Artificial Intelligence Project--RLE and MIT Computation Center
Memo 53--

ARGUS

by Warren Teitelman

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0. Summary

This report describes the use of ARGUS, a program
that recognizes hand-drawn characters in real time. The
program is a result of research reported in "New Methods
for Real-Time Recognition of Hand-Drawn Characters",
submitted in partial fulfillment of the requirements for
the degree of Master of Science. The report does not
assume any previous knowledge of the theory behind ARGUS,
but some of the discussion may be more meaningful if the
reader refers to the thesis mentioned above.[1]

ARGUS is written for the DEC PDP-1 with 4096 words of
high speed memory and a parallel drum. It is compatible with
the installations at both M.I.T. and B.B.N. Briefly, the
program learns to recognize characters drawn on the face
of the cathode ray tube with the light pen. The program
may be trained to recognize a particular style of handwrit-
ing and a particular character set, and the results of this
training may be punched off and saved for future use. The
salient features of the program are described below.

1. Modes of Operation

There are two different modes of operation for ARGUS

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1. Reprints may be obtained from Marvin Minsky at M.I.T.
or Thomas Marill at B.B.N.

corresponding to the differences in the installations at M.I.T. and B.B.N. Since the mode determines which iot instructions will be used for drum operations, the program must be in M.I.T. mode to operate at M.I.T. and in B.B.N. mode to operate at B.B.N.

1.1 M.I.T. Mode

Sense switch four must be up.

Program uses space war controls for binary feedback of approval and disapproval (described below); acceleration and left turn correspond to approval, and hyperspace and right turn to disapproval. Thus only one toggle switch need be used.[2]

If sense switch 6 is up, the fire torpedo space war control acts as a pen switch. In other words, the pen is not activated unless the switch is depressed. However, a small circle of light is displayed where the pen is pointing.

1.2 B.B.N. Mode

Sense switch four must be down.

Program displays two light buttons, "+" and "-", at bottom of screen for binary feedback of approval and disapproval (described below); "+" corresponds to approval

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2. The box with four toggle switches corresponding to the eight low order bits of the IO has been found more useful than the actual space war controls.

"-" to disapproval.

Program uses contact pen switch.

2. Loading the Program

Make sure the correct mode has been selected. Load the binary tape in the reader and press read-in. Program should write on field 10, calculate for five seconds, write on field 1, and halt. (The program does not use field 10, except when debugging.)

Press read-in again. Program should write on field 1 and halt.

Press read-in once more. Program should write on field 2 and begin operating. If the program has read in correctly, there should be displayed on the scope:

1. a small light button in the upper right hand corner,

2. a raster in the center,

3. the words "ARGUS is ready" immediately above the raster,

4. (in B.B.N. mode only) "+" and "-" below the raster.

3. Training the Program

Training the program consists of drawing characters in the raster, and correcting ARGUS's guesses where necessary. The program must first be placed in training mode (see below). The user draws a character and indicates approval (as discussed above) when ARGUS is to recognize it. Indicating disapproval causes the character to be erased.

ARGUS displays its guess in the upper left hand corner of the screen. This character is underlined if ARGUS is sure. If it is correct, the user indicates this by approving. If incorrect, the user indicates disapproval, and the program displays its alphabet. The user selects the correct character with the light pen in the manner described in section 1. If the correct character is not on the first page of characters, the user may see additional pages by indicating disapproval again.

If ARGUS is incorrect but sure, the user must generate a new tree to expand the discriminators of the program. See thesis for further discussion.

4. Control Panel

The small light button in the upper right hand corner of the screen is for calling the control panel. The control panel offers the various options available to the user.

4.1 Enter Training Mode

This button puts the program in training mode. (See section 3).

4.2 Leave Training Mode

This button takes the program out of training mode. (When the program is not in training mode, it merely adds

characters to the input string as described in section 5.)

4.3 Enter Hysteresis Mode

This button puts the program in hysteresis mode. Normally the program should remain in hysteresis mode.[3]

4.4 Leave Hysteresis Mode

This button takes the program out of hysteresis mode.

4.5 Erase Trees

This button causes the panel to put up a message "ERASE ? ?". If the user wishes to erase, he points at the new button.[4] If not, the program will return to the control panel after five seconds.

Erasing destroys any new trees generated and strips the four original trees. The program erases when it reads in, so that garbage on the drum does not affect its performance.

4.6 Generate New Tree

This button causes the raster to be displayed. The user shades in the area of the raster corresponding to the property he is generating. The area may be disconnected.

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4. Using the appropriate pen switch or space war control method.

3. For discussion of hysteresis, see above-mentioned thesis.

Indicating approval causes the property table to be modified
and the new tree set up. Disapproval wipes out what has
been shaded in. There is no exit other than restarting.

4.7 Punch Off

This button causes the existing trees to be punched off.
If any new trees have been generated, the property table
is punched off also.

4.8 Read In

This button causes the panel to put up a message
"READ ? ?". If the user wishes to read, he points at the
new button. If not, the program will return to the control
panel after five seconds.

The read routine reads trees punched by the punch
routine. Load the tape in the reader and turn the reader
on before attempting to read. If read in is successful, the
program will jump back to normal operation. If not it will
halt. In the latter case, the user may press continue, or
restart the program. The trees should be read in again as
they are probably incorrect and will cause the program to
hang up.

4.9 Generate New Character

This button causes the panel to jump to a routine which
allows the user to generate a new 5 x 7 character. The
raster on the left is for writing, and that on the right

for erasing. In other words, points on the left are entered into the character, on the right removed. The character is displayed between the words "actual" and "size". Pointing at the character causes it to be subscripted. Pointing at it again will cause it to revert to normal positioning. Indicating approval causes the new character to be appended. to the list of characters in the alphabet of the program. Any new characters generated will be placed on the third page of the select routine (described above in section 3). Indicating disapproval causes the new character to be erased, but does not exit from the generate new character routine.

4.10 Set Up Raster

This button causes a raster that fills the entire scope to be displayed. The user indicates the lower left hand corner of the new raster by pointing at it. The program will pause for a second. The user then indicates the upper right hand corner of the new raster. The raster is positioned and scaled accordingly. This may be repeated as many times as is necessary, and does not affect the recognition process.

4.11 Exit from ARGUS

This button causes the input string to be erased and returns to normal operation.

4.12 Dismiss Panel

This button dismisses the panel without any further action.

5. Input String

The input string is the string of characters the user has input to the program. It is displayed above the raster. Initially, the input string is "ARGUS is ready".

When the program is in training mode, the character that is the correct guess, as indicated by the user, is added to the input string at the pointer.

When the program is not in training mode, the character that is the program's guess is added to the input string at the pointer ('?' if no guess).

The pointer may be repositioned to any character by pointing at that character. This character may be deleted from the input string by pointing at the pointer.

The first five characters on the second page of the select routine have special functions. These are carriage return, tab, up shift, down shift, and backspace. They act as operators on the input string. Carriage return, tab, and backspace do precisely what they imply. Up shift causes the next character to superscript the last character. Down shift causes the next character to subscript the last character.

6. In case of panic...

6. In Case of Panic

The program may be restarted at location 37 (octal). It is then ready for input on the raster, and the input string and trees are not disturbed.

If the user wishes to have the program ignore what he has drawn after the program has attempted to recognize it, this can be done by pointing at the character displayed as its guess.

If the user wishes the program to ignore what he has drawn, after the program has attempted to recognize it and he has signaled disapproval (the alphabet is now being displayed), this can be done by indicating approval.

7. Error Halts

There are three error halts. They are identified by the contents of the accumulator.

7.1 Error Halt with 1 in Accumulator

Storage on a particular tree is exhausted. No further growth will take place on this tree.

7.2 Error Halt with 2 in Accumulator

More than 40 candidates at a node. First 40 taken.

7.3 Error Halt with 3 in Accumulator

More than 64 total candidates. First 64 taken.

7.4 Action Following Error Halts

The user should be able to press continue and have the program proceed with the action taken as indicated above. However, these error halts have not been fully debugged, so no guarantee about the result of pressing continue can be made. I would be interested in any outcome of such a procedure, however.

8. Miscellaneous

There is one known bug, which will be fixed. If the program identifies a character, and is sure, and the user wishes to inform the program that it is a different character, he may do this by indicating disapproval and then pointing at the correct character when the alphabet is displayed. However, this procedure cannot be repeated. If you decide a 'Z' is to be a '2', then you are committed. This should not affect normal usage, however.

Please report any other misbehavior or suggestions about the program to Warren Teitelman, via the A.I. Office at M.I.T.

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