

# LogoMor Documentation

## What is Logo

Logo is a programming language that dictates the drawing of a sketch.

The drawing vehicle is an avatar that can be moved inside the 3-dimensional space, leaving a trail behind it. The avatar is initiated at the origin with orientation towards the y axis.

Movement commands indicate the movement of the avatar with reference to its current position and orientation. Exceptionally, the set commands can place the avatar to a specific position with reference to the absolute coordinate system of the space.

## Movement Commands

These are the basic commands that control the movement of the avatar.

All following commands do not return any value

Command Name	Arguments	Description	Example
fd or forward	1 (steps distance)	Move forwards	fd 50
bk or back	1 (steps distance)	Move backwards	bk 50
rt or right	1 (degrees)	Turn right	rt 90
lt or left	1 (degrees)	Turn left	lt 90
up	1 (degrees)	Turn up	up 90
dn or down	1 (degrees)	Turn down	dn 90
rr or roll_right	1 (degrees)	Roll right	rr 90
rl or roll_left	1 (degrees)	Roll left	rl 90
home	-	Move to home position	home
setx	1 (position)	Move to specific x coordinate	setx 50
sety	1 (position)	Move to specific y coordinate	sety 50
setz	1 (position)	Move to specific z coordinate	setz 50
setxyz	3 (position)	Move to specific point (x,y,z)	setxyz 50 50 50
arc	2 (angle degrees, radius)	Draw a clockwise arc with center the avatar position. Avatar does not move	arc 90 50

## Position Commands

These are the commands that provide information about the current position of the avatar in the 3 dimensional space.

Their return value can be used by any Logo command accepting arguments

Command Name	Arguments	Description	Example
getx	-	returns the current position on x axis	getx
gety	-	returns the current position on y axis	gety
getz	-	returns the current position on z axis	getz
dist	3 (x, y, z)	returns the distance of the current position from a specified point in space	dist 20 35 40

## Trail appearance Commands

These are the commands that configure whether the avatar movement leaves a trail and how it should appear. Once called, they affect all consecutive movement commands until another change is made.

All following commands do not return any value

Command Name	Arguments (unit)	Description	Example
penup or pu	-	Avatar stops leaving trail	penup
pendown or pd	-	Avatar starts leaving tail	pendown
setpensize or sps	1 (pixels)	Sets the trail width	setpensize 4
color	3 (0-255 r g b)	Sets the trail color in RGB	color 255 20 40
colorhsb	3 (0-360 h, 0-100 s, 0-100 b)	Sets the trail color in HSB	color 300 90 90
coloralpha	1 (0-255)	Sets the color opacity	coloralpha 128
showturtle or st	-	Shows the avatar (default)	showturtle
hideturtle or ht	-	Hides the avatar	hideturtle

## Output Commands

These are the commands that enable output to the user

All following commands do not return any value

Command Name	Arguments (unit)	Description	Example
print	1	Prints a value to the terminal	print "starting
label	1	Displays a value on the sketch	label "corner
settextsize or sts	1 (pixels)	Sets the font size used by label	settextsize 15
point	-	Draws a point at current position.	point

## Arguments

An argument in Logo can be:

- Any number. E.g. 2, 3.14, 2.76e3
- The value of a defined variable name, using the prefix ':'. E.g. fd :var
- A word literal, using the prefix '"'. Only a few commands can accept this kind of argument  
E.g. print "helloWorld label "corner
- Any function or command that returns a value e.g. print getx
- Any expression with a combination of arguments and arithmetic operators (+, -, \*, /) or comparison operators (<, >, <=, >=, =).

E.g. fd :n + 10 rt 360 / 5 print :k <= 5

The result of a comparison is 1 if the comparison is true and 0 if it is false

Note 1:

A literal can also be constructed by string concatenation of 2 arguments, using the command word

E.g. print word "hello "world  
print word "item 1

Note 2:

A space character can be encoded into a literal for using with output commands, with the sequence '\s'

E.g. print "hello\sworld This will print 'hello world'

### Note 3:

Any expression can be sub-grouped using parentheses '()'\*

\*Parentheses are useful for determining the precedence of operations. Moreover, they are critical for separating arguments in the case of negative numbers.

E.g.: To set the position of the avatar to x:6, y:-7, z:8, Writing the below:

```
setxyz 6 -7 8
```

Will yield an error, as it will consider that the first argument is 6-7 and the second argument is 8. The error will indicate that the command is missing a third argument. The correct way is to write:

```
setxyz 6 (-7) 8.
```

Grouping like that leaves no ambiguity for the arguments separation. Of course parentheses may be optionally used for the other arguments as well.

### Note 4:

Operators precedence: multiplication/division > addition/subtraction > comparisons > equality

Associativity among operations of equal precedence: Left-to-Right

## Variables

Variables are places in memory that we can store any numeric value or literal.

The variables can be assigned names and values by the user, using the `make` command

After setting it, the value of that variable can be accessed by using the prefix ':' followed by its name.

Alternatively, we can get the value of a variable by using command `thing`, followed by the variable's name literal

Any variables made outside of a function are considered 'global' variables and can be accessed by any part of the code, as long as they have already been made when the reference occurs.

Variables made in a function are considered local and can only be accessed within that function.

There is no difference when defining a variable or assigning a value to it. Using `make`, if the variable already exists at the current scope or in global or static scope, it is assigned a new value. Otherwise, it is created.

### Syntax:

```
make <variable name literal> <variableValue>
```

```
:< variable name >
```

### Example :

```
Make "var 50
```

```
fd :var (now equivalent to fd 50)
```

```
fd thing "var (same as above)
```

**\*Note1:** we can increment/decrement variables by using commands `increment`, `decrement` followed by the variable name literal:

```
increment "var (equivalent to make "var :var + 1)
```

```
decrement "var (equivalent to make "var :var - 1)
```

**\*Note2:** Storing variable names literals in variables provide a means of referencing variables and passing variables by reference to functions

### Example:

```
make "a 5
```

```
make "b "a
```

```
print "b ;will print 'b'
```

```
print thing "b ;will print 'a'
```

```
print thing thing "b ;will print '5'
```

## Static Variables

Regular variables may have global or local scope, but their lifetime is limited to a single execution of the program. Using the keyword `static`, the user can create a variable that is initiated only the first time that the interpreter will come across it in the source code, and the variable remains accessible for the whole lifetime of the program. After initiating the static variables, the user can access them regularly with the `'.'` prefix and assign new values to it with the `make` keyword

Syntax:

```
static <variable name literal><initializationValue>
```

Example:

```
static "counter 0
make "counter :counter+1
print :counter
```

The above example will print an incrementing number on each frame/execution, starting from 1

## Conditionals

If, Ifelse

A block of code can be executed conditionally, by using the command `if`

Syntax:

```
If <condition> [ <commands to execute if condition is true> ]
```

<condition>: An argument expression that can be evaluated as true or false

< commands to execute if condition is true > : any program code

Example:

```
If :n < 5 [ print "lessThanFive ]
```

Similarly, two different blocks of code can be executed, depending on the truth value of a condition, using `ifelse`

Syntax

```
Ifelse <condition > [ <commands to execute if condition is true> ] [ <commands to execute if condition is false> ]
```

Example

```
Ifelse :n < 5 [ print "lessThanFive ] [ print "higherOrEqualToFive ]
```

Note:

Any plain number can also be evaluated for its truth value. Any value other than 0 evaluates as true and the value of 0 evaluates as false.

E.g `if 5 [ fd 10 ]` - The `fd` command will be executed

`If 0 [ fd 10 ]` - The `fd` command will not be executed

## Loops

Repeat

A block of code can be executed repeatedly `n` times, with the command `repeat`:

Syntax:

```
Repeat <number of executions> [ <commands> ]
```

Example:

```
repeat 4 [ fd 10 rt 90 ]
```

Note:

Using the command `repeatcount` we can get the number of the current execution of the innermost repeat block being executed, starting from number 1. If no repeat block is executed, 0 is returned

## While

A block of code can be executed repeatedly, as long as a condition is true, with the command `while`

Syntax:

`While <condition> [ <commands>]`

Example:

```
make "n 4
while :n > 0 [ fd 10 rt 90 make "n :n - 1 ]
```

## Until

Similarly, a block of code can be executed repeatedly, as long as a condition is false, with the command `until`

Syntax:

`until <condition> [ <commands>]`

Example:

```
make "n 4
until :n = 0 [ fd 10 rt 90 make "n :n - 1 ]
```

## Functions

- A function is a part of code (called function's body) that can be given a name and can be executed whenever this name is called inside the program.
- A function can accept any predefined number of parameters and use them inside its body as variables. The declaration of the parameters names is done by using the prefix ':'
- A function can optionally return a value to the command that called it. The `return` statement can be at any position in the body and the execution will stop once it reaches it
- Functions are called by using their names, followed by their parameters arguments
- The function parameters and variables declared inside the function body define a 'local scope' of variables, visible only within the function. If there is also a global variable with the same name, the local variable takes priority.
- ***In fact, all Logo commands can be considered as functions***

Syntax:

`to <functionName> <list of parameter names> <body> <return statement> end`

Example:

```
to square :side repeat 4 [ fd :side rt 90 ] end
to add :a :b return :a + :b end
square 50           – will draw a square of side length 50
print add 2 3       – will print the number '5' on the terminal
square add 10 40    – will first call function add with parameters 10, 40 and then call square with
parameter the output of function add, which will be 50
```

## Mathematical commands

These are commands that are useful for performing mathematical calculations

Name	Arguments	Return value units	Description	Example
sqrt	1		compute square root	sqrt 4
pow	2 (base, exponent)		raises the base to the exponent	pow 2 3
mod	2 (Divisor, divider)		remainder of integer division	mod 4 3
cos	1 (degrees)		cosine of angle	cos 60
sin	1 (degrees)		sine of angle	sin 30
tan	1 (degrees)		tangent of angle	tan 30
arccos	1	degrees	inverse cosine	arccos 0.5
arcsin	1	degrees	inverse sine	arcsin 0.5
arctan	1	degrees	inverse tangent	arctan 4
degtorad	1	radians	convert degrees to radians	degtorad 180
radtodeg	1	degrees	convert radians to degree	radtodeg pi
ln	1		natural logarithm	ln 7
log	1		logarithm with base 10	log 150
exp	1		e raised to value	exp 2
pi	0		returns the number $\pi$	pi
int	1		rounds to closest integer	int 7.8
trunc	1		truncates integer part	trunc 7.8
abs	1		returns absolute value	abs -3.7
min	2		returns smallest of two values	min 3 5
max	2		returns biggest of two values	max 3 5

## Logical commands/functions

These are commands that are useful for performing logical operations between arguments that can be evaluated for their truth value

Name	Arguments	Description	Example
or	2	Returns true if any of the arguments is true	or :n < 5 :n > 10
and	2	Returns true if both of the arguments are true—	and :n < 5 :k < 5
not	1	Returns true if the argument is false	not :n = 5

## Random number generation

The following command is useful to produce random numbers

Name	Arguments	Description	Example
rand	1	Returns an integer random number in the range of [0, n) where n is the argument*	rand 100

\*Since the drawing is repeated in every frame of the display, the same random number will be returned at every execution, but a different one for each new run of the program. Alternatively, use **randcrazy** for a different output at each frame

## Timing commands

These are commands that provide timing information and enable the user to create animated sketches

Explanation: The sketch code is run over and over again and displayed multiple times per second. Each execution displays a 'frame' to the view panel. All code and variables remain the same for every execution, except these timing functions, that provide timing info starting from the first run of the program. This means that they give a different result at every frame. And this ability can be exploited to produce animated sketches. None of the below commands accept any arguments

Name	Description	Example
time	Returns the current time in seconds since the first run of the program	time
frame	Returns the current frame number since the first run of the program	frame

## Faces

These are commands that enable the user to draw surfaces as solid objects faces. To draw a face the user should begin it on its first vertex, draw the edges of the face by using the regular move commands and then end it on its final vertex. When ending a face the avatar should have arrived back to the initial vertex, but if not, the face will be closed with an extra edge to the initial vertex. This extra edge will not create a line, to indicate the opening to the user.

Name	Description	Example
beginface	Starting a new surface on its initial vertex	beginface
endface	Ending a surface on its final vertex	endface

## Mouse Commands

The following commands provide info about the user's mouse position and button.

The position of the mouse is 2D and it is calculated with reference the origin of the drawing.

The position calculation takes into account the pan and zoom of the drawing, but not the rotation.

The viewing perspective also affects the position calculation.

All of the below commands take no arguments

Name	Description	Example
mousex	Returns the X position of the mouse	mousex
mousey	Returns the Y position of the mouse	mousey
mousepressed	Returns true if the mouse button is pressed, false otherwise	mousepressed

## 3D Primitives

These are the commands that draw some basic 3D shapes.

The shapes are solid objects with faces, centered at the avatar's position.

If the avatar's tail is visible (`pd` command), the strokes that produce the shapes are also visible.

All of the following commands do not return any value

Name	Arguments	Description	Example
box	1 (side length)	Draws a square box	<code>box 50</code>
sphere	1 (radius)	Draws a sphere	<code>sphere 50</code>
cylinder	2 (radius, height)	Draws a cylinder	<code>cylinder 30 50</code>
cone	2 (radius, height)	Draws a cone	<code>cone 30 50</code>
torus	2 (radius, tube radius)	Draws a torus	<code>torus 30 50</code>
ellipsoid	3 (radiusX, radiusY, radiusZ)	Draws an ellipsoid	<code>ellipsoid 30 50 20</code>

## Models

By pressing the 'Add' button of the MODELS area, we can upload valid .STL 3D object files

The objects described in the files are loaded as models and they are given initial default names (`model1`, `model2` etc.). These names can be changed by the user to any valid literal.

The models can be drawn on the sketch using the `model` command, followed by the model name we want to draw and the size of it. The size is defined as the size of a cube that would exactly fit the object.

When the interpreter encounters a `model` command, it renders the corresponding object centered at the avatar's current position.

If the avatar's tail is visible (`pd` command), the strokes that produce the object are also visible.

Name	Arguments	Description	Example
model	2 (model name literal, size)	Draws the object on the sketch	<code>model "model1 50</code>

## Comments

Comments are notes on the source code that are used for human readability and are not part of the actual program.

Comments in Logo start with the semicolon '`;`'. Any appearance of the semicolon will make the interpreter ignore the rest of the specific line where it appeared

### Example

```
fd 20 ;move a bit forward
```

## Ignored Characters

Space characters are vital to separate keywords, function names, variable names and arguments.

The user can add as many of these characters in-between the source code tokens as desired, without any effect on the actual code.

These characters are: space( ), new line(`\n`), carriage return(`\r`), tab(`\t`), vertical tab(`\v`), form feed(`\f`)



## Naming

- The interpreter treats the source code in a case-insensitive manner. This means that capitalization does not alter the way a token is conceived. E.g., `EnD` is the same as `end`
- Variable names and function names may contain any sequence of alphanumeric characters. Symbols as any of the operators (+, -, \*, /, <, >, =), parentheses or brackets or ';' are not allowed.
- The symbols mentioned above also cannot be part of literals used with the prefix "