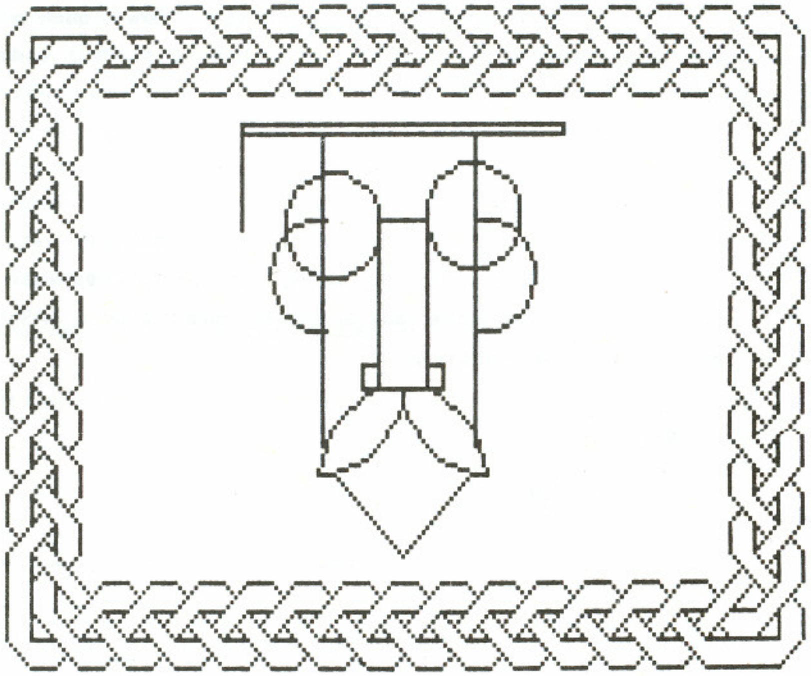
Dr. Logo Newsletter



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EDITOR'S INTRODUCTION

Welcome to the first ever Dr. Logo Newsletter! We have worked long and hard to bring you information I hope will be both useful and enjoyable to you. There is quite a bit of material here, so don't be surprised if it doesn't all make sense at the first reading (it didn't all make sense at the first writing). We made the newsletter the same format as all the other Dr. Logo documentation to help you keep all of your material together.

As you read through the articles you will probably notice a slightly more sophisticated orientation than is usual in Logo materials. This is a reflection of the survey responses and my personal tastes, both in Logo and in writing. If you find you need help penetrating my purple prose I will answer any letters accompanied by a SASE (Self Addressed Stamped Envelope). My address is:

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The Dr. Logo Newsletter was printed in the United States of America.

*** First Edition: April 1984 ***

RESPONSE CARD RESULTS

At the end of December, 1983 we had received back 470 response cards for the free Dr. Logo Newsletter. This reflects a much higher response rate than for ANY other Digital Research product (including CP/M). There were some surprises in the numbers we recorded - most of you are adults or adult & child combinations and Dr. Logo is being used almost exclusively in the home. The numbers are listed below with percentages that were derived by dividing the totals by 470. The numbers don't always add up to 470 (100%) because many cards had multiple items checked off. This is who you are:

I use Dr. Logo at

Home 401 (85.3%) School 65 (13.8%) Business 106 (22.6%)

Dr. Logo's primary user's age is

5- 8 137 (29.1%) 9-12 166 (35.3%)
13-18 55 (11.7%) Adult 312 (66.4%)

By State or Country

AK	2	.42 %	MD	12	2.55 %	RI	1	.21 %
AZ	6	1.3 %	ME	2	.42 %	SC	2	.42 %
CA	113	24.0 %	MI	8	1.7 %	SD	1	.21 %
CN	1	.21 %	MN	3	.638%	TN	3	.638%
CO	10	2.1 %	MO	7	1.49 %	TX	31	6.59 %
CT	13	2.76 %	MT	1	.21 %	UT	2	.42 %
DC	3	.638%	NC	6	1.3 %	VA	14	2.98 %
FL	5	1.06 %	NE	2	.42 %	VT	2	.42 %
GA	4	.85 %	NH	3	.638%	WA	11	2.34 %
HI	22	4.68 %	NJ	11	2.34 %	WI	8	1.7 %
IA	2	.42 %	NM	9	1.91 %	WV	1	.21 %
IL	16	3.4 %	NV	1	.21 %	WY	1	.21 %
IN	5	1.06 %	NY	24	5.1 %	CANADA	21	4.47%
KS	6	1.27 %	OH	6	1.3 %	COLUMBIA	1	.21%
KY	3	.638%	OK	7	1.49 %	JAPAN	1	.21%
LA	3	.638%	OR	8	1.7 %	KOREA	1	.21%
MA	29	6.17 %	PA	13	2.76 %	SWEDEN	1	.21%

Since this initial survey, the numbers have been changing somewhat, with the kids (especially the 9-12 age range) starting to overtake the adults. Come on adults, let's get in there and rally back to the lead. They might be able to demolish us at blinkey-death video games but in Logo we all start as equals.

LOGY, MORF, AND MA BELL

The Young Person's Logo Association has a special treat for all you Logophiles - a computer bulletin board system (CBBS for short). A CBBS is a computer that people can call and talk to using their own computer and a modem. Your computer must be able to act like a terminal (usually by running a terminal program like PC-Talk III) and your modem must be in 'originate' mode at 300 Baud. Once all that is set up, call the Midnight Turtle (the name of this CBBS) after 7PM CST at (214)-783-7548 and once the two computers start whistling at each other, you're in!

This bulletin board is a great place to leave messages, ask questions, and answer someone else's questions if you can. There will be useful information, friendly tips, and even Logo programs you can download. So give it a try.

Here is a brief summary of the commands available at the CBBS's 'toplevel'. Once you have chosen one of these commands, other subcommands might be needed. If you are ever unsure of what to do, simply type HELP or ?.

Command	Stands For	Effect
B	Bulletins	read or send messages to everyone
C	Chat	try to talk to Jim Muller
H	Helpful info	helpful hints and command summary
I	Information	information about the CBBS
L	List TP files	for up- and down-loading
N	Normal info	more information about the CBBS
R	Recommendation	private message to Jim Muller
RN	Reread News	retypes the log-in messages
S	Status	information about your call
T	Time info	info about duration of call
U	new User info	a very good place to start
MR	Mail Read	read messages sent to you
MS	Mail Send	send messages to other users
OFF	get OFF CBBS	end session and hang up

Unless you are a member of YPLA (which we heartily recommend), some functions are unavailable to you. The system is VERY new and there might be some bugs in it. If something doesn't seem to work right, leave a message for Jim Muller via the R command.

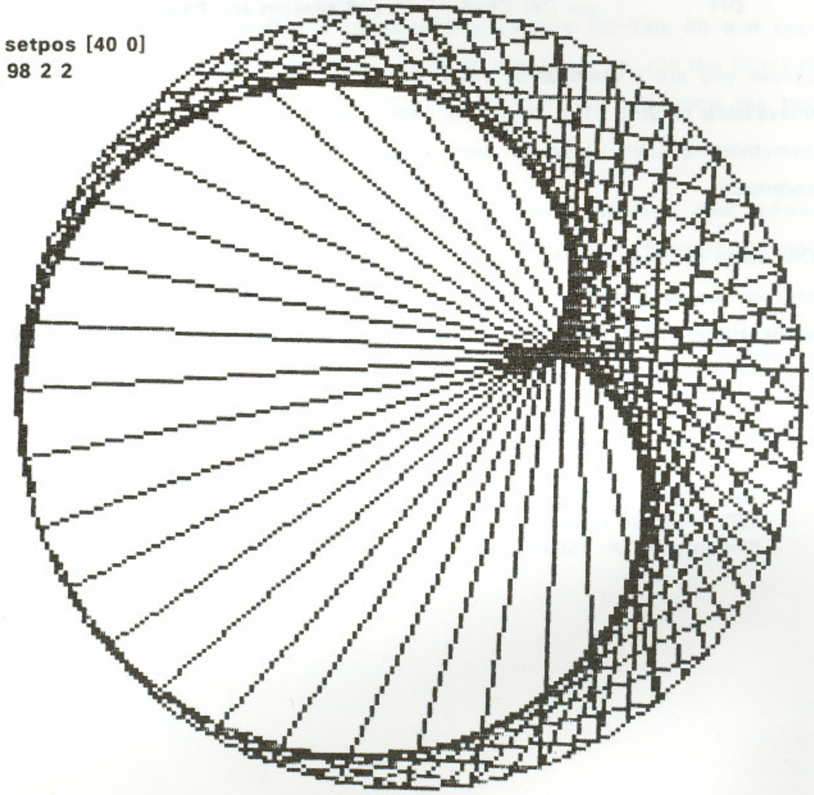
One word of caution: Ma Bell eats pennies faster than Pac-Man chomps dots, so don't stay on the system for hours at a time. Also remember that this is a text-only system. While there might be turtle graphics procedures on the CBBS, there are no finished drawings to look at.

For more information contact

The Young Peoples' Logo Association
1208 Hillsdale Drive.
Richardson, TX 75081.

STRING ART WITH DR. LOGO

```
to string :sz :offset :halves
(local "n "o "p "q)
make "o pi / 108
clean ht make "p pos pu setx xcor + :sz pd
repeat 360 [fd :sz * :o lt 1]
pu setpos :p make "n 1
repeat 36 * :halves [
 pu fd :sz make "q pos
 setpos :p seth remainder (5 * :n * :offset) 360
 fd :sz pd setpos :q pu
 setpos :p seth remainder (5 * (:n - 1)) 360
 make "n :n + 1]
end

cs pu setpos [40 0]
string 98 2 2
```



FASTER TURTLE GRAPHICS IN DR. LOGO

While Dr. Logo currently has the fastest graphics of all the Logos we know about, there probably isn't anyone who wouldn't like to see even faster graphics. This article presents a number of techniques for speeding the turtle on its merry way.

We begin with a very simple, but often overlooked one: hide the turtle! When the turtle is shown, and you move or rotate it, the old turtle is erased, the action is performed, and the turtle is redrawn at the new position and heading. When the turtle is hidden, all the overhead of erasing and redrawing it is saved. A hidden turtle ALWAYS moves faster than a shown turtle when it is on the screen.

Another technique that helps is the use of **setheading** (**seth**) instead of **left** (**lt**) and **right** (**rt**). Pointing the turtle at absolute headings instead of relative ones generally reduces the amount of math performed by the Logo interpreter. Thus, if the turtle is pointing straight up (heading = 0) use **seth 90** in preference to **rt 90**. If the turtle's heading is 315 (after a **lt 45**) use **seth 288** instead of **lt 27** (288 = 315 + -27). The general formula is New_heading = Old_heading + Angle, which means that the new heading is the sum of the old heading and the angle to be turned. This angle will be a positive number if the turn is to the right and a negative number if the turn is to the left. Numbers larger than 360 (or smaller than -360) will work properly (seth's argument is taken modulus 360).

A closely related technique is the use of setpos in lieu of **forward** (**fd**) and **back** (**bk**). Here again, absolute positioning requires less math on Logo's part than relative motion does. One way to make use of these two techniques is to code a procedure with the normal relative commands originally until it works properly. Then add print statements that tell what the turtle's heading and/or position are at various points in the program. Finally, using this information, many of the relative commands can be replaced by moving the turtle directly to the locations and headings observed in the print statements.

Another appropriate use of setpos and setheading is to go quickly to some fixed position. Instead of :

```
fd 60 rt 90 fd 100 bk 100 lt 90 bk 60
```

use:

```
make "p pos
make "h heading
fd 60 rt 90 fd 100
pu setpos :p seth :h pd
```

Now before Logo purists descend with fire in their eyes at the espousing of such rank heresies, it must be stressed that all of these techniques should be employed only when faster graphics are important. Follow the principle of 'make it work, then make it fast'.

The observant reader will have noticed the **penup** (**pu**) command in the second example above. It is plain to see that putting the pen up prevented drawing an unwanted diagonal line. What is not so plain to see is that the turtle also moves faster with the pen up than with it down (or erasing or reversing). Why is this?

When the turtle is commanded to move, Logo must calculate the new position and draw a line from where the turtle is to where it will be. When the pen is up, Logo can quit right after figuring out the new position. So whenever possible keep that pen up.

In the discussion of **setheading** and **setpos** it was stated that use of those primitives cut down on the amount of math that Logo had to perform. Another trick that cuts down on the amount of math is to cut down on the precision of the numbers being used. Whenever possible use integers as these are the easiest for Logo. If decimal numbers are needed, use the fewest digits of precision tolerable. For example, Logo says the expression **sqrt 2** is 1.4142135623731 but for most graphics applications 1.4142 is more than adequate.

Finally, there is a great deal of overhead when Logo enters and exits a procedure and a smaller, though still noticeable, amount when using repeat loops. Whenever possible, therefore, unwind loops and expand procedures in-line. As an example of these two try these procedures:

```
to design
 repeat 36 [square 30 rt 10]
end

to square :sz
 repeat 4 [fd :sz rt 90]
end
```

First, the loop in square is unwound:

```
to square :sz
 fd :sz rt 90 fd :sz rt 90 fd :sz rt 90 fd :sz rt 90
end
```

Next, expand the square procedure in-line in design:

```
to design
 repeat 36 [fd 30 rt 90 fd 30 rt 90 fd 30 rt 90 fd 30 rt 100]
end
```

Finally, unwind the loop in design:

```
to design
 fd 30 rt 90 fd 30 rt 90 fd 30 rt 90 fd 30 rt 100 ;repeat
  :                                         ;35
  :                                         ;times
 fd 30 rt 90 fd 30 rt 90 fd 30 rt 90 fd 30 ;no final turn
end
```

This is a great deal less tedious if ^K and ^Y are used.

In summary, the primary techniques for making Logo graphics run faster are

1. Hide the turtle

2. Use **setheading** and **setpos**

3. Use only the required amount of precision

4. Keep the pen up as much as possible

5. Unwind loops and expand procedures in-line

These techniques will work with most versions of Logo, although with varying levels of speedup. Remember - do it right, then do it fast.

A CASCADE OF COLOR

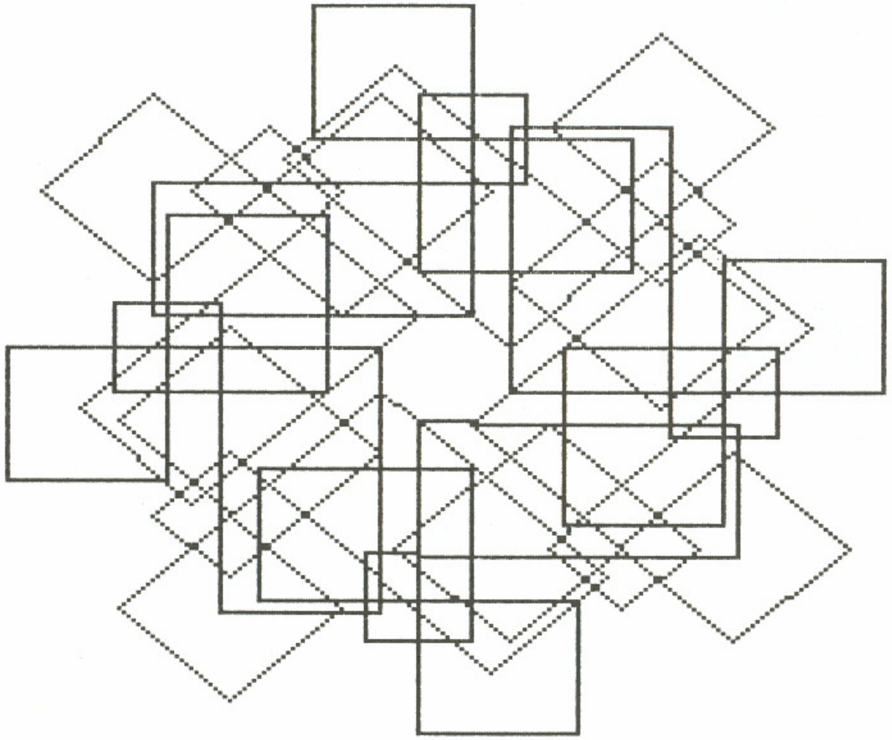
These three procedures draw a spectacular pattern on the graphics screen. After you have typed them in and saved them on disk (always save your work on disk) simply type **cascade**.

```
to cascade
make "sqr2 sqrt 2
setbg 16 fullscreen
cs ht pu setpos [-70 -85] pd
make "x xcor make "y ycor
repeat 5 [side] pu setx :x sety :y + 20 seth 45
repeat 5 [top] pu setx :x sety :y + 20 seth 45 fd 20 seth 0
make "x xcor make "y ycor
repeat 4 [side] pu setx :x sety :y + 20 seth 45
repeat 4 [top] pu setx :x sety :y + 20 seth 45 fd 20 seth 0
make "x xcor make "y ycor
repeat 3 [side] pu setx :x sety :y + 20 seth 45
repeat 3 [top] pu setx :x sety :y + 20 seth 45 fd 20 seth 0
make "x xcor make "y ycor
side side pu setx :x sety :y + 20 seth 45
top top pu setx :x sety :y + 20 seth 45 fd 20 seth 0
make "x xcor make "y ycor
side pu setx :x sety :y + 20 seth 45
top
end
```

```
to top
setpc 2
repeat 7 [
 pd fd 20 seth 135 fd :sqr2 seth 45
 bk 20 pu seth 135 fd :sqr2 seth 45]
fd 20
end

to side
setpc 1
repeat 6 [
 pd fd 20 seth 135 fd :sqr2 seth 0
 bk 20 seth 135 pu fd :sqr2 seth 0]
pd fd 20 seth 135 fd :sqr2 seth 0 bk 20 pu
setx xcor + 1
setpc 3
repeat 6 [
 pd fd 20 seth 45 fd :sqr2 seth 0
 bk 20 pu seth 45 fd :sqr2 seth 0]
pd fd 20 seth 45 fd :sqr2 seth 0 bk 20 pu
setx xcor + 1
end
```

People who frequent video arcades should recognize this pattern.

```
mine2 20 8
```



```
to mine :sz
 fd 5 * :sz rt 90 fd 3 * :sz rt 90 fd 6 * :sz lt 90 fd 4 * :sz lt 90
 fd 3 * :sz lt 90 fd 3 * :sz lt 90 fd 6 * :sz rt 90 fd 3 * :sz rt 90
 fd 4 * :sz rt 90 fd 4 * :sz rt 90 fd 2 * :sz rt 90 fd 2 * :sz rt 90
 fd 1 * :sz lt 90 fd 3 * :sz rt 90 fd 1 * :sz bk :sz
end

to mine2 :sz :num
 repeat :num [mine :sz rt 360 / :num]
end
```

A SIMPLE 3-D GRAPHICS PACKAGE

By now all of you are familiar with the turtle graphics of Dr. Logo. Many of you are quite good at putting fantastic objects on the screen with amazing ease. So, having mastered this level of difficulty it is time to move up to the next dimension – the third dimension. That's right, this article is about a three dimensional graphics system written in Dr. Logo.

In searching for a system that was small and not too slow I finally chose to abandon the usual turtle graphics for Cartesian coordinate graphics. This allowed me to use some simple matrix multiplications to rotate or alter the view of the shape.

In this package the basic unit is the point, defined with the procedure **point** (oddly enough). Points have names and [x y z] coordinate lists telling where they are in 3-D space.

Once you have defined all the points you can construct shapes. The **shape** procedure takes the shape name and a list of two-element lists (ex: [[a b] [a c] [b g] [g j]]). The two-element lists represent the line segments of the shape, with each element being an endpoint. You can have as many shapes as you want, but only one at a time can be manipulated.

Once you've defined your shape you can expand (or contract) it, rotate it, magnify (or shrink) it, shear it, or restore it to its original state.

To expand a shape use the **expand** procedure and tell it which shape to expand, which axis (x, y, or z) the expansion will operate on, and how much to expand it. Amounts between 1 and 0 will contract rather than expand the shape. Negative amounts mirror the shape across the center point of the screen.

Rotation occurs not on an axis, but on a plane (xy, xz, or yz). Again you specify the shape, the plane, and the amount to rotate with the **rotate** procedure.

The procedure **magnify** is very similar to the **expand** procedure. You don't specify an axis, however, because the shape is expanded or decreased in all directions.

Shearing the shape involves tilting it to the left or right or up or down direction. Because of the way the shapes are displayed, shearing in the z axis has no effect and is therefore forbidden.

When you want to start all over with a shape (since trnasformations are cumulative) use the **restore** procedure.

Believe it or not, that's all there is to it. We strongly suggest you play with these procedures to get a better feel for how they work. If you want to explore 3-D graphics further, try the Sept. 1978 issue of BYTE magazine and the Abelson and DiSessa book, Turtle Geometry (listed in your Dr. Logo Bibliography).

In addition to providing the listings, we are also providing a simple shape to get you started. Just type in the following lines and watch what happens.

```
point "a [0 0 0]
point "b [50 0 0]
point "c [0 60 0]
point "d [0 60 20]
point "e [50 60 20]
point "f [50 60 0]
point "g [0 10 20]
point "h [50 10 20]
point "i [0 10 80]
point "j [0 0 80]
point "k [50 10 80]
point "l [50 0 80]

shape "V [[a b] [a c] [a j] [b f] [b l] [c d]
 [c f] [d g] [d e] [e f] [e h] [g i] [g h] [h k]
 [i j] [i k] [j l] [k l]]

rotate "V "xz 45
rotate "V "yz 30
```

```
  Top          Side                Front     Side
i _____ k      d __ e              c __ f         d __ c
 |     |   +Z   |  |        +Y      |  |           |  |  +Y
 |     |  /|\   |  |        /|\     |  |           |  |  /|\
 |     |   |    |  |         |      |  |           |  |   |
 |     |   |    |  |         |      |  |           |  |   |
 |     |   |    | h|_____k   |      |  |    i _____|g |   |
d|_____|e  |    |________|  \|/     |__|     |________|  \|/
 |     |  \|/  b         l  -Y      a    b   j          a -Y
 |_____|  -Z                    -X <---> +X
c       f
>
```

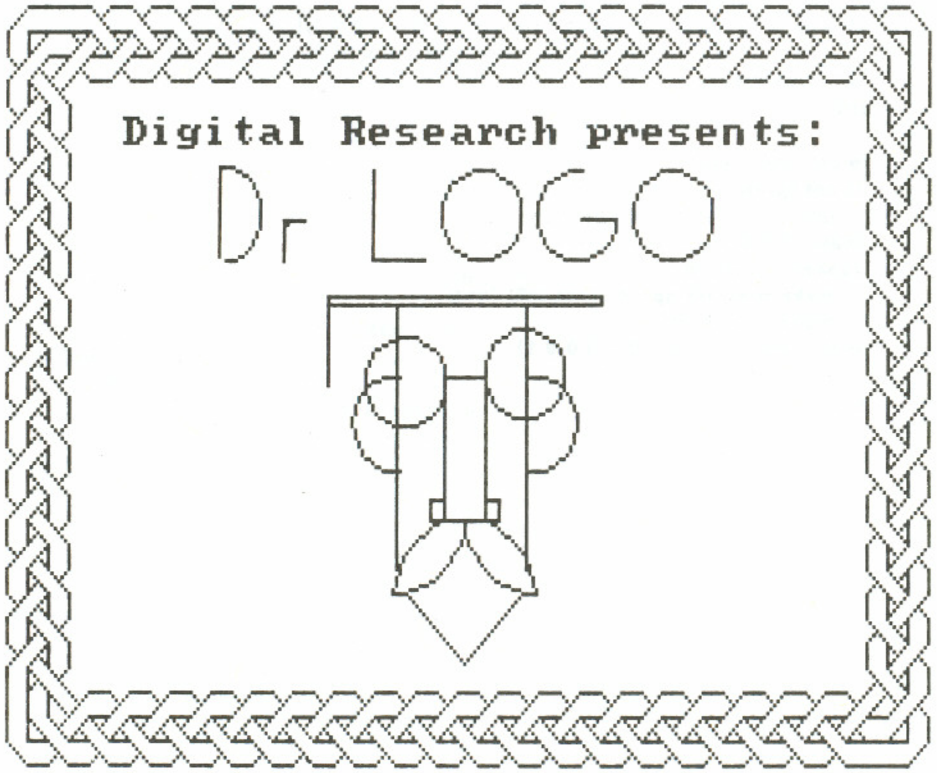
```
to point :point_name :coords
 make :point_name :coords
 pprop :point_name "point "TRUE
 pprop :point_name "orig :coords
end

to shape :shape_name :line_pairs
 if (gprop :shape_name "point) = "TRUE [
    (pr :shape_name [is already a point name.]) stop]
 make :shape_name :line_pairs
 pprop :shape_name "shape "TRUE
 make "shapex (word :shape_name "_pts)
 make :shapex [] make "n9 1
 repeat count :line_pairs [
  if not memberp first (item :n9 :line_pairs) thing :shapex [
   make :shapex fput first (item :n9 :line_pairs) thing :shapex]
  if not memberp last (item :n9 :line_pairs) thing :shapex [
   make :shapex fput last (item :n9 :line_pairs) thing :shapex]
  make "n9 :n9 + 1]
make "matrix [1 0 0 0 1 0 0 0 1] draw :shape_name
(pr :shape_name [is now a shape.])
end
```

```
to expand :shape :axis :amt
 if not memberp :axis [x y z] [
    pr [The axis must be "x, "y, or "z.] stop]
 if not (gprop :shape "shape) = "TRUE [
    (pr :shape [is not a shape.]) stop]
 if :axis = "x [make "matrix (list :amt 0 0 0 1 0 0 0 1)]
 if :axis = "y [make "matrix (list 1 0 0 0 :amt 0 0 0 1)]
 if :axis = "z [make "matrix (list 1 0 0 0 1 0 0 0 :amt)]
 draw :shape
end

to rotate :shape :axis :amt
 if not memberp :axis [xy xz yz] [
    pr [The axis must be "xy, "xz, or "yz.] stop]
 if not (gprop :shape "shape) = "TRUE [
    (pr :shape [is not a shape.]) stop]
 if :axis = "xy [
    make "matrix (list (cos :amt) 0 - (sin :amt) 0
                       (sin :amt) (cos :amt) 0
                       0 0 1)]
 if :axis = "xz [
    make "matrix (list (cos :amt) 0 0 - (sin :amt)
                       0 1 0
                       (sin :amt) 0 (cos :amt))]
 if :axis = "yz [
    make "matrix (list 1 0 0
                       0 (cos :amt) 0 - (sin :amt)
                       0 (sin :amt) (cos :amt))]
 draw :shape
end
```

```
to magnify :shape :amt
 if not (gprop :shape "shape) = "TRUE [
    (pr :shape [is not a shape.]) stop]
 make "matrix (list :amt 0 0 0 :amt 0 0 0 :amt)
 draw :shape
end

to shear :shape :axis :amt
 if not memberp :axis [x y] [
    pr [The shear axis must be "x or "y.] stop]
 if not (gprop :shape "shape) = "TRUE [
    (pr :shape [is not a shape.]) stop]
 if :axis = "x [make "matrix (list 1 :amt 0 0 1 0 0 0 1)] [
                make "matrix (list 1 0 0 :amt 1 0 0 0 1)]
 draw :shape
end

to restore :shape
 if not (gprop :shape "shape) = "TRUE [
    (pr :shape [is not a shape.]) stop]
 make "n9 thing (word :shape "_pts)
 repeat count :n9 [
    make first :n9 gprop (first :n9) "orig
    make "n9 bf :n9]
 make "matrix [1 0 0 0 1 0 0 0 1]
 draw :shape
end
```

PRESENTING--THE DOCTOR

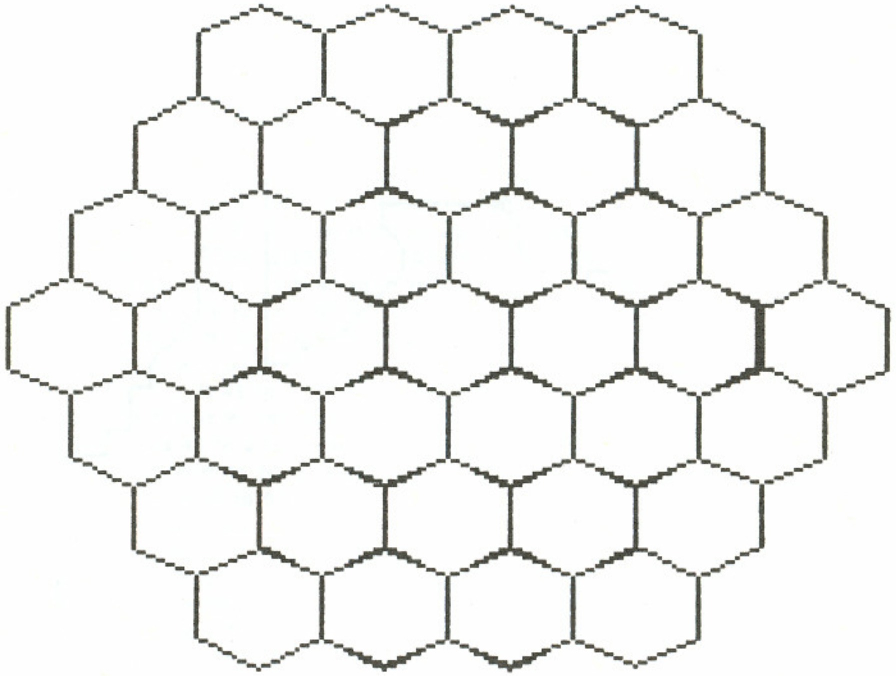
Here is another set of procedures to astound and confound! Yes, drlogo will display a grand portrait of the good Doctor himself. The three braid routines (**braid**, **strip**, and **corner**) have been modified for speed in this collection. The picture gives a monochrome preview of the results.



```
to braid
(local "sqr2 "hfsq2 "s2 "h2 "s2h2)
make "sqr2 1.4 ;sqrt 2
make "hfsq2 0.7 ;:sqr2 * 0.5
make "s2 8.5 ;:sqr2 * 6
make "h2 4.2 ;:hfsq2 * 6
make "s2h2 12.7 ;:s2 + :h2
pu fd 24 rt 45 fd 4.2 seth 0 pd
strip 13 corner strip 21 corner
strip 13 corner strip 21 corner
end

to circle
repeat 36 [forward 2 right 10]
end

to face
make "x xcor make "y ycor
repeat 2 [circle lt 90 fd 12 lt 90] ht lt 180 fd 35 bk 5
lt 90 fd 4 rt 90 fd 5 rt 90 fd 20 rt 90 fd 5
rt 90 fd 4 lt 90 fd 30 rt 180 fd 35
lt 90 fd 6 repeat 10 [fd 3 rt 9]
rt 90 repeat 10 [fd 3 rt 9]
lt 90 repeat 10 [fd 3 lt 9]
lt 90 repeat 10 [fd 3 lt 9] pu
lt 90 fd 20 rt 90 pd bk 12 fd 65
lt 90 fd 20 lt 90 fd 20 bk 22 lt 90 fd 80
rt 90 fd 2 rt 90 fd 60 bk 38
lt 90 fd 65 pu sety :y - 70 setx :x - 6
lt 135 pd fd 22 bk 22
lt 90 fd 22 pu setx :x - 25 sety :y seth 0
lt 90 pd repeat 10 [fd 4 lt 20] pu setx :x + 13 sety :y seth 0
rt 90 pd repeat 10 [fd 4 rt 20] ht
end

to strip :n
repeat :n [
 lt 45 fd :h2 rt 45 fd 6 rt 45 fd :s2h2 pu
 rt 90 fd :h2 pd rt 90 fd :s2 lt 45 fd 6
 if pc < 3 [setpc pc + 1] [setpc 1]
 pu lt 45 fd :s2h2 pd lt 135
 rt 45 fd :h2 lt 45 fd 6 lt 45 fd :s2h2 pu
 lt 90 fd :h2 pd lt 90 fd :s2 rt 45 fd 6
 pu rt 135 fd :s2h2 rt 45 fd 6 pd]
end
```

```
to corner
lt 45 fd :h2 rt 45 fd 6
rt 45 fd :s2 rt 45 fd 18
rt 45 fd :s2h2 pu
rt 90 fd :h2 pd rt 90 fd :s2
lt 45 fd 18 lt 90 fd 6 pu
if pc < 3 [setpc pc + 1] [setpc 1]
lt 45 fd :s2 pd lt 90 fd 17 pu
rt 90 fd :h2 pd rt 90 fd 17 pu
if pc < 3 [setpc pc + 1] [setpc 1]
rt 45 fd 6 rt 90 fd 12 pd
rt 45 fd :h2 rt 45 fd 6
rt 45 fd :h2 pu rt 90 fd :h2 pd
rt 45 fd 6 pu bk 15 rt 90 fd 9 rt 90 pd
if pc = 1 [setpc 3] [if pc = 2 [setpc 1] [setpc 2]]
end

to drlogo
(local ”y)
setbg 24 setpc 1 textbg 0
cs ht
face
pu setpos [-150 -98] pd ht seth 0
braid
pu setpos [-110 60]
tt [Digital Research presents:]
bk 30 setx xcor + 25 pd seth 0
if pc < 3 [setpc pc + 1] [setpc 1]
;
; Dr LOGO in turtle graphics
;
make ”y ycor fd 22 rt 90 repeat 18 [fd 2 rt 10]
pu setx xcor + 17 pd seth 0 fd 10 bk 3 rt 22 fd 3 seth 90 fd 5
pu seth 0 sety :y setx xcor + 20 pd fd 22 bk 22 rt 90 fd 15
pu fd 5 seth 0 fd 11 pd circle pu
repeat 9 [fd 2 rt 10] fd 30 rt 180 pd
repeat 27 [fd 2 lt 10] lt 90 fd 10 pu bk 15 rt 90 pd circle
end
```

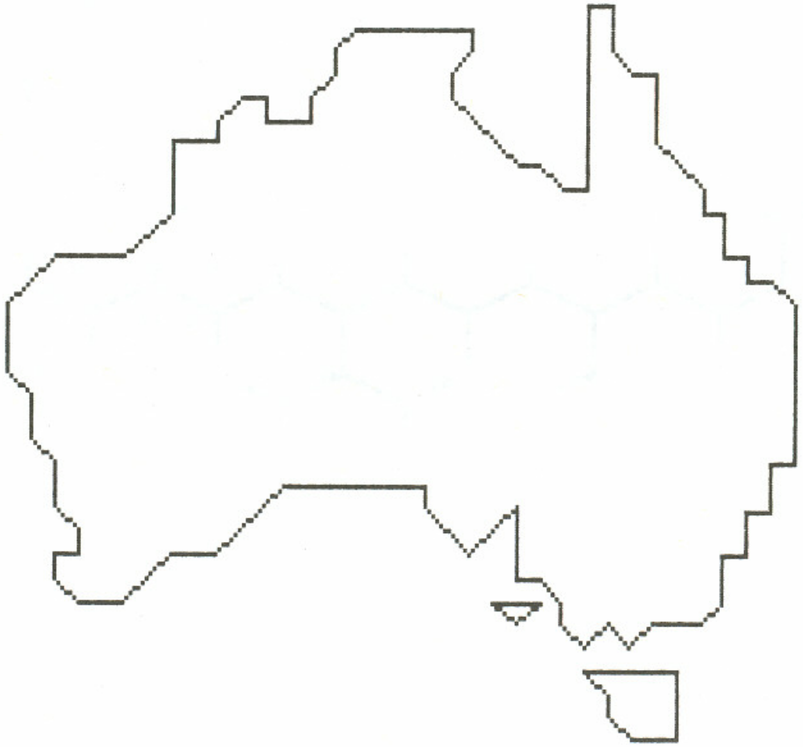
```
hex 20 3
```



```
to hex :sz :level
 repeat 6 [
    lt 30 fd :sz
    if :level > 0 [lt 30 hex :sz :level - 1 rt 30]
    rt 90]
end
```

Logo At Work

The following program is a modified version of one that will be in a forthcoming Digital Research product. The picture shows what the end result will look like on your screen. A worthwhile project might be to plot some of the major cities and show the 6 Australian states. The larger island is Tasmania and the smaller is King Island. Hats off to the winners of the 1983 America's Cup!



```
to australia :n
(local "p "h)
make "p pos make "h heading pu lt 90 fd 8.5 * :n rt 90 pd
fd 1.5 * :n rt 45 fd 1.414 * :n rt 45 fd 1.5 * :n lt 45
fd 1.414 * :n lt 45 fd 1.5 * :n rt 90 fd :n lt 90
fd 0.5 * :n rt 45 fd 0.707 * :n rt 45 fd 0.5 * :n rt 90
fd 0.5 * :n lt 90 fd :n lt 90 fd 0.5 * :n rt 45
fd 0.707 * :n lt 45 fd 0.5 * :n rt 45 fd 0.707 * :n rt 45
fd 2.5 * :n rt 90 fd 0.5 * :n rt 45 fd 0.707 * :n lt 45
fd 0.5 * :n lt 45 fd 2.121 * :n lt 45 fd 0.5 * :n rt 45
fd 0.707 * :n lt 45 fd 0.5 * :n lt 90 fd 4 * :n rt 90
fd 0.5 * :n rt 90 fd :n lt 45 fd 0.707 * :n lt 45
fd 0.5 * :n rt 90 fd 1.5 * :n lt 45 fd 1.414 * :n rt 45
fd 0.5 * :n lt 90 fd 0.5 * :n rt 90 fd :n lt 90
fd 0.5 * :n rt 90 fd 0.5 * :n lt 90 fd 0.5 * :n rt 45
fd 0.707 * :n rt 45 fd 3.5 * :n rt 90 fd 0.5 * :n lt 90
fd :n rt 90 fd 0.5 * :n lt 90 fd :n rt 90
fd 0.5 * :n lt 90 fd :n rt 45 fd 0.707 * :n rt 45
fd :n lt 45 fd 0.707 * :n rt 90 fd 0.707 * :n lt 90
fd 0.707 * :n rt 90 fd 0.707 * :n rt 45 fd 0.5 * :n lt 45
fd 0.707 * :n lt 45 fd 0.5 * :n rt 90 fd 1.5 * :n lt 135
fd 1.414 * :n rt 90 fd 1.414 * :n rt 45 fd 0.5 * :n lt 90
fd 3 * :n lt 45 fd 2.121 * :n rt 45 fd :n lt 45
fd 1.414 * :n rt 45 fd :n rt 45 fd 0.707 * :n rt 45
fd 0.5 * :n rt 90 fd 0.5 * :n lt 90 fd 0.5 * :n lt 45
fd 0.707 * :n rt 45 fd :n lt 45 fd 0.707 * :n rt 45
fd :n lt 45 fd 0.707 * :n rt 45 pu bk 5 * :n rt 90 fd 10.5 * :n
pd fd :n rt 135 fd 0.707 * :n rt 90 fd 0.707 * :n rt 45 pu
bk 1.5 * :n rt 90 fd 2 * :n pd fd 2 * :n rt 90 fd 1.5 * :n rt 90
fd :n rt 45 fd 0.707 * :n rt 45 fd 0.5 * :n lt 45
fd 0.707 * :n rt 45 pu setpos :p seth :h
end
```

TOOLBOX

Graphics Tools

circle :center :radius	**circle [10 30] 40**
filled.cir :radius	**filled.cir 8**
arc.l :center :radius :angle	**arc.l [1 17] 13 45**
arc.r :center :radius :angle	**arc.r [12 3] 21 7**
pie :center :radius :angle	**pie [100 14] 7 32**
filled.pie :center :radius :angle	**filled.pie [0 0] 10 15**

The procedure **circle** draws a circle with the given radius centered at the given point. The turtle's state and color is obeyed. When the circle is complete, the turtle is positioned at the center point with it's initial heading.

The procedure **filled.cir** assumes the turtle's current position is the center and draws a solid circle of the given radius. Again the procedure obeys the current state of the turtle.

The procedures **arc.l** and **arc.r** are very similar to **circle**, but they require you to specify the number of degrees of arc to draw. The direction of the arc draw (to the left or right of the current turtle heading) is determined by which procedure is used.

The procedure **pie** is identical to arc.r except that the endpoints of the arc are connected to the centerpoint. The procedure **filled.pie** is to **pie** what **filled.cir** is to **circle**.

Workspace Management Tools

nerase :keeplist	**nerase [sort.procs verall]**
sort.procs	**sort.procs**
unpkgall :set	**unpkgall proclist**
verall	**verall**
uses	**uses**

The procedure **nerase** is, in some ways, the inverse of the primitive **erase**. Invoking this procedure will erase all procedures except those listed. This is very useful if you have many procedures but only want to retain a few. Note that **nerase** claims to erase buried procedures but it cannot. Neither can it erase itself.

The procedure **sort.procs** simply sorts all procedures in the workspace into alphabetical order. This generally makes it easier to find procedures in the workspace.

The procedure **unpkgall** takes the specified procedures out of any packages they are in. The example above, **unpkgall proclist**, drops all packaging.

The procedure **verall** inquires, for each procedure in turn, whether you want to erase that procedure. When finished, **verall** shows you all the files you have chosen to delete and reconfirm your choice. This is a very popular procedure.

The procedure **uses** lists the title line of each procedure in your workspace and, indented underneath, any procedures that each of those procedures references, including themselves if recursive. After each procedure, the system waits for a keypress to continue.

List Manipulation Tools

delete :object :objlist	**delete "cat [dog cat pony]**
every :objlist# :predicate#	**every [1 2 a 3 b] "numberp**
intersection :set1 :set2	**intersection [1 2 3] [2 4 6]**
remove :object :objlist	**remove "cat ["cat "dog "cat]**
replace :old :new :in	**replace "1 "2 [1 2 3 2 1]**
reverse :set	**reverse [eat snails everyday]**
some :objlist# :predicate#	**some [a [1] [2 3]] "wordp**
subset :objlist# :predicate#	**subset [[1] 2 [3 4] 5] "listp**
union :set1 :set2	**union [1 2 3 4] [1 2 a b]**

The procedures **delete** and **remove** are very similar in function. They both remove an object from something. The former removing only the first occurrence, the latter removing all occurrences.

The procedures **every**, **some**, and **subset** work by applying some test (called a predicate in Logo) to each element of the list being tested. The procedure **every** returns "TRUE if the predicate returns "TRUE when applied to every item in the list. The procedure **some** returns "TRUE if the predicate returns "TRUE when applied to any element of the list. The procedure **subset** returns a list of those elements which the predicate returned "TRUE when applied to.

The procedures **intersection** and **union** compare the membership of two lists. Only those items in both lists are returned by **intersection**, while all the items in both lists are returned by **union** (with no duplicates in the return list). There is a very special case under which **union** returns duplicate items. This occurs when :set2 has more than 2 extra items than :set1 and there are duplicates in these extra items. Fixing **union** would be a great project in list processing.

The procedure **replace** changes all occurrences of the first object to the second object in the list. This is the classic search and replace function. Note that this function is level sensitive so that no replacement occurs for items in sublists.

The procedure **reverse** returns a list with the elements in reverse order of the elements in the list passed to it. It does not reverse the order of elements in sublists.

Mapping Tools

```
apply :function# :maplist#          apply "print [This is a triangle]
map :function# :maplist#            map "xyzzy [2 12 a b]
mapc :function# :maplist#           mapc "random [6 6 6]
mapfirst :function# :maplist#       mapfirst "sin [0 45 90 -90]
```

The procedure **mapfirst** returns a list whose elements are created by applying the function to each element of the maplist in turn. Note that the function, whether a built-in primitive or a user-defined function, must return a value or an error occurs.

The procedures **map** and **mapc** are similar to **mapfirst** but instead of having the function operate on the individual elements of the list, it operates on the whole list and then

successive **butfirst**'s of the list. The two forms are provided to give you a chance to compare how they operate. There might be cases where one would be better to use than the other. The same restriction on the functions for **mapfirst** apply to the functions for both of these as well.

The procedure **apply** is just like **map**, except the function you use does NOT need to output values. Building an **applyfirst** procedure is left to you.

These procedures are very similar to the mapping functions of Lisp and should prove very useful in constructing Artificial Intelligence programs.

Flow of Control Tools

```
cond :condition#             cond [[xy 1] [yz 2] ["TRUE 0]]
loop :body#                  loop [op run readline]
until :cond# :body#          until [:n < 10] [make "n :n + 1]
while :cond# :body#          while [not night] [measure light]
```

The procedure **cond** works just like the Lisp primitive of the same name--if the first condition evaluates to "TRUE, **cond** returns the value from evaluating the first body. Otherwise it tests the second condition, and so on, until it finds a "TRUE condition or runs out of possibilities. If the latter case occurs, **cond** returns []. Remember that the evaluated bodies must return a value, so you might need to use the **rise** function described below.

The **loop** procedure repeats forever the evaluation of :body#. It can be exited only by **stop**, **op**, **throw "TOPLEVEL**, or a ^G (control-G). In the actual code for **loop**, the expression 1 / 0 returns +INF, which stands for infinity.

The procedures **until** and **while** are two useful loop constructs that allow you to express certain ideas with great clarity. The :cond# list can contain multiple statements, as long as evaluating it returns a "TRUE or "FALSE value. In **while**, the condition is tested and, while "TRUE, the body is performed. In **until** the body is performed, then the condition is checked until the condition becomes "TRUE.

Miscellaneous Tools

ask :question	**ask [What should I do now ?]**
askyn :question	**askyn [Play again (y/n) ?]**
forget :object	**forget "xyzzy**
inkey	**inkey**
menu :menulist#	**menu [[on][sw.on][off][sw.off]]**
pop :stack	**pop "addresses**
push :value :stack	**push 123.3 "rpn**
rise :object#	**rise [print "xyzzy]**
sink :object	**sink rc**

The procedures **ask** and **askyn** type out the question and wait for a response. The procedure **ask** returns the first item of the response, while **askyn** returns "TRUE if the response was 'y' (upper- or lowercase) and "FALSE otherwise.

The procedure **forget** completely eliminates a word from the workspace, erasing any procedure definition, value, and bound properties. WARNING: This procedure can even eliminate primitive functions. Use it carefully or you might blow the system away.

The **inkey** procedure was provided for people familiar with the Basic function of the same name. If a key is pressed, it is returned, otherwise [] is returned. Unlike **readchar**, this function does not wait for a key to be pressed.

The **menu** procedure allows you to quickly construct a simple selection menu. The format of :menulist# is [choice1 action1 choice2 action2 ...] where the choices are objects that are printed out and the actions are the list of statements to be executed if the associated choice is picked. When printing out the choices, **menu** numbers each one, then asks the user to type in the number of the choice he wants to take.

Procedures **push** and **pop** implement software stacks. They allow for multiple stacks, so you must specify the stack name.

The procedure **sink** allows you to throw away the returned value of a procedure, using it only for the side-effects. The example above (**sink rc**) simply waits for a key to be pressed.

The procedure **rise** does just the opposite, it allows you to use functions that don't return a value in places that require values by returning []. In many versions of Logo, procedures that return a value are called functions, while those that return no value are called commands. These mirror image procedures allow you to interchange the usage of the two types of procedures. These two procedures allow Logo to be more Lisp-like (always a desirable goal).

What the Tools are Made Of

```
to apply :function# :maplist#
if emptyp :maplist# [stop]
run (list :function# :maplist#)
apply :function# bf :maplist#
end

to arc.l :center :radius :angle
(local "p "amt)
make "p pen
make "amt :radius * 1.75e-2 ; pi / 180
pu setpos :center
fd :radius lt 90
setpen :p
repeat :angle [fd :amt lt 1]
end

to arc.r :center :radius :angle
(local "p "amt)
make "p pen
make "amt :radius * 1.75e-2 ; pi / 180
pu setpos :center
fd :radius rt 90
setpen :p
repeat :angle [fd :amt rt 1]
end
```

```
to ask :question
(type :question)
op first readlist
end

to askyn :question
(local "ans)
(type :question)
make "ans lc rc
(pr :ans)
op :ans = "y
end

to circle :center :radius
(local "p "amt)
make "p (list pen heading)
make "amt :radius * 1.75e-2 ; pi / 180
pu setpos :center setx xcor - :radius seth 0 setpen first :p
repeat 360 [fd :amt rt 1]
pu setpos :center setpen first :p seth first bf :p
end

to cond :condlist#
; format of :condlist# is [test1 result1 test2 result2 ...]
(local "cl#)
if (remainder (count :condlist#) 2) > 0 [
  op [condlist unbalanced]]
make "cl# :condlist#
label "loopst
if emptyp :cl# [stop]
if run first :cl# [run first bf :cl# stop]
make "cl# bf bf :cl#
go "loopst
end

to delete :object :objlist
if not memberp :object :objlist [op :objlist]
if emptyp :objlist [op []]
if :object = first :objlist [op bf :objlist]
op fput first :objlist delete :object bf :objlist
end
```

```
to every :objlist# :predicate#
repeat count :objlist# [
 if not run (se :predicate# "first (list :objlist#)) [
    op "FALSE]
 make "objlist# bf :objlist#]
op "TRUE
end

to filled_cir :radius
(local "x "p)
make "x pos make "p pen
repeat 360 [fd :radius pu setpos :x rt 1 setpen :p]
end

to filled_pie :center :radius :angle
(local "p)
make "p pen
pu setpos :center setpen :p
repeat :angle [fd :radius pu setpos :center rt 1 setpen :p]
end

to forget :object
if (se :object) = [forget] [stop]
repeat (count plist :object) / 2 [
    remprop :object first plist :object]
end

to inkey
 if keyp [op rc] [op []]
end

to intersection :set1 :set2
 if or (emptyp :set1) (emptyp :set2) [op []]
 if memberp (first :set1) :set2 [
   op (se (list first :set1) intersection (bf :set1) :set2]
 op intersection (bf :set1) :set2
end

to loop :body#
repeat 1 / 0 :body#
end
```

```
to map :function# :maplist#
if emptyp :maplist# [op []]
op (se
   (run (list :function# :maplist#))
   (map :function# bf :maplist#))
end

to mapc :function# :maplist#
repeat count :maplist# [
    run lput :maplist# :function#
    make "maplist# bf :maplist#]
end

to mapfirst :function# :maplist#
if emptyp :maplist# [op []]
op (se
 (run
 (list :function# "first :maplist#))
 (mapfirst :function# bf :maplist#))
end

to menu :menulist#
; menulist# format is [choice action ...]
(local "l# "m# "n#)
if emptyp :menulist# [stop]
label "loopst
make "l# :menulist#
make "n# 0
pr []
repeat (count :menulist#) / 2 [
    make "n# :n# + 1
    (pr :n# first :l#)
    make "l# bf bf :l#]
pr [] type [Enter choice:]
make "m# first readlist
if not numberp :m# [go "loopst]
make "m# int :m#
if or (:m# < 1) (:m# > :n#) [go "loopst]
run (se item :m# * 2 :menulist#)
end
```

```
to nerase :keeplist
(local "x "y "z)
make "x sort proclist
if wordp :keeplist [
     make "y (list :keeplist)] [make "y :keeplist]
make "y (se :y "nerase)
make "z count :y
repeat :z [
    if memberp (first :y) :x [
        if where = 1 [make "x bf :x] [
        if where = count :x [make "x bl :x] [
        make "x (se
                 piece 1 (where - 1) :x
                 piece (where + 1) (count :x) :x)]]
    make "y bf :y]]
pr [These procedures will be erased:]
pr []
(pr :x)
pr []
type [Is this what you want (y / n) ?]
if "y = lc rc [pr [y] erase :x] [pr [n]]
end

to pie :center :radius :angle
(local "p "amt)
make "p pen
make "amt :radius * 1.75e-2 ; pi / 180
pu setpos :center setpen :p
fd :radius rt 90
repeat :angle [fd :amt rt 1]
rt 90 fd :radius rt 180
end

to pop :stack
local "pop##
if emptyp thing :stack [op []]
make "pop## first thing :stack
make :stack bf thing :stack
op :pop##
end

to push :object :stack
if emptyp (plist :stack) [make :stack []]
make :stack fput :object thing :stack
end
```

```
to remove :object :objlist
(local "n "m)
if not memberp :object :objlist [op :objlist]
make "n where make "m count :objlist
if :n = 1 [op remove :object bf :objlist]
if :n = :m [op bl :objlist]
op remove :object (se
                  piece 1 (:n - 1) :objlist
                  piece (:n + 1) :m :objlist)
end

to replace :old :new :in
if emptyp :in [op []]
if :old = :new [op :in]
if wordp :in [if :old = :in [op :new] [op :in]]
op fput (replace :old :new (first :in))
        (replace :old :new (bf :in))
end

to reverse :set
if count :set < 2 [op :set]
op (se (list last :set) reverse bl :set)
end

to rise :object#
(local "y##)
catch "error [(make "y## run (se :object#)) op :y##]
op []
end

to sink :object
end

to some :objlist# :predicate#
repeat count :objlist# [
 if run (se :predicate# "first (list :objlist#)) [op "TRUE]
 make "objlist# bf :objlist#]
op "FALSE
end
```

```
to sort.procs
(local "x)
make "x sort proclist
if count :x = 1 [stop]
repeat (count :x) - 1 [
    (follow (first :x) (first butfirst :x))
    make "x butfirst :x]
end

to subset :objlist# :predicate#
(local "x##)
if emptyp :objlist# [op []]
make "x## []
repeat count :objlist# [
    if run (se :predicate# "first (list :objlist#)) [
        make "x## lput first :objlist# :x##]
        make "objlist# bf :objlist#]
op :x##
end

to union :set1 :set2
 if emptyp :set1 [op :set2]
 if memberp (first :set1) :set2 [op union bf :set1 :set2]
 op union bf :set1 (se (list first :set1) :set2)
end

to unpkgall :set
(local "x)
if emptyp :set [stop]
make "x :set
repeat count :set [remprop first :x ".PAK make "x bf :x]
end

to until :cond# :body#
 label "loopst
 run :body#
 if not run :cond# [go "loopst]
end
```

```
to uses
(local "x "y)
make "x sort proclist
repeat count :x [
    pocall first :x
    make "x bf :x
    pr []
    if not emptyp :x [make "y rc pr []]]
end

to verall
(local "x "y)
make "x sort proclist
make "y []
pr []
repeat count :x [
    type (se [Erase] first :x [\  (y / n) ?\ ])
    if "y = lc rc [
     pr [y] make "y lput (first :x) :y] [
     pr [n]]
    make "x bf :x]
pr [] pr [These procedures will be erased:] pr []
pr :y pr []
type [Is this what you want (y / n) ?]
if "y = lc rc [pr [y] erase :y] [pr [n]]
end

to while :cond# :body#
 label "loopst
    if run :cond# [run :body#] [stop]
 go "loopst
end
```

An Example of Tool Usage

Some people find they can understand something much better if they can see an example of it in operation. In fact, given Logo's use of familiar objects to express abstract ideas, many of you using the language should learn this way. Therefore we have included an example program using a number of these tools. The program play implements the classic game REVERSE – a simple thinking game. Examine the procedures and you will see how using the tools makes the code easier to understand.

```
to ask :question
; returns a user response to a question
(type :question)
op first readlist
end

to askyn :question
; returns TRUE if user answers question yes
(local "ans)
(type :question)
make "ans lc rc
(pr :ans)
op :ans = "y
end

to check_for_win
if not (:board = [0 1 2 3 4 5 6 7 8 9]) [stop]
make "game_over "TRUE
pr [] show :board pr []
(pr [You've done it in only\ ] :move - 1 [\ moves!])
pr []
end

to reverse :set
; returns a reversed copy of the input list
if emptyp :set [op []]
op (se (list last :set) reverse bl :set)
end

to loop :body#
; repeat instructions in body (until stop or op).
repeat 1 / 0 :body#
end
```

```
to until :cond# :body#
; perform the body until the condition is true
 label "loopst
 run :body#
 if not run :cond# [go "loopst]
end

to sink :x
end

to explain_rules
 ct
 pr [This is the game of REVERSE] pr []
 pr [I will give you a scrambled list of 10 numbers and you have to put]
 pr [them in order, from the smallest to the largest.] pr []
 pr [The tricky part is that the only thing you can do is to reverse]
 pr [some or all of the numbers. For example, if you have the list]
 pr [] pr [[1 3 2 6 4 9 8 5 0 7]]
 pr [] pr [and you reverse 5 , the new list will be:]
 pr [] pr [[4 6 2 3 1 9 8 5 0 7]]
 pr [] pr [If you now reverse 3 the list becomes:]
 pr [] pr [[2 6 4 3 1 9 8 5 0 7]] pr []
 pr [] pr [Now press the RETURN key to begin]
 sink rq
end

to init_game
 ct
 pr [The game of REVERSE]
 pr []
 make "board shuffle [0 1 2 3 4 5 6 7 8 9]
 make "game_over "FALSE
 make "move 1
end
```

```
to move
 loop [
    (pr [list is:] (list :board) [\ move:\ ] :move) pr []
    make "n ask [How many items to reverse ?]
    if not numberp :n [make "n 11]
    if :n > 10 [pr [Sorry, I can't do that.]] [stop]]
 make "move :move + 1
 if :n < 2 [stop]
 make "board if :n = 10 [
    reverse :board] [
    (se reverse piece 1 :n :board piece (:n + 1) 10 :board)]
end

to play
; the game of REVERSE
 (local "board "game_over "move "n "m)
 explain_rules
 loop [
    init_game
    until [:game_over] [move check_for_win]
    if not askyn [Play again (y / n) ?] [stop]]
end
```