THE PERSONALITY OF THE INTERACTIVE PROGRAMMED COMPUTER

Edmund C. Berkeley, Editor
Computers and Automation
815 Washington St.
Newtonville, Mass. 02160

"The interactive computer will respond, obey, teach, and play. It is in many ways like a powerful Arabian genie arising out of a fisherman's bottle to do enormously difficult things at one's command."

Answer to "What files do I have?" (The user was Edward Fredkin, Visiting Professor at M.I.T.)

```
233)    .IOT 1,16↑F
DSK  EF
FREE BLOCKS UØ   PK3 #3 13Ø UØ     PK5 #5
  3   BURST  1    1 9/15/69 12:15:47.5 Ø
  3   PERIOD 1    1 -
  5   R4     BIN  1 9/14/69 13:ØØ:46 Ø
  5   R4     2    1 9/14/69 13:ØØ:Ø6 Ø
  3   PERIOD 2    1 -
  5   R4     1    1 9/14/69 12:55:25.5 Ø
  5   RR     1    1 9/13/69 17:27:44.5 Ø
  3   NEW    LISP 1 6/2Ø/69 22:Ø2:58 Ø
  3   TRIE   A4   1 -
  3   SET    UP   1 6/2Ø/69 21:45:41 Ø
  3   FIZZ   5    1 6/29/69 11:13:47.5 Ø
  5   R      BIN  1 9/9/69 ØØ:1Ø:37.5 Ø
  3   NUM    4    1 6/8/69 17:24:17.5 Ø
  3   LISPT  6    1 2/8/69 18:ØØ:25.5 Ø
  3   MAP    3    1 6/2Ø/69 19:51:12 Ø
  5   R      1    1 9/9/69 ØØ:Ø5:26.5 Ø
  5   R      3    1 9/8/69 23:5Ø:5Ø.5 Ø
  3   TRIE   7    1 -
  3   RAM    1    1 9/8/69 2Ø:Ø6:22 Ø
  3   LES    SON  1 1Ø/2/69 15:25:59.5 Ø
  3   RAM    2    1 9/8/69 2Ø:4Ø:Ø2.5 Ø
 1Ø   RAM    3    1 9/8/69 17:45:14 Ø
  5   R      2    1 9/8/69 23:44:25.5 Ø
  3   T      5    1 5/18/69 19:15:17.5 Ø
 1Ø   DOC    TOR  5 9/3/69 15:1Ø:Ø6 Ø
```

Any human being who has used a programmed computer with direct access to the machine (either time-shared or not time-shared) has inevitably started to form a notion of the "personality" of the interactive programmed computer which he has been dealing with.

The personality of the interactive computer consists of the features of behavior which it is possible for a group of intelligent (and we hope friendly) programmers to program into a computer. In this way the personality of the interactive computer is derived essentially from:

- the requirements of the given situation;
- the instructions for producing the program under which the programmers operated; and
- the personalities of the programmers in the group.

A Dynamic Book

If the program is well done, the user of the computer is greatly helped, enjoys his relation with the interactive programmed computer, and accordingly feels satisfied,

Edmund C. Berkeley took part in building and operating the first automatic computers, the Mark I and II at Harvard University in 1944-45. He is: a founder of the Association for Computing Machinery; its secretary 1947-53; the author of eleven books on computers and related subjects; a Fellow of the Society of Actuaries; and an invited lecturer on computers in the United States, Canada, England, Japan, the Soviet Union, and Australia. He has been working with interactive computer-assisted explanation, documentation, and instruction since 1963.

Testing LISP on the interactive computer. For example, the REVERSE of the list A B C is the list C B A.

```
EF$U
:LISP!

LISP 107B
ALLOC? N


(CAR'(A B))
A
A
A UNBOUND VARIABLE - EVAL

(SETQ A  7)
7
A
7
(EQUAL (QUOTE (A B)) (QUOTE (A B)))
T
(REVERSE (QUOTE (A B C)))
(C B A)
(CDR 'REVERSE)
(SUBR 7134 PNAME (#37224 #37225))
(LAST (QUOTE (A B C D E)))
(E)
```

happy, and rewarded. If superlatively done, the relation of the user to the computer is much like his relation to a wonderful book, a book full of the most interesting and exciting information and experiences—but in this case the book is not static but dynamic, not motionless but responsive. From this point of view a good book and a suitably programmed computer both have a personality.

Access to the Computer

A user's perception of the personality of a computer may also be influenced by the type of access the user has. In the case of a time-shared computing system, the personality of the interactive computer can become foggy and obscured, because the pressure of many users often slows and clogs the computing system. The clogging produces sluggishness and the human reaction of impatience. Sometimes in fact the time-shared computer system will not allow a human being to log in, because of overload, or will suddenly terminate his use of the system, because of users with higher priorities than his, exhaustion of his block of allotted time, etc. This leads to frustration and anger. In the case of direct access to a computer that is not time-shared, problems of this category disappear. But here we shall side-step the issue of time-shared vs. not time-shared; here we shall consider only the features of a powerful interactive computer (either time-shared or not), plus friendly, skillful, and adaptive programming, at the service of a human user.

What is this personality?

For six years I have used interactive computers with various programs, and found the experience informative, very interesting, and often rewarding. This article seeks to generalize from these experiences, and to present: (1) what has actually been put into many interactive programs, (2) what could very easily be put into interactive computer programs; and (3) what cannot so far be programmed.

The illustrations for this kind of interaction with a computer presented in this article are all taken from one session with an interactive computer system, the PDP-6 (made by Digital Equipment Corp.) currently in use at Project MAC at Mass. Inst. of Technology. The basic purpose of this PDP-6 installation is experimentation and in advancement of computer science.

The interactive computer will respond, obey, teach, and play. It is in many ways like a powerful Arabian genie arising out of a fisherman's bottle to do enormously difficult things at one's command.

We shall consider the nature of the genie—his assets, his liabilities, his virtues, his vices—and how one can best deal with him. For just as one learns to understand and appreciate a close friend, it is useful to learn to understand and appreciate the personality of the genie.

Defining an approximate square root of X with a LISP definition, expressing convergence using 1/2 (X + X/K) and then using it to calculate the square root of 2 times 10 to the 12th power.

```
(DEFUN SQRT(X)(COND((MINUSP X)'NEGATIVE)
     (T (SQRT1 X 1))))
SQRT
(DEFUN SQRT1 (X K)(COND((LESSP(ABS
    (DIFFERENCE X(TIMES K K))) .00001)K)
    (T(SQRT1 X (TIMES 0,,.5(PLUS K
    (QUOTIENT X K)))))))
SQRT1
(SQRT 2)
1.41421 56
(SQRT 1)
1
(SQRT 200)
11.313708
(SQRT 200.)
14.142135
(SETQ BASE(SETQ IBASE 10.))
10.
(SQRT 200)
14.142135
(SQRT 0)
0.1953125E-2
(SQRT 0.001)
0.3164201 6E-1
(SQRT 2E12)
/2 E12 UNBOUND VARIABLE - EVAL

(SQRT 2.E12)
1414213.5
```

I. Its Intellectual Behavior

1. Reading. It can read (in a limited way).
   a. It can accept unlimited strings of characters typed on a keyboard or the equivalent.
   b. By means of optical character recognition devices, it can accept strings of characters produced other than by typing on a keyboard.
2. Understanding. It can understand (in a limited way).
   a. If it is told precisely in "words" that it "knows",

it can respond appropriately to the meaning of the words.

b. It can also discover what meaning a human being wishes to convey to it, by proceeding along a network or tree of choices.

3. Writing. It can write (quickly).
   a. It can type at ten characters a second.
   b. It can print lines of 120 characters at the rate of 5 lines a second and up.
4. Drawing. It can draw (on a display scope) at the rate of 10 drawings a second and up.
5. Arithmetic. It can do arithmetic (very quickly).
6. Reasoning. It can perform logic and reasoning (very quickly).
7. Computing. It can calculate and compute; it can perform correctly very long sequences of reasonable operations on information.
8. Data Processing. It can process data (in large quantities).
9. Problem Solving. It can solve problems.
10. Analyzing. It can analyze logical and mathematical situations.
11. Learning. It can provide learning experiences.
12. Game Playing. It can play a game with a human being.
    a. It can lose a game often enough to keep a human being encouraged and cheerful.
    b. It can win a game often enough to keep a human being challenged and eager.
13. Random Action. It can behave randomly, drawing numbers from a random source.
14. Remembering. It can remember until told to forget.
    a. It can remember data for long periods.
    b. It can remember exactly what transpired between it and the human being during an interactive session.
15. Forgetting. It can forget (or erase) when instructed to.
16. Asking Questions. It can ask questions appropriately.
17. Accepting Answers. It can accept a wide variety (but not an unlimited variety) of answers to the questions it asks.
18. Accepting Questions. It can accept questions (in a limited way).
19. Supplying Answers. It can supply answers to any of these questions (if the answers can be computed).
20. Accepting Commands. It can accept a wide variety of commands from the human being, and execute them.
21. Responding to Actions. It can respond to a wide variety of actions by the human being.
22. Help. It can offer to help, and it can provide help.

Answer to "Who is using the time-shared computer system right now?"

```
:PEEK

   ITS 549   PEEK 147    11/01/69 21:50
MEMFR=41  USRHI=21              RNABLU=1
I= U-JNAME  STATUS TTY    CORE %TIM
 0 SYS      CLOSE  T5      31  0%
 1 CORE     UUO    ?        0  1%
 2 RG       TYI    T0       6  0%
 3 MS       S      >        6  0%
14  TECO    TYI    T3  D    6  1%
 4 CDH      S      >        6  0%
10  >       TYI    T13     57  0%
 5 FW       TYI    T4      11  0%
15  J       10!0   ?        6  0%
 6 AKG      S      >        6  0%
 7  TECO    10!0   <        6  0%
11  LISP    TYI    T14 P   44 14%
12 EF       S      >        6  4%
17  PEEK    +GETSY T7  C    6  0%
16 RJL      TYI    T12      6  1%
20  CHESS   10!0   ?       14  0%
USR MEM= 275  USR TIM= 21%
STIME = 2:02:27  LOUTIM = 6
```

Asking another user who is on the system "How make the chess program print the board?"

```
23757)   .IOT 1,1   :SEND RG
(MAIL) 25:75:12 96/10/11 FE

?   ?   ↑C
:SEND MS DO YOU KNOW HOW TO MAKE
CHESS PRINT THE BOARD ON A RANDOM TTY???
↑C

↑P

Z↑Z↑Z↑Z:    S?
MESSAGE FROM MS HACTRN
22:00:55 " BD"
```

II. Its Emotional Behavior

1. Patience. It can be inexhaustibly patient.
2. Calmness. It never gets angry or disgusted. It never displays a bad temper (unless so programmed).
3. Strength. It never gets tired or weary, no matter how late the hour or how prolonged the session.
4. Politeness. It can be unfailingly polite and courteous.
5. Adaptability. It can adjust its mode of presentation to the choices and the record of behavior of the human being.
6. Friendliness. It can be friendly.
7. Sympathy. It can be sympathetic. *Example:* Dr. J. Weizenbaum's program Eliza.
8. Humor. It can crack jokes.

III. Common Acceptable Responses from the Human Being

1. "Yes." True. (OK, check mark, T, 1)
2. "No." False. (Not OK, X, F, 0)
3. "I don't know." No knowledge how to answer that question.
4. "It depends." Sometimes yes and sometimes no. Both yes and no.
5. A Multiple Choice. Selection among multiple choices.
6. A Number. Typed.
7. A Word. Typed.
8. Quit. I'm tired; I want to stop; I quit.

Playing three moves of chess with the interactive computer, which is using the Greenblatt program.

```
:CHESS

←PB
CLOCK STARTED
←
P K4
←B P/K2-K4 0.2 IN 0.0
BD
WR WN WB WK WQ WB WN WR
WP WP WP -- WP WP WP WP
-- ** -- ** -- ** -- **
** -- ** WP ** -- ** --
-- ** -- BP -- ** -- **
** -- ** -- ** -- ** --
BP BP BP ** BP BP BP BP
BR BN BB BK BQ BB BN BR
←
?

N KB3
←B N/KN1-KB3 0.6 IN 1.0
N QB3
←B B/KB1-QN5 1.0 IN 1.0
BD
WR ** WB WK WQ WB -- WR
WP WP WP -- WP WP WP WP
-- ** WN ** -- WN -- **
** -- ** WP ** -- BB --
-- ** -- BP -- ** -- **
** -- BN -- ** -- ** --
BP BP BP ** BP BP BP BP
BR -- ** BK BQ BB BN BR
←
?

P Q3?
P QR3
←
```

IV. Common Acceptable Commands from the Human Being

1. LOG IN. I wish to begin.
2. Definition. Please define . . . . What is . . . . ? Please explain . . . .
3. More Definition. Please say that in other words; please define further.
4. Example. Please illustrate; please give me an example; for instance?
5. Another Example. Please give me another illustration; another example.
6. Problem. Give me a problem; give me a test; give me an exercise to see if I have the right idea.
7. Another Problem. Give me another problem; a second test; a second exercise.
8. Fast. You are too fast for me; go more slowly, please. Don't rush me. I would like some more time. I want to think a bit.
9. Slow. You are too slow for me; go faster, please.
10. Help. Please help me; I don't understand; give me a hint.
11. More Help. Please give me some more help; another hint.
12. Answer. I give up—what is the right answer?
13. Reasons. Why? How come? How do you get that result? Please state your reasoning.
14. Score. What is my score so far? How many right, how many wrong, so far?
15. Shut Up. Oh, shut up. Stop talking. I know what you are going to say, and I am not interested.
16. New Topic. I'm tired of this topic. Let's go on to the next topic.
17. LOG OUT. I wish to stop.

V. Common Facilities for Preparing and Editing Commands to the Computer

A. Short Commands

1. One Character Correction. Delete the character at the current location, and space backwards one space.
2. Entire Line Deletion. Delete the entire line of characters at the current location.
3. Go. Command is complete, and seems accurate. Execute it.

Two examples of interacting with a program for arithmetic drill. The computer poses a set of ten arithmetic drill problems, and reports the number of seconds for the teletype user to respond with the right answer.

```
(UREAD LES SON)
(DSK EF)
↑Q
10.

10.

T

(+ - X //)↑WS↑V(RUN)
5X3=15  6
3 X9=27  4
5-3=2  3
9X1=9  4
9+5=14  3
0+3=3  2
4X8=32  2
15/5=3  2
7-4=3  2
4-1=3  1
THANKS
(RUNP 6 877 '(X))
5X4=20  3
1X4=4  2
2 X5=10  2
0X2=0  2
2 X2=4  2
2 X3=6  2
0X5=0  2
4X2=8  2
THANKS
```

B. Long Commands

1. Read.
   a. Read page of commands from tape into the buffer.
   b. Read line N.
   c. Read lines N to N2 inclusive.
2. Write.
   a. Write the contents of the buffer (the page).
   b. Write line N.
   c. Write lines N to N2 inclusive.
3. Change. Change line N into the following line . . . .
4. Deletion.
   a. Delete N characters forward from the pointer.
   b. Delete N characters back from the pointer
   c. Delete line N.
   d. Delete lines N to N2 inclusive.
   e. Delete the entire buffer.
5. Insertion.
   a. Immediately before line N, insert the following character string . . . .
   b. At the location of the pointer, insert the following character string . . . .
6. Append. Add at the end of the buffer the following character string . . . .
7. Pointer Location. Show where the pointer is located.
8. Moving the Pointer. Move the pointer back or forward N characters or N lines.
9. Record. The set of commands in the buffer is complete, and seems accurate; record it on tape for execution later.

The Genie's Vices

We now come to the topic of the failings, the vices, of the genie: the things that the programmed computer so far is not able to do, or is able to do so wretchedly that it is often better not to ask the genie to do them at all.

Here is a list of these features—the defects, the vices—of the genie:

1. *Stupidity.* It is often stupid. It understands only what you say, it does not understand what you mean.
2. *Deafness.* It often appears "deaf". You may seek to explain to it how to do something, but it fails to comprehend what you wish it to do, and it behaves as if it could not hear you.
3. *Unperceptive.* It cannot perceive the expressions on a human face, nor respond to the mood of a human being, nor take in the meanings of gestures.
4. *Spelling.* It is often sensitive to misspelled words. Like the door to the cave in Ali Baba and the Forty Thieves, it will respond to the command "open sesame", but only if you spell the words correctly. If you spell the command "open sesamy", the computer will probably respond by typing a question mark, "?".
5. *Meanings of Words and Discourse.* At the present stage of development of the genie, it cannot understand the meanings of words in general, nor the meanings of words freely put together into sentences, paragraphs, and discourse.

   This problem is probably not insuperable; but at present the genie regularly will react like a rude and uneducated man on an occasion when you say to him, "The Pythagorean theorem states that the sum of the squares on the two sides of a right-angled triangle are equal to the square on the hypotenuse": both the man and the genie will respond. "Huh?"

An example of carrying on a conversation with Dr. J. Weizenbaum's program ELIZA, which has been translated into LISP, and is called by the command (WORKER) given to LISP.
The first statement by the program to the human being sitting at the teletype is SPEAK UP. At this session, I (the author) sat at the teletype, and I "spoke" to ELIZA, and my first remark was "I WISH YOU WOULD EXPLAIN YOUPSELF". The alternate lines were uttered by ELIZA and by me.

```
(WORKER)
SPEAK UP!
I WISH YOU WOULD EXPLAIN YOURSELF

WE WERE DISCUSSING YOU - NOT ME

WHY ?

WHY INDEED

YOU ARE NOT VERY CLEAR.

WHAT MAKES YOU THINK I AM NOT VERY CLEAR

ARE YOU ELIZA?

WHY ARE YOU INTERESTED IN WHETHER I AM ELIZA OR NOT

YOU REMIND ME OF JOE WEIZENBAUM'S PROGRAM ELIZA.

IN WHAT WAY

YOU BEHAVE LIKE HER.

OH, I BEHAVE LIKE HER

YOU SURE DO.

IS THIS REALLY RELEVANT TO YOUR PROBLEM

I THINK IT IS AND YOU CAN'T REALLY SHOW ME THAT IT IS NOT RELVEANT.

PERHAPS I DO CAN'T REALLY SHOW YOU THAT IT IS NOT RELVEANT

DEFUN WORKER.

I AM NOT SURE I UNDERSTAND YOU FULLY

GIVE THE DEFINITION OF WORKER.

I AM NOT SURE I UNDERSTAND YOU FULLY

EXPLAIN YOURSEFL SAYING WHAT YOU ARE DEFINED AS.

TELL ME ABOUT WHAT I ARE DEFINED AS

YOU ARE DEAF AND STUPID.

DOES IT PLEASE YOU TO BELIEVE I AM DEAF AND STUPID

NO I WOULD RATHER YOU BE CLAER AND INTELLIGNET.

ARE YOU SAYING 'NO' JUST TO BE NEGATIVE

YOU ARE DESIRED TO BE CLEAR AND INTELLIGENT.

PERHAPS YOU WOULD LIKE TO BE DESIRED TO BE CLEAR AND INTELLIGENT
```

6. *Meanings Derived from Observations of a Generalized Environment.* The genie cannot "look" at a generalized environment and understand the significance of what it "sees". For example, it cannot "look" at a traffic intersection, "know" which lights are the traffic lights, make a judgment of the traffic, and proceed through the intersection safely and sensibly.

With this appraisal of the powers of the genie—the interactive programmed computer—we should be better able to include in its behavior (its programming) the features that we desire, and thus obtain the efficient and comfortable assistance of the computer in computer-assisted activities of many, many kinds. □