Graphing Calculator and the Algorithmic Questions in the 2010 China College Entrance Examination

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Abstract: *Algorithm is not only an important part of mathematics and its application but also an important foundation for computer science. As we can see, traditional teaching methods have obvious drawbacks when applied in algorithms teaching, and graphing calculator programming function can successfully allow students experience the transition process from mathematical algorithms to computer algorithms. The combination of Graphing calculator and mathematical algorithms teaching can help students understand and grasp the concept of algorithm and develop their application capability at the same time. In this paper, we take the algorithmic questions form 2010 Chinese University Entrance as an example to explore the application of Graphing calculator.*

A set of feasible, identified, and finite rules of model analysis were called algorithm ([1]). Generally speaking, algorithm can be considered as a complete problem-solving process composed of basic operations and operation orders; it can also be seen as a designed, finite, definite calculation sequence which can solve one kind of problems.

Algorithm is not only an important part of mathematics and its application, but also an important foundation for computer science. Although "Preliminary algorithm" is the new curriculum newly add in, it is closely related to the previous knowledge that students have learned, and also very closely related to the practical issues. Therefore, preliminary algorithm is the new bright spot of University Entrance Examination, as it can integrate function, sequence, probability and real-life problems. Furthermore, such questions also follow the principle question formulation of exam," formulate questions in the knowledge intersection point", which not only correspond with the starting point of "capacity" of University Entrance Examination but also highlights the characteristics of mathematical discipline.

However, the drawbacks of traditional teaching method obviously manifested out in algorithmic teaching: monotonous, cumbersome, emphasizing too much on theory and restrain practice, so students' understanding often stays on the surface level, such as concepts and definitions, and easily be confused in application. Education can promote the development of science, and in return, the development of science can provide more technical support for education. The emergence of graphing calculator is a good example to explain this. "Graphing calculator, is a handheld mathematical tool, more specifically, is designed for mathematics learning and teaching (secondary and university)" (see [2]). Graphing calculator has features such as: "Portable, real-time, accurate, comprehensive, intuitive" (see [3]) and so on, use graphing calculator programming function can successfully let students experience the transition process from mathematical algorithms to computer algorithms, understand the necessity of algorithm in operations, grasp basic contents of algorithm(structure, diagram, language, etc.), and understand basic ideas and operation process of algorithm.

We shall utilize the model of graphing calculator (HP39gs) to explore some algorithmic questions in the 2010 University Entrance Examination. Algorithm questions in the 2010 University Entrance Examination are mostly in the forms of multiple choices and filling the blanks. The questions are from easy to moderate level and primarily designed to test students' knowledge in Algorithm, particularly the concept of algorithm, flow chart and basic algorithm statement. As for the item forms, there are two main forms: one is to fill the blanks, to finish incomplete program or algorithm statement; and the other is problem solving in order to access students' ability to read the block diagram and algorithm statements. The second form can be solved with a graphing calculator.

Example 1 (Jiangsu Province): You can see a flow chart of the algorithm on the right, and then the output value of S is ____▲____.

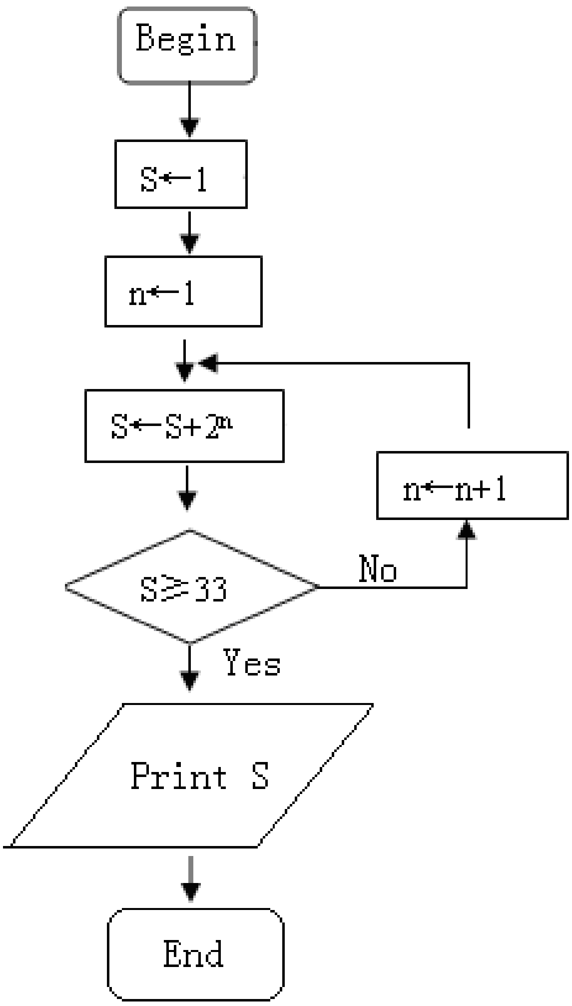

Figure 1

Analysis: This item tests the content of flow chart and loop statement.

We can solve this problem with the help of graphing calculator. First of all, open the graphing calculator's programming function to name the program; in this case we named it "LI1". Second, follow the block diagram to compile procedures and change it into calculator language. In this case, the difficulty is to compile the "Loop" programming statement, here we choose "Do-Until-End" loop statement, the program as shown below:

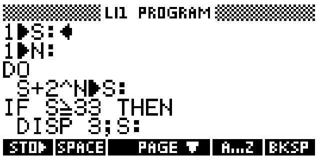

Figure 2

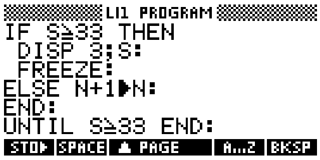

Figure 3

And finally, we debug, and run the program. The final result is 63.

If we follow the block diagram to compile program, we will find that this program structure is not very clear. We can learn by carefully analyze the block diagram that N ← N +1 can be placed on the conditions part of the loop. Then we can consider using "FOR" loop to solve this problem. According to the block diagram, we can estimate, the maximum value of N will not surpass 5 (because $2^5 +1 = 33$, of course, a larger number can be given, will not affect the final results). Procedure as shown below:

Figure 4

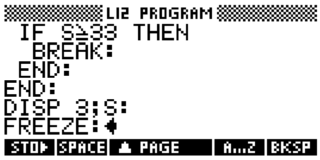

Figure 5

Although these two methods can help us in obtaining the final structure, but it is obvious that the program is not the best. The first method seems very complicated, for "S ≥ 33" was used twice. Even though "S ≥ 33" was used only once in the second method but the judgment of upper limit of N still needs certain experience. Is there a better algorithm so that "S ≥ 33" can be used only once and we don't need to judge N? When we check the block diagram carefully, we can find that if we change the block diagram into the one below, we can easily use the "While-Repeat-End" statement to compile the program. Procedure is shown on figure 6, 7 and 8 (next page):

Comparing with above mentioned two methods, this method seems to be simpler and easier for students to use, but it requires students to have a comprehensive understanding of algorithm block diagram and can make equivalent transformations of block diagrams. The key point is that the transformation between S ≥ 33 and S ≤ 33 and students need to grasp this point during operations.

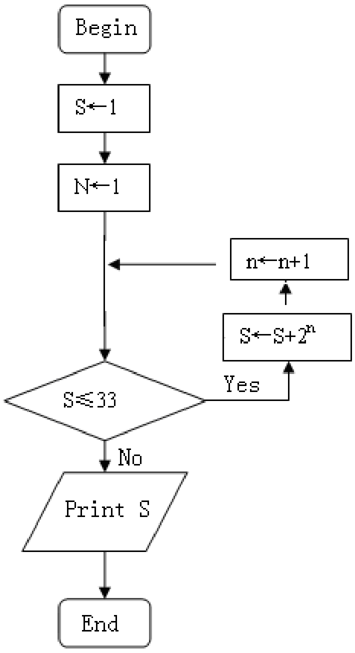

Figure 6

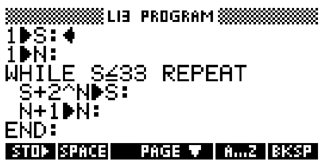

Figure 7

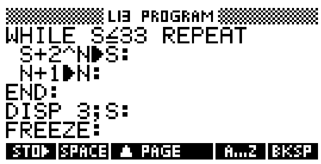

Figure 8

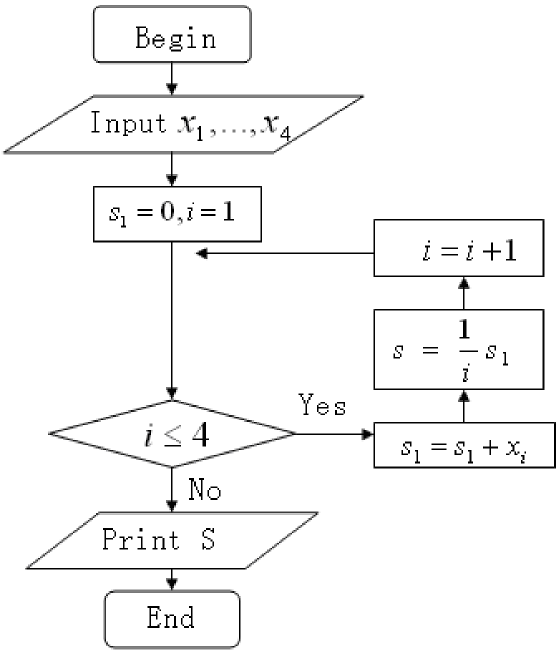

Figure 9

Example 2 (Guangdong Province): City A has a prominent water shortage problem, in order to make new ways to save water, there is a sample survey about average water consumption per month in a year by the residents. Statistics from four residents are shown as following: x_1, ……, x_4 (Unit: tons). According to the block diagram shown in Figure 2, if the value of x_1, x_2, x_3, x_4 ,are 1,1.5,1.5,2, then the output S is_________.

Analysis: This question not only combines algorithm with sequence knowledge, but also has the statistics background. This problem is no more difficult than the previous one, however it is more difficult to solve this problem with Graphing calculator. This is because Graphing calculators cannot define in the program and denote array directly. To solve problems that involved array, first we need to assign the array with the initial value in the list panel and then you can run and call the array in the program.

Following previously stated steps: First of all, open the Graphing calculator's programming function to name the program, in this case we named it "A1". Secondly, follow the block diagram to compile procedures and change it into calculator language. In this case, the difficulty is to define and transfer the array. We can press SHIFT + 7, into the array interface, then open "L1", to assign the first four elements of array with values shown in figure 10 :

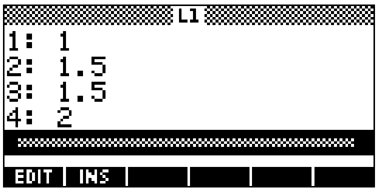

Figure 10

You can then use arrays "L1" in the program and, x_1 in diagram corresponds with "L1 (1)", x_2 in diagram corresponds with "L1 (2)"……; S_i in diagram corresponds with "A". In order to observe the program operation carefully, I added the first output statement: DISP 1; "X (" I ") =" L1 (I). Procedures are shown below:

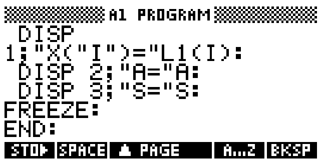

Figure 11 **Figure 12**

To finish, debug and run the program, the outcome is 1.5.

Needless to say, the above discussed two problems can also be solved by reasoning without using

Graphing calculator. My conclusion is, the usage of Graphing calculator will greatly reduce the difficulty of the problem, stimulate students' interest in mathematics learning and boost students' confidence at the same time.

Algorithm thinking is becoming one of the mathematical literacies that everyone should have in modern times. The combination of algorithms and mathematics demonstrates the innovative ideas of University Entrance Examination. Teachers should use Graphing calculator consciously for CAI. The combination of Graphing calculator and mathematical algorithms teaching is a good way to help students understand and grasp algorithmic concept, develop students' ability of application, and build a good foundation for their study of computer technology in the future.

References

[1] http://baike.baidu.com/view/7420.htm?fr=ala0_1(2010-7-22).

[2] Changpei Wang, *Graphing calculator is an irreplaceable mathematics tool?* Journal of Elementary and Secondary School Information Technology Education, 2007 (3).

[3] Shaobing Wu, *The properties research of Graphing calculator using in classroom*, Journal of Mathematics Education, 2009 (2).