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Getting Started in Classroom Computing

by
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Digital Equipment Corporation
Maynard, Massachusetts

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Preface

What it's All About

This little booklet is designed to help you take your first steps in learning about computers and how to use them. You don't have to know anything about mathematics, binary number systems, or computer programming to use this booklet. In fact, you don't even need a computer. But, of course, it's much more fun if you have one.

The six examples in this booklet of classroom computer usage are games. Why games? Because they motivate, they increase curiosity, they encourage inquiry, and they make learning fun. For maximum value, follow the suggestions when they say to divide into teams of two or three members. Far more learning takes place during peer interaction than if the games are played individually.

This booklet isn't going to make you an expert in computers or teach you to write a program. On the other hand when you finish, you should feel that the computer is a friendly tool that's willing and able to work for you.

And If You Have a Computer

All the programs in the sample runs are contained in 101 BASIC Computer Games except the two Caves programs; listings follow the discussion in the text.

Maynard, Massachusetts
January, 1974

David H. Ahl

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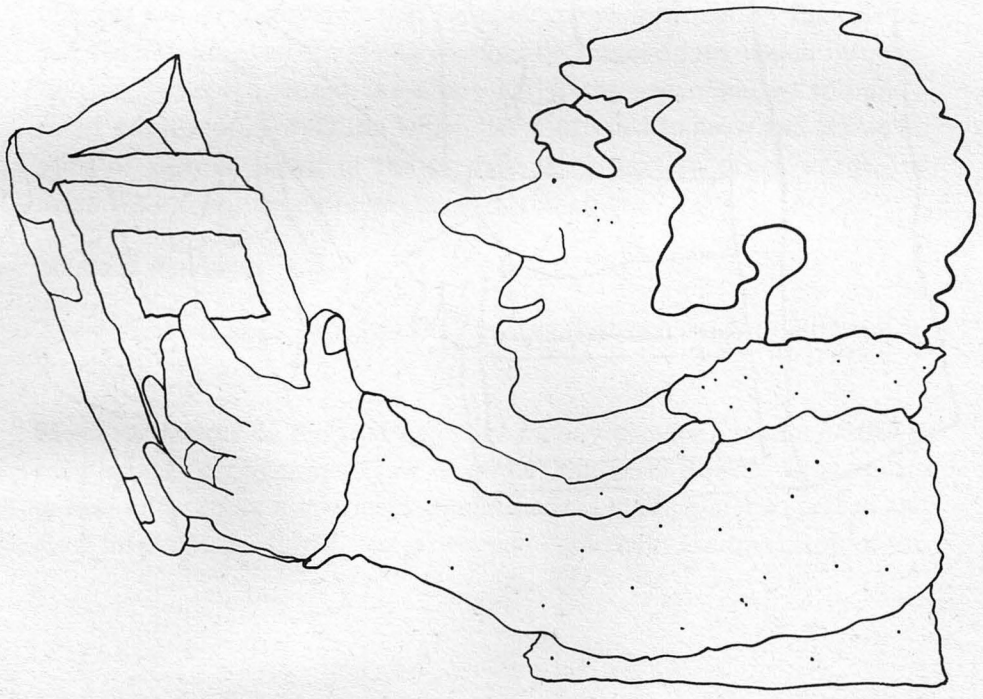
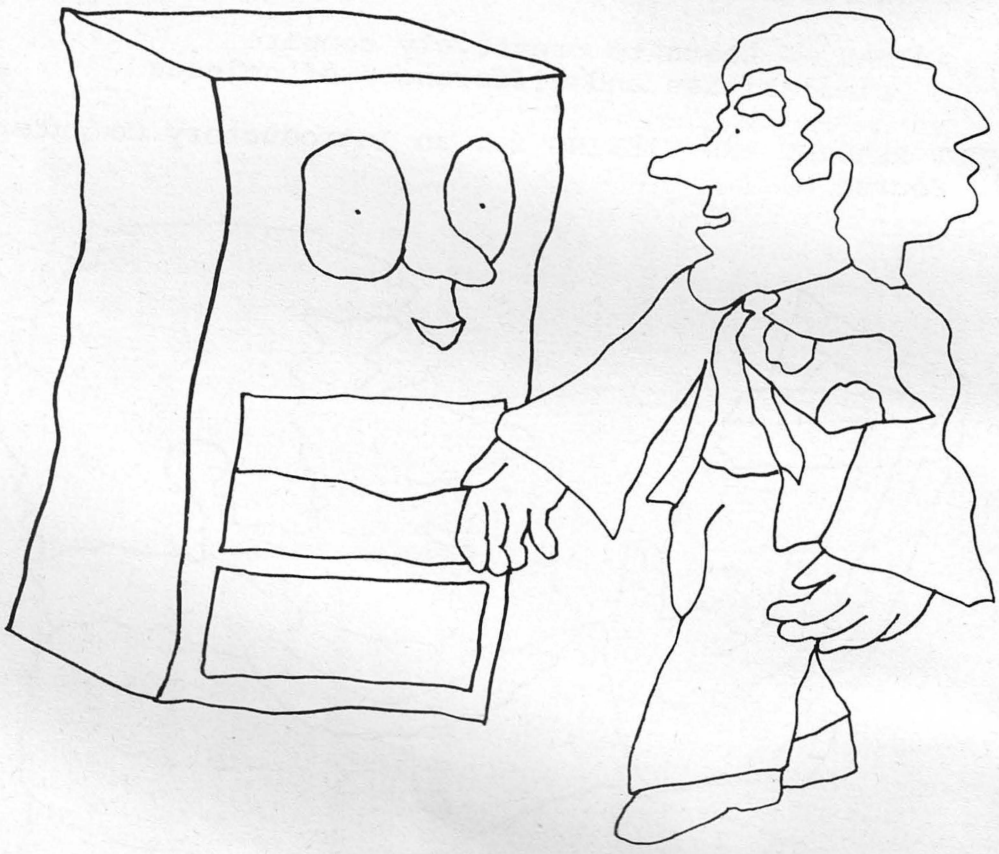




The Computer

One bright morning quite early in his career, the curious creature we know as man awoke with the bothersome feeling that he'd forgotten something.

Since he was at that time rather young (as species go) and hadn't been thinking for very long, the feeling of forgetfulness bothered him deeply. He resolved to do something about it at the earliest opportunity. Hastening from his bed of pine needles and saber-toothed tiger fur, our hero went straight out and invented a memory machine.

By modern standards his efforts did not amount to much. Although his exact actions are lost in the darkness of pre-history, it's a good bet that he did something like scratching a mark on his cave wall or cutting a notch in his favorite war club.

Precisely what he did is unimportant. The important thing is that he made a permanent record which, whenever he confronted it, would serve to recall the thing he wanted to remember. He had stored information, demonstrating a capability which has proved one of the most important traits setting man apart from lower creatures.

THE DRIVE TO REMEMBER

Man no sooner discovered that he could store information than he began finding an ever increasing number of things about which information needed to be stored. At a very early stage, man started to build a spiral of stored information which has continued to grow and shows no signs of slowing down in the predictable future. In other words, the more we know, the more we need to remember.

Memory Machines

There are two basic categories of devices that man uses to store information.

Memory devices of the first category merely provide records of things man wants to remember. For example, the invention of written languages and simple numerical systems made it much easier to record and store information. Further improvement came with the invention of the

printing press; now information could be recorded and stored by the libraryful. Later, with the aid of electronics, information other than written words or numbers could be recorded and stored in the form of sound tapes and recordings. But all these devices did no more than to record and store information.

The second category of storage device is fundamentally different. It not only can store information, but also can alter information in some way and thus provide new information. The abacus used by the ancient Romans was such a device. A Roman could use the abacus to record numbers, or to do sums and even more complicated arithmetic. Thus, the abacus stored information (numbers) and could also alter the information (do arithmetic) to provide new information (new numbers).

The most modern device in this second category is the electronic computer. Information – say, a list of student's scores – can be stored in the computer. The computer can alter that information to provide new, useful information for the user. It can rank the scores and produce an honor roll and a failure list. It can compute the average, mean, and median scores. It can print report cards. Like the abacus, a computer is a device which not only can store information but also can alter it to provide new information.

Advantages of the Computer

What makes computers so useful to man in handling the ever-increasing quantities of information he must remember, analyze, and use?

First, computers are fast. Using today's computers, man can increase his computing power roughly a million times. In other words, a problem which a computer could solve in thirty seconds would take a man thirty million seconds, or nearly a year of working day and night.

Second, computers are accurate. A man working on a problem for a year, even for a normal work year, could be expected to make hundreds of mistakes. A computer solving that same problem in thirty seconds would be unlikely to make a single mistake.

Third, computers are tireless. They can work day and night without fatigue, slowdown or error.

Finally, computers are versatile. Computers are constantly being assigned new roles ranging from monitoring critically ill patients to controlling rocket launchings. We should remember that the millionfold increase in the power to calculate was inconceivable only a few short years ago. Yet the ultimate capabilities of this new power have barely been explored.

The comparison between today's computers and the potential for computerization is about like the comparison between the caveman's first attempts at recording information and the English language as it is used today.

As far as the computer's ability to handle information, we have barely started to use it.

Man Versus Machine

As the use of the computer has expanded, a myth has emerged which attributes human capabilities to computers. This misconception may stem from the application of similar descriptions to people and computers; most common is the use of the word *memory* to refer to the storage capacity of both the computer and the human mind.

In reality, there are vast differences in the capabilities of man and computer; knowing these, we can put computer power into perspective. Computers have to be told what to do in complete and precise detail. A list of instructions called a *program* must be prepared and stored in the computer every time it is to solve a problem. This logical sequence of instructions to be followed by the computer must necessarily be developed by man's intellectual processes.

A computer can be programmed to perform any process that can be described in a logical and precise way. The ability of human beings to feel, imagine, create, reason, and use instinct and intuition cannot be duplicated by a computer, even with the cleverest of programmers at work.

Computers are fast and reliable, once instructed by man. But left to themselves, computers are just as inanimate as our caveman's club.

> No machine can ever replace man's unique ability to temper fact with reason and intuition, or to think and to feel. The greatest imaginable benefit to be derived from computers is that man will be given more time to ask better questions. Perhaps he will then find time to make better use of the answers.[1]

[1] Crawford, F.R. *Introduction to Data Processing.* New York: Prentice-Hall, 1968.

Objectives

The computer, used as a tool of instruction and a subject of instruction, can help convert routine courses into exciting experimental subjects. Some of the objectives of teaching about and with computers in the secondary school are as follows:

To develop student appreciation of the computer's role in society.

To remove the mystery and bewilderment that may exist in the student's mind about computers and automation.

To enrich existing programs through use of the computer. Allow students to work on creative and complex problems that would be impossible to solve by manual methods.

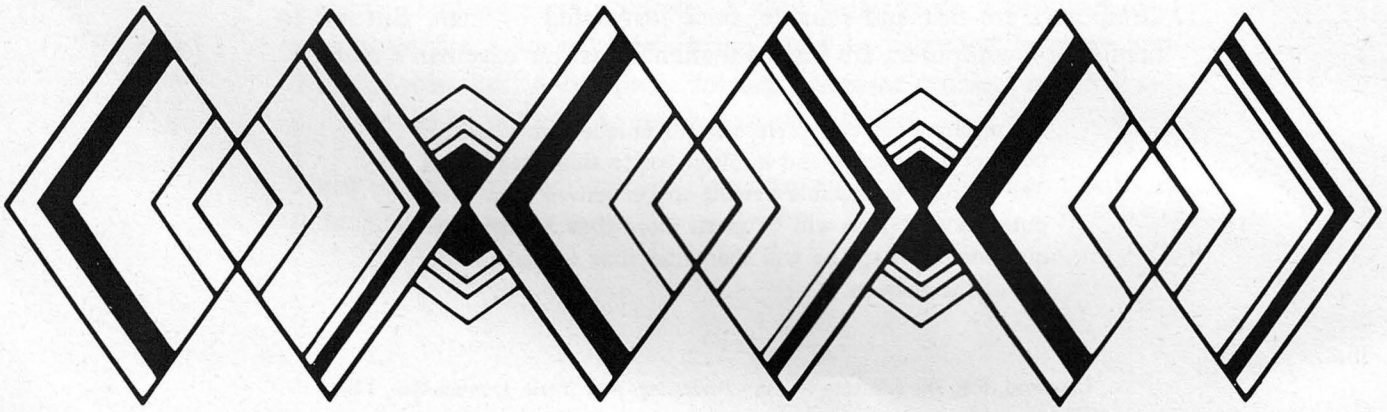
To motivate students and teachers to more individual, challenging instruction.

To develop the students' abstract reasoning ability and general problem solving skills. To teach him algorithmic thinking and explore rigorous thought processes.

To encourage students to apply computer concepts creatively to a variety of application areas.

To better prepare college-bound students with an understanding of the computer and how it can and cannot be used to solve problems.

To provide students with vocational training in computer technology.

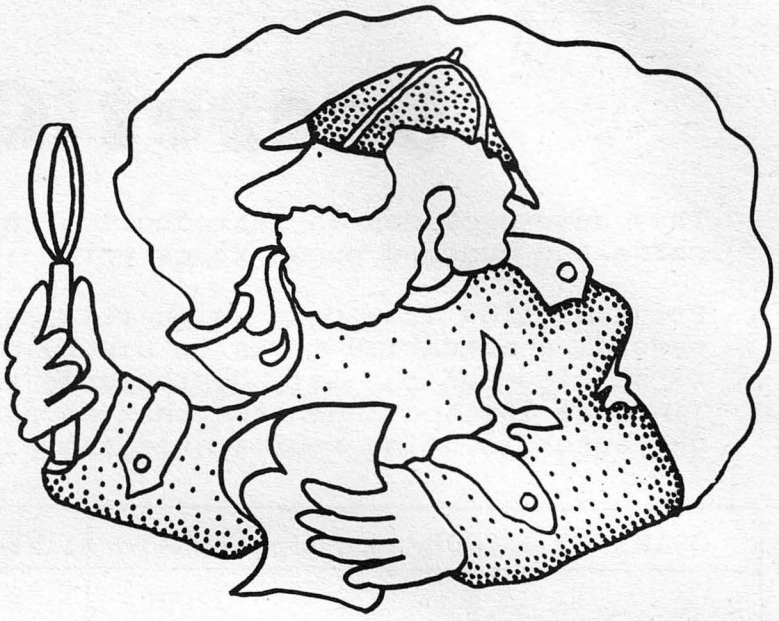


Secret Codes

This game provides an introduction to the way that punched cards and punched paper tapes work.

Printed below is a code which relates numbers, letters, and several punctuation marks to binary numbers of 6 places. The first place on the left corresponds to a bar over the number (in base 10) and indicates that an alphabetic or punctuation character is being represented instead of a number.

CHAR.	CODE	BINARY	CHAR.	CODE	BINARY
0	0	0 00000	L	$\overline{12}$	1 01100
1	1	0 00001	M	$\overline{13}$	1 01101
2	2	0 00010	N	$\overline{14}$	1 01110
3	3	0 00011	O	$\overline{15}$	1 01111
4	4	0 00100	P	$\overline{16}$	1 10000
5	5	0 00101	Q	$\overline{17}$	1 10001
6	6	0 00110	R	$\overline{18}$	1 10010
7	7	0 00111	S	$\overline{19}$	1 10011
8	8	0 01000	T	$\overline{20}$	1 10100
9	9	0 01001	U	$\overline{21}$	1 10101
A	$\overline{1}$	1 00001	V	$\overline{22}$	1 10110
B	$\overline{2}$	1 00010	W	$\overline{23}$	1 10111
C	$\overline{3}$	1 00011	X	$\overline{24}$	1 11000
D	$\overline{4}$	1 00100	Y	$\overline{25}$	1 11001
E	$\overline{5}$	1 00101	Z	$\overline{26}$	1 11010
F	$\overline{6}$	1 00110	,	$\overline{27}$	1 11011
G	$\overline{7}$	1 00111	.	$\overline{28}$	1 11100
H	$\overline{8}$	1 01000	-	$\overline{29}$	1 11101
I	$\overline{9}$	1 01001	"	$\overline{30}$	1 11110
J	$\overline{10}$	1 01010	?	$\overline{31}$	1 11111
K	$\overline{11}$	1 01011	space	$\overline{0}$	1 00000



EXERCISE 1

Think up a message with 12 or fewer characters. Write it in the "card" reproduced below. Then, using the binary code from the table above, mark your message on the card.

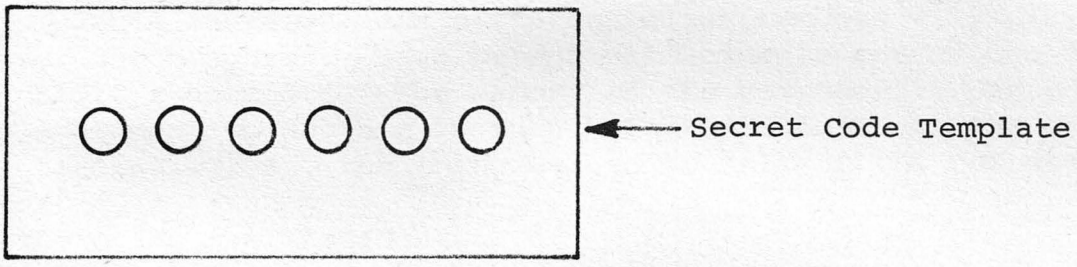
Message												
Bar												
16												
8												
4												
2												
1												

The card below contains the message "I love you".

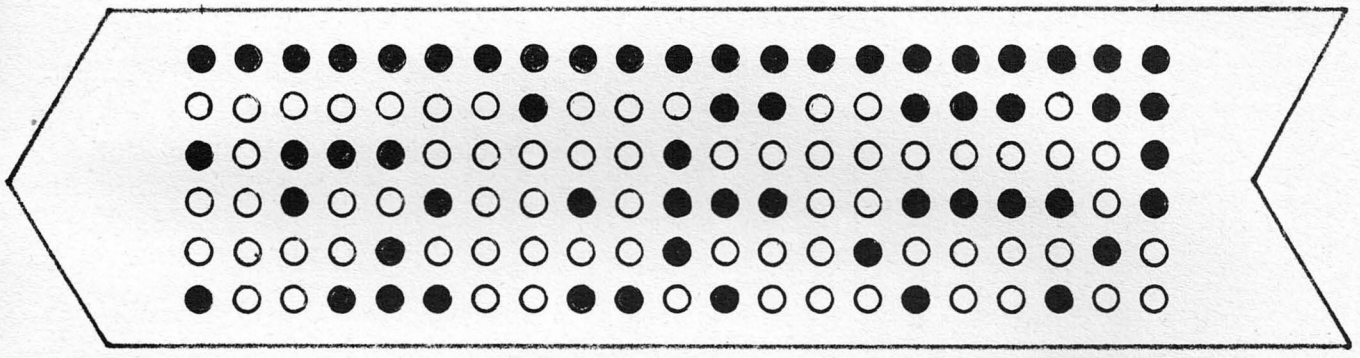
Message	I		L	O	V	E		Y	O	U	.	
Bar	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮
16					▮			▮		▮	▮	
8	▮		▮	▮				▮	▮		▮	
4			▮	▮	▮	▮			▮	▮	▮	
2				▮	▮				▮			
1	▮			▮		▮		▮	▮	▮		

EXERCISE 2

For this exercise, get long strips (about 3" wide, 24" long) of brown wrapping paper, tag board, cut up file folders, or adding machine tape. Trim the ends of the "tapes" so they look like the arrows on regular computer paper tapes. These arrows indicate the direction of the tape as it goes through a "reader." Each student should have one or two tapes and a cardboard template like this one.



Each student should think of some message and, using the templates, transcribe the binary code for this message onto the tape. Use open circles for a zero and filled in circles for a 1. Before transcribing your own message, decode the message on the tape reproduced below. It starts out, "I LIKE ..."



This is not the same code used on actual computer tapes, but it is very similar. If you want to see the actual codes used on computer tapes, get a computer manual or handbook like Introduction To Programming.

GUESS

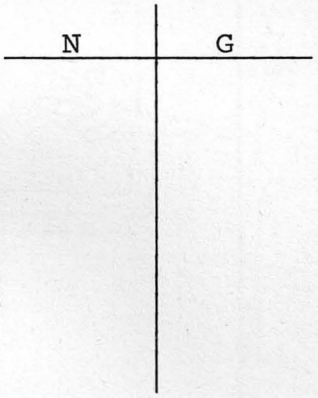
GUESS is a simple introduction to the idea of a computer program. It can be used with children as young as 8 years old. Program GUESS chooses a random number between 1 and 100. The player tries to guess the number and the computer furnishes clues of "TOO HIGH" or "TOO LOW." It should never take more than 7 guesses to find the mystery number. Do you know why?

In this exercise, six different class members will play the part of the computer. Each person will execute one of the following BASIC statements. The memory of the computer is passed from one statement to another in turn. The blackboard is the computer terminal, i.e., the thing we use to talk to the computer.

Here are the statements:

```
10 PRINT "I'M THINKING OF A NUMBER.  TRY TO GUESS IT."
20 N = INT(100 * RND + 1)
30 INPUT "YOUR GUESS"; G
40 IF G>N THEN PRINT "TOO HIGH.  TRY AGAIN." \ GO TO 30
50 IF G<N THEN PRINT "TOO LOW.  TRY AGAIN." \ GO TO 30
60 PRINT "YOU GOT IT!  LET'S PLAY AGAIN." \ GO TO 10
```

And here is the "memory":



GUESS - Player Instruction Cards

10 Write on the blackboard, "I'm thinking of a number. Try to guess it." Pass the memory to 20

20 Pick any number between 1 and 100. In the memory, cross out any previous number under N, and then write your number under N. Pass the memory to 30.

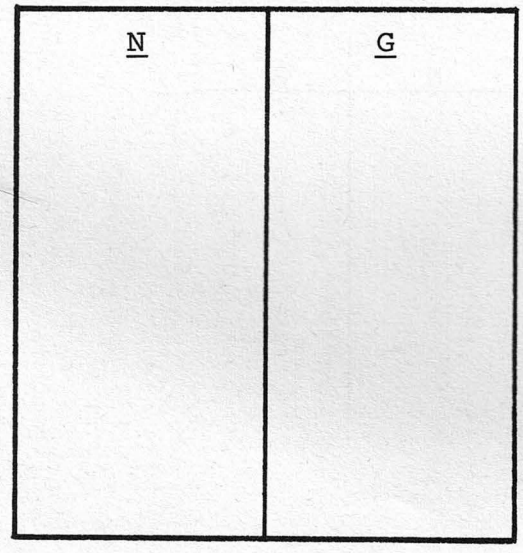
30 Write on the blackboard, "Your guess?" Accept a guess G from a member of the class and write it on the blackboard. In the memory, cross out any previous number under G and then write the new guess under G. Pass the memory to 40.

40 If G is greater than N, write on the blackboard, "Too high. Try again." Pass the memory to 30.
If G is not greater than N, pass the memory to 50.

50 If G is less than N, write on the blackboard, "Too low. Try again." Pass the memory to 30.
If G is not less than N, pass the memory to 60.

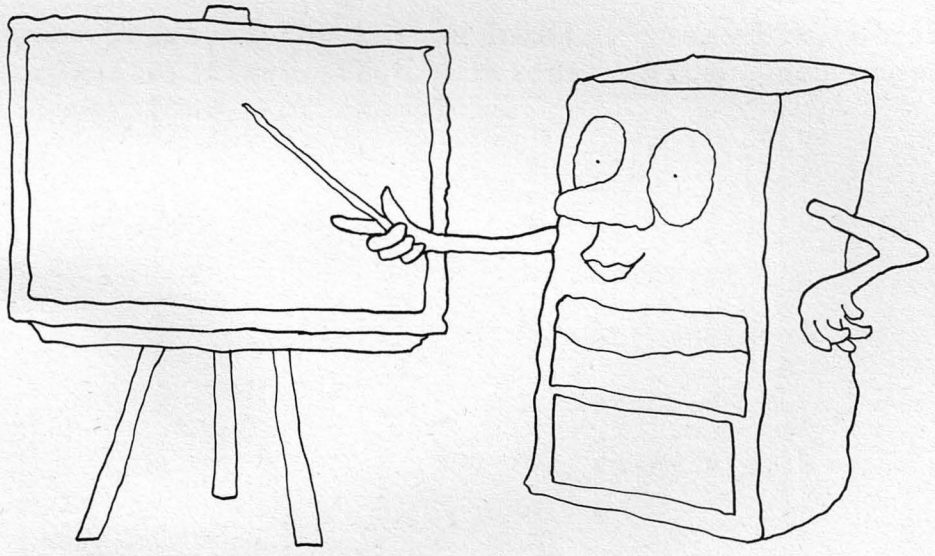
60 Write on the blackboard, "You got it! Let's play again." Pass the memory to 10.

Memory



Here is a sample what the blackboard should look like after a "run" of GUESS:

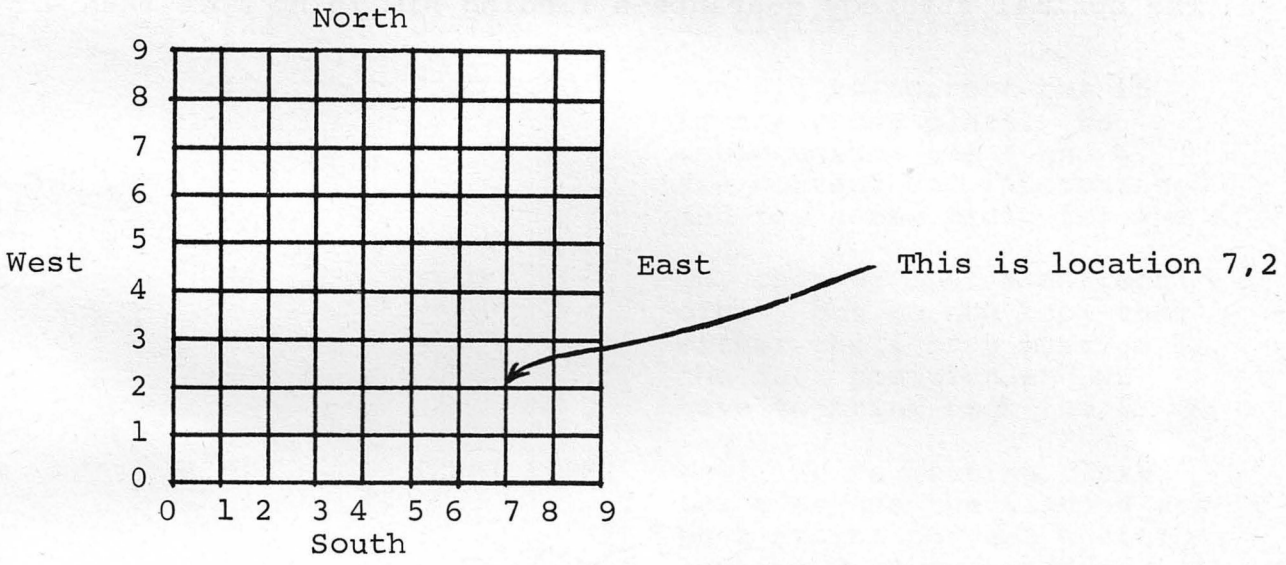
```
I'M THINKING OF A NUMBER. TRY TO GUESS IT.
YOUR GUESS ?
62
TOO HIGH. TRY AGAIN.
YOUR GUESS ?
38
TOO LOW. TRY AGAIN.
YOUR GUESS ?
55
TOO HIGH. TRY AGAIN.
YOUR GUESS ?
45
TOO HIGH. TRY AGAIN.
YOUR GUESS?
41
YOU GOT IT!  LET'S PLAY AGAIN.
```



HURKLE

Now we jump to another galaxy where we're going to hunt Hurkles. Hurkles? A Hurkle is a happy beast that lives on the planet Lirht that has three moons. Hurkles are favorite pets of the Gwik, the dominant race of Lirht and if you really want to know more, get the book A Way Home by Theodore Sturgeon.

Happy Hurkles radiate. Scared Hurkles go invisible. Most of the time they're scared but they want to be found so they'll give you clues where they're hiding. They live on the intersections of a town with dimensions of 10 x 10.



You try to guess where the Hurkle is hiding. Remember, horizontal location (coordinate) first, then vertical. After each guess, you get clues of direction. For example:

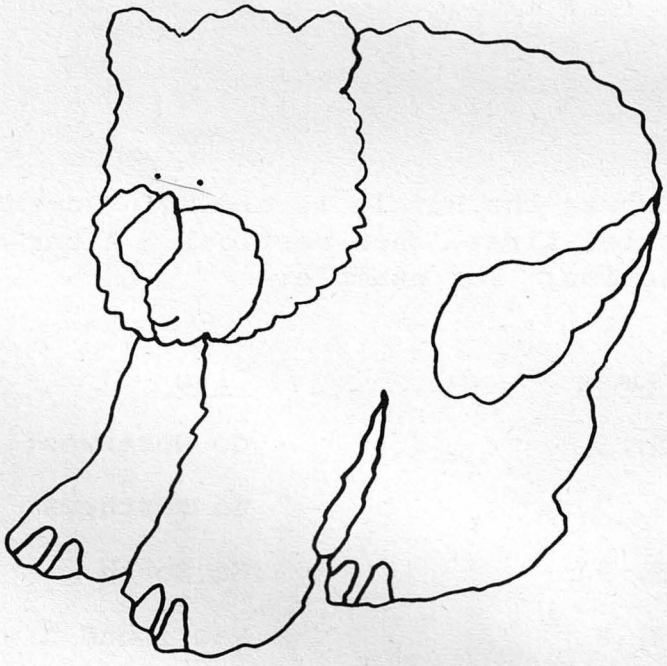
Guess	Clue
5, 5	Go Northwest
2, 7	Go Northeast
3, 9	Go South
3, 8	You found him!!

EXERCISE 1

Play Hurkle in class. Have a student (or team of 2 or 3 students) decide where the Hurkle is hiding and have other class members guess the location. Mark these guesses on a 10 x 10 grid on the blackboard. The student who hid the Hurkle gives clues to the class.

EXERCISE 2

Divide the class into teams and have them play Hurkle on the computer. Teams should attempt to come up with an optimal guessing strategy. A good strategy should always locate the Hurkle in 5 or fewer guesses. The optimal strategy guarantees finding him in no more than 4 guesses.



BAGELS

In the game of BAGELS the object is to use logic to guess a mystery 3-digit number. All three digits are different. After each guess, you are given clues as follows:

PICO - One digit correct but in the wrong place.
FERMI - One digit correct and in the right place.
BAGELS - No digits correct.

Let's say the mystery number is 685. Let's look at a possible sequence of guesses to get the number.

Guess #	Guess	Clue	Discussion
1	123	BAGELS	No digits correct
2	456	PICO PICO	Two digits correct but in in the wrong place. We could assume the 4 and 5 are correct but interchanged and try a new digit for the 6.
3	547	PICO	Oh, oh. We lost a correct digit, but we now know that either the 4 or 5 must go in the last position and we have to bring back the 6.
4	684	FERMI FERMI	Wow! We're getting close. Let's assume the 6 and 4 are both in the correct position, but the 8 is incorrect.
5	694	FERMI	Oh, oh. Since we already know the 6 must be correct from Guess #3, it looks like we've been wrong about the 4 all along. That means (from Guess #4) the 6 and 8 are correct and the other digit must be 5 (from Guess #2).
6	685	YOU GOT IT!	We got it in 6 guesses.

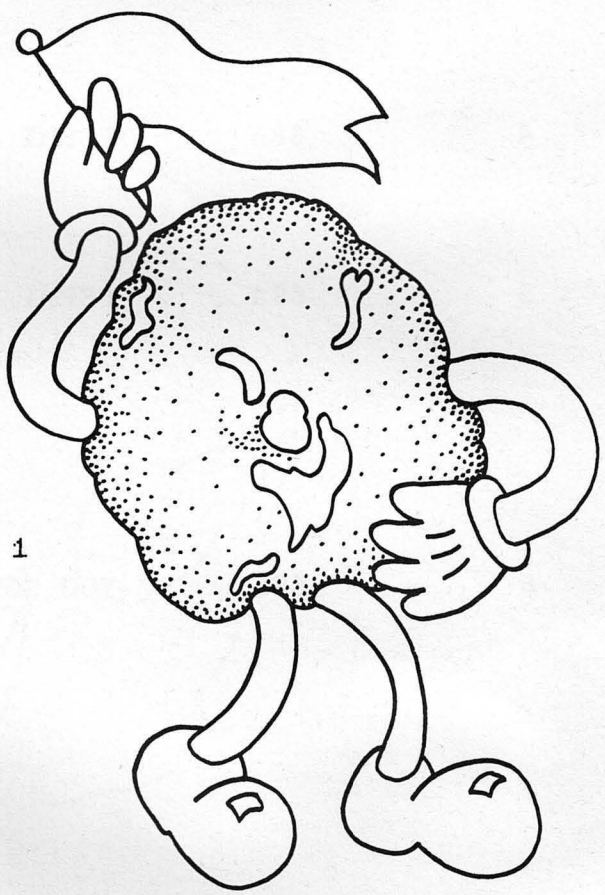
EXERCISE 1

Play BAGELS in class. Have a student (or team of 2 or 3 students) think of a number and write the clues on the blackboard as other students try to guess it.

EXERCISE 2

Divide the class into teams of four members. Have each team come up with a strategy for playing BAGELS. Have them try their strategy by playing the game on the computer 10 times. What is the average number of guesses for each strategy? Did any groups come up with the same strategy?

```
I AM THINKING OF A THREE-DIGIT NUMBER.  TRY TO GUESS
MY NUMBER AND I WILL GIVE YOU CLUES AS FOLLOWS:
   PICO   - ONE DIGIT CORRECT BUT IN THE WRONG POSITION
   FERMI  - ONE DIGIT CORRECT AND IN THE RIGHT POSITION
   BAGLES - NO DIGITS CORRECT

O.K.  I HAVE A NUMBER IN MIND.
GUESS # 1 ? 123
PICO FERMI
GUESS # 2 ? 421
YOU GOT IT!!!

PLAY AGAIN (1 FOR YES, 0 FOR NO)? 1

O.K.  I HAVE A NUMBER IN MIND.
GUESS # 1 ? 123
PICO
GUESS # 2 ? 415
BAGLES
GUESS # 3 ? 267
PICO
GUESS # 4 ? 892
PICO
GUESS # 5 ? 638
FERMI FERMI
GUESS # 6 ? 639
FERMI
GUESS # 7 ? 738
YOU GOT IT!!!

PLAY AGAIN (1 FOR YES, 0 FOR NO)? 1

O.K.  I HAVE A NUMBER IN MIND.
GUESS # 1 ? 123
PICO
GUESS # 2 ? 415
FERMI
GUESS # 3 ? 617
PICO
GUESS # 4 ? 436
YOU GOT IT!!!

PLAY AGAIN (1 FOR YES, 0 FOR NO)? 0
```

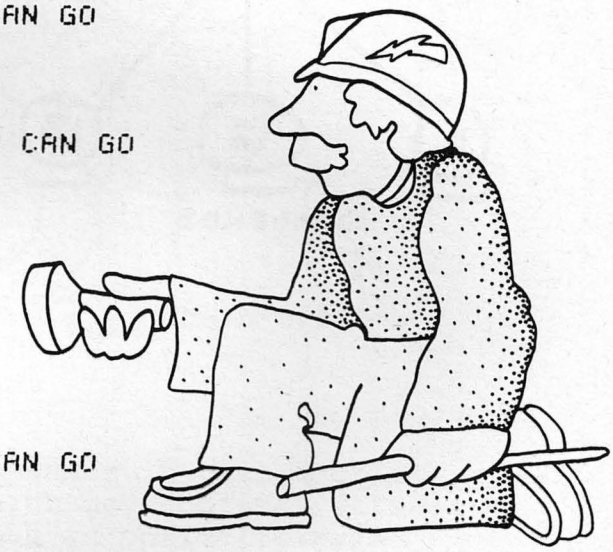


CAVES

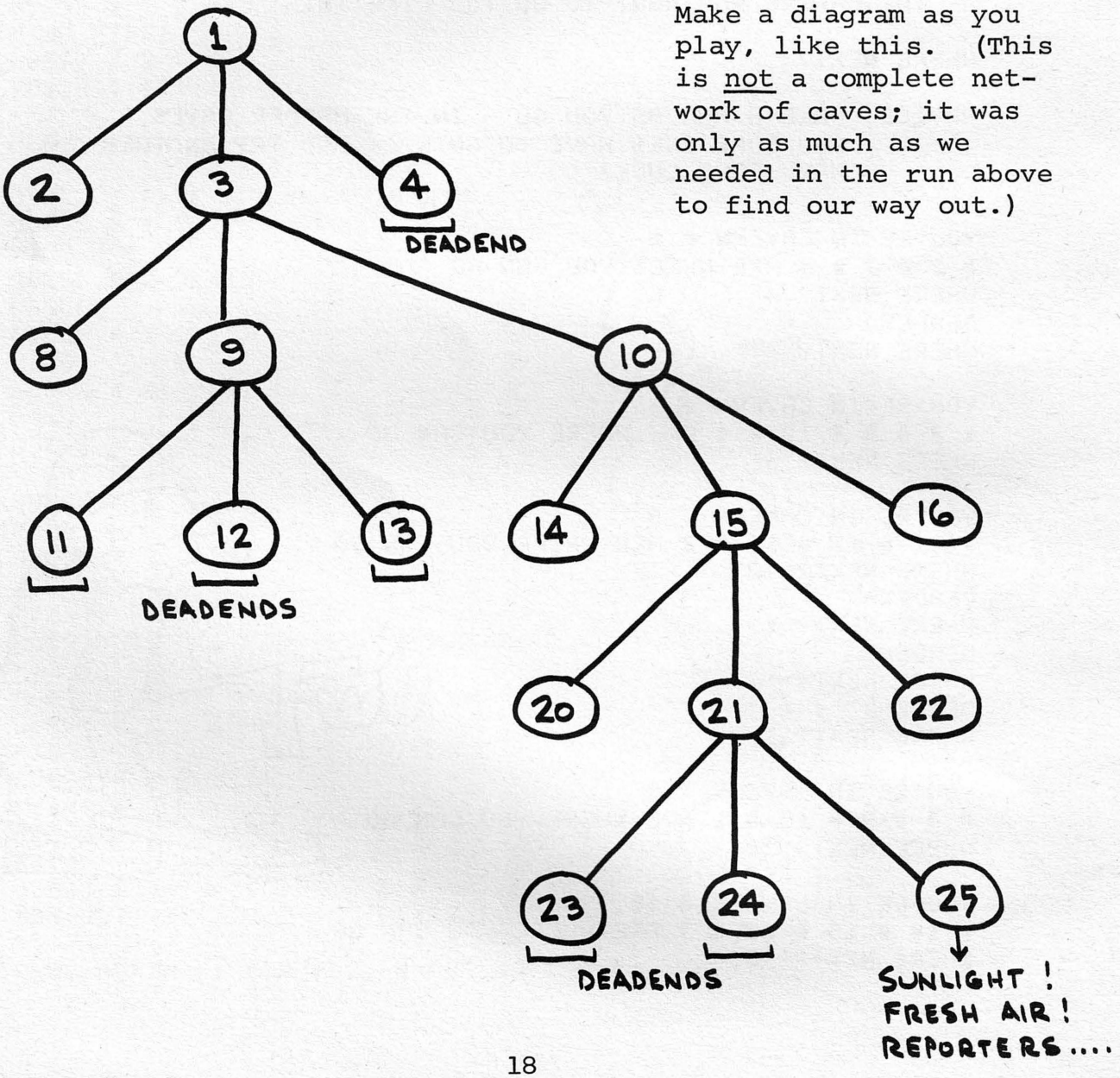
CAVES is a game which lets you explore tree structures and networks represented as caves. Various programs in the CAVES family let you explore caves of various complexity in either a tree or circular structure, and let you make caves for someone else to explore.

Here is a run of CAVES1 which lets you explore caves in a tree structure.

```
   IMAGINE YOURSELF AN EXPLORER OF THE FAMOUS
DUZZLEDORF CAVES.  YOU'VE BEEN UNDERGROUND
FOR DAYS, TRIPPING THROUGH THE CAVERNS AND
TUNNELS.  UNFORTUNATELY, YOU'RE LOST, AND
YOUR FOOD HAS RUN OUT.

   THERE IS ONLY ONE PATH OUT.  SEE IF YOU
CAN FIND IT.

   WHEN I TYPE A '?', YOU GIVE ME THE NUMBER
OF THE CAVERN YOU WANT TO GO TO. LIKE THIS:

WHERE NEXT?  7

ADVICE: MAKE A MAP AS YOU GO - IN THE HARDER CAVES
        YOU SOMETIMES HAVE TO GO BACK AND TRY ANOTHER
        WAY.  GOOD LUCK!


YOU'RE IN CAVERN # 1
# 2 # 3 # 4 ARE WHERE YOU CAN GO
WHERE NEXT? 4
DEADEND
WHERE NEXT? 3

YOU'RE IN CAVERN # 3
# 8 # 9 # 10 # 1 ARE WHERE YOU CAN GO
WHERE NEXT? 9

YOU'RE IN CAVERN # 9
# 11 # 12 # 13 # 3 ARE WHERE YOU CAN GO
WHERE NEXT? 12
DEADEND
WHERE NEXT? 13
DEADEND
WHERE NEXT? 11
DEADEND
WHERE NEXT? 3

YOU'RE IN CAVERN # 3
# 8 # 9 # 10 # 1 ARE WHERE YOU CAN GO
WHERE NEXT? 10

YOU'RE IN CAVERN # 10
# 14 # 15 # 16 # 3 ARE WHERE YOU CAN GO
WHERE NEXT? 15
```



```
YOU'RE IN CAVERN # 15
# 20 # 21 # 22 # 10 ARE WHERE YOU CAN GO
WHERE NEXT? 21

YOU'RE IN CAVERN # 21
# 23 # 24 # 25 # 15 ARE WHERE YOU CAN GO
WHERE NEXT? 24
DEADEND
WHERE NEXT? 23
DEADEND
WHERE NEXT? 25

          !!!   SUNLIGHT   !!!

          !!!  FRESH  AIR  !!!

          ...   REPORTERS   ...

WELL, AT LEAST YOU'RE OUT
```



Make a diagram as you play, like this. (This is not a complete network of caves; it was only as much as we needed in the run above to find our way out.)

EXERCISE 1

Divide the class into groups of 3 players. Have each group make up a cave network with 28 caves. Here are the rules for making up a network:

1. Cave 1 is at the top; Cave 1 leads to Caves 2, 3, and 4.
2. Each Cave after Cave 2 may:
   a. be a deadend
   b. lead to 3 more Caves
   c. lead out to sunshine and fresh air

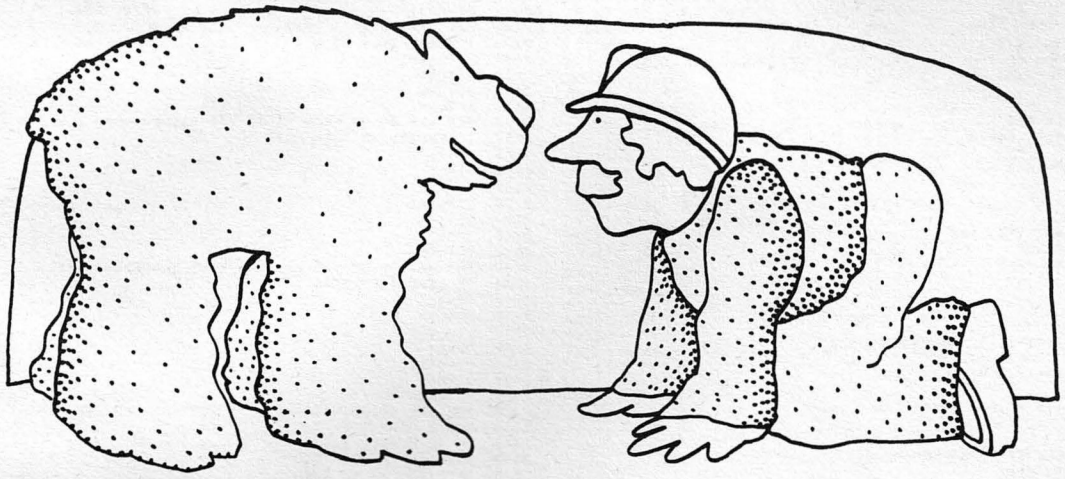
Select one team to act as the computer. Starting at Cave 1, the other class members try to find their way out of the network created by this team. It helps if someone draws the network on the blackboard as the guessing progresses.

EXERCISE 2

Play CAVES1 on the computer either individually or in teams. This game allows you to find your way out of Cave networks of three levels of complexity.

EXERCISE 3

Play CAVES2 on the computer either individually or in teams. This game allows you to create networks of caves for other people to use.



NOTE: In comparison to the preceding games in this booklet (GUESS, HURKLE, and BAGELS) which have optimal strategies for playing, CAVES does not have an optimal playing strategy. However, the type of networks formed in CAVES is very useful in making decision networks or hierarchical structures as we'll see in ANIMAL.

```
 0  REM ***  CAVES1  ***
30  REM ***  PROGRAM MAKES A SET OF LINKED ROOMS FOR YOU TO EXPLORE
40  REM ***  WRITTEN BY DAVE KAUFMAN, PEOPLE'S COMPUTER CO.
45  REM ***  CONVERTED TO BASIC-PLUS BY DAVE AHL, DIGITAL
50  N1,D1,G,G2=1
70  PRINT "WELCOME TO THE CAVES"
80  PRINT
90  INPUT "IS THIS YOUR FIRST VISIT (Y OR N)";X$
110  IF X$="Y" THEN 170
120  PRINT
130  PRINT "HOW HARD SHOULD I MAKE THE CAVES?"
140  PRINT "  1=USUAL,  2=HARDER,  3=!!!   ";
150  INPUT G
160  IF G>3 THEN G=3 ELSE IF G<1 THEN G=1
170  V1=0
180  GOSUB 1700
190  R=2
200  FOR I=1 TO 4
210  GOSUB 1360
220  GOSUB 1500
230  FOR J=1 TO G-1
240  GOSUB 1450
250  GOSUB 1500
260  NEXT J
270  NEXT I
280  W=R-1
290  IF G2>1 THEN 520
300  PRINT
310  INPUT "DO YOU WANT AN INTRODUCTION (Y OR N)";X$
330  IF X$="N" THEN 520
340  PRINT
350  PRINT "   IMAGINE YOURSELF AN EXPLORER OF THE FAMOUS"
360  PRINT "DUZZLEDORF CAVES.  YOU'VE BEEN UNDERGROUND"
370  PRINT "FOR DAYS, TRIPPING THROUGH THE CAVERNS AND"
380  PRINT "TUNNELS.  UNFORTUNATELY, YOU'RE LOST, AND"
390  PRINT "YOUR FOOD HAS RUN OUT."
400  PRINT
410  PRINT "   THERE IS ONLY ONE PATH OUT.  SEE IF YOU"
420  PRINT "CAN FIND IT."
430  PRINT
440  PRINT "   WHEN I TYPE A '?', YOU GIVE ME THE NUMBER"
450  PRINT "OF THE CAVERN YOU WANT TO GO TO, LIKE THIS:"
460  PRINT
470  PRINT "WHERE NEXT?  7"
480  PRINT
490  PRINT "ADVICE: MAKE A MAP AS YOU GO - IN THE HARDER CAVES"
500  PRINT "         YOU SOMETIMES HAVE TO GO BACK AND TRY ANOTHER"
510  PRINT "         WAY.  GOOD LUCK!"
520  D1=1
530  V1=8
540  GOSUB 1700
550  X=9999
560  PRINT
570  PRINT "YOU'RE IN CAVERN #";N1
580  D1=9999
590  V1=7
600  FOR I=1 TO 3
610  GOSUB 1700
620  PRINT "#";D1;
630  IF D1=W THEN 660
640  NEXT I
650  IF N1=1 THEN 720
660  V1=4
670  GOSUB 1700
680  PRINT "#";N1;
690  X=N1
700  V1=6
710  GOSUB 1700
720  PRINT "ARE WHERE YOU CAN GO"
730  PRINT "WHERE NEXT";
740  INPUT D1
750  IF D1=N1 THEN 730
760  IF D1 <> X THEN 830
770  V1=4
780  GOSUB 1700
790  GOTO 560
800  V1=6
810  GOSUB 1700
820  IF V2>0 THEN 850
830  PRINT "ILLEGAL MOVE"
840  GOTO 730
850  IF N1=W THEN 940
860  D1=9999
870  V1=7
880  GOSUB 1700
890  IF D1 <> 9999 THEN 560
900  PRINT "DEADEND"
910  V1=4
920  GOSUB 1700
930  GOTO 730
940  PRINT
950  PRINT
960  PRINT TAB(10);"!!!   SUNLIGHT   !!!"
970  PRINT
980  PRINT TAB(10);"!!!  FRESH  AIR  !!!"
990  PRINT
1000  PRINT TAB(10);"...  REPORTERS   ..."
1010  PRINT
1020  PRINT
1030  PRINT "WELL, AT LEAST YOU'RE OUT"
1040  IF G>1 THEN 1100
1050  PRINT
1060  PRINT "CONGRATULATIONS, INTREPID EXPLORER"
1070  PRINT "OF THE FEARSOME CAVES.  IF YOU WANT TO"
1080  PRINT "EXPLORE AGAIN, YOU CAN CHOOSE A HARDER SET"
1090  PRINT "OF CAVES OR ANOTHER ONE JUST AS DIFFICULT"
1100  PRINT
1110  INPUT "AGAIN (Y OR N)";X$
1130  IF X$="N" THEN 1210
1140  G2=G2+1
1150  IF G=3 THEN 160
1160  INPUT "HARDER (Y OR N)";X$
1180  IF X$="N" THEN 160
1190  G=G+1
1200  GOTO 160
1210  PRINT "IF YOU LIKED THIS GAME, OTHER GAMES"
1220  PRINT "IN THE SAME FAMILY ARE:"
1230  PRINT
1240  PRINT "  CAVES2   YOU SET UP A CAVE FOR A"
1250  PRINT "           FRIEND TO EXPLORE"
1260  PRINT
1270  PRINT "  CAVES3   SAME AS CAVES2, BUT YOU CAN SET"
1280  PRINT "           UP MORE COMPLICATED CAVES"
1290  PRINT
1340  PRINT "GOODBYE!"
1350  GOTO 2790
1360  REM *** ADD DAUGHTERS TO CURRENT NODE
1370  V1=1
1380  FOR J1=1 TO 3
1390  IF R=50 THEN 1440
1400  D1=R
1410  GOSUB 1700
1420  R=R+1
1430  NEXT J1
1440  RETURN
1450  REM *** CREATE DAUGHTERS, AND RETURN
1460  GOSUB 1360
1470  V1=4
1480  GOSUB 1700
1490  RETURN
1500  REM *** PICK A DAUGHTER NODE AT RANDOM AND GO DOWN
1510  V1=7
1520  FOR J1=1 TO INT(RND(0)*3)+1
1530  GOSUB 1700
1540  IF D1=9999 THEN 1530
1550  NEXT J1
1560  V1=6
1570  GOSUB 1700
1580  D1=9999
1590  V1=7
1600  GOSUB 1700
1610  IF D1=9999 THEN 1650
1620  V1=4
1630  GOSUB 1700
1640  GOTO 1510
1650  RETURN
1660  DIM N(50),P(150),L(50)
1670  DEF FND(X)=INT(P(X)/10000)
1680  DEF FNN(X)=INT((P(X)-FND(X)*10000)/100)+50
1690  DEF FNU(X)=P(X)-INT(P(X)/100)*100
1700  REM ***ENTRY POINT FOR TREE SUBROUTINES
1710  V2=1
1720  ON V1+1 GOSUB 1750,1860,2120,2130,2140,2230,2320,2460,2640
1730  N1=N(P1)
1740  RETURN
1750  REM *** INITIALIZE TREE
1760  N(1)=1
1770  N9=2
1780  FOR P1=1 TO 150
1790  P(P1)=0
1800  NEXT P1
1810  P1=1
1820  P2=1
1830  P9=51
1840  L1=1
1850  RETURN
1860  REM *** ADD D1 AS THE NEXT DAUGHTER TO CURRENT NODE
1870  GOSUB 2700
1880  IF P2>0 THEN 1970
1890  IF N9 <= 50 THEN 1920
1900  V2=-2
1910  RETURN
1920  V2=2
1930  N(N9)=D1
1940  P2=N9
1950  P(P2)=P1
1960  N9=N9+1
1970  P3=P1
1980  IF P(P3) <= 99 THEN 2080
1990  IF FNN(P3)=50 THEN 2020
2000  P3=FNN(P3)
2010  GOTO 1990
2020  IF P9<150 THEN 2050
2030  V2=-3
2040  RETURN
2050  P(P3)=P(P3)+(P9-50)*100
2060  P3=P9
2070  P9=P9+1
2080  P(P3)=P(P3)+P2*10000
2090  IF V2=1 THEN 2110
2100  P(P2)=P1
2110  RETURN
2120  RETURN
2130  RETURN
2140  REM *** GO UP FROM N1 TO ITS MOTHER NODE (UNLESS AT TOP)
2150  IF FNU(P1)=0 THEN 2210
2160  P2=P1
2170  D1=N1
2180  P1=FNU(P1)
2190  L1=L1-1
2200  RETURN
2210  V2=-1
2220  RETURN
2230  REM *** GO UP THE WAY YOU CAME (UNLESS AT TOP)
2240  IF L1>1 THEN 2270
2250  V2=-1
2260  RETURN
2270  L1=L1-1
2280  P2=P1
2290  P1=L(L1)
2300  D1=N1
2310  RETURN
2320  REM *** GO DOWN TO D1 FROM CURRENT NODE(IF LEGAL)
2330  GOSUB 2700
2340  IF V2<0 THEN 2410
2350  P3=P1
2360  IF P(P3) <= 99 THEN 2400
2370  IF FND(P3)=P2 THEN 2420
2380  P3=FNN(P3)
2390  IF P3 <> 50 THEN 2370
2400  V2=-1
2410  RETURN
2420  L(L1)=P1
2430  P1=P2
2440  L1=L1+1
2450  RETURN
2460  REM *** RETURN WITH NEXT DAUGHTER NODE IN D1 (IF NO MORE, D1=9999)
2470  IF P(P1) <= 99 THEN 2620
2480  GOSUB 2700
2490  V2=1
2500  P3=P1
2510  IF FND(P3) <> P2 THEN 2540
2520  P3=FNN(P3)
2530  GOTO 2580
2540  P3=FNN(P3)
2550  IF P3=50 THEN 2570
2560  GOTO 2510
2570  P3=P1
2580  IF P(P3) <= 99 THEN 2620
2590  P2=FND(P3)
2600  D1=N(P2)
2610  RETURN
2620  D1=9999
2630  RETURN
2640  REM *** RESET TO NODE D1
2650  GOSUB 2700
2660  IF V2<0 THEN 2690
2670  P1=P2
2680  L1=1
2690  RETURN
2700  REM *** FIND POINTER FOR D1
2710  IF P2>N9-1 THEN 2730
2720  IF N(P2)=D1 THEN 2780
2730  FOR P2=1 TO N9-1
2740  IF N(P2)=D1 THEN 2780
2750  NEXT P2
2760  V2=-4
2770  P2=-1
2780  RETURN
2790  END
```

```
10  REM *** CAVES2 *** YOU MAKE A SET OF LINKED CAVES FOR A FRIEND
20  REM *** TO EXPLORE
30  REM *** WRITTEN BY DAVE KAUFMAN, PEOPLES COMPUTER CO
40  REM *** CONVERTED TO BASIC-PLUS BY DAVE AHL, DIGITAL
50  PRINT "WELCOME TO THE CAVES"
60  PRINT
70  INPUT "DO YOU WANT AN INTRODUCTION (Y OR N)";X$
90  IF X$="N" THEN 250
100  PRINT
110  PRINT "THIS GAME IS JUST LIKE CAVES1,"
120  PRINT "EXCEPT YOU SET UP THE CAVES"
130  PRINT
140  PRINT "THEN, YOU CAN EXPLORE THEM,"
150  PRINT "OR ASK A FRIEND TO FIND HIS WAY OUT"
160  PRINT
170  PRINT "A GOOD IDEA IS TO MAKE A MAP"
180  PRINT "AS YOU GO ALONG, SO YOU CAN SEE"
190  PRINT "WHAT YOUR CAVES LOOK LIKE"
200  PRINT
210  PRINT "EACH CAVERN HAS A NUMBER OF TUNNELS"
220  PRINT "LEADING TO OTHER CAVERNS - 0 TUNNELS"
230  PRINT "MEANS A DEADEND CAVERN.  OTHERWISE,"
240  PRINT "YOU CAN HAVE 1,2,3,4 OR 5 TUNNELS"
250  V1=0
260  GOSUB 1560
270  R=1
280  IF R >= 50 THEN 430
290  PRINT
300  PRINT
310  PRINT "YOU'RE IN CAVERN #";N1
320  PRINT "HOW MANY TUNNELS";
330  INPUT X
340   ON X+1 GOTO 550,370,370,370,370,370
350  PRINT "HOW MANY (0,1,2,3,4,5 ONLY)";
360  GOTO 330
370  PRINT "THEY LEAD TO ";
380  V1=1
390  FOR D1=R+1 TO R+X
400  IF D1 <= 50 THEN 450
410  PRINT
420  PRINT
430  PRINT "THAT'S ALOT OF CAVERNS!  IN FACT, THAT'S MY LIMIT!"
440  GOTO 640
450  PRINT "#";D1;
460  GOSUB 1560
470  NEXT D1
480  R=D1
490  D1=9999
500  V1=7
510  GOSUB 1560
520  V1=6
530  GOSUB 1560
540  GOTO 280
550  V1=5
560  GOSUB 1560
570  IF V2<0 THEN 640
580  V1=7
590  GOSUB 1560
600  IF D1=9999 THEN 550
610  V1=6
620  GOSUB 1560
630  GOTO 300
640  PRINT
650  PRINT "THE CAVES ARE COMPLETE EXCEPT FOR ONE SMALL THING -"
660  PRINT "THEY NEED A ROOM THAT LEADS TO THE OUTSIDE."
670  PRINT
680  PRINT "WHICH ROOM # WILL THAT ONE BE";
690  INPUT D1
700  V1=8
710  GOSUB 1560
720  IF V2>0 THEN 750
730  PRINT "NO FAIR!";D1;"ISN'T A ROOM # !"
740  GOTO 670
750  W=D1
760  D1=1
770  V1=8
780  GOSUB 1560
790  PRINT "WHEN YOU'RE READY, TYPE ANY NUMBER"
800  INPUT X
810  X=9999
820  PRINT
830  PRINT "YOU'RE IN CAVERN #";N1
840  IF W=1 THEN 1200
850  D1=9999
860  V1=7
870  GOSUB 1560
880  IF D1=9999 THEN 910
890  PRINT "#";D1;
900  GOTO 870
910  IF N1=1 THEN 980
920  V1=4
930  GOSUB 1560
940  PRINT "#";N1;
950  X=N1
960  V1=6
970  GOSUB 1560
980  PRINT "ARE WHERE YOU CAN GO"
990  PRINT "WHERE NEXT";
1000  INPUT D1
1010  IF D1=N1 THEN 990
1020  IF D1 <> X THEN 1060
1030  V1=4
1040  GOSUB 1560
1050  GOTO 820
1060  V1=6
1070  GOSUB 1560
1080  IF V2>0 THEN 1110
1090  PRINT "ILLEGAL MOVE"
1100  GOTO 990
1110  IF N1=W THEN 1200
1120  D1=9999
1130  V1=7
1140  GOSUB 1560
1150  IF D1 <> 9999 THEN 820
1160  PRINT "DEADEND"
1170  V1=4
1180  GOSUB 1560
1190  GOTO 990
1200  PRINT
1210  PRINT
1220  PRINT TAB(10);"!!!   SUNLIGHT   !!!"
1230  PRINT
1240  PRINT TAB(10);"!!!  FRESH  AIR  !!!"
1250  PRINT
1260  PRINT TAB(10);"...  REPORTERS   ..."
1270  PRINT
1280  PRINT
1290  PRINT "WELL, AT LEAST YOU'RE OUT"
1300  PRINT
1310  PRINT "THIS SET OF CAVES AGAIN (1=YES, 0=NO)";
1320  INPUT X
1330  IF X=1 THEN 760
1340  PRINT "DO YOU WANT TO MAKE ANOTHER SET OF CAVES";
1350  INPUT X
1360  IF X=1 THEN 250
1370  PRINT "IF YOU LIKED THIS GAME, OTHER GAMES"
1380  PRINT "IN THE SAME FAMILY ARE:"
1390  PRINT
1400  PRINT "  CAVES1    YOU CAN EXPLORE CAVES THAT"
1410  PRINT "            THE COMPUTER DESIGNS"
1420  PRINT
1430  PRINT "  CAVES3    SAME AS CAVES2, BUT YOU CAN SET"
1440  PRINT "            UP MORE COMPLICATED CAVES"
1450  PRINT
1460  PRINT "  TREES     A GAME WHERE YOU CAN MAKE CAVES,"
1470  PRINT "            GET A MAP PRINTED OUT, AND GO"
1480  PRINT "            CHANGE THE CAVES"
1490  PRINT
1500  PRINT "GOODBYE!"
1510  GOTO 2620
1520  DIM N[50],P[150],L[50]
1530  DEF FND(X)=INT(P[X]/10000)
1540  DEF FNN(X)=INT((P[X]-FND(X)*10000)/100)+50
1550  DEF FNU(X)=P[X]-INT(P[X]/100)*100
1560  REM ***ENTRY POINT FOR TREE SUBROUTINES
1570  V2=1
1580  ON V1+1 GOSUB1610,1710,1970,1980,1990,2080,2170,2310,2490
1590  N1=N[P1]
1600  RETURN
1610  REM *** INITIALIZE TREE
1620  N[1]=1
1630  N9=2
1640  FOR P1=1 TO 150
1650  P[P1]=0
1660  NEXT P1
1670  P1=1
1680  P9=51
1690  L1=1
1700  RETURN
1710  REM *** ADD D1 AS THE NEXT DAUGHTER TO CURRENT NODE
1720  GOSUB 2550
1730  IF P2>0 THEN 1820
1740  IF N9 <= 50 THEN 1770
1750  V2=-2
1760  RETURN
1770  V2=2
1780  N[N9]=D1
1790  P2=N9
1800  P[P2]=P1
1810  N9=N9+1
1820  P3=P1
1830  IF P[P3] <= 99 THEN 1930
1840  IF FNN(P3)=50 THEN 1870
1850  P3=FNN(P3)
1860  GOTO 1840
1870  IF P9<150 THEN 1900
1880  V2=-3
1890  RETURN
1900  P[P3]=P[P3]+(P9-50)*100
1910  P3=P9
1920  P9=P9+1
1930  P[P3]=P[P3]+P2*10000
1940  IF V2=1 THEN 1960
1950  P[P2]=P1
1960  RETURN
1970  RETURN
1980  RETURN
1990  REM *** GO UP FROM N1 TO ITS MOTHER NODE (UNLESS AT TOP)
2000  IF FNU(P1)=0 THEN 2060
2010  P2=P1
2020  D1=N1
2030  P1=FNU(P1)
2040  L1=L1-1
2050  RETURN
2060  V2=-1
2070  RETURN
2080  REM *** GO UP THE WAY YOU CAME (UNLESS AT TOP)
2090  IF L1>1 THEN 2120
2100  V2=-1
2110  RETURN
2120  L1=L1-1
2130  P2=P1
2140  P1=L[L1]
2150  D1=N1
2160  RETURN
2170  REM *** GO DOWN TO D1 FROM CURRENT NODE(IF LEGAL)
2180  GOSUB 2550
2190  IF V2<0 THEN 2260
2200  P3=P1
2210  IF P[P3] <= 99 THEN 2250
2220  IF FND(P3)=P2 THEN 2270
2230  P3=FNN(P3)
2240  IF P3 <> 50 THEN 2220
2250  V2=-1
2260  RETURN
2270  L[L1]=P1
2280  P1=P2
2290  L1=L1+1
2300  RETURN
2310  REM *** RETURN WITH NEXT DAUGHTER NODE IN D1 (IF NO MORE, D1=9999)
2320  IF P[P1] <= 99 THEN 2470
2330  GOSUB 2550
2340  V2=1
2350  P3=P1
2360  IF FND(P3) <> P2 THEN 2390
2370  P3=FNN(P3)
2380  GOTO 2430
2390  P3=FNN(P3)
2400  IF P3=50 THEN 2420
2410  GOTO 2360
2420  P3=P1
2430  IF P[P3] <= 99 THEN 2470
2440  P2=FND(P3)
2450  D1=N[P2]
2460  RETURN
2470  D1=9999
2480  RETURN
2490  REM *** RESET TO NODE D1
2500  GOSUB 2550
2510  IF V2<0 THEN 2540
2520  P1=P2
2530  L1=1
2540  RETURN
2550  REM *** FIND POINTER FOR D1
2560  FOR P2=1 TO N9-1
2570  IF N[P2]=D1 THEN 2610
2580  NEXT P2
2590  V2=-4
2600  P2=-1
2610  RETURN
2620  END
```

ANIMAL

When a young child looks at an ABC primer there isn't much to distinguish a dog from a horse. Then one day he learns (sees, is told, etc.) that a horse is BIGGER than a dog. Wow! Now there is a way to tell the two apart.

This is an example of the all important process of identification by comparison. Comparison involves finding a common descriptive facet about the things to be compared and then determining whether the objects are similar or different on that facet. For example, let's compare our horse (a pinto) with a dog (pointer).

	Horse	Dog	
Size	Large	Small	Different
Marking	Spots	Spots	Same
Color spots	Brown	Black	Different
Tail	Long	Long	Same
Ears	Pointed	Drooping	Different
Used by man	Hunting	Hunting	Same

So we see on the six dimensions we've looked at, the horse and dog are similar on three and different on three. As we grow older, we continue to refine this process until we can distinguish between very similar things (cocker spaniel and springer spaniel, for example).

One way to learn more about this process of comparison to identify things and also to sharpen your own descriptive skills is to teach someone else to identify similar things by comparison. The computer program ANIMAL is just such a willing "someone" waiting to be taught.

In playing ANIMAL, the idea is to teach the computer to identify various animals by asking questions that can be answered with a YES or NO. When you first start with the computer, you'll find it knows very little. It asks you to think of an animal. Let's say you think of an elephant. The computer will ask:

```
DOES IT FLY? NO  (your reply)

IS IT A FISH? NO
```

So you see the computer knows only a BIRD (no specific kinds) and a FISH (again, no varieties). After you respond NO to the question, "Is it a fish?" the computer says:

```
THE ANIMAL YOU WERE THINKING OF WAS A? ELEPHANT
```

And now we come to the crux of the comparison process as the computer says:

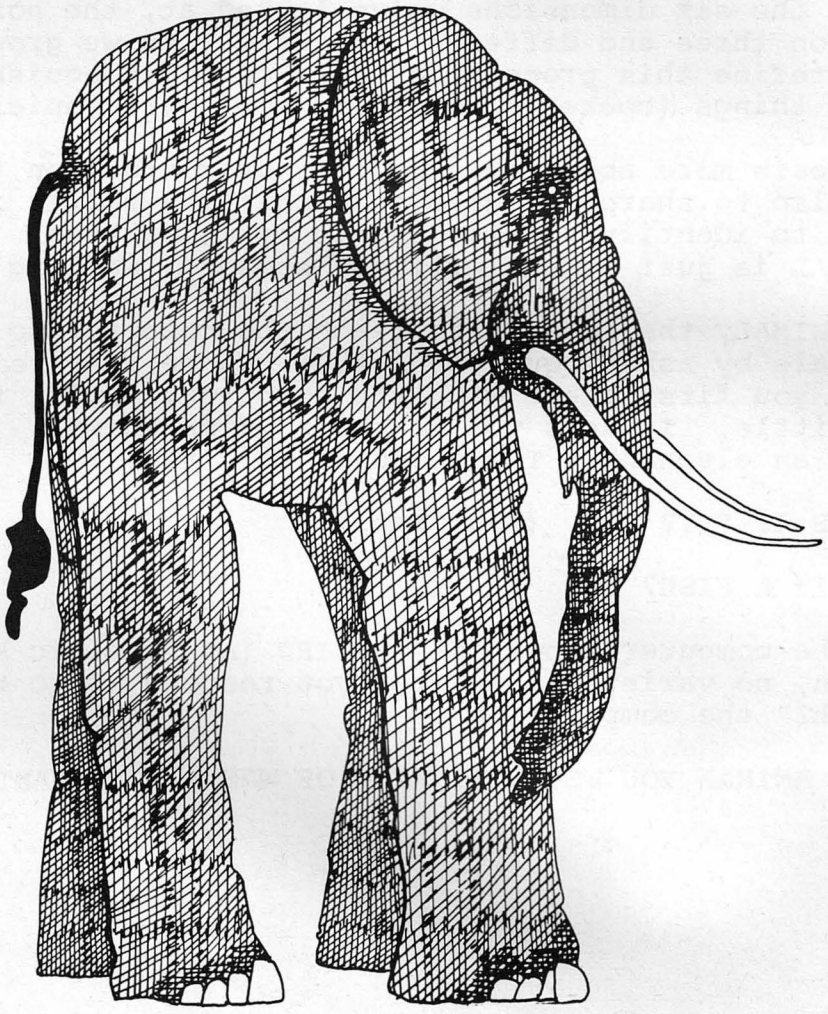
```
PLEASE TYPE IN A QUESTION THAT WOULD DISTINGUISH
AN ELEPHANT FROM A FISH

? DOES IT HAVE A TRUNK

FOR AN ELEPHANT THE ANSWER WOULD BE? YES
```

The next time through the program, if you said your animal was not a fish, the computer would ask, "Does it have a trunk?" Gradually through this process the computer builds up its repertoire of animals.

Notice that where the computer asked for a question to distinguish an elephant from a fish, we could have said:

```
? DOES IT HAVE FINS

FOR AN ELEPHANT THE ANSWER WOULD BE? NO
```

In other words, animals can be distinguished with either YES or NO questions.



EXERCISE 1

For each of the following pairs of animals, write <u>two</u> questions that will distinguish between them. Write one question so that it can be answered "yes" for the first animal in the pair; the other, "no".

DOG	TIGER	MOOSE
HORSE	PUMA	RAM
ELEPHANT	CAMEL	OCELOT
HIPPOPOTAMUS	LLAMA	CHEETAH

EXERCISE 2

There are many possible ways to distinguish between two things. For each of the following pairs of animals, write <u>seven</u> questions that will distinguish between them.

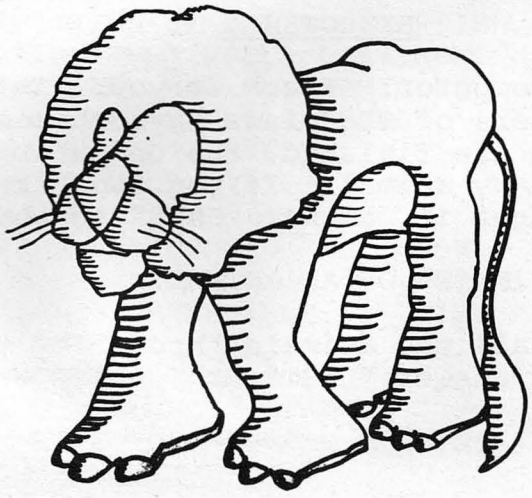
OSTRICH	PENGUIN
GIRAFFE	GORILLA

EXERCISE 3

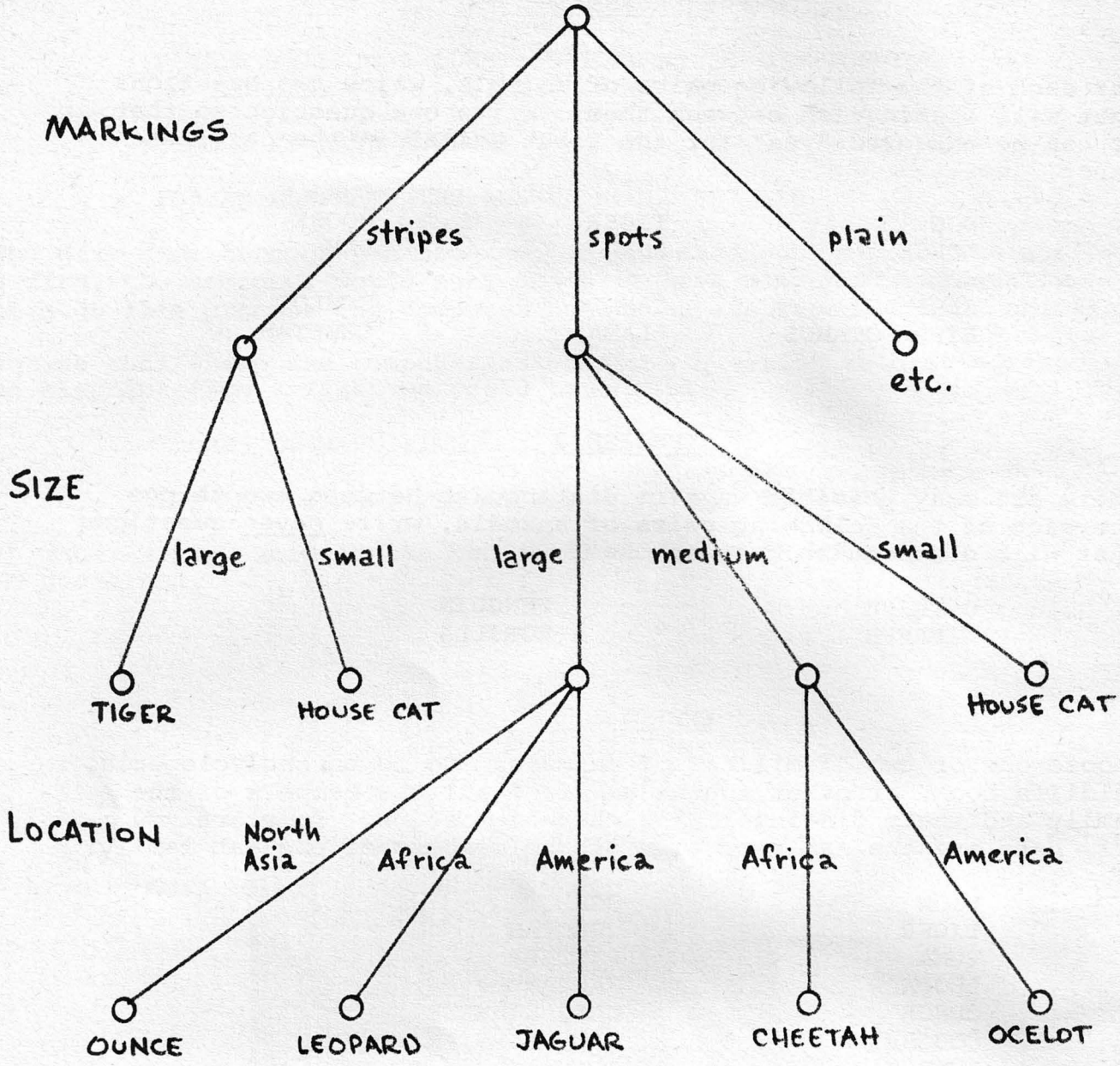
Choose one or two "families" of animals. Go to an enclyclopedia, wildlife book, or other source and find all the members of the family and their distinguishing characteristics. To start you off, here are the names of some of the members of the cat family:

LION	OCELOT
TIGER	CHEETAH
PUMA	PANTHER
LEOPARD	JAGUAR
OUNCE	CAT, SIAMESE
COUGAR	CAT, PERSIAN
LYNX	

Put these animals in a network like the one on the next page.



Animal "network" for Exercise 3.



EXERCISE 4

Play ANIMAL on the computer. Teach it your family of animals from Exercise 2. If members of the class have chosen different families of animals, when you are finished, the computer should be able to identify just about any animal. If you want it to remember the animals you have taught it, answer "SAVE" to the question:

ARE YOU THINKING OF AN ANIMAL?

Also, for a list of all the animals "known" by the computer, to the above question, just answer "LIST".

```
PLAY 'GUESS THE ANIMAL' WITH RSTS
THINK OF AN ANIMAL AND THE COMPUTER WILL TRY TO GUESS IT...

ARE YOU THINKING OF AN ANIMAL? YES
DOES IT SWIM? NO
DOES IT HAVE A TRUNK? NO
DOES IT GO 'ARF? NO
DOES IT HAVE RETRACTIBLE CLAWS? YES
DOES IT LIVE IN THE JUNGLE? YES
IS IT THE KING OF THE JUNGLE? NO
IS IT A TIGER? NO
THE ANIMAL YOU WERE THINKING OF WAS A ? PANTHER
PLEASE TYPE IN A QUESTION THAT WOULD DISTINGUISH A PANTHER FROM A TIGER
? DOES IT HAVE STRIPES
FOR A PANTHER THE ANSWER WOULD BE? NO
ARE YOU THINKING OF AN ANIMAL? YES
DOES IT SWIM? NO
DOES IT HAVE A TRUNK? NO
DOES IT GO 'ARF? NO
DOES IT HAVE RETRACTIBLE CLAWS? NO
DOES IT GIVE MILK AND GO 'MOO'? NO
DOES IT GIVE MILK AND EAT TIN CANS AND ALMOST ANYTHING ELSE? NO
DOES IT HAVE A WOOLY COAT AND SAY 'BAA? NO
DOES IT HAVE LARGE ANTLERS? NO
IS IT A BIRD? NO
THE ANIMAL YOU WERE THINKING OF WAS A ? ARMADILLO
PLEASE TYPE IN A QUESTION THAT WOULD DISTINGUISH A ARMADILLO FROM A BIRD
? ISITS BODY AND HEAD ENCASED IN AN ARMOR OF SMALL BONY PLATES
FOR A ARMADILLO THE ANSWER WOULD BE? YES
ARE YOU THINKING OF AN ANIMAL? YES
DOES IT SWIM? YES
DOES IT HAVE FLIPPERS? NO
IS IT THE LARGEST KNOWN MAMMAL? NO
IS IT A FISH? NO
THE ANIMAL YOU WERE THINKING OF WAS A ? TURTLE
PLEASE TYPE IN A QUESTION THAT WOULD DISTINGUISH A TURTLE FROM A FISH
? DOES IT HAVE A BONY SHELL WHICH ENCLOSES IR\R\TS BODY
FOR A TURTLE THE ANSWER WOULD BE? YES
ARE YOU THINKING OF AN ANIMAL? YES
DOES IT SWIM? NO
DOES IT HAVE A TRUNK? NO
DOES IT GO 'ARF? NO
DOES IT HAVE RETRACTIBLE CLAWS? YES
DOES IT LIVE IN THE JUNGLE? NO
IS IT A CAT? NO
THE ANIMAL YOU WERE THINKING OF WAS A ? PERSIAN CAT
PLEASE TYPE IN A QUESTION THAT WOULD DISTINGUISH A PERSIAN CAT FROM A CAT
? IS IT STOCKY, LONG-HAIRED, AND ROUND-HEADED
FOR A PERSIAN CAT THE ANSWER WOULD BE? YES
ARE YOU THINKING OF AN ANIMAL? SAVE
ARE YOU THINKING OF AN ANIMAL? LIST
ANIMALS I ALREADY KNOW ARE:
SEAL          ELEPHANT      DOG           COW           GOAT
WHALE         SHEEP         LION          MOOSE         TIGER
PANTHER       BIRD          ARMADILLO     FISH          TURTLE
CAT           PERSIAN CAT
ARE YOU THINKING OF AN ANIMAL? NO

O.K.  SEE YOU LATER.  HOPE YOU HAD FUN PLAYING!!


READY
```

Must Reading

1. What is a Computer? by Marion J. Ball ($4.40)
   A colorful, profusely illustrated, easy-to-read book about the computer, its history, basic workings, and software.
   Available from:

   Houghton Mifflin Co.
   110 Tremont Street
   Boston, MA 02107

2. Populution, A Self-Teaching BASIC Primer by Robert Albrecht ($2.00)
   A step by step self-teaching book using examples and problems from population growth and mobility.

3. 101 BASIC Computer Games by David Ahl ($5.00)
   A comprehensive collection of games, puzzles, recreations and other programs for getting people using the computer quickly and easily.

4. Understanding Mathematics and Logic Using BASIC Computer Games by David Ahl ($1.50)
   A combined teachers guide and student workbook for teaching fundamental math and logic principles with computer games.

5. Problems for Computer Mathematics by Ronald Allison ($1.25)
   An interesting, descriptive set of problems for in or outside of class for a beginning computer course.

Books 2, 3, 4, and 5 are available from:

Software Distribution Center
Digital Equipment Corporation
Maynard, Massachusetts 01754

Add 50¢ postage and handling to all orders. Payment must be enclosed on orders under $25.

Must Viewing

My Computer Understands Me produced by Project SOLO, University of Pittsburgh. 20 minutes, color, sound, 16mm.

Available from:

Film Library
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