Development of a BASIC Language Processing System in Accordance with ISO and its Aim

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Abstract.

The author prepared a BASIC language processing system in accordance with ISO to show that mathematics education in which Full BASIC is used can be executed. Most of the functions that ISO demands are implemented. Especially, almost all functions needed in mathematics education at the high school level are implemented.

The latest edition works on Microsoft Windows 95. This BASIC system is distributed via the Internet.

1. Aim of Research

1.1 Meaning of teaching computer programming

In mathematics education, the aim of teaching computer programming is not to train professional computer programmers but to give ordinary students the concept of algorithm and to make them able to use computer to probe mathematics. For instance, the proper use of the integer type and the floating-point type is indispensable for system developing but not so for probing mathematics.

Hence we need a refined language suitable to use in mathematics education. It should be a language for human to describe algorithm, to communicate algorithm with others. And it should be a tool for problem solving and exploration. Thus it must be able to describe algorithm easily, plainly, clearly and accurately. And as a tool, it must have sufficient built-in functions and a refined graphics instruction set. But we want no complicated languages such as those for system developing.

1.2 Problem of mathematics education in which N88-BASIC is used

Personal computer NEC PC-9801 series had been a de facto standard of the personal computer until several years ago in Japan. Many of people who had the concern in the computer were familiar with the programming in N88-BASIC, which was equipped by standard in the PC9801 series. Therefore, many people have taken N88-BASIC for BASIC. From the reason of which such people have promoted to take the computer into mathematics education, N88-BASIC or the interchangeable BASIC has been often used. As the compatibility with Microsoft BASIC was put stress on, the basis part of the grammar of N88-BASIC is the same as of Microsoft BASIC.

However, the use of N88-BASIC or the interchangeable BASIC in mathematics education is not recommendable. That is, N88-BASIC or the interchangeable BASIC is unsuitable for describing algorithm and for probing mathematics.

Of course, it is one of the reasons that N88-BASIC is old-fashioned unstructured BASIC. However, there are some problems in another properties. It is grounds by which N88-BASIC is judged to be unsuitable that there are the following problems, many of which also apply to other Microsoft compatible BASIC.

The first is the grammar of Microsoft compatible.

For instance, when ' IF 1<A<4 THEN PRINT "Y" ' is executed, 'Y' is displayed on the screen regardless of the value of variable A because the truth values are treated as part of the numeric (truth becomes -1, and false becomes 0). In a word, the inequality may be interpreted in N88-BASIC as a meaning different from the inequality in usual mathematics.

Besides mentioned above, Microsoft compatible BASIC conceives some elements to make the beginner bewildered in the syntax of numerical expressions, IF-statements or the grammar of multi-statements.

In N88-BASIC, as in Microsoft BASIC, there are three types of numerical values, the single precision type, the double precision type, and the integer type. Because a syntax error occurs when a double precision variable is specified for a FOR-statement, the programming with double precision is considerably troublesome. Because we often want to use double precision for the questions that relate to mathematics, this character is undesirable.

The Second is the accuracy of the power operation and some built-in functions such as SQR(). On N88-BASIC A^2 dose not agree with A*A, and SQR(A*A) dose not agree with A. Therefore, the program written without assuming the calculation to be inaccurate does not operate correctly. This is an unfavorable character to describe algorithm or to use the computer as a tool for exploration.

The third is the coordinate system of graphics. The positive direction of y-axis is downward. This is different from the standard in mathematics. Thus, a program that draws the graph of a function or a curve expressed by an expression becomes troublesome.

Finally, numerical values are approximated by binary floating-points, though this is a common character of most language processing systems. But this is a characteristic that is beyond understanding of ordinary high school students. It might be impossible that students master the computer as a tool for exploration if they can not use easily at the level of knowledge that the computer can treat the numerical value only by a limited digit.

1.3 Current state in Japan

In present Course of Study, the national study guideline, which have been executed since 1994, two optional areas called "Calculation and computers" and "Algorithm and computers" were introduced to high school Mathematics.

And BASIC programs written in the grammar of Microsoft Corporation were set in

the first Center Examination for the new course executed in the spring of 1997. Center Examination is the unified entrance examination in which all national universities and many private universities participate, and hence has much influence.

From mathematical viewpoint those were easy. However, those programs were written in the original grammar of Microsoft not permitted in the Japanese Industrial Standard (JIS) such as a substitution statement that omits LET, a multi-statement, or an INPUT-statement with Microsoft syntax. One of these will be shown in the appendix of this article. Because it is easy to write the content that those programs intend to agree with regulations of JIS, it seems that the purpose of those questions were to test whether the examinee knew Microsoft BASIC.

The questions relating to computers were some of the multiple-choice questions. Although few applicants seemed to select those, as those were relatively easy, the number of the applicants who select the question related computers might increase in future.

1.4 Selection of language

We need both of the ability of describing algorithm and the practical mechanism such as graphics. Center for Educational Computing (in Japan) proposed a new specification for BASIC language, which is called CEC-BASIC'90 [1]. It can be considered as a structured edition of N88-BASIC. That is to say, The Compatibility with N88-BASIC is given priority. For instance, the comparison operation is an arithmetic operation in CEC-BASIC'90. Thus this specification is not valuable except for those who have got skilled in N88-BASIC.

Pascal is a language generally used in computer science. It has a good ability of describing algorithm, but no standard exist about graphics. Pascal is good at system describing but not at application.

C is a language in vogue. But C has a lot of pitfalls for amateur programmers. C has superior capacity but it is hard to master.

Thus these languages should be out of considering. I think it preferable to use not Microsoft interchangeable BASIC as N88-BASIC but Full BASIC.

Full BASIC is new international standard (ISO) for BASIC language. The industrial standard (JIS) corresponding to ISO is enacted at 1993 in Japan [2].

2. About Full BASIC

2.1 Several Reasons of recommending Full BASIC

The first reason of recommending Full BASIC is that it is the international standard. Having common language will give us a benefit. But the reason does not consist of it only. Full BASIC has a lot of favorite characters.

The major characteristic of Full BASIC is that it is a structured edition of BASIC. It has the control structure that suits the structured programming and the procedure

definition provides us with the recursive call.

In addition, Full BASIC seems to be designed as a human language to describe algorithm. For instance, the use of abbreviations and symbols is suppressed, and a comprehensible expression of full spelling is assumed to be a principle though there is a fault that the time and labor of typing increases. Moreover, reserved words are suppressed, and it comes to be easy to reflect user's favor in the program. For instance, any function defined in a DEF statement is permitted to be named as f(x) or g(x) in Full BASIC while its name should start with FN as FNF(x) in N88-BASIC.

The grammar is devised never to cause the difference in the interpretation of the meaning of the program between the user who does not know details of the language and the computer. For instance, the result of the comparison operation is not compatible to the numerical value, any IF-statement cannot be followed by an IF-statement after THEN, and no multi-statement is allowed.

2.2 Decimal operation and guarantee of accuracy

In Full BASIC, a numeric variable takes a value of decimal floating point. Decimal fractions are treated accurately. The concept of the type of numerical values like the integer type does not exist.

The accuracy of the calculation result is rigorously prescribed in Full BASIC. Thus no problem will be caused in most cases even if one considers that the result is accurately rounded off for a single operation. Especially, the result of an operation is guaranteed to be true when the true value can be expressed within the precision. For instance, the following is a right program that outputs Pythagorean numbers.

```
10 FOR X=1 TO 100
20 FOR Y=X TO 100
30 LET Z=SQR(X^2+Y^2)
40 IF INT(Z)=Z THEN PRINT X,Y,Z
50 NEXT Y
60 NEXT X
70 END
```

Therefore, to write the program of the search purpose, special knowledge concerning the calculation of the computer is rarely demanded.

2.3 Supplied functions

It is merit of Full BASIC that wealthy built-in functions are supplied. For example, the arcsine, the arccosine, the common logarithm, and the function that returns the argument in the polar coordinates, etc. are prepared. Moreover, the instruction to change the unit of the magnitude of angles to degrees is prepared.

2.4 Graphics

The graphics instructions are standardized in suitable form for taking up the problem which relates to mathematics.

The coordinate system of the graphics is a problem coordinate system, which the user sets. Therefore, the position of a point can be specified with mathematical coordinates.

The shape of the drawing area is a square when not especially specified. Thus, The phenomenon that the figures obtained by executing a same program is not similar by reason of the difference of the length and breadth ratio of the display device can not be brought about.

Picture and its transform is a peculiar mechanism equipped with Full BASIC. A picture is a variety of subprograms. We can define a drawing procedure as a picture, and we can transform it with SHIFT, SCALE, ROTATE, and SHEAR functions and transformation matrices. As a picture allows recursive call, we can use this mechanism to draw self-similar figures [3].

3. The Realized System

3.1 Outline of the realized system

The author prepared a BASIC language processing system that is in accordance with JIS [4]. The first edition worked on PC-9801 with MS-DOS. The second edition was a 16-bit program working on Microsoft Windows 3.1. The latest edition is a 32-bit program working on Microsoft Windows 95.

Hereafter, we describe the outline based on the latest Windows 95 edition.

The prepared BASIC was developed with Delphi, which is the object-oriented Pascal language that Borland Inc. developed. It is a compiler that internally generates some objects of Delphi. Generated objects are designed to operate in autonomy. The routine of the decimal operation, on which high speed is demanded, is described in the assembly language.

This system has not conformed to JIS perfectly while almost all of the mechanisms that JIS demands are implemented and almost all of the implemented mechanisms operate according to prescript of JIS. On this system, JIS is respected to the maximum.

3.2 Language specification

The precision of a numeric variable is decimal 15 digits. It is also possible to use the floating-point arithmetic of hardware by specifying ARITHMETIC NATIVE for the OPTION statement. All numeric supplied functions of JIS Full BASIC are prepared.

The matrices operation and the array input-output also have been implemented. Function definitions, Subprograms, and picture definitions are implemented according to prescript of JIS. Of course, recursion call is possible. The mechanism of exception handling is also prepared according to JIS.

Major instructions about graphics are selected and prepared to draw the graph of a function or the curve. Transformation of a figure by a DRAW statement is also

possible.

The mechanism to treat the character strings and the text files are prepared intending this system to spread by bringing close to the level which JIS demands even a little. Only few differences with JIS exist for those also.

3.3 Enlargement of language specification

The grammar is enlarged within the extent where the intention of Full BASIC is not ruined. For example, the omission of the line-number is permitted. But the syntax of multi-statement is not adopted.

The decimal 1000 digit mode and the complex number mode are prepared as original modes of this BASIC.

In the decimal 1000 digit mode, the calculation of a square root and the integer power are possible though the transcendental functions cannot be used. The decimal 1000 digit mode is suitable for treating the problem concerning the integer and the topic concerning the approximation calculation.

In the complex number mode, a high-speed calculation of the complex number is possible. Supplied functions SQR(), EXP(), LOG() are extended to the complex numbers, and several functions are added. Transformation functions SHIFT() and SCALE() are also extended to the complex numbers. But this enlargement has not harmed JIS except the domains of some functions are extended. No reserved word is added, which is required by JIS.

3.4 Operating environment

The files necessary for execution of BASIC are only the main body EXE file and the help file. This system operates without forwarding a special file such as DLL to the Windows system folder. AS the files are small and no registry entry is required, this system can start from a floppy disk. Thus the student can carry this system in a floppy disk.

This BASIC is a program with GUI. No line-number is used for the input and the correction of the program. After the program is executed, the execution results of PRINT statements are put out to another window. The whole of those can be read by scrolling after execution. Moreover, the result can be printed out to the printer, written to the file, and passed to other software via the clipboard. The execution result of the graphics is put out to a square window besides the output of the PRINT statements.

This BASIC prepares debugging mechanism. It can be handled easily. As the menu system is effective even if the program is executing, one can order the interruption from the menu. When the execution of the program is interrupted, the values of all variables of the internal procedure and the program unit running now are displayed. The operation of the program can be traced by choosing the step execution from that state. The operation of the program also can be traced by selecting the step

execution command on the menu instead of selecting the run command.

To help the shift from N88-BASIC, the mechanism to correct no-LET substitution statements, multi-statements and so on are prepared.

Conclusion

The prepared BASIC system is distributed via the web site http://www.vector.co.jp/authors/VA008683/ and others.

As a result of this, this BASIC is used by a lot of people, who are not only mathematics educators but also physics educators, factory engineers, and so on. While educational use in mathematics is delayed, I recently found a web page that shows the educational use of this BASIC. That page is http://www.nikonet.or.jp/spring/10b_grp/10b_grp.htm .

Although these attempts give no help or some obstacles to increase the score of Center Examination, those attempts are seem to be necessary to make progress in mathematics education. I hope these attempts to expand more.

This BASIC system has only Japanese version now. English version may be prepared before long.

I hope more educators to understand the advantage of Full BASIC.

References (all in Japanese)

[1] Center for Educational Computing: 1990, CEC-BASIC'90 specification edition of Investigation report concerning the function of the computer system used at school, Center for Educational Computing

[2] Japanese Industrial Standards Committee: 1993, the Programming Language Full BASIC JIS X 3003-1993, Japanese Standards Association

[3] Shiraishi Kazuo: 1996, Possibility of geometry education in which self-similar figures are used, the 5th issue of Bulletin of Bunkyo University Institute of Educational Research, 1-6

[4] Shiraishi Kazuo: 1996, A BASIC language system which works on Windows environment, the 30th Annual Report of The Faculty of Education Bunkyo University, 34-40

Note

The international standards corresponding to Full BASIC are the following. This note is due to JIS Full BASIC. ISO/IEC 10279:1991(E) Information technology - Programming languages - Full BASIC ANSI X3.113-1987 Information Systems - Programming languages - Full BASIC ECMA-116 BASIC-ECMA BASIC-1, ECMA BASIC-2, ECMA Graphics Module (1986)

Appendix

An example of questions posed on Center Examination.

The sixth question for Mathematics 2 & B on the supplementary examination 1997
|_| stands for a blank to be filled in with one numeric.

When the following program is executed, input of a number is demanded twice. Assuming that two positive integers are input, answer the questions below.

```
110 INPUT "n=";N
120 INPUT "f=";F
130 D=0
140 FOR I=1 TO N
150     X=I :C=0
160     IF X=INT(X/F)*F THEN X=INT(X/F) :C=C+1 :GOTO 160
170     IF C0 THEN PRINT C
180     D=D+C
190 NEXT I
200 PRINT "d=";D
210 END
```

(1) If the input for 'n=?' is 30 and the input for 'f=?' is 5, then '1' is displayed |_| times and '2' |_| times, and 'd=|_|' is displayed at the last.

(2) If the input for 'n=?' is 300 and the input for 'f=?' is 7, then 'd=|_||_|' is displayed at the last.

(3) Assume that if the input for 'n=?' is some number k and the input for 'f=?' is 7, then 'd=|_||_| (these blanks coincide with those in (2))' is displayed at the last. The number of such k is |_|, and the smallest of such k is |_||_||_|.