STO IND 15      ;store x
        X<>Y
        1
        ST+ 15          ; up index
        X<>Y
105     STO IND 15      ;store y
        1
        ST+ 15          ;up index
        RCL 15
        2
110     /
        RCL 12
        X<=Y ?          ;finished ?
        SF 01           ;yes - so set flag
        RTN             ;return with flag
*
*EVALUATE PARTIAL PRODUCT
*
115     LBL 07
        RCL 13          ;get x
        RCL 11          ;k
        1
        -
120     2
        *
        RCL IND X       ;Xk
        X<>Y
        RDN             ;position Xk
125     RCL 10          ;i
        1
        -
        2
        *
130     RCL IND X       ;Xi
        X<>Y
        RDN             ;position Xi
        X<>Y
        CHS
135     ENTER
        RDN             ;data now in position
        +               ;(Xi - Xk)
        RDN
        +               ;(X - Xk)
140     X<>Y
        RDN             ;position args
        X<>Y
        /               ;(X - Xk)/(Xi - Xk)
145     END             ;return with result
                        ;and end of programme.
```

- Enter a value for N in response to "NO. OF PNTS?"
- In response to each "Yi/Xi" prompt, put a y value into the Y register, an x value into the X register and press the R/S key.
- In response to the "X=?" prompt, enter an x value for which an interpolated y value is sought. The program will then perform the interpolation and display the result.
- Press the R/S key; program control will go to the preceding step, allowing interpolation of more y values. EDN

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