

l3gui(1)

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section

1 NAME

l3gui - graphical environment for interacting with l3 programs and data.

2 SYNOPSIS

```
l3gui [-help | -h] [-version] [-f FILE | -file=FILE] [-s STATEFILE | -statefile=STATEFILE]
[-i | -interactive] [-d | -developer]
```

3 DESCRIPTION

The `l3gui(1)` command starts an interactive graphical interface for editing, viewing and executing l3 language scripts and viewing and editing the data produced by the scripts. See `l3lang(1)` for a language description.

Standard facilities include interactive toplevels for l3 and Python, and a worksheet-style interface for l3 scripts providing editing facilities and the usual open/edit/save options.

The l3 language introduces several new features to support use from a graphical interface; they are:

- A script is used as its own data browser. Every expression is turned into an object with inspection facilities. Both the expression and the value(s) computed by the expression can be accessed through the script's text.
- Scripts can evolve, even after execution. The combination of need-based evaluation, lexical scoping and persistence allows l3 scripts to *evolve*; they can be added to without re-running existing code, and references to all previously computed data are available.
- Scripts can nest arbitrarily. Lexical scoping allows for arbitrarily nested (static) namespaces and avoids name collisions. Every function call introduces a new (dynamic) scope, so multiple calls to the same function do not produce naming conflicts, even when file names are used. Multiple calls to a function are tracked separately, so all values computed by all calls to a function can be inspected.

- A data flow graph can be generated from a script. In this view, named data are emphasized, and data interdependencies shown. Loops cause no “explosion” of the data flow graph.

4 OPTIONS

-help, -h

Print this documentation and exit.

-version

show program’s version number and exit

-f FILE, -file=FILE

Load this l3 script.

-s STATEFILE, -statefile=STATEFILE

Load this l3 state file.

-i, -interactive

Go to Python console on exit. This allows moving between Python and the gui. To restart the gui, use `gtk.main()`

-d, -developer

Import all l3 modules (`from ... import*`) when using `-i`. Allows for interactive updates.

5 USAGE

The typical l3 usage cycle is very similar to scripting sessions:

1. Select scripts / functions from a library
2. Assemble custom scripts on the canvas
3. Adjust parameters and scripts
4. Run the script
5. Examine values
6. Repeat the process

The l3 gui provides several features to simplify high-level script use, full editing for control over detail, make(1)-like incremental evaluation and persistence to avoid unnecessary repetition, and data examination through the scripts themselves.

While the l3 gui could be used for script writing (via graphical assembly), it is meant for **script use** and **user interaction**. User-assembled scripts should be high-level and consist mostly of topic-specific blocks (with parameters), loops, functions and conditionals.

Practical use of the l3 gui requires a library callable from Python and a collection of simple Python/l3 drivers (scripts with parameters) for that library.

For writing such drivers, use l3lang(1) directly, via a text editor.

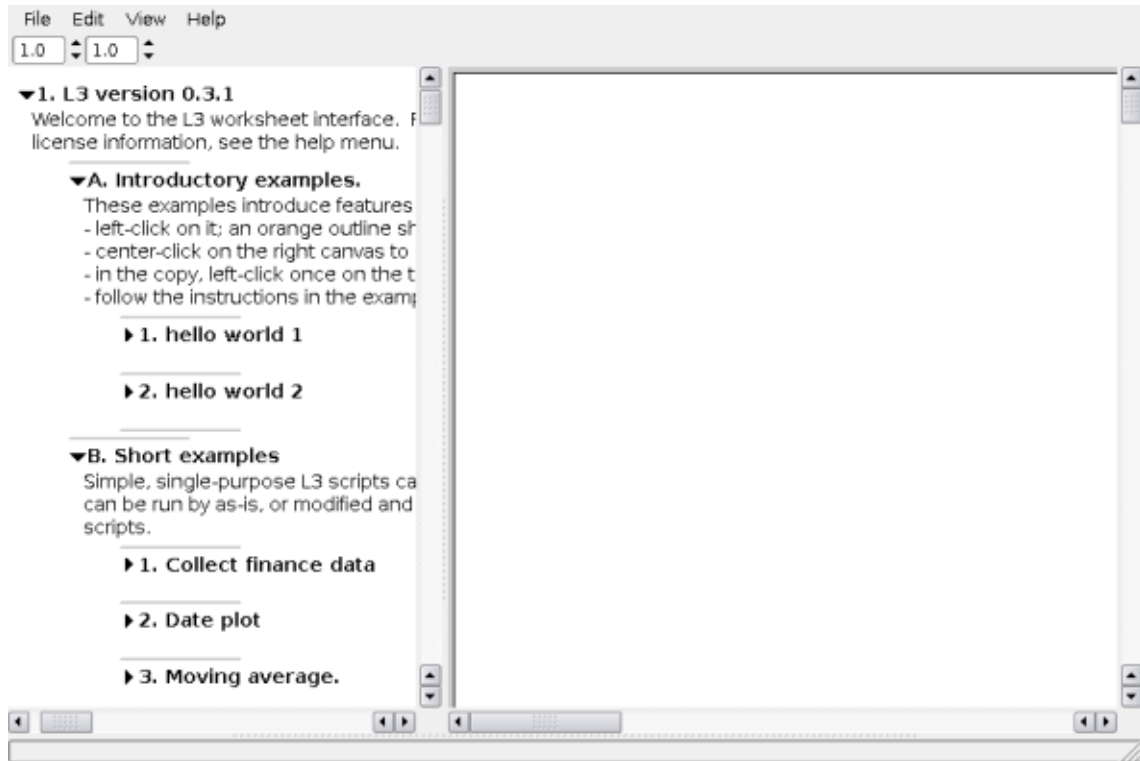
For more complex programming, use Python to implement a library, or a connection to a library.

The intended use of l3gui(1), with libraries and driver scripts already present, is illustrated via the examples at <http://l3lang.sf.net>.

The rest of this manual page describes the mechanics of the interface.

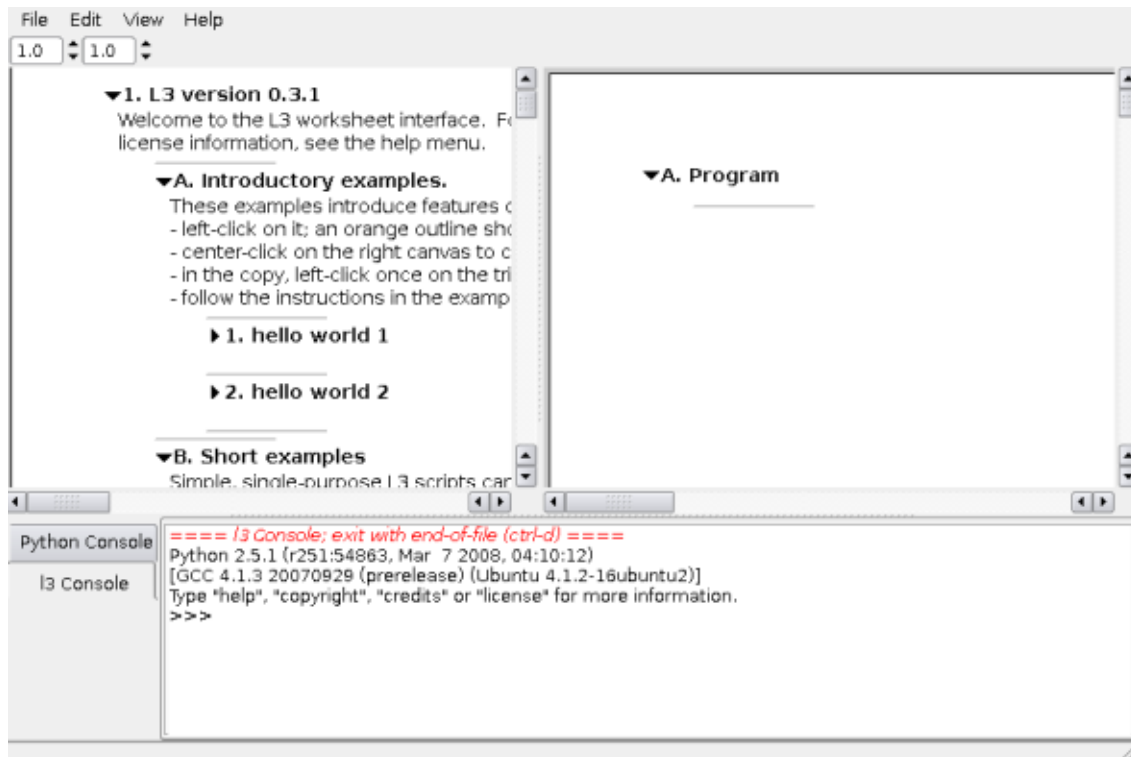
6 INTERFACE STRUCTURE

The interface starts with two canvases and some support structures as shown in this figure.



From top to bottom, there is the menu bar, two canvas zoom selectors, the two canvases, and a status line. The left canvas is the library canvas, presenting examples from introductory to complete program, and l3 templates used to assemble custom scripts. The right canvas is the user work area for assembling, editing, running and examining scripts and data. The canvases can be scrolled via the scrollbars, or via button-1-drag on a canvas.

The relative sizes of the canvases can be adjusted by dragging the vertical separator between them. The horizontal separator between the canvases and status line can be moved up to reveal a Python console and any l3 consoles present. See also the View menu entries. Fully exposed, the interface looks like the following.



The menubar entries are as follows; more details are found later in this manual.

File menu

import script

Load a script from a file. The script is added to the session.

save session to

Save the current session to file.

load session

Load a prior session from file. This replaces the current session

exit

Exit the gui unless **-i** was used; with **-i**, starts Python on the console.

Edit menu

l3 gui console

Run an interactive l3 toplevel in an area below the canvas, insert expressions in a single Program on the canvas.

l3 terminal console

Run an interactive l3 toplevel on the console, insert expressions in a single Program on the canvas.

l3 terminal console, one program/expr

Run an interactive l3 toplevel on the console, insert every expression as a separate program on the canvas.

View menu

show / hide python console

toggle visibility of areas below the canvases.

show program only

Hide the left canvas and areas below the canvas.

Help menu

About l3

Show version information.

l3 manual

Show references to this manual.

l3 License

Display the license for l3.

7 MOUSE AND KEYBOARD

The mouse buttons are referred to as `button-1` through `button-3`. On a right-handed mouse, `button-1` is the left button, `button-2` is the scrollwheel button, and `button-3` is the right button.

The keyboard's `Ctrl` and `Alt` keys are called `control` and `alt` here.

8 ITEM SELECTION AND HANDLING

The currently selected items are outlined in orange. Items are selected via the mouse in two ways.

button-1 on item

Select the item under the pointer, clear existing selection.

control + button-1 on item

Add the item under the pointer to the existing selection.

A selection can be copied to the canvas, or moved into another expression.

button-2 on canvas

Insert a copy of the current selection; if there is no selection, try to parse the text on the clipboard and insert the resulting script.

button-2 on list item separator

Move the current selection into the list at this location (the top item when multiple items are selected).

The selection can be cleared.

button-1 on canvas (without dragging)

Clear the selection.

9 LOADING AND SAVING SESSIONS

The session state includes all visible scripts and data, their display positions, and all data accumulated during program execution.

The current session can be saved when no program is executing, via `file > save session to`.

Restoring a session from a file replaces the current session, which must be saved if it is to be kept. To restore a session, use `file > load session`.

10 ACQUIRING PROGRAMS

The gui provides several ways to get scripts for further assembly and use. Once imported, the script is treated as a structure, although the display still resembles the original text. Most expressions display in the original's text form, but source code lines are separated with a narrow horizontal marker that can be used for insertion. All imported scripts are put into a Program block to allow for collapsing/expanding and execution of the script.

10.1 Copying from the procedure library

Prepackaged functionality provided for l3 is kept in the left canvas as outline. Select the parts of interest via `button-1`, copy them to the canvas via `button-2`, and adjust parameters as described in section 11.

10.2 Pasting text

Short script fragments copied from another application can be pasted via `button-2` on the canvas if no other expression is currently selected. To paste text, first use `button-1` on the canvas to clear its selection, then `button-2` to paste the text.

The pasted text is parsed and checked for valid syntax, but not executed. If the syntax is valid, a script is inserted as a Program at the mouse location. Otherwise, a single string holding the pasted text is inserted.

Example 1 Successful pasting of script

The script

```
a = 1
b = 2
print b-a
```

looks like

▼A. Program

```
a = 1
b = 2
print b-a
```

after pasting via `button-1` (to clear any other selection) followed by `button-2`.

Example 2 Unsuccessful pasting of script

The script

```
a = 1
b = 2
print b - / a
```

contains a syntax error and looks like

▼A. Program

```
"""# ERROR: unable to parse:
3:14-15 at '//':
    print b - / a
              ^

Original:
    a = 1
    b = 2
    print b - / a
"""
```

after pasting via *button-1* (to clear any other selection) followed by *button-2*.

10.3 Importing from file

For writing larger scripts from scratch, using a text editor with support for Python programs is strongly recommended. See [emacs\(1\)](#) or [vim\(1\)](#). Once such a script is written (and ideally, tested on trivial data using Python), it can be imported via file

```
> import script.
```

10.4 Recording input and output from console interaction

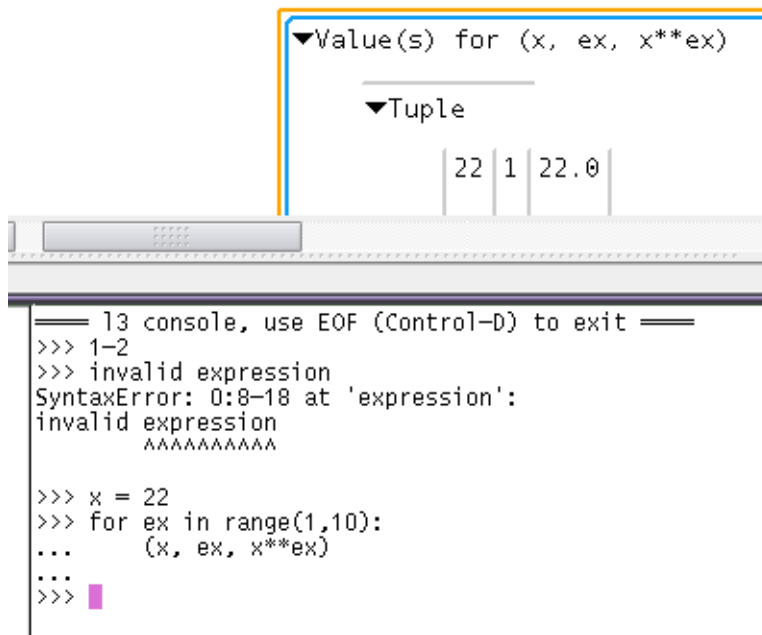
For more interactive use, command-line input can be used. Using the menu `> edit > l3 terminal console` selection, an interactive l3 toplevel is run on the console the gui was started from. At the same time, a new empty Program: is inserted on the canvas. Expressions can be entered at the toplevel in the same way as in Python, and are evaluated when complete. If evaluation succeeds, the expression is appended to the Program: and the l3 structural manipulations are then available; in particular, the value(s) may be examined.

Example 3 *Using the toplevel with the gui.*

The toplevel is started and expressions tried. The Program accumulates the history of successful commands, while the values accumulated by the loop are inserted via the gui menu.

▼A. Program

```
1-2
x = 22
for ex in range(1,10)
    (x, ex, x**ex)
```



The screenshot shows the l3gui interface. At the top, a program is displayed with the expression `(x, ex, x**ex)` highlighted in an orange box. Below the program, a window titled "Value(s) for (x, ex, x**ex)" shows a "Tuple" containing the values 22, 1, and 22.0. At the bottom, a console window shows the execution history:

```
==== l3 console, use EOF (Control-D) to exit ====
>>> 1-2
>>> invalid expression
SyntaxError: 0:8-18 at 'expression':
invalid expression
^^^^^^^^^^^^^^

>>> x = 22
>>> for ex in range(1,10):
...     (x, ex, x**ex)
...
>>>
```

At any time expressions may be inserted in the history through the gui, and the Program re-run. As for any l3 program, only the inserted expression is run, providing a way to evolve running programs through insertion, not only appending.

11 EDITING SCRIPTS

The editing facilities of l3gui are focused on structural editing – insertion and removal of expressions, and the selection of values associated with expressions. These operations can be done any time, but are most useful after a script has been run (whether successfully or not), and allow incremental refinement of scripts.

Notably absent is an advanced text-editing facility, as there are better and established tools for writing scripts. For the simple textual edits required (such as setting parameter values and other form-filling), a simple edit window is used.

Most expressions display as text, but outlines, programs, lists, functions, conditionals and loops can display in long form.

Programs, lists and tuples displayed in long form have explicit item separators that allow insertion of items in the position of the separator, by selecting an item elsewhere and using button-2 on the separator.

Items already in the list/tuple can be dragged out via button-1-drag.

Example 4 *Editing long-form expressions*

Paste the expression

1 + 2

and via button-1 select the 1; this highlights just 1. On the canvas next to the program, press button-2; a copy of the 1 is put at the pointer location. Repeat this for the 2 to get something like the following.

▼A. Program

1+2

1

2

To insert the 1 into the program, select the copy via button-1 and click on the grey bar above the 1+2 with button-2.

Repeat this for the 2 to get a new program:

▼A. Program

1

1+2

2

Text display allows selecting of individual subexpressions, but editing is always done on the entire textual expression. Double-clicking button-1 on an expression pops up a simple edit window. In the window, ESC or Cancel abort the edit, while Ctrl-Enter or Ok commits the change.

Note In the edit window, replacing a script expression with another containing the same **text** and pressing Ok is not the same as pressing Cancel. Replacing an expression **always** removes the original and inserts the new one, even if the text is identical. And a new expression will be evaluated again when its containing Program: is run. See section 15.

12 THE EXPRESSION MENU

Prior sections discuss obtaining and manipulate expressions. Further operations are specific to that expression, and are available through the expression's menu, accessed via Button-3.

The following is a summary of the menu entries. Their usage details follow.

12.1 Common entries

Every expression has these menu entries.

add comment

Add a comment to the expression. This inserts the template "double-click to edit" which can be edited.

copy to clipboard (as raw text)

Form a pretty-printed string representation of this expression and copy it to the clipboard.

delete

Delete this expression.

delete selected

Delete all selected expressions. This entry is for convenience and may not affect its expression.

dump code

(developer) Print an AST dump of the expression to the console, including ID and timestamp for every node.

dump values

(developer) Print all values of the expression the expression to the console, with indentation indicating clone structure.

export values as string

Print all values of the expression to the console.

insert values as I3 list

Insert a vertical list holding all the values associated with the selected expression.

insert values as I3 list list

Insert a near-square list of lists holding all the values associated with the selected expression. Makes better use of display area.

evaluate locally

(developer) Start a new Python toplevel at the bottom of the gui, with `self` bound in its environment.

evaluate locally, use console

(developer) Start a new Python toplevel on the console, with `self` bound in its environment.

exit

Exit the gui unless `-i` was used; with `-i`, starts Python on the console.

hide

Display this expression in a compact, single-line form.

select value

Deprecated. Value selection is done using the selection. See subsection 14.2.

12.2 Additions for outlines/programs

Only a Program (outline) expression has a Run menu entry, so to execute a fragment of code that is not already inside a program requires putting it in one.

run code

Execute this program.

view full contents

Show this outline, its comment, and the full contents. Program editing is only possible in this view.

view nested outlines

Show this outline, its comment, and all contained outlines.

view this level only

Collapse the outline to this level.

show values written

Show all names assigned to in this outline.

show values read

Show all names referred to in this outline.

12.3 Additions for the selection

The selection is the orange outline surrounding one or more expressions; in addition to highlighting items, it also provides some features of its own.

print values in context

When an expression is used in loops or multiple function calls, values can be viewed more selectively by narrowing to one of the loops/function calls. See subsection 14.2.

item screenshot to /tmp/foo.png

For development. Take a screenshot of just this item, save to /tmp/foo.png. Requires the canvas to be at the upper left scroll limits.

12.4 Additions for list item separators

The list item separators serve to insert items, but can also be used to select a range of items between two of them.

set mark

Set end position for range selection.

select region (from here to mark)

Select all items in the range.

12.5 Additions for strings representing local files

For files holding known data of certain type, special viewing / insertion actions are available.

First are those calling external programs to view files.

.spi ■ xmipp_show -sel <path>

Display spider selection file via `xmipp_show`

.spi ■ `xmipp_show -vol <path>`

Display spider volume file via `xmipp_show`

.txt ■ `$EDITOR <path>`

Open a plain text file in an external editor.

The following files types are directly handled in I3.

.png ■ `view image`

Insert a view of the image on the canvas.

.hdf file ■ `insert as I3 list`

For HDF files using a simple list-of-images structure (`eman2`), display a vertical list of images.

.hdf file ■ `insert as I3 list list`

For HDF files using a simple list-of-images structure (`eman2`), try to display a square array of images to maximize use of canvas area.

12.6 Additions for names with string values representing local files

Name expression (`a`, `"a"`, and `a.b`) with string values that represent local files have entries to view those files.

.any ■ `insert (file path) list`

Insert the list of files represented by the name.

.png ■ `insert (file path, image) list`

Insert the list of (file name, image) tuples represented by the name.

12.7 Additions for 'Map's

examine dir

Treat a map like a directory and list all names bound in it.

print working directory (pwd)

(deprecated) For a `Subdir`, show its name.

12.8 Additions for some native Python values

Values representing images (certain numpy arrays) have some simple display adjustments

set image size as default

Set the current scale size as default for future image insertions.

shrink image 40%

Reduce this image by 40%. Does not affect future image insertions.

enlarge image 40%

Enlarge this image by 40%. Does not affect future image insertions.

13 RUNNING PROGRAMS

Code in L3 is never executed automatically. Further, execution can only start from programs (which display as outlines).

Example 5 *Running a program*

Paste the expression

3 - 2

Then right-click (button-3) on Program > run code. The text (1, INT) is shown on the console, where INT is some integer. The 2 is highlighted in an orange outline.

Because expressions and outlines can nest, it is possible to start execution from the “inside” of a program. This is not necessary because L3 evaluation skips already-executed expressions, but it can be convenient while working on a nested script. If needed values have not been calculated, an error is given and execution of the program stops at the error location.

14 SELECTING DATA

Data are the result of expression evaluation. L3 attaches a datum to the expression that created it, allowing point-and-click examination of data.

14.1 Simple data selection

For scripts with single-level loops or function calls, a single item selection is sufficient to view data.

Example 6 *Selection of datum value.*

Paste and run the program

```
3 - 2
```

Then select the - menu (button-3) and dump values. Note that there is only one value, 1.

Expressions inside loops or tail calls may have more than one value, so every expression's menu has a dump values entry that prints all values associated with the expression to the terminal.

Example 7 *Selection of data values.*

Paste and run the program

```
for ii in [1,2,3]:  
    ii - 3
```

Then select the - menu (button-3) and dump values. Note that there are now three values.

Instead of printing values, values can be wrapped as l3 expressions and inserted on the canvas, using the insert values as menu entry. In this form, values are ready to be used in or by other scripts.

Wrapped values are referenced, not copied.

Example 8 *Insertion of data values.*

Paste and run the program

```
for ii in [1,2,3]:  
    ii - 3
```

To import these values for further editing, select the - menu (button-3) and insert values as l3 list. This inserts a list containing the values.

When a data to PNG converter is available, the bitmap image is displayed by l3gui instead of the textual representation of the data. These custom viewers are never interactive, and are intended to provide a quantitative view only. The image is manipulated just like any other value.

Example 9 *Insertion of data thumbnails.*

Paste the script

```
inline "import numpy as N"  
N.random.rand( (35, 14) )
```

and run the program. The array data is printed to the console. Now right-click N and select insert values as l3 list. This inserts a list with one entry, the image. Right-click the image, select enlarge image 40% several times. This will look like the following.

▼A. Program

```
inline "import numpy as N"  
N.random.rand( (35, 14) )
```



For more detailed data examination or manipulation, data must be saved to file and external processes used. File names should be formed via e.g.

```
'_plot-%d.png' % new_id()
```

so their names are always unique. l3 makes no attempt at tracking the data passed out this way; instead, the data is assumed CONSTANT. If an external program is used to modify data, the new data should be written to a new file.

14.2 Narrowing the data selection

When loops are nested or functions called from multiple sources, the simple selection mechanism displays **all** values. This is usually not desired, so the selection can be narrowed.

Example 10 Selection narrowed to single function call

The following script defines a simple iteration scheme to (very) roughly approximate $\text{sqrt}(x)$, and tries this scheme using two starting values.

```
# Sqrt iteration with error bound.
def try(x, xn):
    if abs(xn**2 - x) > 0.0001:
        xnp1 = 1.0 / 2 * (xn + x / xn)
        return try(x, xnp1)
    else:
        return xn

# First try.
try(9.0, 5.0)

# Try a different starting point.
try(9.0, 8.0)
```

*To examine the values of $xnp1$ generated by the first try, select $xnp1$ via left-click, and add `try(9.0, 5.0)` to the selection via control-left-click. Then use a right-click on $xnp1$ and choose *insert values as l3 list* to get the following.*

▼A. Program

Sqrt iteration with error bound.

```
try = Function
  x
  xn
  If abs(xn**2 - x) > 0.0001
    xnp1 = 1.0 / 2 * (xn + x / xn)
    return try(x, xnp1)
  else
    return xn
```

First try.
try(9.0, 5.0)

Try a different starting point.
try(9.0, 8.0)

▼Value(s) for xnp1

3.4
3.02352941176
3.00009155413
3.0000000014

15 INCREMENTAL SCRIPT DEVELOPMENT

Script execution and script writing can be mixed using the I3 gui, without saving intermediate values to files or incurring a time penalty for rerunning all scripts.

A program that ran successfully may reveal the need for more information. Instead of writing a new script replicating many of the same iterations and data references, the new relevant expressions can be added to the existing program, and the resulting program run. In the rerun, only the additions are executed.

Note on make(1) This is similar to the behavior of make(1), in which targets are only updated when their dependencies require it. Unlike make(1),

- there is only one “target”, the successful execution of the program;
- there is no search for prerequisites; variables must be bound before use.
- scripts can be nested, and additions can be made inside loops or functions.

16 ERRORS

Errors in scripts return control to the user for correction, with the faulty expression highlighted in orange. The expression can be replaced with a correct one, and the program run again.

Execution resumes from the fixed expression; previously run code and values produced by it are reused.

Example 11 *Fixing a run-time error inside a program*

This script has a small typo in a branch executed late in the script’s execution.

```
inline('from time import sleep')
for work in range(0, 4):
    # A long-running command...
    sleep(1.01)
    print "%d%% done" % (100.0 * work / (4-1))
    if (work == 2):
        # ... with a small error in later execution
        worj
```

Running this script takes about 3 seconds and results in the console output

```
0% done
33% done
66% done
Traceback (most recent call last):
...
...
l3lang.ast.UnboundSymbol: 'No binding found for: worj'
```

and the following display:

▼A. Program

```
inline('from time import sleep')
for work in range(0, 4)
    A long-running command...
    sleep(1.01)
    print "%d%% done" % (100.0 * work / (4-1))
    If (work == 2)
        ... with a small error in later execution
        worj
    else
```

*Fixing the error (double-click button-1 on worj and change it to work) and running again takes only the remaining second and produces **only** the output*

100% done

indicating that prior parts have not been re-run.

17 FILES

\$HOME/.l3lang/l3rc, ./l3rc

18 ENVIRONMENT VARIABLES

L3HOME Directory containing l3lang/ and l3gui/

EDITOR The executable name of the external editor to use.

19 BUGS

Many annoyances; this is version 0.3.1 after all.

This manual page contains examples.

20 SEE ALSO

l3lang(1), l3gui(1)

21 AUTHOR

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22 COPYING

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