

GNU ed

The GNU line editor
for GNU ed version 1.2, 31 January 2009

by Andrew L. Moore and Antonio Diaz Diaz

Copyright © 1993, 2006, 2007, 2008, 2009 Free Software Foundation, Inc.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.3 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.

Table of Contents

1	Overview	2
2	Introduction to Line Editing.....	3
3	Invoking Ed	7
4	Line Addressing.....	8
5	Regular Expressions.....	10
6	Commands	12
7	Limitations.....	16
8	Diagnostics.....	17
9	GNU Free Documentation License.....	18

Copyright © 1993, 2006, 2007, 2008, 2009 Free Software Foundation, Inc.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.3 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.

1 Overview

ed is a line-oriented text editor. It is used to create, display, modify and otherwise manipulate text files. **red** is a restricted **ed**: it can only edit files in the current directory and cannot execute shell commands.

If invoked with a *file* argument, then a copy of *file* is read into the editor's buffer. Changes are made to this copy and not directly to *file* itself. Upon quitting **ed**, any changes not explicitly saved with a **w** command are lost.

Editing is done in two distinct modes: *command* and *input*. When first invoked, **ed** is in command mode. In this mode commands are read from the standard input and executed to manipulate the contents of the editor buffer. A typical command might look like:

```
,s/old/new/g
```

which replaces all occurrences of the string *old* with *new*.

When an input command, such as **a** (append), **i** (insert) or **c** (change), is given, **ed** enters input mode. This is the primary means of adding text to a file. In this mode, no commands are available; instead, the standard input is written directly to the editor buffer. A *line* consists of the text up to and including a `\n` character. Input mode is terminated by entering a single period (.) on a line.

All **ed** commands operate on whole lines or ranges of lines; e.g., the **d** command deletes lines; the **m** command moves lines, and so on. It is possible to modify only a portion of a line by means of replacement, as in the example above. However even here, the **s** command is applied to whole lines at a time.

In general, **ed** commands consist of zero or more line addresses, followed by a single character command and possibly additional parameters; i.e., commands have the structure:

```
[address [,address]] command [parameters]
```

The *addresses* indicate the line or range of lines to be affected by the command. If fewer addresses are given than the command accepts, then default addresses are supplied.

2 Introduction to Line Editing

`ed` was created, along with the Unix operating system, by Ken Thompson and Dennis Ritchie. It is the refinement of its more complex, programmable predecessor, *QED*, to which Thompson and Ritchie had already added pattern matching capabilities (see [Chapter 5 \[Regular Expressions\]](#), page 10).

For the purposes of this tutorial, a working knowledge of the Unix shell `sh` (see [section “Bash” in *The GNU Bash Reference Manual*](#)) and the Unix file system is recommended, since `ed` is designed to interact closely with them.

The principal difference between line editors and display editors is that display editors provide instant feedback to user commands, whereas line editors require sometimes lengthy input before any effects are seen. The advantage of instant feedback, of course, is that if a mistake is made, it can be corrected immediately, before more damage is done. Editing in `ed` requires more strategy and forethought; but if you are up to the task, it can be quite efficient.

Much of the `ed` command syntax is shared with other Unix utilities.

As with the shell, `RETURN` (the carriage-return key) enters a line of input. So when we speak of “entering” a command or some text in `ed`, `RETURN` is implied at the end of each line. Prior to typing `RETURN`, corrections to the line may be made by typing either `BACKSPACE` (sometimes labeled `DELETE` or `DEL`) to erase characters backwards, or `CONTROL-u` (i.e., hold the `CONTROL` key and type `u`) to erase the whole line.

When `ed` first opens, it expects to be told what to do but doesn’t prompt us like the shell. So let’s begin by telling `ed` to do so with the `P` (*prompt*) command:

```
$ ed
P
*
```

By default, `ed` uses asterisk (`*`) as command prompt to avoid confusion with the shell command prompt (`$`).

We can run Unix shell (`sh`) commands from inside `ed` by prefixing them with `!` (exclamation mark, aka “bang”). For example:

```
*!date
Mon Jun 26 10:08:41 PDT 2006
!
*!for s in hello world; do echo $s; done
hello
world
!
*
```

So far, this is no different from running commands in the Unix shell. But let’s say we want to edit the output of a command, or save it to a file. First we must capture the command output to a temporary location called a *buffer* where `ed` can access it. This is done with `ed`’s `r` command (mnemonic: *read*):

```
*r !cal
143
```

*

Here `ed` is telling us that it has just read 143 characters into the editor buffer - i.e., the output of the `cal` command, which prints a simple ASCII calendar. To display the buffer contents we issue the `(p)` (*print*) command (not to be confused with the prompt command, which is uppercase!). To indicate the range of lines in the buffer that should be printed, we prefix the command with `(,)` (comma) which is shorthand for “the whole buffer”:

```
* ,p
      September 2006
Mo Tu We Th Fr Sa Su
                1  2  3
  4  5  6  7  8  9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30
```

*

Now let’s write the buffer contents to a file named `junk` with the `(w)` (*write*) command. Again, we use the `(,)` prefix to indicate that it’s the whole buffer we want:

```
* ,w junk
143
*
```

Need we say? It’s good practice to frequently write the buffer contents, since unwritten changes to the buffer will be lost when we exit `ed`.

The sample sessions below illustrate some basic concepts of line editing with `ed`. We begin by creating a file, ‘`sonnet`’, with some help from Shakespeare. As with the shell, all input to `ed` must be followed by a `(newline)` character. Comments begin with a ‘`#`’.

```
$ ed
# The ‘a’ command is for appending text to the editor buffer.
a
No more be grieved at that which thou hast done.
Roses have thorns, and filvers fountains mud.
Clouds and eclipses stain both moon and sun,
And loathsome canker lives in sweetest bud.
.
# Entering a single period on a line returns ed to command mode.
# Now write the buffer to the file ‘sonnet’ and quit:
w sonnet
183
# ed reports the number of characters written.
q
$ ls -l
total 2
-rw-rw-r--  1 alm          183 Nov 10 01:16 sonnet
$
```

In the next example, some typos are corrected in the file ‘`sonnet`’.

```

$ ed sonnet
183
# Begin by printing the buffer to the terminal with the 'p' command.
# The ',' means 'all lines.'
,p
No more be grieved at that which thou hast done.
Roses have thorns, and filvers fountains mud.
Clouds and eclipses stain both moon and sun,
And loathsome canker lives in sweetest bud.
# Select line 2 for editing.
2
Roses have thorns, and filvers fountains mud.
# Use the substitute command, 's', to replace 'filvers' with 'silver',
# and print the result.
s/filvers/silver/p
Roses have thorns, and silver fountains mud.
# And correct the spelling of 'fountains'.
s/utia/untai/p
Roses have thorns, and silver fountains mud.
w sonnet
183
q
$

```

Since `ed` is line-oriented, we have to tell it which line, or range of lines we want to edit. In the above example, we do this by specifying the line's number, or sequence in the buffer. Alternatively, we could have specified a unique string in the line, e.g., `/filvers/`, where the `/`'s delimit the string in question. Subsequent commands affect only the selected line, a.k.a. the *current* line. Portions of that line are then replaced with the substitute command, whose syntax is `'s/old/new/`.

Although `ed` accepts only one command per line, the print command `'p'` is an exception, and may be appended to the end of most commands.

In the next example, a title is added to our sonnet.

```

$ ed sonnet
183
a
  Sonnet #50
.
,p
No more be grieved at that which thou hast done.
Roses have thorns, and silver fountains mud.
Clouds and eclipses stain both moon and sun,
And loathsome canker lives in sweetest bud.
  Sonnet #50
# The title got appended to the end; we should have used '0a'
# to append 'before the first line.'
# Move the title to its proper place.

```



```
5mOp
  Sonnet #50
# The title is now the first line, and the current line has been
# set to this line as well.
,P
  Sonnet #50
No more be grieved at that which thou hast done.
Roses have thorns, and silver fountains mud.
Clouds and eclipses stain both moon and sun,
And loathsome canker lives in sweetest bud.
wq sonnet
195
$
```

When `ed` opens a file, the current line is initially set to the last line of that file. Similarly, the move command `'m'` sets the current line to the last line moved.

In summary:

Structurally, Related programs or routines are `vi` (1), `sed` (1), `regex` (3), `sh` (1). Relevant documents are:

Unix User's Manual Supplementary Documents: 12 — 13

B. W. Kernighan and P. J. Plauger: "Software Tools in Pascal", Addison-Wesley, 1981.

3 Invoking Ed

The format for running `ed` is:

```
ed [options] [file]
red [options] [file]
```

file specifies the name of a file to read. If *file* is prefixed with a bang (!), then it is interpreted as a shell command. In this case, what is read is the standard output of *file* executed via `sh (1)`. To read a file whose name begins with a bang, prefix the name with a backslash (\). The default filename is set to *file* only if it is not prefixed with a bang.

`ed` supports the following options:

```
--help
-h          Print an informative help message describing the options and exit.

--version
-V          Print the version number of ed on the standard output and exit.

--loose-exit-status
-l          Do not exit with bad status if a command happens to "fail" (for example if a
            substitution command finds nothing to replace). This can be useful when ed is
            invoked as the editor for crontab.

--prompt=string
-p string   Specifies a command prompt. This may be toggled on and off with the 'P'
            command.

--quiet
--silent
-s          Suppresses diagnostics. This should be used if ed's standard input is from a
            script.

--traditional
-G          Forces backwards compatibility. This affects the behavior of the ed commands
            'G', 'V', 'f', 'l', 'm', 't' and '!!'. If the default behavior of these commands does
            not seem familiar, then try invoking ed with this switch.

--verbose
-v          Verbose mode. This may be toggled on and off with the 'H' command.
```

4 Line Addressing

An address represents the number of a line in the buffer. `ed` maintains a *current address* which is typically supplied to commands as the default address when none is specified. When a file is first read, the current address is set to the last line of the file. In general, the current address is set to the last line affected by a command.

A line address is constructed from one of the bases in the list below, optionally followed by a numeric offset. The offset may include any combination of digits, operators (i.e., ‘+’ and ‘-’) and whitespace. Addresses are read from left to right, and their values may be absolute or relative to the current address.

One exception to the rule that addresses represent line numbers is the address ‘0’ (zero). This means “before the first line,” and is valid wherever it makes sense.

An address range is two addresses separated either by a comma or semicolon. The value of the first address in a range cannot exceed the value of the second. If only one address is given in a range, then the second address is set to the given address. If an n -tuple of addresses is given where $n > 2$, then the corresponding range is determined by the last two addresses in the n -tuple. If only one address is expected, then the last address is used.

Each address in a comma-delimited range is interpreted relative to the current address. In a semicolon-delimited range, the first address is used to set the current address, and the second address is interpreted relative to the first.

The following address symbols are recognized.

.	The current line (address) in the buffer.
\$	The last line in the buffer.
n	The n th, line in the buffer where n is a number in the range ‘0,\$’.
+	The next line. This is equivalent to ‘+1’ and may be repeated with cumulative effect.
-	The previous line. This is equivalent to ‘-1’ and may be repeated with cumulative effect.
$+n$	
<code>whitespace n</code>	The n th next line, where n is a non-negative number. Whitespace followed by a number n is interpreted as ‘+ n ’.
$-n$	The n th previous line, where n is a non-negative number.
,	The first through last lines in the buffer. This is equivalent to the address range ‘1,\$’.
;	The current through last lines in the buffer. This is equivalent to the address range ‘.,\$’.
<code>/re/</code>	The next line containing the regular expression <i>re</i> . The search wraps to the beginning of the buffer and continues down to the current line, if necessary. ‘//’ repeats the last search.

- `?re?` The previous line containing the regular expression `re`. The search wraps to the end of the buffer and continues up to the current line, if necessary. `'??'` repeats the last search.
- `'x` The apostrophe-`x` character pair addresses the line previously marked by a `'k'` (mark) command, where `'x'` is a lower case letter from the portable character set.

5 Regular Expressions

Regular expressions are patterns used in selecting text. For example, the `ed` command

```
g/string/
```

prints all lines containing *string*. Regular expressions are also used by the `'s'` command for selecting old text to be replaced with new text.

In addition to specifying string literals, regular expressions can represent classes of strings. Strings thus represented are said to be matched by the corresponding regular expression. If it is possible for a regular expression to match several strings in a line, then the left-most longest match is the one selected.

The following symbols are used in constructing regular expressions:

- `c` Any character *c* not listed below, including '{', '}', '(', ')', '<' and '>', matches itself.
- `\c` Any backslash-escaped character *c*, other than '{', '}', '(', ')', '<', '>', 'b', 'B', 'w', 'W', '+' and '?', matches itself.
- `.` Matches any single character.

[*char-class*]

Matches any single character in *char-class*. To include a ']' in *char-class*, it must be the first character. A range of characters may be specified by separating the end characters of the range with a '-', e.g., 'a-z' specifies the lower case characters. The following literal expressions can also be used in *char-class* to specify sets of characters:

```
[:alnum:] [:cntrl:] [:lower:] [:space:]
[:alpha:] [:digit:] [:print:] [:upper:]
[:blank:] [:graph:] [:punct:] [:xdigit:]
```

If '-' appears as the first or last character of *char-class*, then it matches itself. All other characters in *char-class* match themselves.

Patterns in *char-class* of the form:

```
[.col-elm.]
[=col-elm=]
```

where *col-elm* is a *collating element* are interpreted according to `locale (5)`. See `regex (3)` for an explanation of these constructs.

[*^char-class*]

Matches any single character, other than newline, not in *char-class*. *char-class* is defined as above.

- `^` If '^' is the first character of a regular expression, then it anchors the regular expression to the beginning of a line. Otherwise, it matches itself.
- `$` If '\$' is the last character of a regular expression, it anchors the regular expression to the end of a line. Otherwise, it matches itself.
- `\(re\)` Defines a (possibly null) subexpression *re*. Subexpressions may be nested. A subsequent backreference of the form '\n', where *n* is a number in the range

[1,9], expands to the text matched by the n th subexpression. For example, the regular expression `\(a.c\)1` matches the string `abcabc`, but not `abcadc`. Subexpressions are ordered relative to their left delimiter.

***** Matches the single character regular expression or subexpression immediately preceding it zero or more times. If `*` is the first character of a regular expression or subexpression, then it matches itself. The `*` operator sometimes yields unexpected results. For example, the regular expression `b*` matches the beginning of the string `abbb`, as opposed to the substring `bbb`, since a null match is the only left-most match.

`\{n,m\}`

`\{n,\}`

`\{n\}`

Matches the single character regular expression or subexpression immediately preceding it at least n and at most m times. If m is omitted, then it matches at least n times. If the comma is also omitted, then it matches exactly n times. If any of these forms occurs first in a regular expression or subexpression, then it is interpreted literally (i.e., the regular expression `\{2\}` matches the string `{2}`, and so on).

`\<`

`\>`

Anchors the single character regular expression or subexpression immediately following it to the beginning (in the case of `\<`) or ending (in the case of `\>`) of a word, i.e., in ASCII, a maximal string of alphanumeric characters, including the underscore (`_`).

The following extended operators are preceded by a backslash `\` to distinguish them from traditional `ed` syntax.

`\‘`

`\’`

Unconditionally matches the beginning `\‘` or ending `\’` of a line.

`\?`

Optionally matches the single character regular expression or subexpression immediately preceding it. For example, the regular expression `a[bd]\?c` matches the strings `abc`, `adc` and `ac`. If `\?` occurs at the beginning of a regular expressions or subexpression, then it matches a literal `?`.

`\+`

Matches the single character regular expression or subexpression immediately preceding it one or more times. So the regular expression `a+` is shorthand for `aa*`. If `\+` occurs at the beginning of a regular expression or subexpression, then it matches a literal `+`.

`\b`

Matches the beginning or ending (null string) of a word. Thus the regular expression `\bhello\b` is equivalent to `\<hello\>`. However, `\b\b` is a valid regular expression whereas `\<\>` is not.

`\B`

Matches (a null string) inside a word.

`\w`

Matches any character in a word.

`\W`

Matches any character not in a word.

6 Commands

All **ed** commands are single characters, though some require additional parameters. If a command's parameters extend over several lines, then each line except for the last must be terminated with a backslash ('\').

In general, at most one command is allowed per line. However, most commands accept a print suffix, which is any of 'p' (print), 'l' (list), or 'n' (enumerate), to print the last line affected by the command.

An interrupt (typically Control-C) has the effect of aborting the current command and returning the editor to command mode.

ed recognizes the following commands. The commands are shown together with the default address or address range supplied if none is specified (in parenthesis).

- (.)a Appends text to the buffer after the addressed line, which may be the address '0' (zero). Text is entered in input mode. The current address is set to last line entered.
- (.,.)c Changes lines in the buffer. The addressed lines are deleted from the buffer, and text is appended in their place. Text is entered in input mode. The current address is set to last line entered.
- (.,.)d Deletes the addressed lines from the buffer. If there is a line after the deleted range, then the current address is set to this line. Otherwise the current address is set to the line before the deleted range.
- e *file* Edits *file*, and sets the default filename. If *file* is not specified, then the default filename is used. Any lines in the buffer are deleted before the new file is read. The current address is set to the last line read.
- e !*command* Edits the standard output of '!*command*', (see the '!' command below). The default filename is unchanged. Any lines in the buffer are deleted before the output of *command* is read. The current address is set to the last line read.
- E *file* Edits *file* unconditionally. This is similar to the 'e' command, except that unwritten changes are discarded without warning. The current address is set to the last line read.
- f *file* Sets the default filename to *file*. If *file* is not specified, then the default un-escaped filename is printed.
- (1,\$)g /*re/command-list* Global command. Applies *command-list* to each of the addressed lines matching a regular expression *re*. The current address is set to the line currently matched before *command-list* is executed. At the end of the 'g' command, the current address is set to the last line affected by *command-list*.

At least the first command of *command-list* must appear on the same line as the 'g' command. All lines of a multi-line *command-list* except the last line must be terminated with a backslash ('\'). Any commands are allowed, except for 'g', 'G', 'v', and 'V'. By default, a newline alone in *command-list* is equivalent

to a ‘p’ command. If `ed` is invoked with the command-line option ‘-G’, then a newline in *command-list* is equivalent to a ‘.+1p’ command.

(1,\$)G /re/

Interactive global command. Interactively edits the addressed lines matching a regular expression *re*. For each matching line, the line is printed, the current address is set, and the user is prompted to enter a *command-list*. At the end of the ‘G’ command, the current address is set to the last line affected by (the last) *command-list*.

The format of *command-list* is the same as that of the ‘g’ command. A new-line alone acts as a null command list. A single ‘&’ repeats the last non-null command list.

H Toggles the printing of error explanations. By default, explanations are not printed. It is recommended that `ed` scripts begin with this command to aid in debugging.

h Prints an explanation of the last error.

(.)i Inserts text in the buffer before the current line. The address ‘0’ (zero) is valid for this command; it is equivalent to address ‘1’. Text is entered in input mode. The current address is set to the last line entered.

(.,.+1)j Joins the addressed lines. The addressed lines are deleted from the buffer and replaced by a single line containing their joined text. The current address is set to the resultant line.

(.)kx Marks a line with a lower case letter ‘x’. The line can then be addressed as ‘x’ (i.e., a single quote followed by ‘x’) in subsequent commands. The mark is not cleared until the line is deleted or otherwise modified.

(.,.)l Prints the addressed lines unambiguously. The end of each line is marked with a ‘\$’, and every ‘\$’ character within the text is printed with a preceding backslash. The current address is set to the last line printed.

(.,.)m(.) Moves lines in the buffer. The addressed lines are moved to after the right-hand destination address, which may be the address ‘0’ (zero). The current address is set to the last line moved.

(.,.)n Prints the addressed lines, preceding each line by its line number and a `\tab`. The current address is set to the last line printed.

(.,.)p Prints the addressed lines. The current address is set to the last line printed.

P Toggles the command prompt on and off. Unless a prompt is specified with command-line option ‘-p’, the command prompt is by default turned off.

q Quits `ed`.

Q Quits `ed` unconditionally. This is similar to the `q` command, except that unwritten changes are discarded without warning.

(\$)*r file*

Reads *file* to after the addressed line. If *file* is not specified, then the default filename is used. If there is no default filename prior to the command, then the default filename is set to *file*. Otherwise, the default filename is unchanged. The current address is set to the last line read.

(\$)*r !command*

Reads to after the addressed line the standard output of '*!command*', (see the '*!*' command below). The default filename is unchanged. The current address is set to the last line read.

(.,.)*s /re/replacement/*

(.,.)*s /re/replacement/g*

(.,.)*s /re/replacement/n*

Replaces text in the addressed lines matching a regular expression *re* with *replacement*. By default, only the first match in each line is replaced. If the '*g*' (global) suffix is given, then every match is replaced. The *n* suffix, where *n* is a positive number, causes only the *n*th match to be replaced. It is an error if no substitutions are performed on any of the addressed lines. The current address is set the last line affected.

re and *replacement* may be delimited by any character other than space and newline (see the '*s*' command below). If one or two of the last delimiters is omitted, then the last line affected is printed as if the print suffix '*p*' were specified.

An unescaped '*&*' in *replacement* is replaced by the currently matched text. The character sequence '*\m*' where *m* is a number in the range [1,9], is replaced by the *m*th backreference expression of the matched text. If *replacement* consists of a single '*%*', then *replacement* from the last substitution is used. Newlines may be embedded in *replacement* if they are escaped with a backslash ('**').

(.,.)*s* Repeats the last substitution. This form of the '*s*' command accepts a count suffix *n*, or any combination of the characters '*r*', '*g*', and '*p*'. If a count suffix *n* is given, then only the *n*th match is replaced. The '*r*' suffix causes the regular expression of the last search to be used instead of the that of the last substitution. The '*g*' suffix toggles the global suffix of the last substitution. The '*p*' suffix toggles the print suffix of the last substitution. The current address is set to the last line affected.

(.,.)*t*(.)

Copies (i.e., transfers) the addressed lines to after the right-hand destination address, which may be the address '*0*' (zero). The current address is set to the last line copied.

u Undoes the last command and restores the current address to what it was before the command. The global commands '*g*', '*G*', '*v*', and '*V*' are treated as a single command by undo. '*u*' is its own inverse.

(1,\$)*v /re/command-list*

This is similar to the '*g*' command except that it applies *command-list* to each of the addressed lines not matching the regular expression *re*.

`(1,$)V /re/`

This is similar to the ‘G’ command except that it interactively edits the addressed lines not matching the regular expression *re*.

`(1,$)w file`

Writes the addressed lines to *file*. Any previous contents of *file* is lost without warning. If there is no default filename, then the default filename is set to *file*, otherwise it is unchanged. If no filename is specified, then the default filename is used. The current address is unchanged.

`(1,$)w !command`

Writes the addressed lines to the standard input of ‘!command’, (see the ‘!’ command below). The default filename and current address are unchanged.

`(1,$)wq file`

Writes the addressed lines to *file*, and then executes a ‘q’ command.

`(1,$)W file`

Appends the addressed lines to the end of *file*. This is similar to the ‘w’ command, expect that the previous contents of file is not clobbered. The current address is unchanged.

`(.)x`

Copies (puts) the contents of the cut buffer to after the addressed line. The current address is set to the last line copied.

`(.,.)y`

Copies (yanks) the addressed lines to the cut buffer. The cut buffer is overwritten by subsequent ‘y’, ‘s’, ‘j’, ‘d’, or ‘c’ commands. The current address is unchanged.

`(.+1)z n`

Scrolls *n* lines at a time starting at addressed line. If *n* is not specified, then the current window size is used. The current address is set to the last line printed.

`!command`

Executes *command* via `sh (1)`. If the first character of *command* is ‘!’, then it is replaced by text of the previous ‘!command’. `ed` does not process *command* for backslash (‘\’) escapes. However, an unescaped ‘%’ is replaced by the default filename. When the shell returns from execution, a ‘!’ is printed to the standard output. The current line is unchanged.

`(.,.)#`

Begins a comment; the rest of the line, up to a newline, is ignored. If a line address followed by a semicolon is given, then the current address is set to that address. Otherwise, the current address is unchanged.

`($)=`

Prints the line number of the addressed line.

`(.+1)⏎`

An address alone prints the addressed line. A `⏎` alone is equivalent to ‘+1p’. the current address is set to the address of the printed line.

7 Limitations

If the terminal hangs up, **ed** attempts to write the buffer to file ‘**ed.hup**’.

ed processes *file* arguments for backslash escapes, i.e., in a filename, any characters preceded by a backslash (‘\’) are interpreted literally.

If a text (non-binary) file is not terminated by a newline character, then **ed** appends one on reading/writing it. In the case of a binary file, **ed** does not append a newline on reading/writing.

Per line overhead: 4 **ints**.

8 Diagnostics

When an error occurs, if `ed`'s input is from a regular file or here document, then it exits, otherwise it prints a `'?'` and returns to command mode. An explanation of the last error can be printed with the `'h'` (help) command.

If the `'u'` (undo) command occurs in a global command list, then the command list is executed only once.

Attempting to quit `ed` or edit another file before writing a modified buffer results in an error. If the command is entered a second time, it succeeds, but any changes to the buffer are lost.

`ed` exits with 0 if no errors occurred; otherwise >0 .

9 GNU Free Documentation License

Version 1.3, 3 November 2008

Copyright © 2000, 2001, 2002, 2007, 2008 Free Software Foundation, Inc.

<http://fsf.org/>

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document *free* in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or non-commercially. Secondly, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of “copyleft”, which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The “Document”, below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as “you”. You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A “Modified Version” of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A “Secondary Section” is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document’s overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The “Invariant Sections” are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released

under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The “Cover Texts” are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A “Transparent” copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not “Transparent” is called “Opaque”.

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The “Title Page” means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, “Title Page” means the text near the most prominent appearance of the work’s title, preceding the beginning of the body of the text.

The “publisher” means any person or entity that distributes copies of the Document to the public.

A section “Entitled XYZ” means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as “Acknowledgements”, “Dedications”, “Endorsements”, or “History”.) To “Preserve the Title” of such a section when you modify the Document means that it remains a section “Entitled XYZ” according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any,

- be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.
 - C. State on the Title page the name of the publisher of the Modified Version, as the publisher.
 - D. Preserve all the copyright notices of the Document.
 - E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
 - F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
 - G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
 - H. Include an unaltered copy of this License.
 - I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
 - J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
 - K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.
 - L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
 - M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.
 - N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.
 - O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their

titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements."

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an “aggregate” if the copyright resulting from the compilation is not used to limit the legal rights of the compilation’s users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document’s Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled “Acknowledgements”, “Dedications”, or “History”, the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, or distribute it is void, and will automatically terminate your rights under this License.

However, if you cease all violation of this License, then your license from a particular copyright holder is reinstated (a) provisionally, unless and until the copyright holder explicitly and finally terminates your license, and (b) permanently, if the copyright holder fails to notify you of the violation by some reasonable means prior to 60 days after the cessation.

Moreover, your license from a particular copyright holder is reinstated permanently if the copyright holder notifies you of the violation by some reasonable means, this is the first time you have received notice of violation of this License (for any work) from that copyright holder, and you cure the violation prior to 30 days after your receipt of the notice.

Termination of your rights under this section does not terminate the licenses of parties who have received copies or rights from you under this License. If your rights have been terminated and not permanently reinstated, receipt of a copy of some or all of the same material does not give you any rights to use it.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <http://www.gnu.org/copyleft/>.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License “or any later version” applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation. If the Document specifies that a proxy can decide which future versions of this License can be used, that proxy’s public statement of acceptance of a version permanently authorizes you to choose that version for the Document.

11. RELICENSING

“Massive Multiauthor Collaboration Site” (or “MMC Site”) means any World Wide Web server that publishes copyrightable works and also provides prominent facilities for anybody to edit those works. A public wiki that anybody can edit is an example of such a server. A “Massive Multiauthor Collaboration” (or “MMC”) contained in the site means any set of copyrightable works thus published on the MMC site.

“CC-BY-SA” means the Creative Commons Attribution-Share Alike 3.0 license published by Creative Commons Corporation, a not-for-profit corporation with a principal place of business in San Francisco, California, as well as future copyleft versions of that license published by that same organization.

“Incorporate” means to publish or republish a Document, in whole or in part, as part of another Document.

An MMC is “eligible for relicensing” if it is licensed under this License, and if all works that were first published under this License somewhere other than this MMC, and subsequently incorporated in whole or in part into the MMC, (1) had no cover texts or invariant sections, and (2) were thus incorporated prior to November 1, 2008.

The operator of an MMC Site may republish an MMC contained in the site under CC-BY-SA on the same site at any time before August 1, 2009, provided the MMC is eligible for relicensing.

ADDENDUM: How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

```
Copyright (C)  year  your name.
Permission is granted to copy, distribute and/or modify this document
under the terms of the GNU Free Documentation License, Version 1.3
or any later version published by the Free Software Foundation;
with no Invariant Sections, no Front-Cover Texts, and no Back-Cover
Texts. A copy of the license is included in the section entitled ‘‘GNU
Free Documentation License’’.
```

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the “with...Texts.” line with this:

```
with the Invariant Sections being list their titles, with
the Front-Cover Texts being list, and with the Back-Cover Texts
being list.
```

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.