# A BASIC Program package for introducing the top-down Approach to Computer Programming

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In the summer of 1978, a program package was produced by six members of the class of course 1516, Programming Applications in Ontario Curricula, offered at the Ontario Institute for Studies in Education. The course participants were secondary school teachers of computer science or related subjects.

## REASONS FOR THIS PROJECT

The primary argument for producing this package is described by Cherniak (1976). He argued that students should be introduced to programming in a top-down manner if we expect them to use the top-down approach in their programming. He proposed a sequence in which students begin as users of computer programs, then write programs by calling high-level subroutines, and finally progress to investigate, modify, and create the subroutines themselves. Therefore, the primary reason for this project was a wish to construct a model program which could be used to illustrate the top-down approach. The model should be capable of being used as a package, as a set of high-level subroutines, or as a set of low-level subroutines to be modified, etc.

A second reason for this project was the desire of members of the class to obtain some experience in a group programming exercise. One element of this experience was to be the creation of a number of program modules and the other was to be the use of some type of team approach to the programming task. The latter was approximated by assigning the three major portions of the program, input, calculation, and output, to three groups of students. In this case one student worked on input, two on calculations, and two on output, with the sixth student serving a coordination - documentation function, and the instructor serving as team leader.

A further goal of this project was to demonstrate the use of a programming exercise which could serve as a vehicle for the learning of some other subject matter (see Ragsdale, 1976). It was also hoped that the package could be constructed so that variable subsets of the package could be used in order to increase the generality of its application. It was also intended to create a program which would allow students of various ability levels to make use of the program.

## METHOD OF GENERATING THIS PACKAGE

The program package was produced in the BASIC language. There were advantages and disadvantages associated with this decision. Obviously, the top-down approach could have been demonstrated more effectively in some other languages, such as PL/1. On the other hand, the availability of BASIC on many inexpensive computers makes it more likely that secondary schools could make use of a package programmed in BASIC. Since all of the participants in the course either had access to a computer which utilized BASIC or were likely to acquire a micro-computer system including BASIC, that language was chosen.

The program was created through each "group" programming individual modules which were combined by the coordination - documentation specialist. This latter person was also responsible for maintaining working documentation notes, which included descriptions of arrays and variables common to the three main routines, local variables, and line numbers assigned to the various modules (see appendix). He also created "dummy modules" and associated data which were used by the groups to debug their routines. Note that there was some error checking built into the subroutine calls, in that the string A$ was used to carry the name of the subroutine being called and A$ was checked to make sure it had the correct value when the subroutine was entered.

There are obvious limitations to this package, including the size (about 1000 lines) of the final program, the fact that subroutines in BASIC do not include the passing of arguments, and the level of difficulty in understanding the function of some of the modules.

## SUGGESTED USES

There are at least four possible uses for this top-down package. The first is to be used as a top-down introduction to programming. Students could begin by running the package, then write a program to call the highest level subroutines, then progress to the lower level routines, and finally, could modify or add subroutines to the package. The hoped for result is that this will encourage students to think about programming problems in this same top-down manner.

A second use is as a model programming package for any programming course, even when the introduction to top-down programming is not used. The package could be used as a framework in which students could be asked to modify subroutines or add new subroutines.

A third use of the program is as a package for a non-computer science course (in this case, statistics). Parts of the program could be modified by the instructor to show the students the effects of varying the form of calculation, etc.

Finally the package could be used as a starting point for expansion of the programs into some larger set of routines. In this case, a statistical library of routines might be the end product of such an expansion.

## References


Cherniak, B. Introductory programming reconsidered - a user-oriented approach. Joint issue of SIGCSE Bulletin, 1976, 8 (1) and SIGCUE Topics, 1976, 2, 65-68.

Ragsdale, R. G. Multi-disciplinary programming exercises. Joint issue of SIGCSE Bulletin, 1976, 8 (1) and SIGCUE Topics, 1976, 2, 295-297.


## Appendix

### Documentation for program PACKG

ARRAYS AND VARIABLES

GLOBAL VARIABLES GENERATED BY HIGH LEVEL ROUTINE
```
A$         - must contain the name of the subroutine being called
B$         - flag for rerun of program or termination
```

GLOBAL VARIABLES GENERATED BY INPUT ROUTINE
```
A(1,1-100) - contains the first vector input by the user
A(2,1-100) - contains the second vector input by the user
A1(1)      - contains the number of elements in row 1 of A
A1(2)      - contains the number of elements in row 2 of A
A3(1)      - estimated minimum value for elements in row 1 of A
A3(2)      - estimated minimum value for elements in row 2 of A
A4(1)      - estimated maximum value for elements in row 1 of A
A4(2)      - estimated maximum value for elements in row 2 of A
L$(1)      - contains the label for row 1
L$(2)      - contains the label for row 2
U$(1)      - contains the units for row 1
U$(2)      - contains the units for row 2
D(1)       - contains the number of significant digits in row 1
D(2)       - contains the number of significant digits in row 2
E          - 1 there is only one vector
           - 2 there is two vectors
```

GLOBAL VARIABLES GENERATED BY CALCULATION ROUTINE
```
A(3,1-100) - contains the elements of row 1 in ascending order
A(4,1-100) - contains the elements of row 2 in ascending order
A(5,1-100) - contains elements of row 2 matched with its
             corresponding elements in row 3
A(6,1-100) - contains elements of row 1 matched with its
             corresponding elements in row 4
G(1)       - contains the number of groups in row 1
G(2)       - contains the number of groups in row 2
```

```
G1(1)     - contains the lower boundary of the groups in row 1
G1(2)     - contains the lower boundary of the groups in row 2
G2(1)     - contains the increment value for the groups in row 1
G2(2)     - contains the increment value for the groups in row 2
H1(1)     - contains the upper boundary of the groups in row 1
H1(2)     - contains the upper boundary of the groups in row 2
F(1,1-15)- contains the frequency table for the groups in row 1
F(2,1-15)- contains the frequency table for the groups in row 2
M1(1)     - contains the mean for row 1
M1(2)     - contains the mean for row 2
M2(1)     - contains the median for row 1
M2(2)     - contains the median for row 2
M3(1,1-50)-contains the modes for row 1
M3(2,1-50)-contains the modes for row 2
M4(1)     - contains the number of modes in row 1
M4(2)     - contains the number of modes in row 2
M5(1)     - frequency of the mode(s) in row 1
M5(2)     - frequency of the mode(s) in row 2
S(1)      - contains the standard deviation for row 1
S(2)      - contains the standard deviation for row 2
V(1)      - contains the variance for row 1
V(2)      - contains the variance for row 2
C         - contains the correlation between row 1 and row 2
C1        - contains the covariance between row 1 and row 2
```

```
LOCAL VARIABLES
    INPUT
              X    - choice indicator
      LISTS
              X1   - counter subscript tagging vector 1 or 2
              X2   - counter of elements in a vector
      ORDERED PAIRS
              X1   - counter subscript tagging vector 1 or 2
              X2   - counter of elements in a vector
        MINTEST
              X1   - counter subscript tagging vector 1 or 2
              X2   - counter of elements in a vector
        MAXTEST
              X1   - counter subscript tagging vector 1 or 2
              X2   - counter of elements in a vector
    CALC
      MEAN
              Y3   - counter
      ST. DEV.
              Y3   - counter
      CORR.
              P1   - square root of the product of the variances
      MEDIAN
              Y3   - counter
              Y7   -temporary storage
              V1   -temporary storage
              V2   -temporary storage
              V3   -temporary storage
      MODE
              Y3   - counter
              I    - counter
              K    - counter
              V9(I)- frequency distribution of ordered raw scores
              L    -temporary storage
              J    -temporary storage
      GROUP FREQUENCY
              V5   - group number
              V6   - dummy variable for lower bound
        SUM
              I    - counter
              Y3   - counter
              Y4(1)- sum of elements in row 1
              Y4(2)- sum of elements in row 2
        VAR
              I    - counter
              Y3   - counter
              Y5(1)- sum of squared deviations from the mean in row 1
```

```
          Y5(2)- sum of squared deviations from the mean in row 2
    SORT
          Y0  - counter
          Y1  - counter
          Y2  -temporary storage
          Y3  - counter
          Y8  -temporary storage
    INCREMENT
          V3  - arbitrary divisor (1,2,5) for number of groups
          V4  - number of groups before rounding
    FACTOR
          V7  - dummy variable for sorted input
          P   - exponent for group calculation
    COVARIANCE
          I   - counter
          Y9  - sum of covariance
    LOWUPBND
          Y6  - intermediate variable in lower bound calculation
          Y8  -intermediate variable in upper bound calculation
OUTPUT
          Z1  - flag for A1(1)=0 and A1(2)=0
          Z2  - counter of vector number
  HEADINGS
          Z1  - flag for A1(1)=0 and A1(2)=0
  ECHO
          Z5  - the number of elements in the smallest vector
                A(1,I) or A(2,I) when they are not equal in size
  LITERALS
          Z1  - transfer of variables to and from SIGNIF. DIGITS
          Z2  - counter of vector number
  PLOT
          Z6  - the number of coincident points on the
                scatterplot at the particular location being
                considered
          Z7  - the number of printing symbols on the scatterplot
                for a single line of printing
          Z8(1,I)- the vector A(3,I) scaled between 1 and 25
                   for the scatterplot
          Z8(2,I)- the vector A(5,I) scaled between 1 and 50
                   for the scatterplot
          Z9$(I)- the printing symbols for the scatterplot in
                  their proper positions
  HISTO
          Z2  - counter of vector number
    LITSUB
          J   - counter for number of modes
          Z1  - dummy one dimensional variable used to pass numbers
                to subroutine sig. dig.
          Z2  - counter of vector number
    SCAL
          Z3  - range between max and min values of A(1,I)
          Z4  - range between max and min values of A(2,I)
          Z8(1,I)- vector A(3,I) scaled between 1 and 25 for
                   the scatterplot
          Z8(2,I)- vector A(5,I) scaled between 1 and 50 for
                   the scatterplot
    HISSCALE
          I   - counter for boundary loop
          J   - counter for boundary to maximum frequency comparison
          Z2  - counter of vector number
          Z4  - width of plotting bars
          Z3  - upper frequency boundary
    HISPLOT
          J   - counter of horizontal bars on histogram
          I   - counter for filling the horizontal print line
          Z6$ - print symbol > or blank
          Z7$ - print symbol > or blank
          Z8$ - print symbol * or blank
      FREQSCALE
          Z3  - upper frequency boundary
          Z7  - increment for frequency scale - actually a decrement
```

```
BOTTOM AXIS
    I   - counter for print line
    J   - counter for print line
    Z1  - transfer variables to and from SIGNIF. DIGITS
    Z2  - vector number
    Z4  - barwidth
    Z5  - scaling exponent if scaling occurs
    Z6  - boundary values
    Z9  - maximum boundary value
  SIGNIF. DIGITS
    K   - see comments
    Z0  - see comments
    Z1  - transfer of variables to and from the calling program
    Z2  - vector number
```

PROGRAM SEGMENTS (line numbers are five digits with the first digit indicating the level of the routine [0 is highest level, etc.] and the second digit indicating the function [1-3 is input, 4-6 is calculation, 7-9 is output].

```
00001-00099  - DIMension of variables and descriptions of variables
00100-00199  - Highest level routine
                :calls:
                  INPUT
                  CALC
                  OUTPUT
11000-11049  - INPUT routine
                :calls:
                  LISTS
                  ORDERED PAIRS
14000-16999  - CALC routine
                :calls:
                  MEAN
                  ST. DEV.
                  CORR.
                  MEDIAN
                  MODE
                  GROUP FREQUENCY
17000-17074  - OUTPUT routine
                :calls:
                  HEADINGS
                  ECHO
                  LITERALS
                  HISTO
                  PLOT
21000-21080  - LISTS
                :calls:
                  MINTEST
                  MAXTEST
22000-22220  - ORDERED PAIRS
                :calls:
                  MINTEST
                  MAXTEST
24000-24100  - MEAN
                :calls:
                  SUM
24300-24350  - ST. DEV.
                :calls:
                  VAR
24600-24710  - CORR.
                :calls:
                  COVARIANCE
24900-24990  - MEDIAN
                :calls:
                  SORT
25200-25280  - MODE
25500-25750  - GROUP FREQUENCY
                :calls:
                  FACTOR
                  LOWUPBND
                  INCREMENT
27000-27068  - HEADINGS
27300-27370  - ECHO
      27494  - LITERALS
                :calls:
                  LITSUB
                  SIGNIF. DIGITS
27600-27774  - PLOT
                :calls:
                  SCAL
27800-27828  - HISTO
                :calls:
                  HISSCALE
                  HISPLOT
31000-31035  - MINTEST
32000-32035  - MAXTEST
34000-34100  - SUM
34300-34350  - VAR
34900-35020  - SORT
35500-35710  - INCREMENT
35800-35866  - FACTOR
36000-36120  - COVARIANCE
36500-36640  - LOWUPBND
37400-37488  - LITSUB
                :calls:
                  SIGNIF. DIGITS
37600-37658  - SCAL
37800-37842  - HISSCALE
                :calls:
                  FREQSCALE
37900-37964  - HISPLOT
                :calls:
                  BOTTOM AXIS
47800-47838  - FREQSCALE
47900-48042  - BOTTOM AXIS
                :calls:
                  SIGNIF. DIGITS
57000-57048  - SIGNIF. DIGITS
99999         - END
```