

To Make APLET according to Actual Condition
——Design and Thinking for Vector APLET and Stem-and-Leaf diagram APLET

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Abstract:

When we use Aplets carried by HP39GS, it is compact, convenient and easy to use. These classical programs are thought over and refined again and again then developed basing on plentiful teaching experience. With this in mind teaching content and test of math all over the country are different, for example, there is no division for Art and Science in Jiangsu Province, what's more, dihedral angle is a point in the College Entrance Examination in Sichuan Province but is not required in Fujian. On the other hand, HP39GS does not have programs like Vector APLET and solid geometry.. We therefore have to develop the APLETs that suit local education according to the actual situation so as to ensure the students use it frequently and correctly. In Fujian Quanzhou No. 7 Middle School, we use APLET's as often as possible and even create the possibility to use them while there is no indication of compliance with "Fujian College Entrance Exam Illustration" . The writer integrated a study situation in the class to develop independently several APLET program along with using them in normal teaching. With many revision and improvement in teaching practices, it leads to good teaching and learning practice.

Key Words: HP39GS, APLET, Develop Independently, Vector APLET, Stem-and-Leaf Diagram APLET

Body:

The essence of math originates from life practice. Through abstract concepts, the theory of math is found basing on an axiomatized system. In the "Exam Illustration 2011", "Abstract Generalize" is definitely expatiated as one separate item of math abilities as well as one of the six abilities' examined by College Entrance Exam.

The understanding of abstract concepts in the past was difficult, especially some unknown modes. For example, the students could easily learn the index concept easily when they studied the index function, but could not understand the logarithmic concept when it is time to study it. In addition, the students know what a line segment is, but cannot understand vector if an "orientation" condition is added. We find the students' ability to understand abstract concept is quite weak. The average scores used to be very low with respect to the creative questions in yearly College Entrance Exam mainly because we lack one intuitionistic tool to explain abstract questions. We usually ask the student to just do the mathematics. It is often said "no reason, just recite". In this respect, students could only learn content of concept but neglect the reason. Therefore we can use HP39GS to help the students to understand abstract concepts so as to further improve their modeling abilities. The HP 39 GS is a visual tool which allows understanding of mathematical

concepts.

In the writer's class, students were found using the HP39GS to answer math questions. Even Some students are able to edit programs and search for the rule and guess the answer, or understand math concepts. This ensures the students learn knowledge in a stable environment understanding the concept deeply, and study with equalpassion. In turn, the teaching pedagogy is heightened. It is assumed that students have initially learned how to use HP39GS analyze questions, then generalize and use experience after they are able to use HP39GS. The function of HP39GS is not only limited to data process but could be used for data collection and question research. Based on this thinking, two programs have been studied, i.e. Original work of Vector APLET and Stem-and-Leaf diagram APLET that are displayed below.

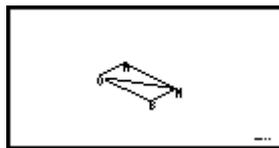
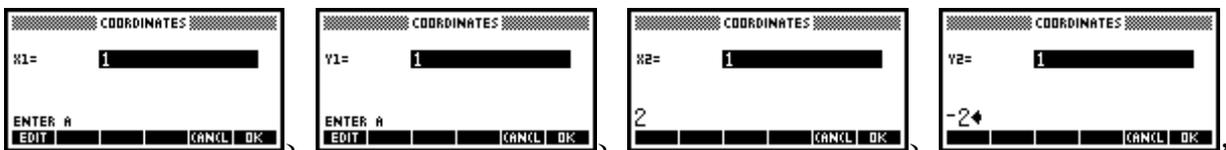
1. Vector APLET

Further to concept of vector, our teaching requires the arithmetic of a vector. Vector and quantity in Physics are usually taught while explaining how to apply the quadrangle and triangle principle into addition and subtraction of vector.

The principle of addition of vectors is usually analyzed with the composition of force, which is on the level of cognition. A thought comes to mind at this time that the students are able to conclude the Principle of Parallelogram by operating the HP39GS and observing the results. As a result, the students would be able to handle the addition of vector more thoroughly by comparison with the composition of force.

There is no default vector aplet on board the HP 39 GS. So a program of addition of vectors was developed, from the original APLET matrix.

Fix the origin (0, 0), and input the coordinates of the endpoint: $A(x_1, y_1)$ and $B(x_2, y_2)$:



the vector is gained: $\vec{OM} = \vec{OA} + \vec{OB}$: . After several operations, the students easily found the principle of the addition of vectors, which is the diagonal of the Parallelogram. With further teaching processes, the multiplication of a vector and a number is calculated, including the geometry meaning of 数乘, and which came to the design of a relative program.

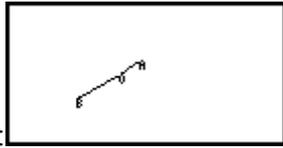


Draw the figure of \vec{OA}

suggest to input Multiplication value $\lambda = -2$:



gain the figure of $\lambda \vec{OA} (\lambda < 0)$ and \vec{OA} :



the same method to gain the figure of:



It is easy to get the geometry character of λ . Compared to the oral analysis by the teacher and the difficult knowledge-getting process, it allowed the students to do experiments with the HP39GS, observe, note the results and draw a conclusion in group work, which in turn turns listening to learn into experimenting to learn.

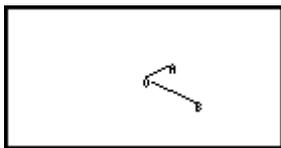
After dealing with the concept of Point multiplication、norm、angle, the design of these program processes are: Figure out the Point multiplication、norm、angle. It is worth mentioning that students seldom mistake the vector $\vec{a} \cdot \vec{b}$ as number.

Finally, a simple function 'plane APLET' came to exist by combination of some short programs.

input coordinates of "A" and "B"

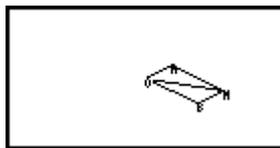


so we can get vector \vec{OA} and vector \vec{OB} :



then plus any key to get hint pressing "Key 1"; to get the subtraction by pressing "Key 2"; and obtain modulus of $\vec{OA} \cdot \vec{OB}$ by pressing "Key 3"; to get included angle by pressing "Key 4".

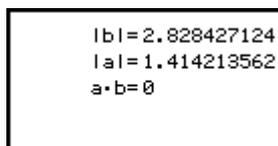
a) Sum::



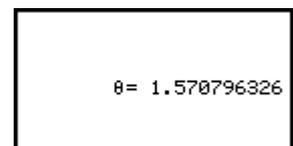
b) Subtract:

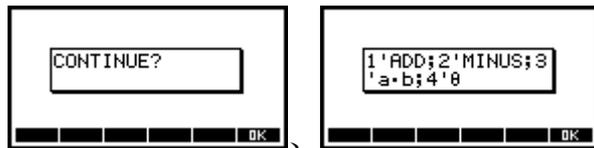


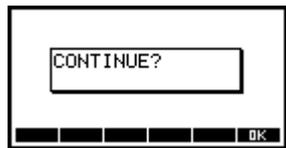
c) Quantitative product and modulus:



d) angle:





e) Hint Key and Exit Key  ,  ; Exit “•”. 【Refer to Attached 1】 .

With expansion of knowledge , I found that there are many knowledge modules that could be incorporated with vectors, for example, solid geometry space right angle coordinate series, line equation, trigonometric function, taper curve and so on. Therefore I am thinking if possible to expand the vector APLET so as to further optimize the program. The plane vector is usually a problem in vacuum vector teaching. The difficult calculation inspired me to develop a ‘space vector APLET’, which especially is to deal with the formalistic solution to solid geometry problems in The Fujian Province. The solution to build series then drawing dots and finally work out the solution with a formula. So the coordinate space geometry becomes the new focus of the research. On the other hand, to use an array function to program basing on the design principle of the Plane APLET seems difficult so I optimized “Plane Vectors APLET” from another side and obtained “Space Vectors APLET” to handle space coordinate issue and complete “Vectors APLET”. Using Question 17 in Fujian Quanzhou Quality Control Examination in 2010 as an example,

【Example1】 Figure and 3D drawing of Quad-pyramid $P-ABCD$ are provided as below,

1) Prove: Plane $PBD \perp PAC$

2) To make a beeline $CE \perp AP$ via C joint AP at E, then work out $\sin()$ of angle between Beeline BE and Plan PBD .

Let me handle the second questions here, regard C as coordinate origin, and the Beeline where CD 、 CB 、 CP are as x 、 y 、 z , then build a space right angle coordinate series, so we can get all coordinates $A(1,1,0)$ 、 $B(0,1,0)$ 、 $C(0,0,0)$ 、 $D(1,0,0)$ 、 $P(0,0,2)$. Use $CE \perp AP$ to get $E(\frac{2}{3}, \frac{2}{3}, \frac{2}{3})$.

Below indicates how to use the vector APLET to work out normal vectors of Plan PBD through $CE \perp AP$:



At first enter coordinate $P(0,0,2)$



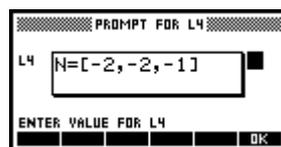
then enter coordinate $B(0,1,0)$



enter once again $P(0,0,2)$



; finally enter



vector from Plan PBD from dialog box turned out: $\vec{n} = \{-2, -2, -1\}$ 【Refer to

attached 2】 then we can further analyze included angle between vector $\vec{BE} = (\frac{2}{3}, \frac{2}{3}, \frac{2}{3})$ and normal



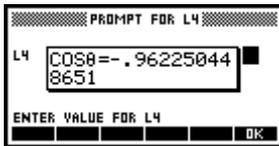
vector of Plan PBD $\vec{n} = \{-2, -2, -1\}$: Enter Origination coordinate and



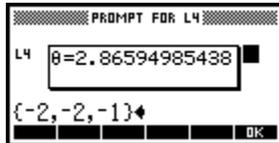
Termination coordinate, i.e. $\vec{BE} = (\frac{2}{3}, \frac{2}{3}, \frac{2}{3})$, in the same way enter normal



vector $\vec{n} = \{2, 2, 1\}$ of Plan PBD, then get cos():



of included angle between two vectors from dialog box turned out and



included angle **【Refer to attached 3】**

In this way, one APLET that is suitable to understand the operation and concepts for vectors has come into being. This program applies different programming principles in editing from plan vector to space vector.³ The vector APLET is suitable for upper data calculation (normal vector), as well as basic concept forming (the geometry meaning of addition and Multiplication of a number and a vector in vector form). Because the results in these programs are all decimal fractions, the students can make good use of vector APLET. This can minimize the negative influence of the calculating ability of the students. The 'vector APLET' and the 'trigonometric function APLET' have something in common, firstly, they both deal with the abstract concept by combining the data and figure, and secondly, they both enhance the concept by drawing a conclusion about the principle. Most importantly, they are good tools for students to study, conclude and gain the knowledge independently. However thinking twice about it the "Vector APLET", for example, due to limit of screen pixel and beeline that use to be shown as folding line so picture looks coarse. In addition, vectors can only be shown with line OM (Vector from O to M) in this program; Furthermore, it cannot be as well as the interface of "Triangle APLET" which has a function of soft keyboard.

II. Stem-and-Leaf diagram APLET

Three kinds of figures need to be examined in middle school, frequency distribution chart, histogram, and stem-and-leaf diagram. Since the default Statistics aplet in the HP 39gs is good but cannot sketch stem and leaf plots. So I decided to design a Stem-and-Leaf diagram APLET. In addition, one of writer's passages specially indicates how to use Boxplot. This function is also an APLET carried by HP39GS itself and usually used for practice. Using Question 18 on Arts Quality Control Exam of Senior 2009 as an example,

【Example】 Student A and Student B participate in Math Competition Training, during when

their pre-competition score records are as below,

A	82	82	79	95	87
B	95	75	80	90	85

- (I) Please demonstrate these two group of data with Stem-and-Leaf diagram
- (II) Randomly choose one among A and B's scores and work out the probability that A's score is higher than B;
- (III) In the point of view of statistics, who do you think is the most suitable students to send for one student to participate the competition? Please explain why.

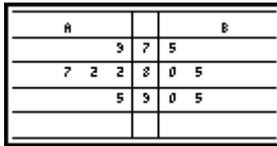
Handle it with Stem-and-Leaf diagram APLET program,



At first enter data of Group A (Disordered enter is allowed): ; a hint of entering data of

Group B (Disordered enter is allowed): ; draw the Stem-and-Leaf diagram



distribution chart: . Following I use the strong data process function of

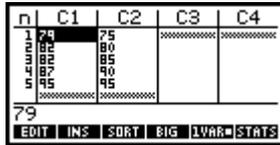
A		B
7	9 7 5	
8	2 2 8 0 5	
9	5 9 0 5	

“Statistics APELT” to process the data: Start the Stat. APLET:  (This is



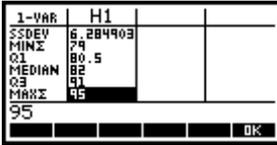
processed with the array saved into Stat. Array in advance, while the programming could be accessed with simple orders: ) undoubtedly logically, we find the data in Stat.



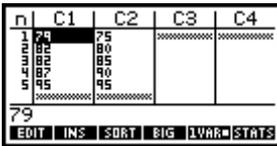
APLET, : , now let's analyze data of Group A

n	C1	C2	C3	C4
1	79	75		
2	82	80		
3	82	85		
4	87	90		
5	95	95		

1-VAR	H1
NΣ	5
TOTΣ	425
MEANΣ	85
VARΣ	31.6
SVARΣ	39.5
SDDEV	5.621388

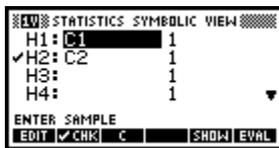
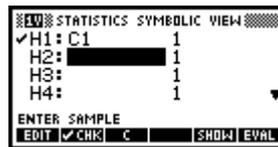
, with the analyses of Data A is finished. Let is return to

1-VAR	H1
SDDEV	5.284903
MINΣ	74
Q1	80.5
MEDIAN	82
Q3	87
MAXΣ	95

, and analyze data of Group B: At first we need to order the HP39GS to

n	C1	C2	C3	C4
1	74	75		
2	82	80		
3	82	85		
4	87	90		
5	95	95		

analyze data of Group B and press the Note Key to get:



by choosing C2; return to data group:

n	C1	C2	C3	C4
1	79	75		
2	82	80		
3	85	85		
4	87	85		
5	95	95		

79				

data :

1-VAR	H2
NΣ	5
TOTΣ	425
MEANΣ	85
PVARΣ	50
SVARΣ	62.5
PSDEV	7.071068
S	

1-VAR	H2
NΣ	5
TOTΣ	425
MEANΣ	85
PVARΣ	50
SVARΣ	62.5
PSDEV	7.071068
S	

, so process of Data B is now finished.

⁶ Obviously we need to find the average score of Data A and Data B is 85 ($MEANΣ$), but

variance for A is 31.6 while 50 ($PVARΣ$) for B. Therefore stability is higher when A is chosen. It is

more reasonable to send A to the competition. 【Attached 4】. (Here the APLET in the HP39GS is used to combine the Stem-and-Leaf diagram, the Frequency Distribution Table and histogram and even the data can be combined if necessary (command: CONCAT) to analyze and graph the histogram)

With knowledge deepening, the verification of questions independently becomes one of my research targets. So I manage to complete the Stem-and-Leaf diagram APLET. A good example is Exercise 20 in the College Entrance Examination Model Text10 in Quanzhou No.7 Middle School:

A Study to learn that if the old people in certain area need the help from volunteers, and involves 500 old persons chosen in this area stochastically:

	MALE	FEMALE
NEED	40	30
NOT NEED	160	270

Is there 99% probability that the need of volunteers relates to the gender of the old in the area?

$P(K^2 \geq k)$	0.050	0.010	0.001
k	3.841	6.635	10.828



input the data :



	A	B	SUM
n0-1	40	30	70
n0-2	160	270	430
SUM	200	300	500

get the chart:

get the result of analysis:

	A	B	SUM
$n k^2=9.9667774086$			
$n 4$			
SUM	200	300	500

. Compare with the data in the charts $P(K^2 \geq 10.828) = 0.001$ and the probability of independence is about 0.1%, namely the probability of mutuality is 99.9%. 【Attached 5】

In this way, with the help of the programming function APELT, we have explored the functions, which are carried or not carried by it originally. We combine the technology and practice. We have got an intuitionistic figure that is suitable for us to construct a Stem-and-Leaf diagram and strict mathematical analyses which provide students with a thinking and verification tool. More importantly, this programming figure can handle the mathematical analyses for math model that has less data but needs to keep the original data. Stem-and-Leaf diagram APLET is a pure calculating APLET. After inputting the data, the graph can be drawn quickly, and combined with the statistic APLET. That uses the statistic function efficiently and is complementary. Thinking about Stem-and-Leaf diagram again, there are some defects, e.g. 1. The contents that table allowed to be inputted is less; 2. Capacity that the data cover is not enough; 3. The area of A,B must be the same.

Limited to examination requirement in Fujian, some knowledge can be handled by the APLET carried by HP39GS itself, e.g. Statistics, polar coordinate, parameter equation, matrix and so on where the APLETS perform well. However, there is some knowledge that the APLET itself cannot handle, e.g. vector, Stem-and-Leaf diagram, solid geometry and so on. Therefore, the writer created several APLETS in their teaching practice for use in his lessons. The students appreciate and study the power of the technology when they experience new something new and exciting. Finally, not only is there a need to use APLET of HP39GS but also adjusting measures to local conditions, inspiring activity based on APLET activity to design APLETS of our own against concrete problem occurring in teaching practice which operate the HP39GS to its optimum. Due to limit of length, only some practical APLETS have been summarized here. Due to limit of writer's programming level, these APLET designs are not perfect therefore and need improvement under practice and verification. The most important element in the developing APLETS is the reflection on the teaching effect. So during recent teaching activities, the following question is always asked: Can an improved teaching effect be achieved by using the HP39GS? Then can this effect be achieved with the existing APLET functions? And finally what is the most difficult thing in the program making process?

Note

- [1] *Arts Exam Illustration Fujian 2011*
- [2] *Wan Jun Min, Regarding development thinking for math teaching*
- [3] *Handbook of HP39GS Figure Calculator Matrix Function and order*
- [4] *Dai Lin Yuan, Middle School Math Test Question Feature & Review Points 2011*
- [5] *Yu Zheng Guang etc, Learn Calculous By Figure Calculator*
- [6] *HP39GS Figure Calculator Handbook Calculation and Statistics for unitary variable*

Reference

- [1] 2011 the Instrument of Arts Examination in Fujian
- [2] Wan Jun Min, Regarding development thinking for math teaching
- [3] The Points of 2010 College Entrance Mathematics Examination and the Focus of the Exam
- [4] Yu Zhengguang etc, Learn Calculous By Figure Calculator
- [5] Solving the Math Questions in High School with IT—Programming Reasonably to Find the Law
- [6] Solving the Math Questions in High School with IT—Learn the Calculation in a Game

【Attached 1】 Vector Source Program (use array)

```

XL PROGRAM
-10XMIN:
10XMAX:
-10YMIN:
10YMAX:
    
```

Edit window size: ;

Hint of entering two coordinates of vector and make the drawing:

<pre> XL PROGRAM INPUT A:"COORDINATES";"X1="; "ENTER A";1: INPUT B:"COORDINATES";"Y1="; "ENTER A";1: </pre>	<pre> XL PROGRAM INPUT C:"COORDINATES";"X2="; "ENTER B";1: INPUT D:"COORDINATES";"Y2="; "ENTER B";1: </pre>	<pre> XL PROGRAM ERASE: LINE 0:0:2A:2B: LINE 0:0:2C:2D: DISPXY 0:0:0:"0": DISPXY 2A:2B:0:"A": DISPXY 2C:2D:0:"B": </pre>
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```

XL PROGRAM
FREEZE:
DO
MSGBOX
"1'ADD;2'MINUS;3'a·b\|
a|;4'θ":
GETKEY W:
    
```

Hint of entering key of function:

Addition of vectors, substrate, point multiplication, included angle:

<pre> XL PROGRAM FREEZE: DO MSGBOX "1'ADD;2'MINUS;3'a·b;4 'θ": GETKEY W: </pre>	<pre> XL PROGRAM FREEZE: DO MSGBOX "1'ADD;2'MINUS;3'a·b;4 'θ": GETKEY W: </pre>	<pre> XL PROGRAM END: IF W==93.1 THEN LINE 0:0:2A:2B: LINE 0:0:2C:2D: LINE 2A:2B:2C:2D: DISPXY 2A:2B:1:"0": </pre>
<pre> XL PROGRAM DISPXY 2C:2D:1:"M": FREEZE: END: IF W==94.1 THEN A+C+B*D>V: DISPXY 0:0:2;V: </pre>	<pre> XL PROGRAM DISPXY -4:0:2;"a·b=": DISPXY 0:4:2;P: DISPXY 0:8:2;Q: DISPXY -4:4:2;" a =": DISPXY -4:8:2;" b =": FREEZE: </pre>	<pre> XL PROGRAM END: IF W==95.1 THEN ACOS(ABS(A+C+B*D)/<J(A ^2+B^2)*J(C^2+D^2))>U: DISPXY 0:0:2;U: DISPXY -3:0:2;"θ=": </pre>

Exit of cycle:

<pre> XL PROGRAM FREEZE: END: ERASE: MSGBOX "CONTINUE?": GETKEY S: UNTIL S==103.1 END: </pre>	<pre> XL PROGRAM FREEZE: </pre>
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【Attached 2】 To get normal vector (use matrix) of space plane

```

███ NL1 PROGRAM ███
PROMPT L1:
PROMPT L2:
PROMPT L3:
PROMPT L4:

```

enter two coordinates:

```

███ NL1 PROGRAM ███
FOR I=1 TO 3 STEP 1:
  <L2<I>-L1<I>>M1<I>:
  <L4<I>-L3<I>>M2<I>:
END:

```

work out two vector coordinates and save into Matrix M1 and M2 separately:

```

███ NL1 PROGRAM ███
CROSS<M1,M2>M3:
ERASE:
MSGBOX "N="M3:

```

get normal vector and exit of dialog box:

【Attached 3】 To get two space vector included angle (use matrix)

```

███ NL1 PROGRAM ███
PROMPT L1:
PROMPT L2:
PROMPT L3:
PROMPT L4:

```

enter two coordinates:

get two vector coordinates and save into matrix M1

```

███ JIAJIAO PROGRAM ███
FOR I=1 TO 3 STEP 1:
  <L2<I>-L1<I>>M1<I>:
  <L4<I>-L3<I>>M2<I>:
END:

```

and M2:

```

███ JIAJIAO PROGRAM ███
M1A:0:M1B:0:M1C:
DOT<M1,M2>A:
4DOT<M1,M1>B:
4DOT<M2,M2>C:

```

work out Inner Product and modulus:

```

███ JIAJIAO PROGRAM ███
ERASE:
MSGBOX "COSθ="A/(B*C):
ERASE:
MSGBOX "θ="ACOS(A/(B*C)):

```

exit

of sin() and cos() of vector included angle:

```

███ JIAJIAO PROGRAM ███
ERASE:
MSGBOX "COSθ="A/(B*C):
ERASE:
MSGBOX "θ="ACOS(A/(B*C)):

```

【Attached 4】 Stem-and-Leaf diagram source program

```

███ FENBU PROGRAM ███
-10>XMIN:
10>XMAX:
-10>YMIN:
10>YMAX:

```

Edit window size:

```

███ FENBU PROGRAM ███
PROMPT L1:
PROMPT L2:
SORT<L1>L1:
SORT<L2>L2:
L1>C1:
L2>C2:

```

Enter array sequence and save into Stat. APLET then Cls :

```

███ FENBU PROGRAM ███
ERASE:

```

```

FENBU PROGRAM
LINE -10:10:10:10:
LINE -10:6:10:6:
LINE -10:0:10:2:
LINE -10:-2:10:-2:
LINE -10:-6:10:-6:
LINE -10:-10:10:-10:

```

```

FENBU PROGRAM
LINE -1:10:-1:-10:
LINE 1:10:1:-10:
DISPXY -6:0:1:"A":
DISPXY 6:0:1:"B":

```

Make Stem-and-Leaf diagram figure :

```

FENBU PROGRAM
SIZE (L1)M:
INT(L1(I)/10)D:
DISPXY 0:5:1:D:
-2X:5Y:
FOR I=1 TO M STEP 1:
IF INT(L1(I)/10)=D

```

```

FENBU PROGRAM
THEN L1(I) MOD 10U:
DISPXY X:Y:1;U:X-2Y:
ELSE
INT(L1(I)/10)D:
-2X:Y-4Y:
DISPXY 0:Y:1:D:

```

Stem-and-Leaf distribution for Data A :

```

FENBU PROGRAM
L1(I) MOD 10U:
DISPXY X:Y:1;U:
X-2Y:
END:
END:

```

Stem-and-Leaf distribution for Data B :

```

FENBU PROGRAM
SIZE (L2)N:
INT(L2(I)/10)E:
DISPXY 0:5:1;E:
-2X:5Y:
FOR I=1 TO N STEP 1:
IF INT(L2(I)/10)=E

```

```

FENBU PROGRAM
THEN
L2(I) MOD 10V:
DISPXY X:Y:1;V:
X+2Y:
ELSE
INT(L2(I)/10)E:

```

```

FENBU PROGRAM
2X:Y-4Y:
DISPXY 0:Y:1;E:
L2(I) MOD 10V:
DISPXY X:Y:1;V:
X+2Y:
END:

```

```

FENBU PROGRAM
2X:Y-4Y:
DISPXY 0:Y:1;E:
L2(I) MOD 10V:
DISPXY X:Y:1;V:
X+2Y:
END:

```

【Attached 5】 Independent Verification

```

PROGRAM
-10XMIN:
15XMAX:
-10YMIN:
10YMAX:

```

Edit window size: ; initialize and hint of entering Data L1, L2 and upper limit

```

PROGRAM
M: N: E: Q:
PROMPT L1:
PROMPT L2:
INPUT
A: "NUM"; "N="; "NUMBER";
Q:

```

Value N:

```

PROGRAM
SORT (L1)L1:
SORT (L2)L2:
SIZE (L1)M:
SIZE (L2)N:

```

Set order and calculate qty. of arrays: ; Count qty. of element >N among L1:

```

PROGRAM
FOR I=1 TO M STEP 1:
IF L1(I) > A THEN
(E+1)E END:
END:

```

```

PROGRAM
FOR I=1 TO N STEP 1:
IF L2(I) > A THEN
(Q+1)Q END:
END:
ERASE:

```

; Count qty. of element >N among L2: ; make a table for

```

PROGRAM
LINE -10:10:15:10:
LINE -10:6:15:6:
LINE -10:2:15:2:
LINE -10:-2:15:-2:
LINE -10:-6:15:-6:
LINE -4:10:-4:-6:

```

data stat.:

